Centre of Planning and Economic Research

ESSAYS in ECONOMICS

Applied Studies on the Greek Economy

50 years anniversary publication

Editors:
Stella Balfoussias
Panos Hatzipanayotou
Costas Kanellopoulos

Athens 2011

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CENTRE OF PLANNING AND ECONOMIC RESEARCH

The Centre of Planning and Economic Research (KEPE) was originally established as a research unit in 1959, with the title "Centre of Economic Research". Its primary aims were the scientific study of the problems of the Greek economy, the encouragement of economic research and cooperation with other scientific institutions.

In 1964, the Centre acquired its present name and organizational structure, with the following additional objectives: first, the preparation of short, medium and long-term development plans, including plans for local and regional development as well as public investment plans, in accordance with guidelines laid down by the Government; secondly, analysis of current developments in the Greek economy along with appropriate short and medium-term forecasts, the formulation of proposals for stabilization and development policies; and thirdly, the education of young economists, particularly in the fields of planning and economic development.

Today, KEPE focuses on applied research projects concerning the Greek economy and provides technical advice to the Greek Government on economic and social policy issues.

In the context of these activities, KEPE has produced more than 650 publications since its inception. There are three series of publications, namely:

Studies. *These are research monographs.*

Reports. *These are synthetic works with sectoral, regional and national dimensions.*

Discussion Papers. *These relate to ongoing research projects.*

KEPE also publishes a tri-annual journal, **Greek Economic Outlook**, *which focuses on issues of current economic interest for Greece.*

The Centre is in continuous contact with foreign scientific institutions of a similar nature by exchanging publications, views and information on current economic topics and methods of economic research, thus furthering the advancement of economics in the country.

FOREWORD

The founding of the Centre of Planning and Economic Research (KEPE) fifty years ago marked the beginning of systematic analysis of the Greek economy and had a profound effect on economic research and policy formation in Greece. The Board of Directors decided to honour the fiftieth anniversary of KEPE with the publication of a volume, containing scholarly contributions by current and past researchers and associates of KEPE. A conference was held at KEPE in February 2010, where original applied research papers were presented, and following a peer review process, they are included as contributions to the volume at hand.

The contributions to this volume examine the evolution and prospects of macroeconomic imbalances of the Greek economy, as well as the effects of structural, institutional and market features upon economic performance. While many papers deal with endemic problems of the Greek economy, there are also papers dealing with the current Greek economic crisis that began in 2008 and escalated in 2010 mainly as a debt crisis.

It is hoped that the documented and systematic examination of many structural and current problems of the Greek economy, will contribute to the debate about overcoming the crisis and fostering economic growth.

Professor PANAGIOTIS G. KORLIRAS
Chairman of the Board and Scientific Director

February 2011

CONTENTS

PART III: SECTORAL STUDIES

PART IV: INSTITUTIONS AND ECONOMIC PERFORMANCE

INTRODUCTION

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The studies included in this Honorary Volume have been grouped into four analytically distinguishable, broad areas of economic research according to their subject and content. Following our initial idea of presenting applied research on important aspects of the Greek economy, the first part contains studies on macroeconomics and fiscal policy, the second deals with labour markets and earnings distribution, the third contains sectoral studies, while the fourth part includes papers on the role of institutions in economic performance. This introduction offers a brief presentation of the papers—focusing on research hypothesis, methodology and main results.

At this point, we wish to thank the authors for responding to the initial call, and for providing informed examination of their topics; we also thank the referees for their valuable contributions to this volume. Compiling this book—with many papers coming from a large number of authors—has required a lot of organizational work, management of the manuscripts and language and production editing. We appreciate the efforts of everyone involved in the completion of this volume and we hope that its readers will, too.

PART I: Issues in Macroeconomics and Fiscal Policy

This part consists of seven studies examining general macroeconomic issues of the Greek economy as such, and also of the Greek economy compared with other eurozone economies. The issues raised in this section range from studying the evolution of output growth and domestic demand and household consumption and borrowing activity; the role and the efficacy of fiscal policy in growth and economic cycles in Greece; the relationship between savings-investment and the role of current account deficits in financing investment activity through expanded international capital flows; the driving factors of yield differences of EMU country-members' government bonds with similar characteristics, focusing on the yield differences between Greek-German 10-year fixed rate euro-denominated government bonds during the recent global financial and economic crisis. Finally, two related studies provide elaborate study of business cycles: one examines the chronology of the different turning points in general Greek economic activity, the other offers a comprehensive comparative examination of medium and long-term relationships between cycles for the majority of countries in the euro area.

Stella Balfoussias, in her study *Potential Output Growth in Greece*, develops a supply-side model of the Greek economy in order to generate estimates of potential output growth and of the output gap in Greece conditional upon alternative functional specifications of the production functions— e.g., Cobb-Douglas and CES—and of parameterizations of production technologies, e.g., capital augmented or neutral technological change. The model is estimated for the period 1980–2008, accounting for prevalent supply side features of the Greek economy—specifically, the evolution of the labour-output and capital-output ratios, factor shares in output and costs, and variability of aggregate mark-up in the economy. The author further examines the question whether the present recession may have a negative impact on potential output and derives indicative scenarios for future developments on the basis of the empirical estimates. The study's main conclusion is that with the current juncture of world economic crisis and growth slowdown, conventional fiscal and monetary policy tools cannot provide the needed rebound of the Greek economy. Rather, the future process of growth and of evolution of potential output can come only through a smooth transition to higher capital stock, better utilization of the labour force, and sustained total factor productivity growth by easing frictions in labour markets and implementing structural policies that increase factor productivity.

Ersi Athanassiou, in her study *Household Borrowing and Domestic Demand*, examines the relationship between growth in household borrowing and domestic demand in Greece and other eurozone countries in recent years (1999–2009). The premise of the study is that fast growth of household debt over a long period produces high gains for domestic demand while it lasts, but inflicts severe losses when it ceases. Specifically for Greece, and on the basis of the above premise, Greece's domestic demand displayed a strong expansionary trend over the period 2000–2007 primarily owing to a very strong expansion of credit to Greek households, resulting in a strong path of GDP growth reaching 4.5% in 2007. Since then —that is, 2008/9—the global financial crisis inflicted a sharp decline in the rate of expansion of household debt, from 30.5% in 2005 to approximately 13% and 3% in 2008 and 2009, respectively. This resulted in a serious weakening of household consumption and substantial decline in the growth of GDP—that is, 2% in 2008 and -2.2% in 2009. In the light of this empirical evidence, the study examines the changed role of household debt from that of a pivotal driver of economic growth to that of a major factor of weakening growth of domestic demand and GDP. The main finding of the study is that for Greece the weakening of domestic demand and output growth may not be as severe as that suffered by other eurozone countries, such as Ireland and Spain (who seemed to bear a high degree of similarity to Greece), or France and Italy who bore fewer similarities to the Greek case. However, in the case of Greece, the minimum rate of credit expansion required for the net injection of household debt to domestic demand to return to positive levels is considerably higher than that of the other eurozone countries. The main reasons for this discrepancy are the considerably higher interest rates on consumer loans, and the relatively higher proportion of these loans to total household debt in Greece compared with other eurozone countries. As a result, the ensuing policy implications in these countries—for both government and the financial-banking sector— differ widely.

Evangelia Kasimati, in her study *The Macroeconomic Relationship between Investment and Saving in Greece*, examines the macroeconomic relationship between investment and savings in Greece. Contesting, both theoretically and empirically, the premise of whether savings are the primary determinant factor of investment is a long-standing issue in macroeconomics for both closed and open economies. In particular, examining the savings-investment nexus in the context of a small open economy and member of the eurozone—like Greece—provides several advantages and draws important policy implications for a variety of reasons. Greece, through its process of integration in EMU, has experienced a significant increase in international capital inflows, and, relative to the past, has thereby enjoyed a higher degree of flexibility in financing its domestic investment through current account deficits. Thus, there shouldn't be a statistically significant relation between domestic investment and domestic savings as, according to the so-called Feldstein-Horioka (1980) puzzle, savings in each country respond to worldwide investment opportunities and investment in each country is financed through a worldwide pool of capital. Given the underlying presence of international capital mobility, the relevant literature argues for a 'de-escalation' of the magnitude of correlation between savings and investment in economies with low trade barriers and a high degree of international capital mobility. Several interesting results surface from the analysis. The 'de-escalation' of the magnitude of correlation between savings and investment appears to be present in the Greek data for the period under examination. Savings is almost half the size of investment throughout the period under examination indicating a persistent and significant deficit in Greece's current account. This empirical observation, on the other hand, raises serious policy considerations regarding the handling of such deficits and the possibility of destabilizing the economy. The analysis also suggests that government policies that encourage savings remain an important factor for boosting investment in the economy, but not the other way round. Other variables—such as the interest rate and profitability—remain of low importance in explaining the variance of savings and investment throughout the period.

Ekaterini Tsouma, in her study *Dating the Greek Business Cycle: Is there Evidence of a Late 2000s Recessionary Regime for the Greek Economy?*, applies various business cycle dating procedures in order to provide a robust reference chronology of the turning points in general Greek economic activity from January 1970 to September 2009. The dates from the interpolated monthly GDP series are considered as the established dates of the Greek business cycle reference chronology for the period under examination. The located switch points identify the mid-1970s recession, the early 1980s 'double' recession, the mid-1980s recession and the early 1990s 'double' recession. In regards to the current economic developments, the data confirm a recessionary period for the Greek overall economic activity in the late 2000s. Specifically, April 2008 is dated as the peak month and, hence, May 2008 presents the first month in the latest recessionary regime ending an expansion phase that lasted 185 months. The absence of any indication of recovery until September 2009 suggests that the Greek economy has not yet exited the contraction. The robustness of the derived reference chronology is enhanced by the confirmation of widely accepted business cycle stylized facts, such as the significant asymmetry characteristic between expansions and recessions. The durations as well as the amplitudes indicate different behaviour during periods of expansion and contraction.

Ioanna Konstantakopoulou and **Efthymios Tsionas**, in their study *New Evidence on Stylized Facts of the Business Cycles in Euro Area Economies*, are driven by the currently standing view of the relevant literature that business cycles are a purely monetary phenomenon. Thus, the eurozone comprised a readily suitable set of countries to study comparatively the evolution of business cycles, in both static and dynamic contexts. Moreover, since in the very recent past several of these countries have been hit hard—and some will be still suffering hard consequences for a long time to come—several important questions arise related to the chronology of their business cycles. For example, how has output fluctuated in these countries over the period in question, and particularly during the recent past of the global economic downturn? Have any countries rebounded or do they show signs of upturn from the current recession? Are the cycles of the eurozone countries interrelated and what are the links between them? Among their findings it is concluded that there are long-run relationships between cycles for the majority of countries in the euro area, with the exception of Italy, Finland and Spain with four lags. Moreover, the German cycle is strongly linked with the Greek and Irish cycles, the Spanish cycle is linked to those of France and Italy, and the Belgian cycle is strongly linked to the Finnish. Austria, Belgium, Germany, France and the Netherlands constitute a core of countries that are closely bound together. Finally there are strong links between specific eurozone countries, e.g., Greece and Germany, France and Spain.

Dimitris Papageorgiou, Apostolis Philippopoulos and **Vanghelis Vassi-**

latos, in their study *A Toolkit for the Study of Fiscal Policy in Greece*, provide a comprehensive study of a longstanding theoretical and macroeconomic policy debate that has puzzled economists and policy makers in Greece—that is, the merits of fiscal expansion versus fiscal consolidation, and the effectiveness of the various fiscal policy instruments on growth and cycles in Greece. The novelty of their study is that it provides quantitative answers to questions such as those above, by using a DSGE model incorporating key stylized facts of the Greek economy, and in particular the inclusion of an active public sector. The model is calibrated to the Greek economy over the period 1960–2005, and despite analytical simplifications (e.g., the absence of imperfect competition in product and factor markets, or the absence of monetary frictions such as price and wage rigidities), it provides very useful insights which at the very least can be viewed as a benchmark understanding of fiscal policy conduct in Greece. Some of the results worth noting are: (i) the current fiscal pattern in Greece proves to be unsustainable in the sense that either cuts in public spending or tax rate increases, relative to their values in the data set, are required in order to ensure a well defined long-run fiscal equilibrium, (ii) a significant portion of macroeconomic volatility in Greece can be attributed to fluctuations in fiscal policy instruments, and (iii) both short and long-term fiscal multipliers in Greece are relatively small, usually less than one, implying that they hardly provide a 'real' multiplier effect.

Nikolaos Georgikopoulos and **Tilemachos Efthimiadis**, in their study *Government Bond Yield Spreads in the EMU: The Case of Greece*, provide an empirical investigation of the medium-term driving factors of the yield differentials (spreads) in government bonds in the EMU, using as a case study the yield differentials between Greek and German long-term government bonds. The motivating factor for this study is, according to the authors, the premise that the creation of the EMU was expected to reduce, even eliminate, the yield differences of member country government bonds of similar characteristics. Thus, utilizing quarterly data for the period 2001–2009 they examine the significance of three primary driving factors of yield differences between 10-year fixed rate euro denominated government bonds. These are, (i) the liquidity of government bonds mostly due to country specific factors associated with the securities issuing process, which they proxy by the overall outstanding volume of sovereign debt, (ii) the credit risks reflecting the market evaluation of the creditworthiness of the borrowing countries, i.e., the possibility of default proxied by a country's (general government) debt-to-GDP ratio, and (iii) two alternative measures of international risk aversion identified in the relevant literatures as factors driving the euro-area government bond yield differences. The main conclusions drawn from this study are: (i) both measures of international risk aversion constitute the most important explanatory factor for the yield differentials between Greek-German government bonds, (ii) the proxy for the liquidity factor is significant for the majority of the models tested, and (iii) the proxy for the credit risk factor, the Greek-German debt-to-GDP spread ratio, is not statistically significant.

PART II: Labour Markets and Earnings Distribution

The second part of this volume consists of eight studies documenting and analysing issues of the Greek labour market referring mainly to the level and structure of employment and wages. The issues raised in this section include the study of the effects of the current economic crisis upon the Greek labour market, the evolution of worker flows between employment, unemployment and inactivity during the period 1998–2009, the documentation and analysis of inter-industry wage differentials using cross sectional data of 2006, the size and dynamics of low pay in the Greek labour market in the 1990s, the decomposition of gender pay gap into that caused by productivity differences and the 'unexplained residual', the identification of the best variable in distributional and poverty studies, the middle term detailed occupational projections by region, and finally the educational achievement of youth of migrant origin—that is, second generation immigrants.

Stavros Zografakis and **Pavlos Spathis**, in their study *The Economic Crisis and the Labour Market*, provide an examination of the effect of the current economic crisis on certain variables of the Greek labour market. In the first part, they identify and model the factors associated with the probability of the employed becoming unemployed during the period 2008:Q1 to 2009:Q2—showing that labour market features, like construction, tourism, manufacturing, as well as personal characteristics, such as mature age, do influence the examined probability. In the second part, using a multi-sectoral general equilibrium model, they investigate the effects of the economic recession on key macroeconomic aggregates depending whether wage flexibility or inflexibility is assumed. While the adjustment of (un)employment turns out lower and wage decline higher under wage flexibility rather than under inflexible labour market wages, in both cases public sector deficit turns out higher, indicating the need for extra measures to reduce it.

Costas Kanellopoulos, in his study *Size and Cyclicality of Worker Flows in Greece*, examines the developments of worker flows between employment, unemployment and inactivity—which helps our understanding of the changes in aggregate stock labour market variables, as well as the business cycle fluctuations. Moreover, the article decomposes the variation of unemployment rate into the contribution of job separation and job finding, using alternative recent methodologies. The analysis, based upon data extracted from the Labour Force Survey, covers the period 1998–2009 on an annual basis (retrospective information on labour market state), and 2004–2009 on a quarterly basis (rotated panel information on transitions between labour market states). The main conclusion is that even though the Greek labour market displays remarkable dynamism, as employment increased substantially during the examined period, its flows are relatively low and substantially lower than those in many other European countries: this is consistent with the inflexible and dual character of the Greek labour market between unemployed and employed statuses. Moreover, these flows remain rather stable during the examined period and turn out to be cyclically countercyclical. Even though unemployment fluctuation is rather limited, alternative decompositions of unemployment flows show that both the job finding rate and job separation rate are important determinants of this fluctuation.

Daphne Nikolitsas, in her study *Evidence on Inter-industry Wage Differentials in Greece*, documents and analyzes the size of raw and conditional (controlling for personal and employer characteristics) inter-industry wage differentials in Greece in 2006, using the Structure of Earnings Survey (SES). While worker and employment characteristics reduce substantially the standard deviation of inter-industry wage differentials, the remaining wage differentials, as in other European countries, turn out to be substantial and with similar pattern to the raw ones, suggesting that other forces might be at play. The paper examines alternative explanations of these conditional inter-industry wage differentials like unobserved ability, working conditions or the potential for rents, using information extracted from other official datasets. A positive association between the size of conditional wage differentials on the one hand, and an industry's rents and an industry's structure on the other is found, supporting the role of ability to pay in inter-industry wage differentials. Furthermore, competitive explanations—such as the risk of accidents at work—also contribute to explaining inter-industry wage differentials. Interestingly, unlike in other applications on this subject, the rank correlation of inter-industry wage differentials across occupations is found to be low; however, according to the author, this doesn't permit the outright rejection of the unobserved ability hypothesis.

Nikolaos Kanellopoulos, in his study *Low Pay Dynamics in the Greek Labour Market*, investigates the development of low pay among Greek men in the 1990s, using data from the Greek side of the European Community Household Panel (ECHP) dataset. While the issue of low pay concerns its determination without damaging productivity or employment, as the author points out, it may also positively affect total employment, providing opportunities to low productivity workers. The paper identifies both the extent and profile of the low paid, defining them as those who earn less than two thirds of hourly median earnings, as well as its determinants by estimating a variety of dynamic random effects probit models of the probability of being low paid. In doing so, he examines whether previous low pay affects current low pay status, i.e. whether there is low pay persistence or genuine state dependence. Moreover, the author pays attention to the treatment of unobserved heterogeneity, as well as the so called initial conditions problem, which arises when the beginning of the examined period does not coincide with the beginning of the stochastic process generating low pay. Both the summary statistics and the estimated models show that the probability of being low paid is considerably higher for those who were low paid a year ago. Furthermore, low paid employees are more likely to exit paid employment than higher paid employees, while those entering paid employment are more likely to end up in low pay, suggesting that there is a low-pay/no-pay cycle in Greece. The estimated models show that ignoring initial conditions tends to overestimate the effect of previous low pay incidence, which varies between 7.2 to 8.4 percentage points, suggesting that there is a scarring effect of low pay. Interestingly when transitions into other labour market states are also included in the analysis, the probability of moving up the wage distribution is higher for those previously low paid than for the unemployed or inactive, which supports the hypothesis that low paid jobs act as a stepping stone to higher paid jobs, suggesting that low pay employment is better than no employment at all.

Maria Albani, Evangelia Papapetrou and **Yannis Stournaras,** in their study *Decomposition of Gender Wage Differentials in Greece using Quantile Regression Analysis: The Impact of Education*, analyze the gender wage gap in Greece using data from the 2005 survey on Income and Living Conditions (EU-SILC). The main features of their approach is the division of the examined sample into low education (secondary education or lower) and high education (post-secondary +) employees, the application of quantile regression, as well as the decomposition of observed wage differential, taking as benchmark the non-discriminatory structure proposed by Oaxaca and Ranson (1994), into 'endowment characteristics', into 'male advantage' and into 'female disadvantage'. Their results (Tables 5 and 6) show that the average gender wage differential is lower for those with high (0.269) than with low education (0.356) employees, while a significant portion of it (0.178 and 0.213 respectively) can be explained by including the productive characteristics of workers in the analysis. While there are differences between the examined quantiles, it turns out that the female disadvantage seems to be a remarkable component of the unexplained part of the wage distribution,raising the issue of potential inefficiencies in the Greek labour market for female workers.

Theodore Mitrakos and **Panos Tsakloglou**, in their article *Analyzing and Comparing the Impact of Alternative Concepts of Resources in Distributional Studies: Greece, 2004/5*, look for a monetary variable that can be used as a reliable welfare indicator and serve effectively for the design and implementation of policies aiming to alleviate poverty or reduce inequality. The problem arises from the potentially inconsistent results obtained when disposable income and/or consumption expenditure are used to measure population welfare. The authors propose the notion of 'permanent income' as a more stable welfare indicator of the population members, which is derived from the information of all available monetary welfare indicators using a latent variable approach. The disadvantages of the normally used disposable income and consumption expenditure, as well as the advantages of permanent income in measuring inequality and poverty, are illustrated using the 2004/5 Greek Family Expenditure Survey. For example, the distribution of permanent income was found to exhibit substantially lower inequality than the distributions of disposable income or consumption expenditure. On the other hand, the structure of inequality, as accounted by all welfare indicators, does not differ substantially across distributions, although in the distribution of the permanent income differences 'between groups' was found to account for a higher proportion of aggregate inequality than in the distributions of disposable income or consumption expenditure. Such findings are likely to have implications for the design of policies aimed to reduce aggregate inequality and, particularly, for the purposes of targeting efficiently the limited resources available for poverty alleviation.

Theodoros Katsanevas and **Ilias Livanos**, in their article *The Balance of Demand and Supply of Professions: A Labour Market Information System for Greece*, deal with the medium term employment projections for various (detailed) occupations at national and regional level. Such reliable projections seem useful for (among others) education and training policy makers, for labour market guidance practitioners and even for individuals choosing their careers. The authors explore possibilities for developing a Labour Market Information System for Greece, which is developed upon the idea of the '*balance of demand and supply of specific professions*' as a tool for occupational predictions. Available information on (un)employment and wages by occupation, on the outflows of the educational system, as well as macroeconomic sectoral projections are taken into account. The results obtained are then combined with primary data on occupational prospects collected through semi-structured interviews carried out by university students with actors within the labour market to produce desired occupational projections. In general, presented results suggest a growing demand for highly skilled mainly technical occupations, while the demand for low skilled ones, with the exception of those related to trade and commerce, is declining.

Jennifer Cavounidis and **Ioannis Cholezas**, in their article *The Educational Outcomes of Youth of Migrant Origin in Greece*, deal with the educational attainment of immigrant children, who mostly have known only Greece as their home country. The educational attainment of migrants is compared to that of native youth aged 15–29, taking into consideration whether they have already completed or are still attending education. The necessary information for the analysis is derived from the Greek Labour Force Surveys for the years 2004–2008 (pooled data) and the results verify the existence of an educational gap between migrant and native youth, similar to the experience of other European countries. Despite controlling for numerous characteristics that seem to have an effect according to gender or ethnic group, native youth have double the chances of having completed or of attending higher education compared to migrants, while women fare better than men in all ethnic groups. What is most worrying, though, is that the largest ethnic group—namely, the Albanians—seems to have the greatest educational deficit. Thus, the authors conclude that efforts must be made to ensure that this educational deficit will not turn into an employability deficit later on, with severe consequences for the lives of youth of migrant origin as well as for Greek society as a whole.

PART III: Sectoral Studies

The third part of this volume consists of five studies examining sectoral issues of the Greek economy. The issues raised in this part include the measurement and evolution of sectoral capital output and capital labour ratios of the Greek economy, the effects of information and communication technology (ICT) in Greek industry, the impact of CAP reforms on the distribution of farm income, the evolution and structure of agricultural employment, and finally the prospects for the biofuel market in Greece and its potentials to meet the EU 10% target of liquid biofuels use for transport in 2020.

Theodoros Skountzos and **Nicolaos Stromplos**, in their study *Sectoral Capital-Output Ratios and Capital Intensity in the Greek Economy*, estimate capital-output and capital-labour ratios for 16 production sectors of the Greek economy, applying the open input-output model. Using the available input-output tables of 2005 and 2000, as well as time series of capital stock by sector, they produce sectoral (total and direct) capital coefficients, which differ substantially among examined sectors and decreased during 2000–2005 for the majority of examined sectors. The authors offer alternative explanations of these changes in combination with the changes in capital intensity.

Sotiris Papaioannou and **Sophia Dimelis**, in their paper *An Empirical Investigation of Direct and Spillover Effects from Information and Communication Technology in Greek Industries*, examine the impact of ICT, as well as their spillovers, on productivity growth in Greek industries. The ICT investment in each industry, proxied as the inflows from the three ICT industries, was very small in 1995 and with sharp increase after 2000, albeit concentrated on a few industries. Applying an extended Cobb-Douglas production function, the authors examine two different time periods—the late 1990s and the period 2001–2008. It turns out that there is a significant increase in the productivity impact of ICT during the period 2001–2008, while it is insignificant during the 1990s. Also the effect of lagged ICT is significantly positive and larger in size than the impact of current ICT investment. On the other hand, the ICT spillover effects appear with negative—though small in size—impact on productivity growth.

Eleni Kaditi and **Elisavet Nitsi**, in their study *The Impact of CAP Reforms on the Distribution of Farm Income*, examine the distributional implications of the successive Common Agricultural Policy (CAP) reforms on farm income in Greece. Using data from the 1998, 2002 and 2006 Farm Accountancy Data Network and applying standard methodology, the authors provide interesting information on the structure and evolution of farm income, as well as the effects of subsidies upon certain inequality and poverty indices at national and regional level. The main results show that income inequality has increased, farms' degree of dependency on support is decreasing, and agricultural income presents a rather stable share in total farm income over time. Interestingly the authors relate the increased income inequality at least partially to continuous CAP reforms.

Prodromos-Ioannis Prodromídis, in his contribution *The Evolution and Composition of the Agricultural Labour Force in Greece: 1998–2008,* examines the contraction of the Greek agricultural labour force in this period when many other sectors of the economy exhibited employment growth. Using data from the Labour Force Survey at the level of the 13 geographic regions and applying relevant econometric techniques, the paper isolates the effects of certain personal productive and structural characteristics which turn out to be significant for agricultural employment. The study concludes, inter alia, that there is diversity of responses (by different segments of the population) to change in the economic environment.

Vassilis Lychnaras and **Calliope Panoutsou**, in their article *Biofuel Options in Greece to Meet the 2020 Targets: Costs, GHG Emission Savings, Fiscal Impact and Land Use Requirements,* examine whether the current and prospective liquid biofuels market in Greece can meet the 2020 EU target (of at least 10%) for use of energy from renewable sources in the transport sector. For the examined period, only biodiesel is available in the Greek market (covering about 2% of the total transport fuel consumption), while there is no projection for bioethanol use in the near future. The study evaluates selected first and second generation biofuel chains under technical, economic and environmental parameters, in order to estimate their impacts for 2010 and 2020. The analysis addresses issues of interest to policy makers—such as cost of production, greenhouse gas (GHG) emissions, fiscal impact, cost of CO_2 rights and land use requirements—that are expected to play a critical role in planning for biofuels and to provide recommendations for future policy formation.

PART IV: Institutions and Economic Performance

The last part of this volume consists of four studies belonging to the broad area of the role of institutions and markets in economic performance or efficiency. These include: the effect of institutions on the lagging of Greece behind relevant group countries in attracting foreign direct investment, the entanglement between politics and the media, the efficiency of the oil price transmission mechanism between wholesale and retail prices, and finally a macroeconomic model developed from Aristotle's thoughts.

Jeffrey B. Nugent and **Constantine Glezakos,** in their study *To What Extent Does Greece Underperform in its Efforts to Attract FDI Relative to its Regional Competitors and Why?*, compare Greece's performance in attracting Foreign Direct Investment (FDI) with that of 24 other countries in Southern Europe, Central and Eastern Europe, North Africa and Western Asia. These countries are those with which Greece competes as an export and FDI base and in which Greece places much of its own outward FDI. The FDI as percentage of GDP for the 2001–2008 period is much lower in Greece (0.009%) than in the compared countries (0.055%); the authors, based on the literature on the determinants of FDI and comparing their means, try to identify factors which encourage or discourage FDI. Cross-country regressions are also used to identify FDI determinants. Among the factors turning out as significant, as summarized by the authors, are: Greece's slow and costly legal system for resolving commercial disputes, the rigidities of its labour and product market regulations, its relatively high investment risk (which in turn seems to be related to its high and rising fiscal deficits and foreign debt), the pressure perceived by its firms to provide officials with gifts in return for services received, and quite surprisingly its tariff rates which are now high relative to those of the compared countries. Greece also enjoys certain advantages such as its location, natural advantages for tourism and residential living, and the relatively high level of education of its domestic labour force.

Maria Constantopoulou, in her contribution entitled *Interweaving between Politics and the Media: A Note*, deals with the current phenomenon of entanglement between politics and the media. She pays attention to the case of Greece and proposes certain measures. She starts by pointing out the peculiarities of the media industry—such as the production of information and entertainment and advertising, public good characteristics and economies of scope—that violate the broad assumptions of economic theory. On the other hand, mass communications media and pressure groups present the greatest interest and can offer very valuable services to politicians encouraging entanglement between politics and the media. The increased resources at the disposal of government in recent decades enhance the phenomenon. Within this framework, the author shows that interweaving drives out of the branches those not willing to offer covert services to the contestants of power. A conclusion is that the media and politicians cannot be relied on to remove interweaving. The creation of an independent authority to prevent it—as well as the use of the internet as a means to promote transparency—could contribute to reduce interweaving.

Stelios Karagiannis, **Yannis Panagopoulos** and **Prodromos Vlamis**, in their study *Are Retail Oil Price Adjustments Asymmetric? Evidence from Greece and Selected Eurozone Countries*, deal with the issue of the oil price transmission mechanism between wholesale and retail prices. Presumably, if the oil price transmission mechanism is efficient, changes in crude oil prices will be transmitted to retail oil prices influencing both disposable income and output produced, otherwise existing rigidities would create rents or shortages. The paper evaluates the performance of the energy markets examining whether oil price changes substantiate the symmetry hypothesis met in competitive markets. The authors—using data from Germany, France, Italy, Spain and Greece and applying modern econometric techniques—conclude that while there are rigidities in the transmission process across the examined countries, the retail oil prices' speed of upward/downward adjustment is considered as symmetric in most of the economies analyzed.

Theodoros Lianos, in his contribution entitled *Aristotle's Macroeconomic Model of the City-State*, presents a model constructed on the basis of implicit thoughts in Aristotle's *Politics* rather than on explicit writings. The variables with which this model is constructed include: the territorial size of the city, the division of land between public and private, the size of the population, and the desired per capita product which is determined on the basis of the concept of good life. This model, reminiscent of aspects of Malthusian population theory, describes the long-run equilibrium position of the economy of the city-state, which is reached and sustained through changes in population. The equilibrium position is reached not a result of individual maximizing behaviour or through technological changes but a result of population changes that occur by means of birth controls.

Part I
Studies in Macroeconomics and Fiscal Policy

Potential Output Growth in Greece

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Abstract

This paper presents a supply-side model of the Greek economy, which is estimated with data for the period 1980–2008. The purpose is to produce estimates of potential output and the output gap, conditional on estimated production function and to examine the sensitivity of output gap estimates with respect to the alternative parameterisation of the technology. Various versions of Cobb-Douglas and CES models are estimated, under alternative assumptions about market conditions, with a view to account for the stylised features of the data. An attempt is also made to build scenarios for possible future growth prospects, under alternative assumptions about the future evolution of demographic, institutional and technological trends.

1 Introduction

Potential output is broadly defined, in a macroeconomic context, as the output level which is sustainable in the medium run without triggering inflationary pressures. It represents the economy's supply side, providing a key indicator of the economy's cyclical position. In recent years, the concept of potential output and the associated concept of output gap, which refers to the difference of potential from actual output, have played an important role in economic policy analysis; they have also become very popular among business economists and forecasters working in international organisations and

[1] I would like to thank Sotiris Petros for his valuable contribution with collection and processing of the data.

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national administrations. The widespread reliance on potential output as a means of assessing economic activity has resulted in the development of a broad range of estimation methods and a growing body of empirical literature focusing on estimation, assessment and comparison of potential output and output gap measures.

Estimates of potential output play an important role in a wide range of short and medium-term macroeconomic analyses. In the short-term, estimates of potential output provide a key indicator for the current and future cyclical position of the economy and of inflationary pressures. They also serve as a useful variable in the formulation of monetary and fiscal policy. In the Euro Area in particular, where monetary policy is based on an inflation target, potential output growth is an input in the derivation of the reference value for monetary growth and serves, further, as a basic ingredient in the construction of monetary rules.

In the field of public finance, potential output is used to split fiscal developments between a part that is linked to the business cycle and a part which comes about as a consequence of discretionary measures. Thus, the potential output concept serves as a means of judging the cyclically-adjusted—or underlying stance of—fiscal policy over time and across countries.

Over the medium term, the estimated trend in potential output provides a benchmark for assessment of comparative economic performance and helps to determine the pace of sustainable growth on the basis of alternative assumptions about the longer-term growth determinants. Furthermore, it serves as a guide to comparative productivity analysis.

The question of the sustainability of potential output growth is often raised during years of strong economic growth. In the case of Greece, the debate whether the high growth rate observed over the last decade was an indicator of higher potential growth in the wake of structural reforms undertaken in Greece, or was simply the consequence of the traditional business cycle, has been popular among policy commentators. The weakening of activity, which began in the course of 2008 and accelerated thereafter, has rendered the debate even more topical. In the present circumstances of downswing phase of the business cycle, the question of interest is whether we can expect substantially stronger economic growth in the coming years, or whether lower growth should prevail for an extended period of time.

Although potential output should, in theory, be independent from the position of the economy, it is not invariant over time and it can be influenced, under certain conditions, by the economic situation. For instance, a long period of low economic growth inevitably affects capital stock accumulation and thereby potential output.

Potential output is, nevertheless, unobservable: thus, many techniques of quantitative measurement have been employed in the literature. This study follows an economic approach. The purpose is to produce estimates of the potential output and output gap conditional on estimated production functions and to examine the sensitivity of output gap estimates with respect to the alternative parameterisation of the production function but also with respect to alternative specifications of market conditions. For this purpose we specify a supply-side model of the Greek economy which attempts to account for the stylised features of the data. The model is estimated with data for the period 1980–2008. Furthermore an attempt is made to build scenarios for possible future growth, on the basis of estimates obtained under alternative assumptions regarding the future evolution of demographic and technological trends.

The paper is organized as follows. The next section contains a categorization of the main approaches used in measuring potential output. In section 3 we introduce the model, while the data and the empirical results are presented in sections 4 and 5 respectively. In section 6 we analyse the sources of growth and discuss prospects and section 7 concludes.

2 Estimation Methods

The widespread reliance on potential output as a means of assessing economic activity has resulted in the development of a broad range of estimation methods. However, the techniques employed to provide quantitative measures of potential output and output gap are based on very different premises. They range from purely statistical techniques—involving simple mechanical filters—to complex, full scale, structural econometric models. Very often the methods involve a mixture of those techniques as they combine statistical approaches and production models. In what follows, we present a short summary distinguishing between predominantly statistical methods and methods focusing on the underlying economic factors.

2.1 Methods Based Predominantly on Statistical Grounds

2.1.1 Filtering Techniques and Other Univariate Statistical Methods

In a simple univariate framework, the estimation of potential output for a given GDP series reduces to a question of separating the trend from the cycle. The most widely used de-trending procedure is the HP filter, suggested by Hodrick and Prescott (1997), while the Band-pass filter, proposed by Baxter and King (1995) is a filtering method with similar properties to the HP filter. Both offer a general, time-varying approach to the identification of GDP trend, incorporating a trade-off between a good fit to the actual series and the degree of smoothness of the trend series. However, the selection of the smoothing parameter is arbitrary and this matters for the estimate, as the size of the output gap and the relative scale and timing of peaks and troughs in output, varies with the smoothing parameter.

Another approach for identifying potential output, using univariate models, is the unobserved components (UC) technique, introduced by Beveridge and Nelson (1981) while Watson (1986) set out a frequently used UC as the method. In both cases, permanent, or potential, output is assumed to follow a random walk.

A problem with the filtering techniques, common to UC models, is the end-point instability. The measure of potential output is symmetric at the middle of the sample; as a result the estimates at the end and the beginning of sample periods suffer from instability and may be subject to substantial revision as new observations become available. The other major criticism for this type of technique is that it is based entirely on statistical considerations, and makes no use of economic information. Because of the end-point problem, the above filters have been heavily criticized, especially with regard to their usefulness to policy-makers in identifying the absolute value of the output gap in real time.

2.1.2 Multivariate Models Combining Statistical Techniques with Economic Information

A variety of multivariate methods have been proposed, in response to the criticisms for univariate models, which introduce economic information and therefore generate a decomposition of the permanent from the transitory component of GDP that can be given a structural or less arbitrary interpretation. The multivariate HP filter (MVF) is such an example. This is an extension of the standard HP filter which takes into account additional sources of information on the output gap. In most cases a reduced form of the augmented Phillips curve is used for relating the output gap to tensions in the goods market measured by the inflation rate. Alternatively, the output gap is linked to constraints on the labour factor on the basis of Okun's law; sometimes, a relationship between the output gap and the capacity utilisation rate is added to link the output gap to constraints on the capital factor. The minimisation of the loss function, under the above constraints results. in a more precise estimate of potential output, and hence of the output gap.

Notwithstanding the introduction of economic information, a main restriction of the univariate context, namely the random-walk process, is maintained in the multivariate extensions.

The structural vector autoregressive model (SVAR), is another approach combining statistical techniques with economic information for the estimation of potential output. The SVAR method was first employed by Blanchard and Quah (1989).[2] A SVAR model allows for taking into consideration all interactions between the various endogenous variables and accounting for feedback effects. The variables used are the inflation rate, the logarithm of output and the unemployment rate.

SVAR models do not impose undue restrictions on the short-run dynamics of the permanent component of output, as the estimated potential output is allowed to differ from a random walk. However, even though the long-run restrictions imposed are consistent with economic theory, they are not derived from fully specified economic models.

2.2 Methods Based on Production Function Models

Estimation of potential output on the basis of a production function represents an economic, as opposed to a statistical, approach. The estimate in this case is determined by the underlying economic factors such as actual factor inputs involved and the nature of technical change. The evolution of these variables also determines, at any given point, the relative importance of the permanent and transitory components of GDP. The structural nature of this

[2] It was also used by King et al. (1991). St-Amant and van Norden (1997) use the same approach for the Canadian economy, Astley and Yates (1999) for the U.K.

method allows the possibility of making forecasts, or at least building scenarios, of possible future growth prospects, by making explicit assumptions about the future evolution of demographic, institutional and technological trends. An additional advantage of the production function approach is the implication of a meaningful link between policy measures and actual growth outcomes.

Potential output in a production-based model is obtained by substituting equilibrium values of inputs in the estimated production function. Consequently, the output growth is determined by the rate of technological progress and the rate optimal growth in physical capacity, through investment, and the growth in equilibrium employment. However, in order to specify properly the econometric production model, the data requirements may be very stringent. Thus, in practice, researchers often proceed non-parametrically, using the standard growth accounting framework on the basis of sample averages. The growth accounting framework has the further advantage of abstracting from conceptual and methodological issues involved in the estimation of a parametric model, but it imposes implicit restrictions on the nature of the production technology.

The major international organisations such as the OECD,[3] the European Central Bank[4] and the European Commission[5] currently use "hybrid" approaches which combine the model-based and the statistical production function approaches. In most cases, the potential technical progress and the potential labour force are estimated using filtering techniques, whereas the NAIRU is estimated simultaneously with a Phillips curve relation.

Some versions of hybrid approaches, such as models based on production function involving extensive use of statistical de-trending techniques, deliver the same results as simple statistical approaches. In other cases, however, hybrid approaches are rather elaborate exercises involving simultaneous estimation of NAIRU with a Phillips curve and trend labour participation, along with some technical function representing production structure. The paper by Lemoine et al. (2008) is a point in case. One criticism of such an approach is that the joint accomplishment of an extended set of tasks may

[3] See Beffy et al. 2007.
[4] See Cahn and Saint- Guilhem 2007.
[5] See Denis et al. 2006.

work against conceptual clarity with regards to the specification of technology and technological progress.

In the next section we formulate a model for the estimation of potential output gap that focuses predominantly on the appropriate parameterisation of the production function.

3 A Supply Model for the Greek Economy

The empirical literature on Greek potential output is rather limited. International organizations publish estimates of Greek potential output growth, which, in some cases, are based on production function approaches but there is little information on the exact functional form and the actual parameter estimates involved because the focus is on similar coverage of many countries. A detail account of an IMF approach is found in a paper by Gagales (2006)—focusing predominantly on long term demographics—where potential output is derived with a set of alternative filtering techniques.

In this study we formulate a supply model of the Greek economy in order to produce estimates of potential output and the output gap. The purpose is to represent the production technology exploring alternative parameterisations of the production function especially with regard to technological progress. At the same time we choose to specify a complete supply model, that is, to include input demand and output price equations along with the production function, so as to base our estimates on a less restrictive framework incorporating market structure features.

3.1 The Theoretical Production Model

Consider an economy that produces one product and let the production technology be defined by equation (1),

$$Q_t = f\left(K_t, L_t, h(t)\right) \tag{1}$$

where Q represents aggregate Value Added, K and L capital and labour input respectively and t stands for time. Technological change is represented by $h(t)$.

With factor markets assumed to be competitive, and output level demand-determined, profit maximization is described by equation (2).

$$Max_{Q_t, K_t, L_t} \Pi_t = P_q Q_t - w_t L_t - c_t K_t \tag{2}$$

where w is the nominal wage rate and c the nominal user cost of capital.

In a dynamic framework changes in the capital stock are not instantaneous and are associated with adjustment costs, hence the maximisation of the present value is required. However in the present case we are interested in the long-run relations, so the static profit maximization framework can be used.

Profit maximization results in a system of output supply, and input demand functions.

$$L_t = f\left(w_t, c_t, Q_t, h(t)\right) \tag{3}$$

$$K_t = f\left(w_t, c_t, Q_t, h(t)\right) \tag{4}$$

$$P_q = (1+\mu) g\left(w_t, c_t, Q_t, h(t)\right) \tag{5}$$

P is the output price or supply function, defined as a mark-up over production cost and $g(.)$ stands for the marginal cost function. Mark-up is defined by the price elasticity of demand ε as $1+\mu = \frac{\varepsilon}{\varepsilon+1} \geq 1$.

The production function can be written in terms of the output-labour ratio $q=(Q/L)$ and capital-labour ratio $k=(K/L)$ as $q=(Q/L)=f(k,t)_t$ and from t he first order conditions of profit maximization we have

$$\frac{w}{c} = \frac{f(k,t) - kf'(k,t)}{kf'(k,t)} \tag{6}$$

$$P_q = (1+\mu) \frac{w}{\left(f(k,t) - kf'(k,t)\right)} \tag{7}$$

3.2 The Choice of Functional Form

Assume now that technology is represented by a CES function of the form

$$Q_t = f(K_t, L_t) = Ae^{\gamma_n t}\left[s(K_t e^{\gamma_k t})^{-\rho} + (1-s)(L_t e^{\gamma_l t})^{-\rho} \right]^{-(v/\rho)} \tag{8}$$

where $\boldsymbol{v}$ denotes returns to scale, $\boldsymbol{A}$ and $\boldsymbol{s}$ are production function scale parameters, t represents technical progress. The elasticity of substitution between labour and capital σ is defined by the "substitution" parameter ρ and is given by $1/(1+\rho)$. If ρ=0, production is characterized by a unitary elasticity of substitution and equation (8) evaluated at the limit is equivalent to Cobb-Douglas production function. Neutral technical progress is represented by the parameter γ_n, while labour and capital augmenting technical progress are captured by the parameter γ_λ , and $\gamma_\varkappa$ respectively.

In practice it is very difficult to disentangle the scale effect from the effects of technological progress. So the assumption of constant returns to scale is imposed. The assumption of constant returns to scale is quite standard in empirical applications.

Under constant returns to scale the production function can be written in terms of the output-labour ratio as follows,

$$\frac{Q}{L} = f(k,t)_t = Ae^{\gamma_n t-\gamma_\lambda t}\left[s\left(ke^{\gamma_\kappa t-\gamma_\lambda t}\right)^{-\rho}+(1-s)\right]^{-1/\rho} \tag{9}$$

The marginal product of labour takes the form

$$f(k)-kf'(k)=(1-s)\left[se^{(\gamma_\lambda-\gamma_\kappa)\rho t}\left(\frac{K}{L}\right)^{-\rho}+(1-s)\right]^{-\frac{1+\rho}{\rho}} \tag{10}$$

And the optimal input ratio is given by

$$\frac{cK}{wL}=\left(\frac{s}{1-s}\right)e^{(\gamma_\lambda-\gamma_\kappa)\rho t}\left(\frac{K}{L}\right)^{-\rho} \tag{11}$$

So the price equation takes the form

$$\log P_q = \log w-\log(1-s)-\frac{1+\rho}{\rho}\log\left[se^{(\gamma_\lambda-\gamma_\kappa)\rho t}\left(\frac{K}{L}\right)^{-\rho}+(1-s)\right]\log A + \\ +\log(1+\mu) \tag{12}$$

Equations (11) and (12) along with the production function (8) form the basis of estimation model.

Additionally, the mark-up rate is defined by

$$\mu=f\,(SSVA,\ \text{Competition}) \tag{13}$$

It is assumed that service industries, on average, are less competitive or experience lower technological progress than other sectors of the economy, so the growth in the share of services in GDP is expected to bring about a widening of the aggregate mark-up. On the other hand, mark-up is negatively related to the degree of foreign competition.

4 The data

In order to estimate the system specified in the previous section, we need the empirical counterparts for the economic variables in equations 8, 11 and 12. The principal source of data for the estimation of the aggregated supply side of the Greek economy is the national accounts system. Table 1 shows the main data definitions and the statistical sources. Output is defined in terms of Gross Value Added at constant prices, while the price of output is represented by the implicit price index of GDP.

The appropriate measurement of factor input quantities and factor input prices is crucial for the accurate identification of the technological structure. The quantity of labour input is represented by total employment in the economy, which includes self-employment. The quantity measure used here is defined in terms of full time equivalent persons employed. The index was constructed on the basis of information on hours worked in different sectors of the economy, including agriculture.

Table 1: Data definitions and sources
Yearly observations for the period 1980-2008

Series	*Description*	*Source/Transformation*
Q	Gross Value Added at constant prices	National Accounts
K_t	Capital Stock at constant prices	$K_t = (1-\delta) \times K_{t-1} + I_t$
L_t	Employment, Total	Full time equivalent NA
P_k	User cost of Capital	
P_L	Price of Labour	Effective wage rate (Total Economy)
Pq	Implicit Price index of GDP	
SSVAA	Share of services in VA	National Accounts
competition	Ratio of implicit deflator of domestic demand to import prices	National Accounts

The capital stock data refer to the economy as a whole. It may be argued however, that business sector capital is more directly related to changes in capacity and thereby the appropriate measure of capital should be based on productive investment alone, excluding public and housing investment. Nevertheless, for a number of reasons, a wider concept of the capital stock is considered a more appropriate measure. First, public capital, in the form of public infrastructure, may have an important bearing on the development and efficiency of private productive capacity. The availability of housing capital also has an impact on production capacity through labour mobility and supply. We use total capital partly because a number of statistical problems arise in the derivation of a time consistent series of public capital owing to definitional changes with regard to the public sector, and also because of changes in the ownership status of many public utilities.

Capital stock is compiled on the basis of the perpetual inventory method; $K_t = (1 - \delta) \times K_{t-1} + I_t$ where δ is the deprecation rate and I the investment at constant prices. Both private and public capital are calculated using three types of capital goods—housing, other constructions, and machinery and equipment. The aggregate measure is constructed as a divisia quantity index. This type of aggregation allows for shifts between different categories of capital to be reflected in the overall measure, thus providing some indication of capital quality.

Factor prices and incomes are not directly available and have to be commutated from the original data. In the case of labour income, the problem is that the NA include the income of self-employed in the operating surplus. Hence, the use of compensation to employees as a proxy for total labour income results in a serious underestimation of both the labour income share and the average compensation rate of total employment. To correct the bias, the average compensation of salary earners in manufacturing was used as a proxy for the compensation of self-employed and the computation of labour income.

We calculate the price of capital services according to a standard user cost of capital

$$user = P_{I_t} \left(rcf + \delta\right)/1 - ctaxr \tag{14}$$

where P_i is an investment deflator, rfc is the real cost of finance, δ is the depreciation rate, and *ctaxr* is the effective corporate tax rate. The real cost of finance is defined as the weighted average cost of capital,

$$rcf = c\left(lrr_b\right) + \left(1 - c\right)\left(lrr + ipremc\right) \tag{15}$$

Equation (15) weights together bank and corporate bond borrowing costs, where c is the share of borrowing that comes from banks. Bank borrowing costs are defined as the real bank interest rate for long term loans (lrr_b), while corporate borrowing is calculated as the risk free real interest rate defined by the yields on 10-year government bonds plus a measure of average corporate spreads borrowing margins (*premc*).

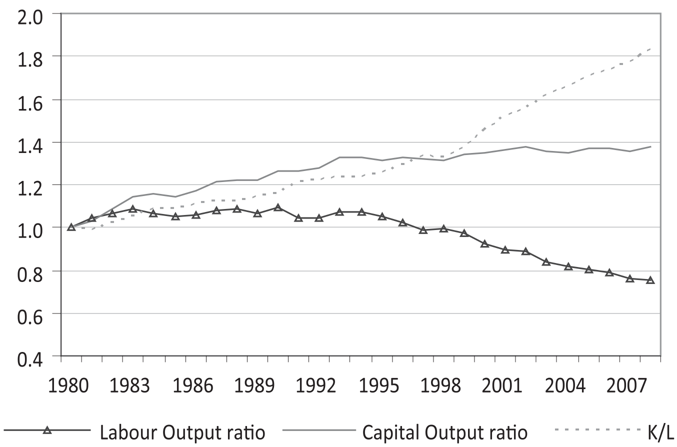
The user cost of capital is employed to calculate the share of capital in the cost of production. Finally, the ratio of cost to the value of output gives an estimation of the aggregate mark-up in the economy.

Some stylized features of the data are presented in the diagrams below. Figure 1 shows the time profile of the labour-output and capital-output ratio. The evolution of these ratios reflects trends in labour force participation, productivity developments and investment growth. The capital-output ratio has followed an upward trend for the greater part of the period and remains stable after 2001. Looking at the capital to labour ratio we observe an acceleration of capital deepening process from the mid-1990s onwards. This process is, in theory, related to the movement of relative factor prices and more particularly to developments in the user cost of capital which has fallen substantially from the mid 1990s to 2007. The resulting increase in the capital–output ratio raised the level of output and, hence, the rate of output growth.

The labour-output ratio, on the other hand, has quite a different time profile. The growth of labour input, which had slowed down significantly in the 1980s, picked up over the past ten years, as Greece experienced relatively large-scale increases in its labour force mainly as a result of an increase in net inward migration and women's participation. This increase was followed by a modest growth of labour input which increased in the period 2001–2007. We can observe two regimes in the labour-output ratio. The first, covering the 1980s and early 1990s, is one in which the ratio is rather constant with mild fluctuations; the second, from 1995 onwards, exhibits diminishing labour-output ratio reflecting rising labour productivity.

The time profiles of factor shares in Value Added are presented in Figure 3. As illustrated in the table, the labour share has declined marginally from an average of 66% at the beginning of the period to 58% at the end. Naturally,

Figure 1: Index of labour-output and capital-output ratio



the capital share has followed the reverse pattern, increasing from 34% to 42% of the value of output. These changes reflect movements in factor quantities and labour and output prices. The capital-to-labour share in cost is also a very important index. Given that aggregate mark-up is defined as the ratio of value of output over cost, it can be shown that if the mark-up is not excessively volatile there is a negative relationship between the time profiles of the labour share in the value of output and the capital-to-labour cost ratio.[6] Clearly, as shown in Figure 2, this relation is quite weak or does not exist for parts of the period, especially the second part of the 1980s and 1980s as well as the early part of the last decade.

Figure 3 shows the variability of aggregate mark-up in the economy. The short period of low mark-up volatility, in the beginning of the 1980s, is followed by a sharp drop from 1986 to 1993, to be followed by an upward trend

[6] $P_qQ/cK + wL = (1+\mu) \rightarrow P_qQ/wL = (1+\mu)(cK/wL+1)$.

Figure 2: Factor shares in output and cost

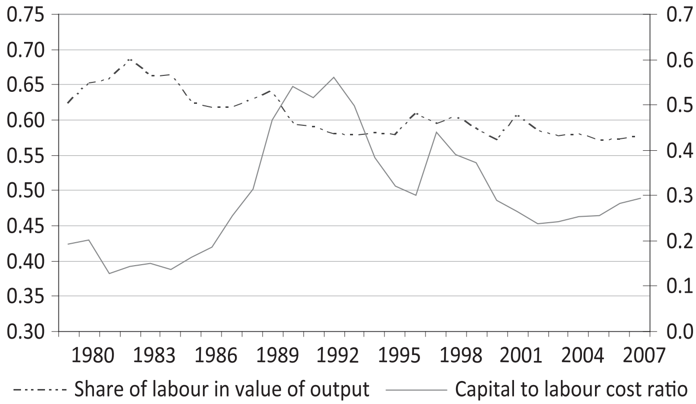
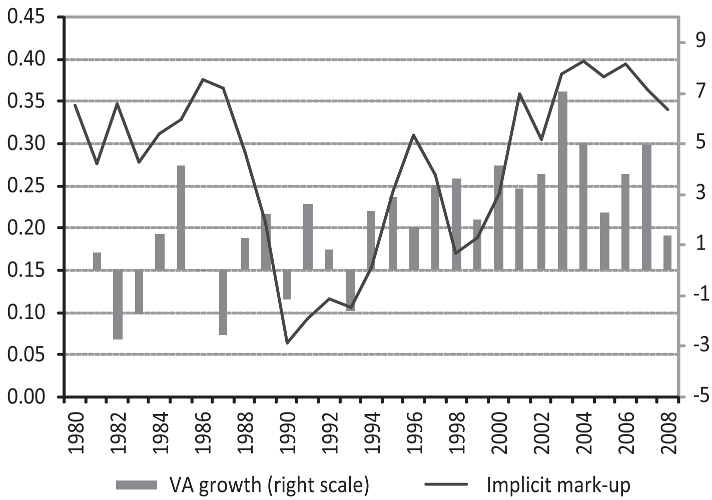


Figure 3: Implicit mark-up



thereafter. Although the comparison of the mark-up profile with growth rate of Value Added points toward a weak cyclical pattern, it is obvious that a further explanation is needed.

Our supply system is appropriate to explain the above developments. Before proceeding in the estimation it is, nevertheless, necessary to discuss some of the weaknesses of the data.

The main issue relates to input quality. Quality aspects are not easily quantifiable, hence measured changes in factor inputs typically reflect only movements in the quantities of labour and capital. The quality aspect of inputs is likely to be reflected to a large extent in the composition of the capital stock and of the labour force. We have already pointed out that some aspects of capital quality are taken into account by the construction of capital, but other important quality aspects (like, for example, the share of high technology capital) are not accounted for due to lack of appropriate data.

The quality of labour input is a further weakness. Measures of aggregate hours worked, typically do not take into account differences in efficiency that may be associated with education or work experience. For instance, for a given rate of growth in overall output and a given rate of growth in total hours worked, the contribution from labour inputs would be larger, if, at the same time, the share of experienced or, better educated employees had increased. It is, however, difficult to aggregate the various categories of labour skills into a meaningful overall labour quality indicator and we have not pursued this task here.

5 Empirical Results

5.1 Econometric Estimates

The estimation of the model described in section 3 is based on the use of iterative nonlinear least squares. A seemingly unrelated regression model is also applied with very similar results. In the previous discussion technological change was defined quite generally, in the sense that technological structure might involve different types of factor augmentation. In actual estimation we treat the cases of neutral (Hicks-neutral), labour augmented and capital augmented technical change separately in order to keep the estimation exercise simple and to obtain convergence with meaningful econometric results.

An estimation of a single equation Cobb Douglas model, as a starting point but also for comparison purposes, is quite useful—especially in view of the fact that the greater part of empirical work on potential output rests on a Cobb Douglas production. The most common assumption with regard to technological change is the labour augmented technical progress; a model consistent with constant capital output ratio is the steady state. A further

Table 2: Cobb-Douglas Production Function

Single equation model:						
Type of technological change	Parameter estimates				R^2 Q	S.E. of Q regression
Estimates constrained by the value of s[1]						
	γ_λ	γ_κ	γ_n			
Neutral			0.0013 (4.671)		0.907	0.055
Labour augmented	0.002 (4.671)				0.907	0.055
Capital augmented		0.0033 (4.671)			0.907	0.055
Unconstrained estimates						
	γ_λ	γ_κ	γ_n	s		
Neutral			0.0019* (0.601)	0.338 (3.177)	0.907	0.056
Labour augmented	0.003* (0.540)			0.338 (3.177)	0.907	0.056
Capital augmented		0.005* (0.462)		0.338 (3.177)	0.907	0.056

s[1]=0.395, the average value of period 1980-2008
*Not significant at the 0.05 significance level.

common practice is the assumption of perfect competition in the output market, which implies that the output elasticity of factor inputs equals the respective share in the value of output. Under this assumption the production function is typically estimated for the value of technological parameter whereas parameter ***s*** is constrained to be equal to the average share of capital for the period under consideration.

In Table 2 we present estimates for three Cobb Douglas specifications of the production function which differ with respect to the type of technological progress. In the upper part of the table the distribution parameter ***S*** is constrained at the average value of share of capital in Value Added for the period 1980-2008.

As shown in Table 2 the unconstrained estimate of capital output elasticity is lower than the average capital share in output, which suggests that per-

Table 3: CES Production function
Models with constant mark up (Neutral Technical change)

	γ_n	ϱ	s	μ	R^2Q	R^2P_Q	S.E. of regression
Perfect** competition	0.005	-0.93	0.225		0.801	0.80	0.082
Unrestricted**	0.01	-1.77	0.038	0.26	0.916	0.813	0.053
Full system	0.006	-1.03	0.148	0.07*	0.92	0.92	0.051

* Not significant at the 0.05 significance level.
** Estimation is based on a two equations system, the production function and price equation.

fect competition may not be a preferable approach, even within the maintained hypothesis of constant elasticity of substitution. On the other hand, the results from the unconstrained model are not satisfactory. Estimates of all technical change coefficients are insignificant at the 5% level, which shows that this model specification is rather poor.

In Table 3, we present parameter estimates of the supply model based on a constant mark-up assumption. The results of the first two rows are obtained from a two equation system, in which the production function is estimated along with the price function. In the model of the third row the capital labour equation is also included in the system. All empirical results in Table 3 are derived on the assumption of a neutral technical change. However, trials with other types of technical change specification show similar results. In the model of the first row, the mark-up parameter, μ, is set to zero, so perfect competition is maintained. Interestingly the zero mark-up case has a poor fit. Also, the elasticity of substitution parameter assumes values close, or, outside the legitimate range, in all three cases.

The results in Tables 4, 5 and 6 are based on the full supply system described in section 3, including a variable mark-up model, in which the mark-up rate is a function of the share of services in aggregate value added and of the import competition variable. Parameter estimates associated with the mark-up are always highly significant and quite stable with respect to the alternative technical change assumptions, but also with respect to alternative estimation periods. We see that both the share of services in aggregate value added and the ratio of competing import prices to domestic prices are important in explaining the mark-up, so the initial assumption about the factors affecting the mark-up ratio is verified.

Table 4: CES Production function
Model with variable mark-up and labour-augmented technical change

	γ_λ	ρ	s	c	Log(ssva)	Log(comp)	R^2Q	R^2PQ	S.E. of regression
1975-2008	0.010 (5.44)	0.14 (2.3)	0.148 (5.32)	2.09 (4.62)	14.50 (7.84)	-4.42 (-7.78)	0. 84	0.93	0.079
1980-2008	0.014 (9.93)	-0.09 (-2.1)	0.062 (5.83)	1.79 (3.86)	13.1 (6.92)	-3.79 (-5.93)	0.85	0.85	0.07
1985-2008	-0.025 (-12.3)	-0.17 (-2.1)	0.64 (28.48)	1.59 (4.87)	12.27 (9.14)	-3.03 (-5.80)	0.91	0.97	0.056

Table 5: CES Production function
Model with variable mark-up and capital-augmented technical change

	γ_λ	ρ	s	c	Log(ssva)	Log(comp)	R^2Q	R^2PQ	S.E. of regression
1975-2008	0.067 (4.75)	-0.46 (-3.2)	0.081 (3.04)	2.10 (6.38)	14.50 (10.86)	-4.43 (-10.77)	0. 64	0.98	0.119
1980-2008	0.042 (6.45)	-0.45 (-3.2)	0.10 (6.49)	0.92 (2.22)	9.63 (5.68)	-3.64 (-4.62)	0.86	0.97	0.068
1985-2008	0.064 (4.00)	-0.44 (-3.3)	0.079 (2.96)	1.59 (5.07)	12.27 (9.52)	-3.03 (-6.04)	0.91	0.96	0.056

Table 6: CES Production function
Model with variable mark-up and neutral technical change

	γ_λ	ρ	s	c	Log(ssva)	Log(comp)	R^2Q	R^2PQ	S.E. of regression
1975-2008	0.010 (11.74)	-0.46 (-3.2)	0.139 (8.99)	2.10 (5.89)	14.50 (10.02)	-4.43 (-9.95)	0. 85	0.96	0.077
1980-2008	0.008 (8.72)	-0.47 (-3.4)	0.149 (9.32)	1.69 (4.06)	12.96 (7.61)	-4.33 (-7.55)	0.91	0.93	0.055
1985-2008	0.010 (13.28)	-0.44 (-3.3)	0.170 (11.96)	1.59 (4.53)	12.27 (8.51)	-3.03 (-3.12)	0.95	0.89	0.039

The neutral technical change model appears to fit the data better than the alternative specifications, as the standard error of the production equation is smaller. Furthermore, the estimated parameters of the neutral technical change model appear to be less sensitive than the other cases with regard to the choice of estimation period. The capital augmenting technical progress model has the poorest fit of the production function. Of the three alternative assumptions regarding the type of technological change, the results associated with labour augmenting technical progress are the least robust. This is reflected, mainly, in the instability of the technical change parameter. Variation in the distribution parameter $\boldsymbol{s}$ is also very high in this model.

A very important outcome is the estimate of the parameter $\boldsymbol{\rho}$ and, therefore, the elasticity of substitution which appears to be greater than one in all three models and rather stable with respect to the choice of estimation period. For the neutral technology model the elasticity of substitution is around 1.8. On the other hand, the estimated distribution parameter is different between the three models with a higher value for the labour-augmented model. In the neutral technological change model the estimate ranges from 0.14 to 0.17 which implies significantly different capital output elasticity, than the sample average of the capital share in Value Added. The elasticity calculated from the derivative of the production function takes a value of 0.24 for the period 1980–2008 and 0.26 for the period 2000–2008.

We can conclude that the results obtained with the neutral technological change assumption are the most reasonable, especially from the point of view of parameter stability. So this model is considered more suitable as a basis for estimation of potential output.

5.2 Estimates of Potential Output

In this section we present estimates of potential output and compare the outcomes of alternative parameterisations of the production model. At this stage we are primarily interested in the sensitivity of potential output growth with respect to different specifications of the supply model and alternative functional forms for the production function. For the calculation of potential output, we need, along with the estimated parameters, some assessment of the potential levels of factor inputs and especially potential employment. To obtain an estimate of potential employment we need information about the structural rate of unemployment—that is, an estimate of the NAIRU (non accelerating inflation level of unemployment). In this case we use two alternative measures of the NAIRU—an HP filter of actual unemployment and OECD estimates for the Greek NAIRU. The results are quite similar; moreover they have very little impact on the comparison between alternative models as potential employment is the same in all alternative estimates of potential output. So potential employment (PL), is defined as a function of equilibrium unemployment and labour force (LF), PL=(1- NAIRU)LF. The normalised values of PL and actual employment are plotted in Figure 4.

One way to introduce a measure of potential services of capital stock is through the use of published capacity utilisation indices. However, in our case, existing indices refer to a small percentage of economic activity (the manufacturing sector) so we have not introduced any discrepancy between actual and potential capital services. Actual output growth is plotted in Figures 5 and 6 against potential output growth obtained from alternative estimation methods and production models. In Figure 5 potential output growth is derived from the three different approaches. HP filter, Cobb Douglas production function with neutral technical change and CES production function with neutral technical change. Finally, Figure 6 illustrates the potential growth rate obtained by alternative specifications of the CES model.

Two observations are of interest regarding the estimated potential output growth rate. First, as expected, model-based estimates are less pro-cyclical than the HP filter estimates. Secondly, the model specification has non-negligible implications on the estimated potential output growth. Hence, a model selection process is desirable. It is also observed that the Cobb Douglas model provides a more flat rate of potential output growth.

Figure 4: Actual and potential employment

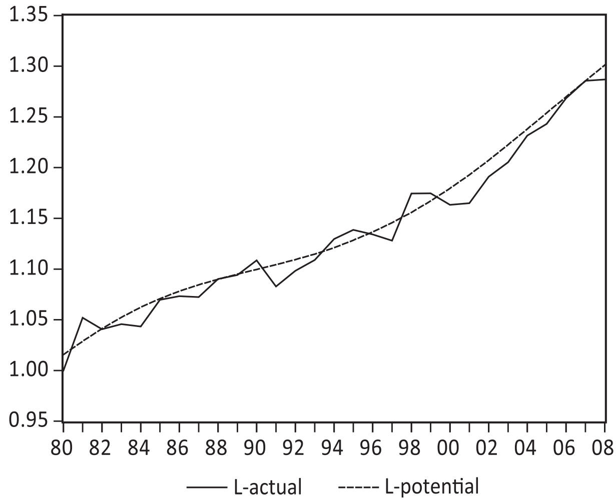


Figure 5: Actual and potential output growth based on alternative estimations

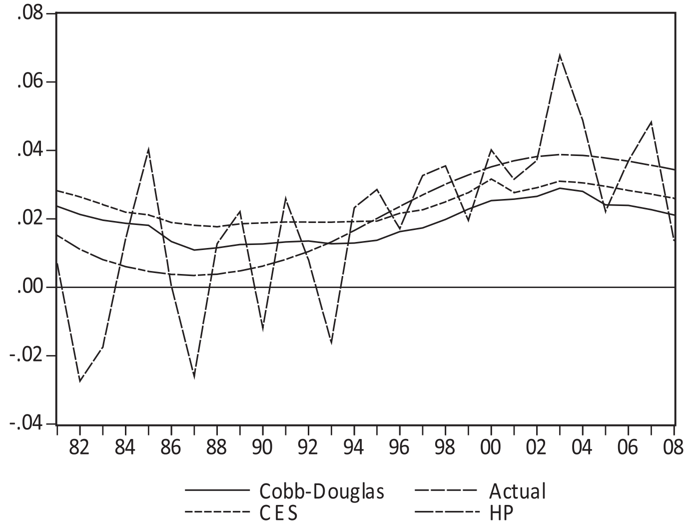
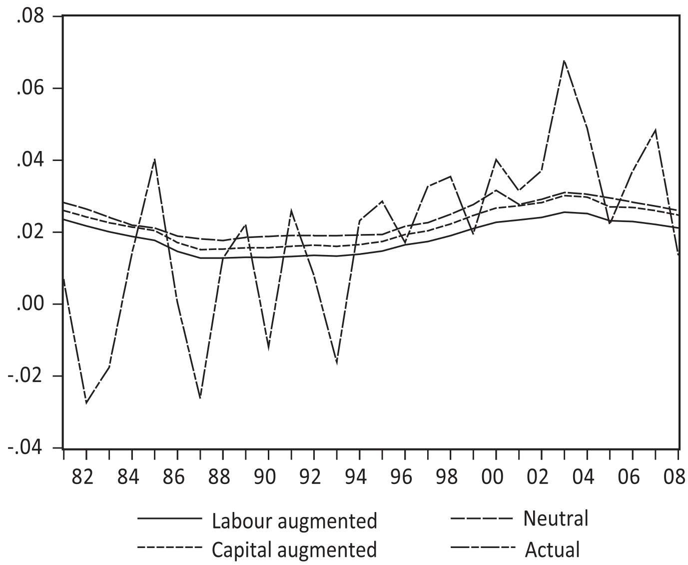


Figure 6: Actual and potential output growth based on alternative CES specifications



A further step is needed to conclude the potential output exercise—namely, an assessment regarding any remaining productivity residual not captured by the supply model. Although, quite often, the terms technical change and productivity are used interchangeably, measured productivity growth may be the result of developments beyond pure technical progress. Most importantly, variations in capacity utilization, or unmeasured changes in input quality along with unidentified scale effects, have an impact on productivity developments over and above technological change. In the next section we obtain an estimate of the impact of these effects.

5.3 Incorporation of the Remaining Productivity Residual

The estimated supply model parameters can be employed to conduct a growth accounting exercise regarding the sources of growth, which, in turn, may serve as a basis for the assessment of future prospects.

In the standard growth accounting framework, potential output growth is obtained on the basis of non-parametric methodology, which abstracts from conceptual and methodological issues regarding the type of technology, or, the formation of output price. The standard procedure allocates the growth rate of real output between a multifactor productivity effect (TFP) and a multifactor input effect using sample averages. More precisely, by logarithmically differentiating a production function in the form of equation (1) we obtain,

$$\frac{1}{Q}\frac{\partial Q}{\partial t}=\frac{1}{h(t)}\frac{\partial h(t)}{\partial t}+\varepsilon_{QK}\frac{1}{K}\frac{\partial K}{\partial t}+\varepsilon_{QL}\frac{1}{L}\frac{\partial L}{L\partial t} \tag{16}$$

where ε_{QK} and ε_{QL} are the elasticities of output with respect to capital and labour respectively. According to equation (16) the growth rate of Q is a weighted average of growth in inputs—with respective elasticities as weights—and technological change, which in the growth accounting context is equivalent to productivity growth. Under the assumption of competitive long-run equilibrium, inputs are paid the value of their marginal product, so, the unknown values of output elasticities are set equal to the respective income shares of capital and labour S_k and S_L.[7] Thus, the fundamental equation of growth accounting is given by equation (17), in which the rate of growth

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[7] $\varepsilon_{QK}=\frac{\partial Q}{\partial K}\frac{K}{Q}$, $\varepsilon_{QL}=\frac{\partial Q}{\partial L}\frac{L}{Q}$, assuming $\frac{\partial Q}{\partial K}=\frac{P_K}{P_q}$ and $\frac{\partial Q}{\partial L}=\frac{P_L}{P_q}$, then $\varepsilon_{QK}=S_K$, $\varepsilon_{QK}=S_L$.

of TFP is calculated as the residual growth rate of output not explained by the total contribution of inputs (Divisia index).

$$\frac{\partial(TFP)}{TFP\,\partial t}=\frac{\partial Q}{Q\,\partial t}-S_K\frac{\partial K}{K\,\partial t}-S_L\frac{\partial L}{L\,\partial t} \tag{17}$$

All variables in equation (17) are measurable since in actual applications continuous growth rates are replaced by the annual difference in the logarithms of the variables.

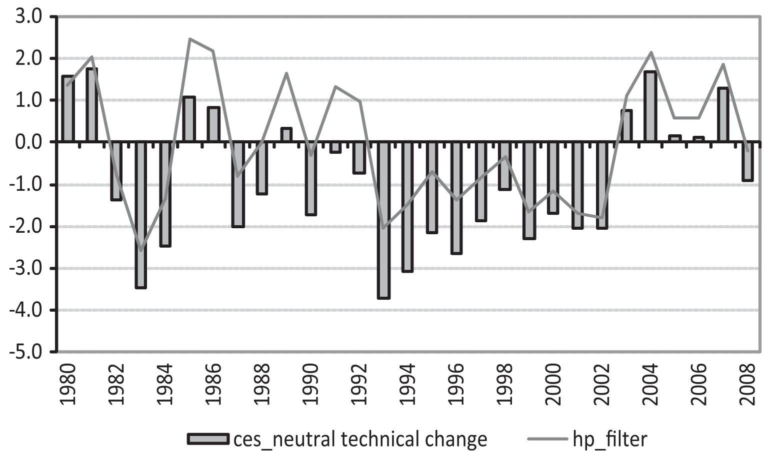
It has been demonstrated above that our empirical models do not provide support for the perfect competition assumption. Therefore, the labour and capital income shares do not offer reliable estimates for the relevant output elasticities of the production function. Our parametric framework, however, provides the basis for measurement of the productivity residual and for the assessment of the sources of growth given the estimated model parameters. It should be noted here that in the present context the residual of estimated production function may represent a productivity component defined in excess of the deterministic technological progress included in the model. In this sense, the residual reflects factors like capacity utilization, variation in input quality or variations in efficiency which are not accounted for in our model specification.

The multiplicative form of the technology component in the neutral technical change CES model allows for the introduction of a separable TFP specification, encompassing the pure technical change term, which is consistent with the parameter estimates given by the whole system and. To do so we obtain the equivalent of the Solow residual from the estimated production function using the selected CES production function with neutral technological progress as follows.

Residual=log(q) - (-1/-0.471)×log((0.149×(k)^(-(-0.471))) + (1-0.149)×(l)^(-(- 0.471)))

The residual is then smoothed, applying the HP filter, and introduced again in the system of production function and price equations as productivity component, replacing the time trend terms. The supply system is then re-estimated using the same iterative approach to obtain a new set of parameter estimates. When this procedure is applied to the CES production function with neutral technological progress, very few iterations were needed to converge, while the re-estimated parameters deviated only marginally from the initial estimates. After this second round of estimation a new series of potential output is obtained which is closer to the actual series as it contains a productivity element not captured by the initial model. According to this estimate potential output growth at the end of 2008 was 3.5%.

Figure 7: Output gap



The output gap defined by the above estimate is presented in Figure 7, along with HP filter estimation. It can be observed that the two approaches offer distinct estimates of output gap. At the end of 2008, the model based approach results in a sizeable negative output gap (-0.76), while according to the HP filter approach the output gap even though negative is quite small (-0.2).

With regards to the economic conditions prevailing after the estimation period one should first point out that a closing of output gap in 2008 was to be expected, ceteris paribus, given that, as shown in Figure 7, actual output was in excess of long-term potential for quite a long period (2003–2007). However, the sizable drop in output that was brought about by the international economic crisis and subsequently by restrictive fiscal policy have led to a far more substantial negative output gap in 2009 and 2010. What is important, nevertheless, is to assess whether the current recession may have a negative impact on potential output. We analyze this issue in the next section in the context of a discussion of the sources of growth.

6 Sources of Growth and Growth Outlook

The re-estimated model can be utilised to obtain estimates of sources of growth. The necessary components are the smoothed productivity residual and the capital and labour contributions obtained on the basis of estimated elasticities. The results of these calculations are given in Table 7 along with standard growth accounting calculations. There is of course an important difference between the two approaches. While model estimates refer to the sources of potential output, standard accounting refers to the sources of actual growth.

Our results show that TFP increased substantially in the period 1995–2008. At the same time, capital deepening resulted in increased capital contribution to growth. However, model based estimates of TFP growth are significantly higher than standard growth accounting estimates. For the period 2000–2008, TFP growth is estimated at 2%—almost half a percentage point higher than standard estimates for the same period. From our technical change estimates, it follows that half of the annual productivity improve-

Table 7: Sources of Growth

Estimates based on standard growth accounting				
	TFP	Contribution of capital	Contribution of labour	Output growth (%)
1980-2008	0.16	1.22	0.55	1.94
1980-1989	0.66	0.93	-1.07	0.53
1990-2000	0.41	1.06	0.15	1.63
2000-2008	1.54	1.73	0.59	3.85
Model based estimates				
	TFP	Contribution of capital	Contribution of labour	Potential output growth (%)
1980-2008	0.64	0.74	0.65	2.03
1980-1989	0.55	0.66	-0.77	0.42
1990-2000	0.62	0.49	0.82	2.03
2000-2008	1.96	1.06	0.73	3.75

ment (0.8–1.0 percentage change) relates to pure technical change effects. A second important result is that capital contribution to growth is lower in the model estimates in comparison to standard index results. The opposite holds true for the contribution of labour. At the end of 2008, potential output growth stood at 3.6%, of which the greater part (1.91 percentage points) was due to TFP, while the respective contributions of capital and labour were 0.83 and 0.81. Consideration of prospects should rely on these estimates, but also on the possible time profile of their future evolution.

The question of interest, at the present juncture, is whether current weak economic conditions may have a negative impact on Greek potential growth. The international experience from previous episodes of financial crises shows that associated recessions are characterized by a sluggish recovery. The relevant empirical literature has shown, nevertheless, that although financial crises normally bring on a recession and the output costs can be large, in the majority of cases output returns to its trend level and there is no permanent effect.[8] Large permanent output losses are often associated with severe banking crises, as Japan experienced in the 1990s.

Currently, a permanent reduction in Greek potential output may be the result of developments relating to all sources of growth—a possible permanent reduction in the relative price of capital and its effect on investment, an adverse impact of the crisis on the labour market, and a possible drop in total factor productivity growth due to negative economic conditions. At the same time, periods of crisis may set some positive factors in motion which mitigate the final outcome.

Periods of crisis are associated with a shrinking capital stock, because of falling business investment. In principle, the adjustment is temporary but it may prove persistent if, for example, the relative price of capital is permanently altered. Is the prospect of such a permanent change in interest rates and risk premiums toward higher levels present?

Here, we need to bear in mind that the accession of Greece to the EU led to considerable reduction in nominal and real interest rates, as well as to the gradual fall in risk premiums, which led to capital deepening and enhanced

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[8] Empirical results from international data are reported in Furceri et al. (2009) and Hoggarth and Saporta (2001) who studied previous episodes of financial crises in the OECD countries since 1970.

growth potential. Presently, the factors affecting the future prospects of these variables relate to structural changes in international financial markets but also to domestic conditions.

One reason for a permanent change of the relative price of capital is investors' reappraisal of risks. Currently, it has become widely accepted internationally, that before the recent financial crisis, risk had been under-priced and that we should not go back to the very low level of risk premium. As a result, forward investment decisions now take account of an increased price for risk. A higher price for risk increases the effective user cost of capital as it raises directly the cost of finance. These increases in risk premia and hence in the user cost of capital reduce the equilibrium capital stock and the potential output level. In the case of Greece the risk premiums are higher owing to the rise in public debt stocks as a proportion of GDP—which is expected to put upward pressure on real interest rates. As a consequence the user cost of capital will rise and sustainable output will be further reduced. On the other hand, one might argue that some of the negative effects on output, that follow from the initial shock in the user cost of capital, may be offset if a rise in risk premiums, across the EU, would decrease investment and hence put downward pressure on real interest rates.

The impact of higher user cost of capital on potential output depends on the capital–output ratio and on the size of the elasticity of substitution. The higher the capital–output ratio, the larger the effect on output of a given rise in the user cost of capital—hence, the larger the impact of higher risk premiums and higher long-term real rates. Also, the more elastic the substitution possibility, the greater the fall in potential output as a result of a permanent rise in the user cost of capital. Given that in our case the capital–labour ratio has increased significantly in recent years, and that the estimate of elasticity of substitution is quite high, such an impact may not be insignificant.

Deterioration in potential output growth, owing to labour market developments, may also be expected in relation to a rise in structural unemployment, or, of a possible drop in the participation rate. Structural unemployment has remained high, above 7.5%, for the last twenty years. It reached a maximum of around 10% towards the end of the 1990s and started to fall gradually in recent years. If, however, higher unemployment in the current recession is prolonged, it could erode workers' skills and lift the structural unemployment rate. The severity of the downturn may also reduce the labour force in the next three to four years. A drop in the participation rate could become permanent if job seekers become discouraged and give up their search. The crisis might also reduce immigration inflows which have contributed positively to the growth of working age population over the past years.

However, at the same time, some factors are working towards improvement of the structural unemployment situation. Structural changes that increase the working life, or increase flexibility in the labour market, should have a positive effect on potential employment. Also, the drop in participation rate may not be that severe if higher unemployment induces a rise in labour force participation by previously non- participating family members, in the event of a job loss by a family member.

Finally, deterioration in potential output growth may come about because of deterioration in trend productivity growth. The latter could be a result of falling business investment, or, falling R&D expenditure. In the case of Greece, one should expect that the impact of R&D on productivity growth is limited, while technical change is tied to imported capital equipment. In that case, a long period of under-investment should have a negative impact on TFP.

On the positive side, the restructuring of efficient firms may moderate the impact of lower investment growth. A positive effect on TFP growth may also come about from the efforts to restructure the public sector, which should operate as an externality for the business sector. Such a restructuring may also provide the right incentives for FDI investment—for example, when it shortens the time it takes to set up a business and get a business license—especially in conjunction with labour market reforms. Over the medium term, the pressure on the public sector to adjust may impact a number of other institutional channels that affect productivity growth—most importantly, reforms which affect educational output and could raise the quantity and quality of human capital.

Given the above considerations, the empirical estimates obtained can help in the formulation of some indicative scenarios for future developments and in particular for the period 2010–2015.

To start with, in the medium term we would not expect to see capital deepening generated by a further decline in the user cost of capital. On the contrary, the price of capital services is expected to remain at high levels for some time, so the contribution of capital is expected to be rather lower than in the recent period. Given our capital output elasticity estimate and assuming two alternative scenarios with regard to the annual increase of capital stock (2.1% and 2.6%, which correspond to stagnating or around 1% increase in real investment), we derive a range of the capital contribution between 0.57 and 0.7 percentage points.

In the face of the uncertainty regarding the impact of economic crises on the labour market participation rate and on structural unemployment, we can envisage two alternative scenarios. In the first scenario, the severity of the downturn will reduce the growth in labour force to 0.3%, as opposed to 0.8 for the period 2000–08 and 0.5 in 2009. Structural unemployment deteriorates marginally in this scenario from 0.75 to 0.78 per cent of labour force. In the second scenario the impact of the crisis on the participation rate is smaller so the rate of growth of labour force is set at 0.6%, while structural unemployment remains unchanged. Under these assumptions the expected labour contribution to growth for the immediate future should range from 0.22 to 0.44. Note, however, that If the labour market impact comes quite early in the coming period it may look like a step down in trend output rather than a reduction in the growth rate.

Finally, variations in the trend growth rate will depend largely on our estimate of trend TFP growth. The question can be formed in terms of possible drop of TFP growth rate from estimates referring to the more recent period, or, in terms of establishing a notion regarding the underlying rate of growth of total factor productivity. From our estimates regarding the rate of growth of neutral technical change, of 0.8% to 1%, it can be argued that the deterministic time component represents a permanent trend growth rate of productivity, reflecting for example the underlying speed of catch-up with the frontier countries. The remaining part of the productivity residual may relate to cyclical factors associated with the investment booms and troughs, or may represent non-linear effects of changes in input qualities. Thus, we can, again, formulate two alternative scenarios. In the first, the underlying rate of growth of total factor productivity is 0.9%, while in the second it is 1.3%, two different assumptions. In the first case, it is maintained that only the technical change component represents trend productivity growth, while in the second it is assumed that about half of the productivity residual, in excess of technical change, for the period 2000–08 is permanent—representing, perhaps structural change or improvement in input quality.

Table 8: Indicative potential output growth profiles for the period 2010–2015

	Contribution of labour	Contribution of capital	TFP	Growth of Potential output (%)
Low growth scenario	0.22	0.57	0.9	1.69
Higher growth scenario	0.44	0.70	1.3	2.44

The implications of this analysis are presented in Table 8 as indicative potential output growth profiles for the next period. According to this analysis, the current economic crisis may result in reduction of output growth of the scale of 1–1.7 percentage points.

However, knowing where we were at the end of 2009 and where we expect to be by 2015 does not provide any information about the speed of adjustment, especially of the capital stock to its equilibrium. Hence, any prediction regarding the precise output gap for the next couple of years is associated with a significant degree of uncertainty.

7 Conclusions

In this paper, we have presented a supply-side model of the Greek economy which was estimated for the period 1980–2008 in order to obtain estimates of potential output and of the output gap. The model accounts for the stylised features of the data, namely, the evolution of the capital-to-labour ratio, the shape of labour income, and the change in implicit profit margins on the assumption that the underlying production function is either Cobb-Douglas or CES.

We have chosen a modelling strategy which explores alternative parameterisations of the production function, focusing on the question of the type of technological progress.

The obtained empirical results support the CES, neutral technical change specification of technology and a variable mark-up price equation. The trend in the aggregate mark-up is explained by the share of the service sector in total Value Added.

The empirical analysis has shown that the model specification has non-negligible implications for the estimated potential output growth. The output gap estimate for 2008 according to the model based approach was significantly different from filter-based estimates. The empirical model and the estimated elasticities were utilised to obtain estimates of sources of growth. Subsequently, we arrived at a set of indicative estimates regarding the future profile of potential output, which is expected to be significantly lower than the achievements of recent past.

Obviously the evolution of potential output—in the past and in the future—reflects the ability for a country to increase its wealth, when this is measured by GDP. It follows that the central aim of economic policy is to strengthen potential growth. At this point it is necessary to face the real issues generated by the crisis—the growth slowdown. The appropriate tools cannot come from standard fiscal and monetary policy, but from a process of smooth transition to a higher capital stock, better utilization of the labour force and sustained total factor productivity growth. In other words, the rebound has to come from the investment process, the easing of labour market frictions and from the implementation of structural policies that increase productivity.

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Household Borrowing and Domestic Demand

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Abstract

Fast household debt growth over a prolonged period of time entails high gains for domestic demand while it lasts, but also severe losses in the event that it is interrupted. Over the past two years, the financial crisis induced sharp drops in the rates of credit expansion to households in Greece and other Euro zone countries previously experiencing rapid household debt growth. As suggested by the analysis presented in this paper, these drops caused the net injection contributed by household debt to domestic demand to shift from the highly positive levels experienced up to then to levels considerably below zero, thus changing radically the role of household debt developments for domestic demand in these countries, from that of a major growth driver to that of a weakening factor. In the case of Greece, the negative injection currently inflicted by household debt to domestic demand may not be as severe as that suffered by certain other Euro zone economies, but the minimum rate of credit expansion required in order for this injection to return to positive levels is relatively higher, due to Greece's comparatively higher interest rates on consumer loans and its relatively elevated analogy of these loans in total household debt.

1 Introduction

In a previous paper written at a time when Greece was experiencing rapid GDP growth and buoyant household credit expansion, we argued that in order to maintain household indebtedness at sustainable levels, an eventual substantial drop in the rate of growth of household debt would have to take place (Athanassiou 2007). As implied by a model developed in the paper, such

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a drop would cause a considerable weakening of the boost provided by household debt to the internal demand for consumption and housing investment. Since domestic demand increases were up until then Greece's main growth driver, the possibility of this weakening was argued to create concerns with regards to the overall growth prospects of the Greek economy, particularly given the fact that public spending growth—another major source of the expansion of domestic demand—was subject to restrictions under the European Union's Stability and Growth Pact.

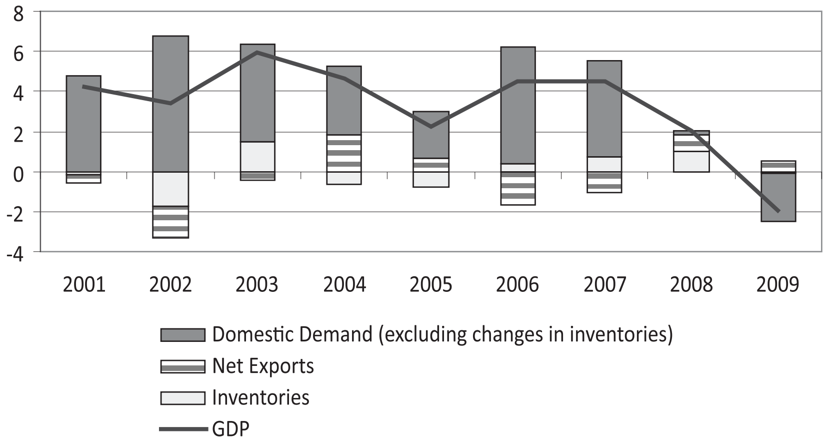
In line with the indications of the aforementioned paper, the rate of expansion of credit to Greek households receded gradually in 2006 and 2007 and dropped sharply in 2008, amounting to 12.8% in that year compared with 31% in 2005. More recently, the financial crisis and the consequent credit crunch have brought household credit expansion to a near halt. This development constitutes a complete departure from the rapid credit growth trend followed since Greece's financial liberalisation in the mid 1990s and, as such, deserves to be studied with respect to its implications for domestic demand and output.

In view of the above, this paper examines the impact of household debt on Greece's domestic demand from 2000 until lately, illustrating the recent rapid transformation of the role of this debt from that of an important growth driver to that of a major weakening factor for demand. Furthermore, and as a guide for economic policy and bank strategy, the paper provides an indication of the minimum rate of credit expansion to households required in order for the net injection contributed by household debt to Greece's domestic demand to be positive. Finally, the paper carries out a similar analysis for five more economies of the Euro zone—namely, Germany, France, Italy, Ireland and Spain. As these economies cover a variety of different patterns with respect to the evolution of household borrowing since 2000 and its effects on demand, the study of their cases is both interesting in its own right and useful for the purpose of comparisons with the case of Greece.

2 Recent Developments in Greece's Domestic Demand and Household Borrowing

As shown in Figure 1, during the period 2001–2007 a pattern of successive large increases in Greece's domestic demand led the country down a path of comparatively rapid GDP expansion, despite the mostly negative growth contributions of the external sector. In 2008, this pattern was suddenly interrupted, with a sharp drop in the momentum of domestic demand bringing about a substantial decrease in GDP growth to 2% versus 4.5% in 2007. In 2009, a significant contraction in domestic demand (-2.2%) took the economy into recession.

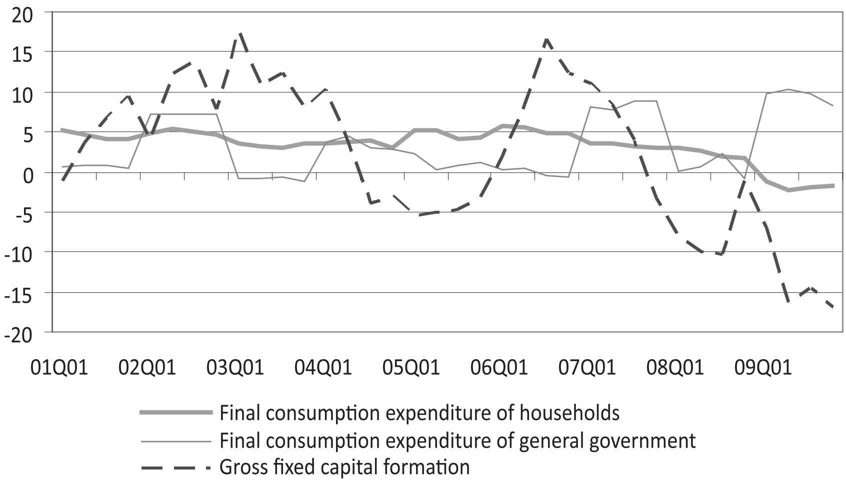
Figure 1: Real GDP growth in Greece and contributions to growth (%)



Source: National Accounts of Greece.

The weakening and recent decline of Greece's domestic demand reflects a very substantial loss of strength of its two larger components—namely, household consumption and gross fixed capital formation (see Figure 2). Household consumption growth faded gradually to 1.7% in the final quarter of 2008 from 4.3% in the fourth quarter of 2006 on a year-on-year basis and turned negative thereafter, averaging -1.8% for 2009 as a whole. Gross fixed capital formation entered a path of very rapid decline from the end of 2007 onwards, amounting to 10.4 bn euro in the fourth quarter of 2009 versus 12.4 bn euro two years earlier. Notably, government consumption, the remaining major component of Greece's domestic demand, continued to increase in 2008 and rose sharply in 2009, serving to delay and alleviate the economic downturn.

Figure 2: Quarterly growth rates of the main components of Greece's domestic demand (% changes on a year-on-year basis)

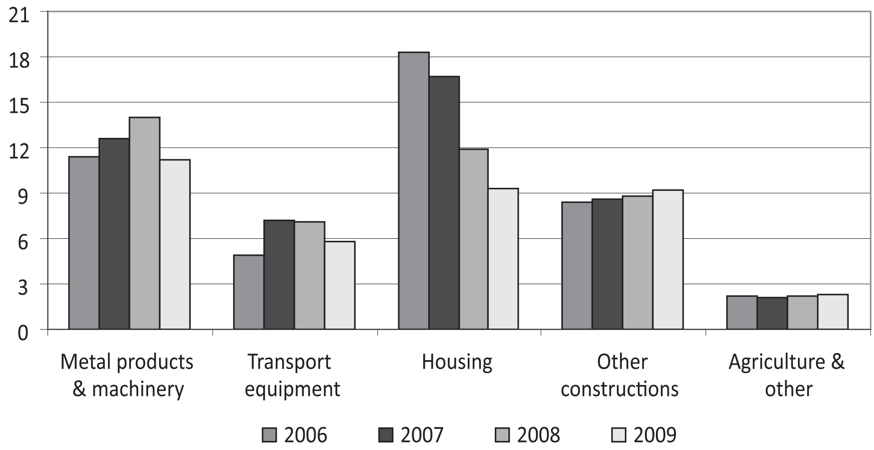


Source: Eurostat.

While this weakening of household consumption obviously corresponds to a loss of strength of household demand for consumer goods, the contraction of gross fixed capital formation is also a reflection of a decline in household demand—in this case, for new housing. As shown in Figure 3, housing investment (the largest component of Greece' gross fixed capital formation until recently) dropped by 8.6% in 2007 and 29.1% in 2008, prevailing over the increases in other investment categories and exerting a heavy negative pressure on demand. In 2009, a further sharp decline in housing investment (-21.7% compared to 2008) played a crucial part in the economy's slide into recession.

On the basis of the above, it appears that, so far, the loss of strength of Greece's domestic demand—and, hence, the downturn of the Greek economy—originate mainly in the weakening of household demand for new homes and consumer goods. This weakening coincided with a major decline of the rate of growth of credit expansion to Greek households, illustrated in Table 1. As already mentioned, the rate of expansion of Greek household debt receded gradually in 2006 and 2007 and dropped sharply in 2008, amounting to 12.8% then as compared with an average of 33% over the period 2000–

Figure 3: Gross fixed capital formation by investment product (billion € at 2006 prices)



Source: National Accounts of Greece, 2000-2008.

2005.[1] In absolute terms, the increase in the outstanding balance of household debt amounted to 13.1 billion euro in 2008, versus 18.2 billion in 2007, with housing loans along with consumer and other loans expanding much less in 2008 compared to the previous year. For 2009, household debt expansion was marginal, with the outstanding balance of loans at the end of the year exceeding by only 3.1% that for the end of 2008.

Although the deceleration of the rate of expansion of household debt experienced until 2008 was largely anticipated on the basis of the need to preserve debt sustainability (Athanassiou 2007), the severe cutback in borrowing over recent months, linked to the financial crisis, came as a shock. On the supply side, the crisis forced banks to cut back the availability of loans and to tighten credit terms, in view of the rise in credit risk and the need to control their exposure to bad debt. On the demand side, the uncertainty induced by the crisis and the economic downturn, coupled with the downfall in house

[1] The rapid credit expansion of Greece's private sector over previous years, the corresponding decrease in private savings and the consequent aggravation of current account imbalances have been linked to the process of goods and financial market integration related to the country's accession to the EU (see e.g. Blanchard and Giavazzi 2002).

Table 1: Analysis of domestic MFI loans to domestic households (current prices, end of period)

	Housing Loans			Consumer & Other Loans			Total		
	Balance (bn €)	% Change	% of GDP	Balance (bn €)	% Change	% of GDP	Balance (bn €)	% Change	% of GDP
1999	8.6	–	6.5%	3.9	–	2.9%	12.5	–	9.4%
2000	11.3	31.2%	8.2%	5.7	46.9%	4.1%	17.0	35.5%	12.3%
2001	15.7	38.9%	10.7%	8.2	43.8%	5.6%	23.8	40.4%	16.3%
2002	21.2	35.6%	13.6%	10.3	26.0%	6.6%	31.5	32.2%	20.1%
2003	26.5	26.2%	15.4%	13.7	38.0%	7.9%	40.2	28.5%	23.3%
2004	34.1	27.6%	18.3%	18.5	36.2%	10.0%	52.6	30.4%	28.3%
2005	45.4	33.0%	23.2%	23.5	27.6%	12.0%	68.9	31.0%	35.3%
2006	57.1	26.3%	27.2%	28.7	24.4%	13.7%	85.9	25.7%	40.8%
2007	69.4	21.9%	30.6%	34.8	23.5%	15.3%	104.1	22.4%	46.0%
2008	77.7	11.5%	32.5%	39.5	15.5%	16.5%	117.2	12.8%	49.0%
2009	80.6	3.7%	33.9%	39.1	1.8%	16.5%	119.6	3.1%	50.4%

Source: Bank of Greece.

Note: Rates of change are calculated taking into account loan write-offs, exchange rate variations and reclassification adjustments.

prices experienced since the beginning of 2009, dampened the confidence of households and reduced their appetite for housing and consumer credit.[2]

Leaving aside the causes of recent developments in household borrowing—the study of which is beyond the scope of this paper—an interesting issue to examine is the role that these developments may have played in the loss of strength of household demand for consumption and housing and, hence, in the weakening of Greece's domestic demand. In section 4 we proceed to examine this issue through an analysis that points to a recent rapid transformation of the role of household debt from that of an important growth driver to that of a major weakening factor for demand. This analysis is based on the theoretical model of Athanassiou (2007), a summary of which,

[2] For a discussion of the role of supply and demand side factors in the recent developments in household borrowing, see Bank of Greece (2009b), Chapter VI.

together with an illustration of its implications in the event of a credit crunch, follows.

3 The Impact of Household Debt on Domestic Demand: The Model and its Implications in the Event of a Credit Crunch

Although household borrowing showed considerable growth in a number of developed economies over the past two decades, the macroeconomic implications of this growth have until recently attracted little attention.[3] Focusing on the impact of borrowing on domestic demand, two opposing effects may in general be identified—an expansionary effect arising from the increase in the debt and a contractionary effect stemming from the debt service on pre-existing and new loans. Since households spend the funds raised through debt shortly after obtaining them, an increase in household debt within any year j may be assumed to have a nearly equivalent expansionary impact on that year's domestic demand. In parallel, given that household borrowing creates an obligation for the payment of interest and hence an obligation for the cutback of expenditure in subsequent years, domestic demand in year j may be assumed to be negatively influenced by the debt burden accumulated by households up until the beginning of this year. On the basis of these assumptions, Athanassiou (2007) expressed the net injection contributed by household debt development to domestic demand in year j as:

$$
\begin{aligned}
I_j &= \text{change in debt} - \text{interest payments} \Rightarrow \\
I_j &= (S_j - S_{j-1}) - (\varrho_j S_{j-1}) \Rightarrow \\
I_j &= S_{j-1}(1 + r_j) - S_{j-1} - \varrho_j S_{j-1} \Rightarrow \\
I_j &= S_{j-1}(r_j - \varrho_j) \qquad (1)
\end{aligned}
$$

[3] For discussions of these implications, focusing on the effects of rising household debt on the exposure of households to shocks in income, house prices and interest rates, see Debelle (2004a and 2004b) and Girouard, Kennedy and André (2006). For a long-run view of the implications of rising household debt for the relationship between wages and aggregate demand, see Barba and Pivetti (2009). For a study of mutually reinforcing boom-bust cycles in housing and credit markets, enhancing the likelihood of future financial fragility, see Goodhart and Hofmann (2007). For a discussion of the risks associated with excessive household borrowing in foreign currency see Barrell et al. (2009).

where S_j is household debt at the end of year j, r_j is the growth rate of household debt in year j and $\varrho_j S_{j-1}$ is the sum of the interest payments paid by households in year j with $0 < \varrho_j$. From equation (1) it follows that the evolution of I_j over a period of *n* years (j=1, 2,..., n), would be equivalent to:

$$
\begin{aligned}
I_1 &= S_0(r_1 - \varrho_1) \\
I_2 &= S_1(r_2 - \varrho_2) = S_0(1+r_1)\,(r_2 - \varrho_2) \\
I_3 &= S_2(r_3 - \varrho_3) = S_1(1+r_2)\,(r_3 - \varrho_3) = S_0(1+r_1)\,(1+r_2)\,(r_3 - \varrho_3) \\
&\vdots \\
I_n &= S_0(1+r_1)\,(1+r_2)\,(1+r_{n-1})\,(r_n - \varrho_n) \qquad (2)
\end{aligned}
$$

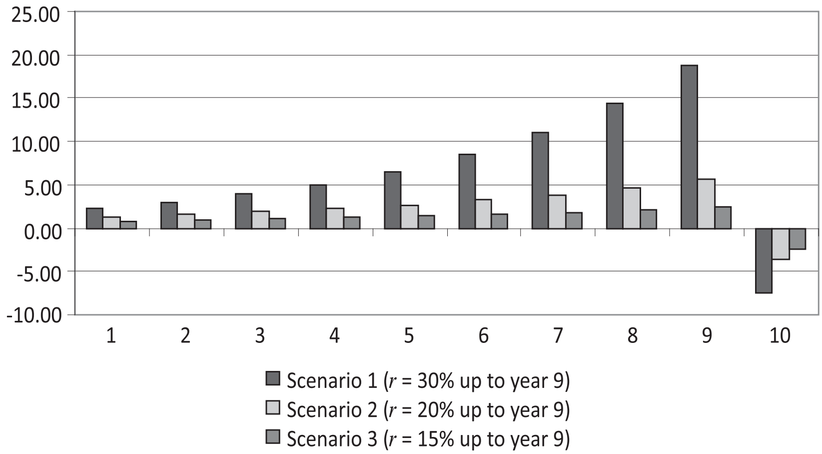
where S_0 is the outstanding debt at the beginning of year 1. In the case where $r_1 = r_2 = \ldots = r_n = r$ and $\varrho_1 = \varrho_2 = \ldots = \varrho_n = \varrho$ the value of I_j in any year j would be equal to:

$$I_j = S_0(1+r)^{j-1}(r - \varrho) \qquad (3)$$

The exponential form of relationship (3), combined with the condition that $I_j > 0$ only if $r_j > \varrho_j$, suggests that the path of I through time depends critically upon the growth rate of credit expansion to households r, so that even relatively limited variations in r would be sufficient in order to alter radically the annual net injection contributed by household debt to domestic demand. Indicatively, given the levels of ϱ applicable to Euro zone economies over recent years (see section 5), rates of credit expansion close to 30% (i.e. similar to those observed in Greece up to 2005) would yield a remarkable strengthening of domestic demand, while rates in the area of 20% would produce a comparatively much weaker positive effect.

Turning to consider the implications of a credit crunch for a country with a previous record of fast credit expansion to households, the first thing to observe on the basis of the above model is that such a development would amount to a major decline in r to a value close to or below zero. As a result of this decline, the condition $r_j > \varrho_j$ would most likely no longer be satisfied and therefore I would be driven to a negative value. Intuitively, the crunch would eliminate the expansionary effect of borrowing, while leaving the obligations to pay interest on pre-existing debt intact, thus transforming household debt developments from an important growth driver to a weakening factor for demand. Importantly, the faster the rate of credit expansion to households prior to the crunch, the stronger this weakening effect would turn out to be, because, other things being equal, a record of faster credit growth translates to greater debt accumulation and hence to higher debt service obligations.

Figure 4: Scenarios for the net injection that household debt contributes to domestic demand over a decade with S_0 = €10 billion, ϱ = 7% and r_{10}=0%



To illustrate the above points, Figure 4 presents three alternative scenarios for the evolution of I_j in a ten-year period (j=1, 2,..., 10) that begins with a debt of S_0 = €10 billion and is characterised by a stable ϱ = 7%. In 'Scenario 1' the assumption is that r remains stable at 30% from year 1 to year 9 and subsequently drops to 0%. In 'Scenario 2' and 'Scenario 3' the assumptions are that r = 20% and r = 15% respectively up to year 9, with a drop to 0% in year 10. As may be observed from the Figure, faster credit growth entails much higher gains for domestic demand while it lasts, but also far more severe losses once a credit crunch emerges.

Before proceeding to examine the cases of Greece, France, Italy, Germany, Spain and Ireland by use of the above model, it should be noted that, although the model captures the essence of the importance that the speed of household credit expansion bears for domestic demand growth, it does not constitute a full representation of all potential channels through which household debt may influence demand. Furthermore, the model does not attempt to account for the potential relationships that may exist between household debt and interest rates or between past and present credit expansion rates and, therefore, while it suffices for the type of analysis carried out in this paper (i.e. for the calculation of I on the basis of the actual record of r and ϱ), it may not be suitable for other applications.

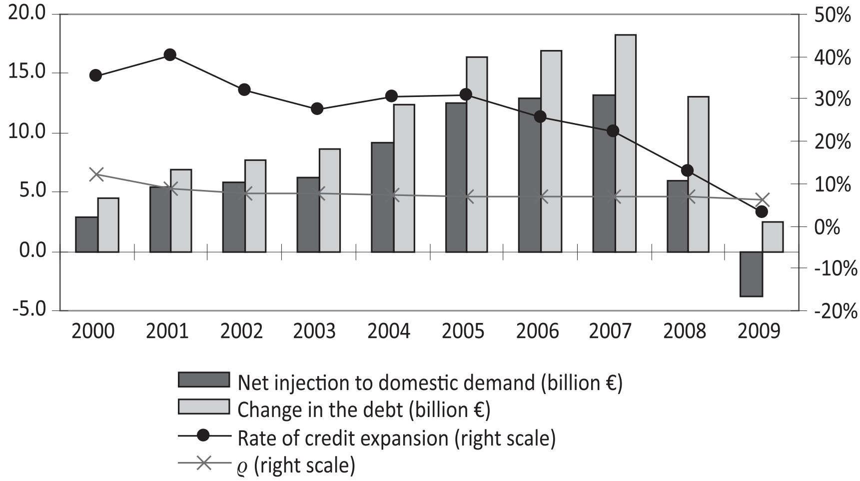
4 The Impact of Household Debt on Domestic Demand: The Case of Greece

On the basis of the above model and scenarios, one would expect that, in the case of Greece, the sharp decline in r experienced from 2008 onwards would translate initially to a considerable decrease of the net injection provided by household debt to domestic demand and, eventually, to a drop of this injection to negative levels. To verify whether and to what extent this may be so, equation (4) has been employed for the calculation of the path of I from 2000 until 2009, using Greek annual data on the evolution of household debt and interest rates on this debt. Specifically, I_j was calculated by (i) setting S_0 as equal Greece's household debt at the end of year 1999, (ii) taking r_j as published by the Bank of Greece and reported in Table 1, and (iii) setting ϱ_j as equivalent to the weighted average of the interest rates on outstanding housing loans and consumer & other loans, data on which are provided by the ECB and the Bank of Greece.

Figure 5 displays the evolution of I on the basis of the calculations just mentioned, illustrating also the corresponding increases in household debt, as well as the course of r and ϱ. As is evident from the Figure, in 2008 the sharp drop in r and the consequent narrowing of its excess above ϱ, drove the net injection contributed by household debt to domestic demand to less than half of its value in 2007. Notably, the value of I in 2008 was lower even than that for the year 2003, despite the fact that the increase of household debt in 2008 was in absolute terms much higher. This is essentially a reflection of the stronger contractionary effect of household debt on I, resulting from the continuous escalation of the debt burden of Greek households.

Turning to developments in 2009, Figure 5 illustrates a sudden shift in I from the highly positive levels experienced up to then, to a level considerably below zero. This shift is a reflection of the dip in r to a level much below ϱ and suggests that household debt developments have entered a phase in

Figure 5: Net injection contributed by household debt to domestic demand (I_j), change in the debt ($S_j - S_{j-1}$), rate of credit expansion to households (r), and interest rate on outstanding loans (ϱ)



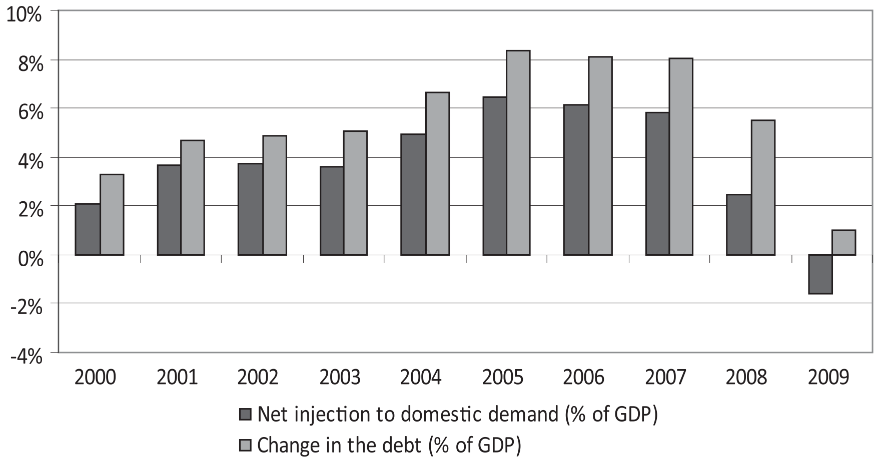
Source: Bank of Greece and own calculations.

which they are exerting a negative net injection to domestic demand, despite the fact that credit expansion to Greek households has not seized altogether.

The importance of the aforementioned movements in I for Greece's domestic demand and growth can be further evaluated through Figure 6, which expresses I and the changes in household debt as shares of GDP. As can be observed from the Figure, I is estimated to about -1.6% of GDP in 2009, versus 2.5% in 2008 and an average of 6.1% over the period 2005-2007, indicating that, in the case of Greece, the role of household debt for domestic demand has recently been reversed from that of an important growth driver to that of a major weakening factor.

Looking at the consequences of the above reversal for Greece's economic growth, these appear to be rather serious—particularly because, in the current recessionary environment, domestic demand is already under the pressure of several other negative factors (e.g. increasing unemployment, rising uncertainty). While under more favourable economic conditions there could be forces at work that would help to counterbalance the effects of a negative net injection from household debt, under the present circumstances such an

Figure 6: Net injection contributed by household debt to domestic demand (I_j) and change in the debt ($S_j - S_{j-1}$) as shares of the GDP (%)



Source: Bank of Greece and own calculations.

injection acts to intensify the downfall of household demand related to the aforementioned factors, thus leading the economy into a deeper recession.

The above analysis and findings have important implications for government and bank policy that will be discussed in section 6 of the paper, once the cases of Germany, France, Italy, Ireland and Spain have also been examined. For now, a final question to consider with respect to the case of Greece relates to the minimum rate of credit expansion to households that would be required in order for the net injection contributed by household debt to Greece's domestic demand to return to positive levels.

As suggested by equation (2), to satisfy the condition $I > 0$ the rate of credit growth r would have to be adjusted so as to exceed the corresponding level of ϱ. Since over recent years, Greece's ϱ has remained within a range of 7% plus or minus 0.5%, an r towards the top of this range may be considered as sufficient to ensure a positive I over the short-term. However, it should be stressed that, in the case of Greece, the future path of ϱ is subject to considerable uncertainty, as it will depend not only upon Eurozone interest policy decisions, which are under the current circumstances difficult to predict, but also upon the course of the spreads between interest rates on Greek and other Eurozone member states' debts. These spreads, which emerged in 2008 as a result of Greece's high fiscal and external imbalances and the increased sensitivity of markets to risk, have fluctuated around high levels over recent months and their prospects are contingent upon the progress of the Greek government's fiscal consolidation plan.[4]

5 Household Debt and Domestic Demand: The Cases of Other EuroZone Countries

Having examined household debt developments and their impact on domestic demand for the case of Greece, we now proceed to a similar analysis for the cases of France, Germany, Italy, Spain and Ireland. These cases are interesting both in their own right and also as useful comparisons to Greece, because they form representative examples of how alternative patterns of household debt growth lead to different degrees of dependence of demand growth upon household borrowing.

Starting with Ireland and Spain, the experience of which bears a higher degree of similarity to that of Greece, it is a well known and widely discussed fact that between 2000 and 2007 both countries went through a phase of very rapid credit expansion to households.[5] During this phase, and particularly over the period 2003–2007, the annual increases of their household debt, expressed for the sake of international comparisons as shares of GDP, rocketed to levels much higher than those of Greece (see Figure 8), driving the Spanish and Irish household debt-to-GDP ratios to over 80% in 2007, from just about 40% in 2000 (see Figure 7). In 2008 Ireland's household debt growth sunk abruptly to negative levels, to remain negative also in 2009. In Spain, a marked drop in the rate of credit expansion in 2008 was followed by negative credit growth in 2009.

On the basis of the above developments, one might expect that, similarly to the case of Greece, Ireland and Spain would go through a sudden reversal of the role of household debt for domestic demand, from that of a major

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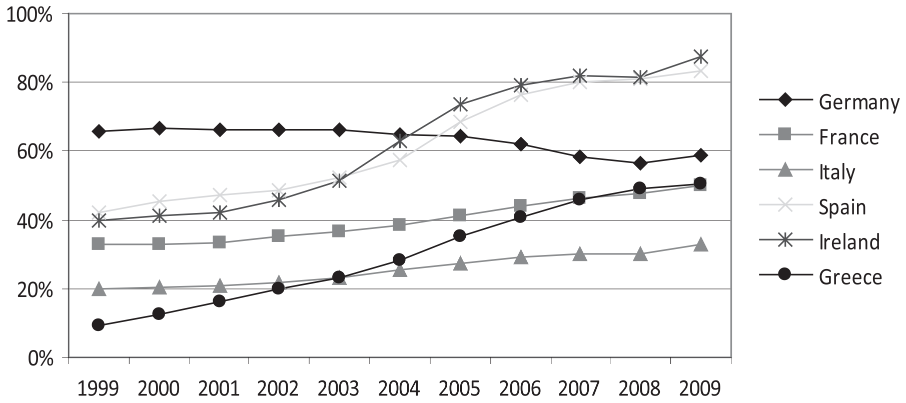
[4] See Athanassiou (2009).

[5] For Ireland see e.g. Bank of Ireland (2005), Kelly, J. and Reilly, A. (2005), OECD (2009) and Law Reform Commission of Ireland (2009). For Spain see e.g. OECD (2008), Febrero and Dejuán (2009).

Figure 7: Household debt-to-GDP ratio (%)



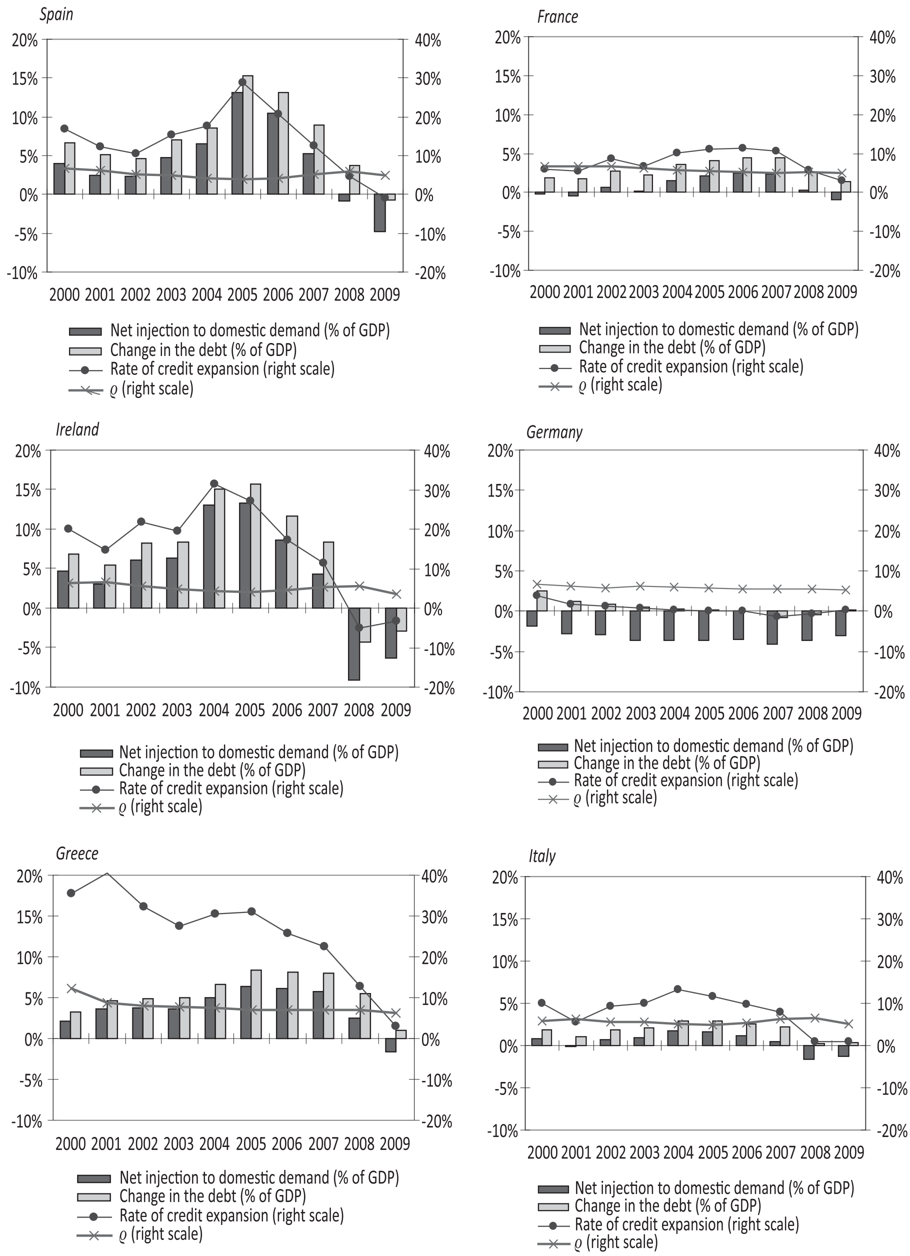
Sources: ECB, Eurostat.

growth driver to a weakening factor. Indeed, as one may observe from Figure 8, which illustrates the path of I for the all countries examined on the basis of calculations[6] using ECB and National Central Bank data on household debt and interest rates, in Ireland and Spain the switch from a positive to a negative net injection of household debt to domestic demand occurred even before that of Greece and was far more pronounced. Having relied to a higher degree upon household borrowing for their growth over the past, and having thus accumulated a larger household debt burden, Spain and, more so, Ireland are facing both a sharper adjustment in household borrowing and higher household interest payments, both leading to a more severe negative injection to demand in the face of the credit crunch.

Turning to France and Italy, credit expansion to households over the period 2000–2007 was much milder, resulting in a relatively moderate rise of their household debt-to-GDP ratios and a positive but comparatively modest net injection of household debt to domestic demand. Following the emergence of the financial crisis, none of the two countries avoided a decline in household credit expansion and a consequent shift in the role of household

[6] The methodology employed for these calculations is the same as that described above for the case of Greece.

Figure 8: Net injection contributed by household debt to domestic demand (I_j) as a % of the GDP, change in the debt ($S_j - S_{j-1}$) as a % of the GDP, rate of credit expansion to households (r), and interest rate on outstanding loans (ϱ)



Sources: Own calculations on the basis of (i) household debt and MFI interest rate data taken from the ECB and National Central Banks and (ii) National Accounts Data taken from Eurostat.

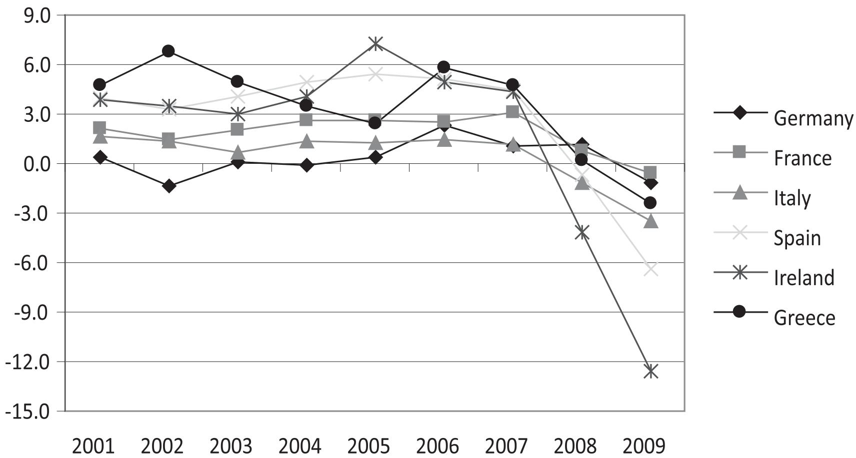
debt for domestic demand from that of a growth driver to that of a weakening factor. However, given their record of modest borrowing over previous years, this shift was on a comparatively limited scale and hence with much lower impact on growth.

A totally different pattern with respect to the evolution of household debt and its effects on demand is represented by the German case. Germany, having set off with a relatively higher debt-to-GDP ratio compared to the other economies considered here, was characterised by marginal or even negative credit expansion to households throughout the period 2000–2009, the result being a persistently negative net injection of debt to domestic demand. While in the German case, household debt has been exercising a weakening effect upon domestic demand for several years, this effect was not intensified in the course of the financial crisis—since a long record of stable household indebtedness implied no necessity for either banks or households to curtail household borrowing.

The above findings, with respect to the evolution of net injection of household debt to domestic demand in different Eurozone economies, lend support to the argument that faster credit growth to households entails much higher gains for domestic demand while it lasts, but also far more severe losses once a credit crunch emerges. Notably, further evidence on the existence of this link between household debt growth and demand appears to be provided by the actual behaviour of domestic demand in the economies considered, particularly during the course of the current recession. Although movements in domestic demand are influenced by many factors other than developments in household debt, the large discrepancies among these economies in the extent of the contraction of their domestic demand over the recession appear to be closely correlated to their differences with respect to the course of household borrowing. Spain and Ireland, which suffered the widest adjustments in borrowing and hence the most dramatic shifts from a positive to a negative I, also experienced the sharpest contractions in domestic demand (see Figure 9), while in France and Italy, where the declines of credit expansion and hence the shifts in I were much milder, domestic demand subsided far less.

Since Germany, France, Italy, Spain and Ireland have all been found to be undergoing a negative injection of household debt to domestic demand, the question that remains to be considered in the framework of the present paper relates to the minimum rate of credit expansion r required in each country in

Figure 9: Contribution of Domestic Demand to GDP Growth
(percentage points, excluding changes in inventories)



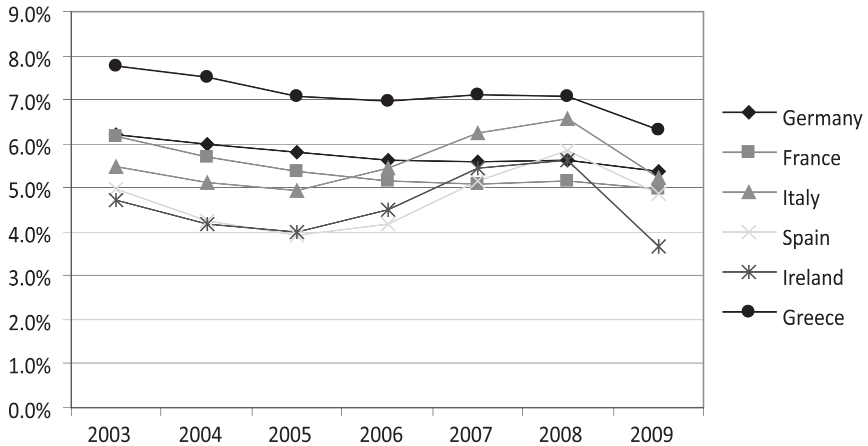
Sources: Eurostat. European Commission forecasts, autumn 2009.

order for this injection to return to positive levels. As implied by equation (2), this minimum rate corresponds for each country to a value just above its ϱ, and therefore in a country with a relatively lower level of ϱ the transition from a negative to a positive I could be achieved through a comparatively smaller percentage rise in household debt.

Even within the Euro zone, where policy interest rates are equal for all member countries, the level of ϱ varies from one country to the other owing to discrepancies in the interest rates charged by Monetary and Financial Institutions (MFIs) and/or differences in the proportion of consumer loans in total household debt. As ϱ represents the weighted average of interest rates on outstanding housing loans and consumer or other loans, the more elevated the level of these rates in a particular country—e.g. owing to an increased probability of default—the higher the level of ϱ. Furthermore, as consumer loans in general carry higher interest rates compared to housing loans, the greater the proportion of consumer loans in total household debt the higher the level of ϱ.

From Figure 10, which displays our calculations on the evolution of ϱ in all the countries considered (on the basis of ECB data on household debt and MFI interest rates on this debt), it is evident that Germany, France, Italy, Spain

Figure 10: Interest rate on outstanding household debt ϱ

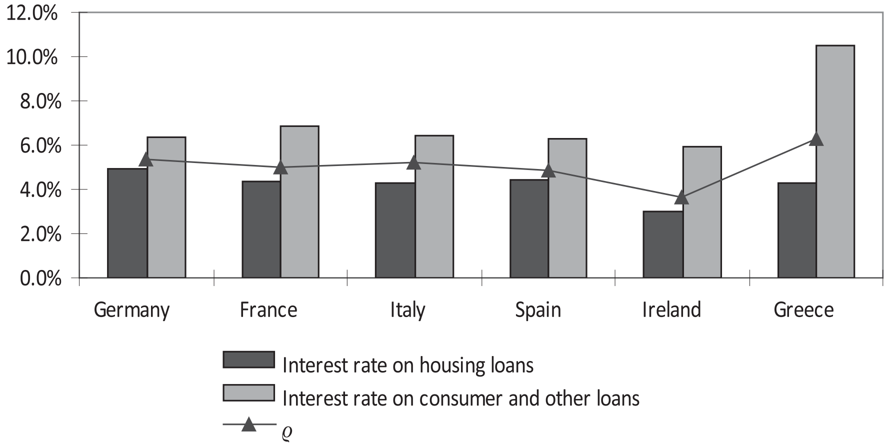


Source: Own calculations on the basis of household debt and MFI interest rate data taken from the ECB's Statistical Data Warehouse.

and Ireland over recent years have all maintained significantly lower levels of ϱ in comparison to Greece. As illustrated in Figure 11, in 2009 Greece's ϱ exceeded by about 0.9 percentage points that of Germany, by 1.1 percentage points that of Italy, by 1.3 and 1.4 percentage points those of France and Spain respectively and by a whole 2.7 percentage points that of Ireland, the reason being Greece's considerably higher interest rate on consumer loans, combined with a relatively elevated proportion of these loans in total household debt.

On the basis of the above differences in the values of ϱ among the countries examined, it follows that even in those countries suffering a much more severe negative injection compared to Greece, the rate of credit expansion r required for this injection to return to positive levels is considerably lower than that required in the Greek case. Most notably in Ireland, where both interest rates on household loans and the ratio of consumer loans in total household debt are comparatively low, current interest rate levels allow for the severely negative injection of household debt to domestic demand to be corrected through a mild credit expansion to households amounting to about 4%.

Figure 11: ϱ and MFI interest rates on outstanding housing loans and consumer & other loans (2009)



Source: ECB's Statistical Data Warehouse and own calculations.

6 Conclusions and Policy Implications

Fast household debt growth over a prolonged period of time entails high gains for domestic demand while it lasts, but also severe losses in the event that it is interrupted. Over the past two years, the financial crisis induced sharp drops in the rates of credit expansion to households in Greece and other Eurozone countries previously experiencing rapid household debt growth. As suggested by the analysis presented in this paper, these drops caused the net injection contributed by household debt to domestic demand to shift from the highly positive levels experienced up to then to levels considerably below zero; thus, the role of household debt in domestic demand in these countries was changed radically, from that of a major growth driver to a weakening factor.

In the case of Greece, the negative injection currently inflicted by household debt to domestic demand may not be as severe as that suffered by certain other Eurozone economies, but its consequences for economic growth should not be underestimated—both because of the high dependence of the country's economic expansion upon developments in household consumption and investment and also because of the fact that, in the current recessionary environment, domestic demand is already under the pressure of several other negative factors. Importantly, as the rise in government spending recedes over the medium term in line with the policy of fiscal restraint required for reducing Greece's public deficit, the effects of household debt stagnation on domestic demand would most likely be more severely felt.

An important implication of our analysis with respect to the minimum rate of credit expansion required in order for the net injection of household debt to domestic demand to return to positive levels is that, in the case of Greece, this rate would be considerably higher compared to the other Eurozone economies examined here. The reason for this discrepancy, which renders more challenging Greece's exit from the current state of a negative impact of household debt developments on demand, lies with the country's considerably higher interest rates on consumer loans and its relatively elevated proportion of these loans in total household debt. The causes of these two characteristics and their significance for Greece's economic development would be very interesting issues to explore in future research.

The above conclusions with regard to the impact of recent developments in household debt upon domestic demand have important implications both for the strategy of banks in Greece and for government policy.

On the part of banks, rising household credit risk, reflected in an increasing ratio of non-performing loans to total household debt, in conjunction with an elevated liquidity risk related to the tensions in money markets and Greek banks' activity in emerging European economies, have rendered the tightening of credit as unavoidable in view of the need to safeguard the banking system's capital adequacy and stability (Bank of Greece 2009a). Nevertheless, in the current recessionary conditions, banks should weigh carefully the risks associated with a moderate easing of the credit crunch against the risks that a halt in household borrowing entails for their balance sheets through its negative impact on demand and growth.

On the part of the government, the decisive role of interest rates in determining the size of the contractionary effect of debt service on demand, calls for policies conducive to the containment of the cost of household credit—particularly in Greece, where interest rates have been kept higher than in other Eurozone countries. A successful policy towards the reduction of Greece's fiscal imbalances would, amongst other benefits, make a crucial contribution in this direction by delivering a reduction in spreads and a rise in Greece's credit rating.

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The Macroeconomic Relationship Between Investment and Saving in Greece

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Abstract

This article examines the investment-saving relationship in Greece through the use of both Error Correction (EC) and Vector Autoregression (VAR) models. The case of Greece is of interest given the relatively small size of its economy, which has recently experienced a significant increase in international mobility of capital through the process of its integration in the European Monetary Union (EMU). The structural break introduced in our model unfolds a relationship whose statistical significance de-escalates through time, verifying the effect of increased capital mobility and mitigating the importance of economic policies encouraging domestic saving as a mechanism to boost investment. Nevertheless, saving still remains valuable as a factor of boosting investment since our VAR analysis underlines the relatively higher contribution of saving in determining investment's variation rather than the other way around.

1 Introduction

The correlation between domestic investment and saving within an economy has long been the subject of extensive academic study. Its implications for the current account dynamics, the international mobility of capital and the economic development and growth are of paramount importance. Cornerstones of world economic policies, like the stability pact of the European Union imposing balanced government budgets, are based on the belief that the economy's saving rate is the primary force of long-term economic growth (Alexiou, 2004).

The classical and neo-classical economists modeled investment as the ad-

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justment of the capital accumulation based on the mechanism of interest rate representing, at the same time, return for saving and cost for investment. Equilibrium is achieved at the level where marginal return equals marginal cost. John Maynard Keynes (1936) and Michal Kalechi (1935) independently developed theories which emphasised the role of expectations on the overall demand within the economy as the main determinant of investment. In simple words, entrepreneurs decide to increase their production capacity when they believe that they can sell the additional products in the market and not necessarily when the cost of investing is low. These arguments were further developed by Duesenberry, Steindl and others (Fazzari and Mott, 1987). One policy implication of this school of thought was that a rise in the saving rate by appropriate government initiatives might accidentally result in reducing the level of investment through a fall in the economy's demand for consumption. Conclusively, saving was not the primary determinant of investment.

Another dimension of the causal relationship between investment and saving is related to the international mobility of capital. The seminar work in this field is the paper by Feldstein and Horioka (1980) which first described what has since been identified as the "Feldstein and Horioka puzzle". The argument was that in the contemporary economies where international trade barriers had been significantly reduced and internal capital was free to flow to other countries, there should have been no statistically significant relation between domestic investment and domestic saving as "saving in each country responds to the worldwide opportunities for investment, while investment in that country is financed by the worldwide pool of capital" (Feldstein and Horioka, 1980). Contrary to expectations, their findings from a cross-sectional examination of twenty three industrial countries for the period 1960-1974 revealed a significant coefficient, not statistically different from one. Subsequent research, extending the period through to the mid 1980s, indicated similar persistence in the correlation between investment and saving (Feldstein, 1983; Feldstein and Bacchetta, 1991).

Nevertheless, critics of Feldstein and Horioka argued that methodological shortcomings weakened the validity of their conclusions. A deficiency often sited was endogeneity, implying that third factors could produce correlation between saving and investment in the presence of perfect capital mobility (Jansen & Schulze, 1996). From another perspective, Murphy (1984) argued that when studying very large countries, an increase in domestic saving reduces interest rates on a worldwide scale, thus having an effect on domestic investment which benefits from internationally lower rates. Obstfeld and Rogoff (2000) measured correlations that, although statistically significant, were clearly lower than those of Feldstein and Horioka twenty years earlier. They concluded that this could be evidence of a de-escalated strength in the correlation over time, plausibly caused by the gradually increased mobility in international capital.

A summary of model specifications used in exploring the relation between investment and saving can be found in Jansen (1996). Usually there is a distinction between long-run, steady-state models which often reveal a one-to-one relationship and short-run more dynamic models where saving and investment could temporarily diverge from their steady-state values. Cointegration features are usually identified in the long-run models. For the more challenging short-run models the most efficient specification has been found to be the EC model. As a rule of thumb, when the results indicate statistically insignificant or even negative correlations, the conclusion is in favour of capital mobility. When high positive correlations are identified, we need further investigation before concluding that capital mobility is weak.

More recent literature, addressing the interdependence between investment and saving, employs VAR models which allow for a more dynamic interaction between the two variables. Such an approach was applied by Alexiou (2004), who investigated the relationship between investment and saving for five EU countries: France, the UK, Belgium, Germany and the Netherlands. His findings cast doubt on the notion that increases in saving would boost investment. Finally, it is useful to introduce structural breaks in the models to examine changes in the robustness of the relation over time.

The organisation of this paper is as follows. Section 2 discusses some methodological issues. Section 3 provides a description of the data, the empirical analysis and the results. Section 4 provides some conclusions and focus on the policy implications of the findings. We give emphasis to policy guidelines relative to Greece's efforts in meeting the EMU requirements.

2 Methodology

National-income accounting identity at the aggregate level states that domestic investment is the sum of domestic saving and net exports:

$$I = S^P + S^G - NX \tag{1}$$

where I is domestic investment, S^P is private saving, S^G is government saving, and NX is net exports.

On an *ex post* basis, a shortfall in domestic saving, as opposed to domestic investment, has no other way than be financed through an equal deficit in the current account. Yet, it stands to reason that the *ex post* relations of the national account identity do not reveal much on the causal directions of the variables. Is it the need for investment that stimulates saving or *vice versa*? What about international mobility of capital and its effect on the investment-saving relation? How important are the policy implications of running a deficit in the government budget and the balance of payments in the short to medium term?

Greece serves as a suitable candidate for examining the investment-saving correlation, since its small size makes international flow of capital more important whereas its recent economic integration in the European Union (EU) accelerated the liberalisation of its otherwise rigid economy over a relatively short period of time. In the past, the Greek economy had been characterised by a widespread use of capital controls, which were progressively dismantled until fully disappearing in 1992[1]. Therefore, Greece's experience could serve as an example for other countries embarking on similar processes of liberalisation and external opening.

The empirical part of our work examines the correlation between investment and saving in Greece for the period 1995Q1 up to 2008Q4, employing

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[1] Tsaveas (2001), who studied the historical evolution of Greece's institutional framework, revealed that a first liberalisation package took effect in Greece since the 1960s, reinforced after its accession to the EU in 1981. By 1986, capital flows for non-residents were liberalised and residents were allowed to invest in European Economic Community and European Investment Bank's bonds. By 1988, residents could invest directly in EU member countries. By 1991, repatriation of profits from direct investments by non-EU residents were fully liberalised and the residents were allowed to buy shares, mutual funds and bonds (with a maturity of at least two years) issued by EU resident companies. By 1992, all remaining current account restrictions were lifted and Greece accepted the obligations of Art. VII of the International Monetary Fund's Articles of Agreement (Mastroyiannis, 2007). This liberalisation process was completed in 2001 with the introduction of Greece in the EMU.

an EC process. This paper partly derives from the methodology of Pelagidis and Mastroyiannis (2003) which studies the case of Greece employing annual data for the period 1960-1997. In particular, by using cointegration analysis with an emphasis on the EC process, Pelagidis and Mastroyiannis identified that investment and saving in Greece are cointegrated and that a significant long-run relationship exists. Short-run correlation decreases in the later years of their sample, indicating that there is a gradual acceleration in the international mobility of capital. A subsequent paper by Mastroyiannis (2007), expanding the period under examination to 2003, revealed a non statistically significant relation in the sub-period 1993-2003 and concluded in favour of the Greek economy's integration in the international capital markets within that period.

Compared to previous studies for Greece, our paper uses the most recent time period and increased data observations, which enable us to examine with more preciseness the investment-saving relationship in Greece and its implications for capital mobility. In addition, the innovation of our paper is the use of quarterly data which is expected to provide more insight into the short-run relation. We identify both a long-run and a short-run model and we enhance our short-run model with a structural break in January 2001 to account for a possible effect of Greece's adherence to EMU on the capital mobility. Finally, this paper takes the investigation one step further, by developing a VAR model to examine the interdependence between investment and saving and whether other factors could have an impact on these two variables.

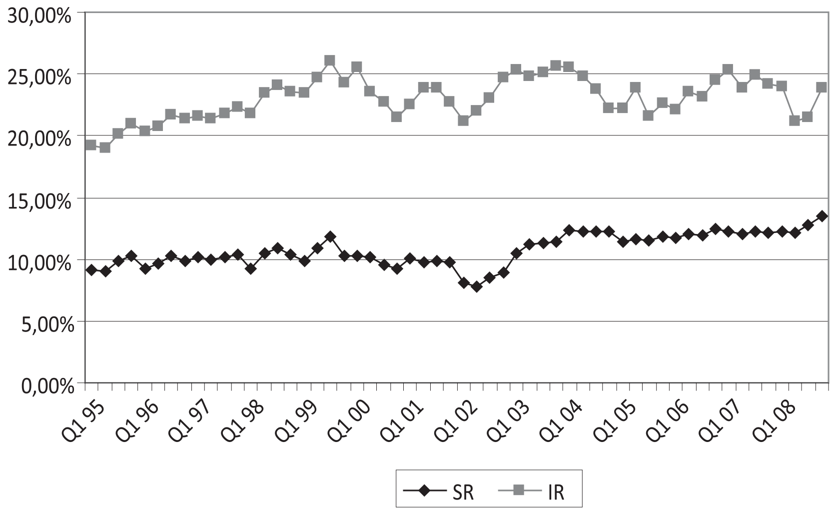
This paper derives also from studies in countries comparable to Greece, including Spain and Norway. Bajo-Rubio (1998), who examined the Spanish economy using annual data for the period 1964-1994, found that saving and investment rates are cointegrated over the long-run, whereas his EC model provided a statistically significant and time-decreasing regression coefficient. Similarly, Jansen and Schulze (1996) found that in Norway the long-run relation is consistent with the steady-state equality, whereas the EC model's specification outperforms all other models. They also demonstrated the importance of introducing structural breaks.

3 Econometric Analysis and Empirical Results

Our empirical analysis is based on quarterly, seasonally adjusted observations on gross domestic investment and gross domestic saving in the period 1995Q1 – 2008Q4. Our main data source is the National Accounts from the National Statistical Service of Greece (NSSG). We have taken care to assemble the longest time series possible (fifty six) in order to increase the power of our econometric tests. We started in 1995 since NSSG does not provide national accounts on a quarterly basis before that date.

The choice of quarterly data is motivated by our expectation to provide more insight into the short-run relation. In addition, by using quarterly data, we are able to use increased data observations in our sample amounting to fifty six, as opposed to only forty eight if we were to adopt annual data starting from the year 1960[2]. We define IR = I/Y as the ratio of investment to GDP and SR = S/Y as the ratio of saving to GDP. Figure 1 plots both series. Looking

Figure 1: Saving and investment rates in Greece 1995Q1-2008Q4



Source: Hellenic Statistical Authority.

[2] In September 2006 the Greek authorities revised the national accounts, increasing the level of real GDP by over one quarter since 2000, although the growth rate of real GDP in subsequent years was little affected. The revision incorporated more up-to-date and direct benchmarks provided by the most recent population census and various enterprise survey data

at the variables' graphic display, we observe that the investment rate is almost double to the saving rate through all time. In contrast, Pelagidis and Mastroyiannis (2003) showed that both variables move much closely together, when plotting their annual time series from 1960-1994.

The visual observation of the time series as well as their autocorrelation graph suggests that the data is not stationary. By experimenting the Augmented Dickey-Fuller (ADF) test on specifications, including and excluding intercept and time trend, we concluded that both series are integrated of order one, I(1). We tested up to ten lags based on the optimum Schwert lag-length selection formula of l = int{12(T/100)$^{1/4}$}, included in Harris (1995). The Johansen cointegration test indicates that the series are cointegrated of order one, C(1). Relevant statistics are presented in Table 1.

Based on the cointegration nature of the two time series and similar to Feldstein and Horioka (1980), Phillips and Hansen (1990), Jansen (1996), Jansen and Schulze (1996) and Bajo-Rubio (1998), the long-run investment-saving equation is specified as:

$$IR_t = a + \beta SR_t + \varepsilon_t, \tag{2}$$

where IR and SR denote the share in output of investment and saving respectively, and ε is the disturbance. The analytically relevant investment-saving correlation is the parameter β.

We have adjusted equation (2) to a first order autoregressive equation AR(1), due to the serious residual autocorrelation identified in its estimation. Such specifications are common for the economy of Greece (Kasimati and Dawson, 2009). Therefore, the equation (2) becomes:

$$IR_t = a + \beta SR_t + \gamma AR(1) + \varepsilon_t \tag{3}$$

A value of β close to zero indicates perfect capital mobility where an in-

which were not previously available (OECD, 2007). Although quarterly data in the period 1995-1999 has not yet been re-adjusted by the NSSG, the fact that we use the investment and saving as a share of Gross Domestic Product (GDP) reduces compatibility problems. Throughout this paper, unless explicitly noted, such ratios are evaluated with respect to the revised GDP.

Table 1: Augmented Dickey-Fuller (ADF) test on levels and first differences & Johansen Cointegration Test

ADF Test		Unit root with drift & time trend	Unit root with drift	Unit root
ADF Critical values at 1%		(4.13)	(3.55)	(2.60)
(A) Levels SR				
	Unit root:	ADF: -2.46	ADF: -1.45	ADF: 0.87
	Drift:	p-value: 0.02	p-value: 0.13	
	Time trend:	p-value: 0.05		
IR				
	Unit root:	ADF: -3.25	ADF: -3.22	ADF: 0.12
	Drift:	p-value: 0.001	p-value: 0.002	
	Time trend:	p-value: 0.273		
(B) First differences ΔSR				
	Unit root:	ADF: -7.37	ADF: -7.43	ADF: 7.38
	Drift:	p-value: 0.86	p-value: 0.34	
	Time trend:	p-value: 0.74		
ΔIR				
	Unit root:	ADF: -8.22	ADF: -8.18	ADF: -8.22
	Drift:	p-value: 0.22	p-value: 0.55	
	Time trend:	p-value: 0.28		
Johansen Cointegration Test Observations: 56				
Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesized No. of CE(s)
0.246924	19.28506	18.17	23.46	None*
0.058976	3.404074	3.74	6.40	At most 1

*(**) denotes rejection of the hypothesis at the 5% (1%) significance level.
L.R. test indicates 1 cointegration equation at the 5% significance level.

crease in the saving rate in Greece is not necessarily invested within the country. Instead, it is distributed to the rest of the world based on the elasticity of the other countries' marginal product of capital. The smaller and more open the country, the closer the coefficient to zero. In contrast, if the coefficient β is close to one, we could either draw the conclusion that there is no international mobility of capital or that other factors provoke the correlation in the presence of full capital mobility (Jansen and Schulze, 1996).

The results of the equation (3) regression estimation are presented below:

$$\begin{array}{ll} IR_t & = \; 0.16 + 0.66SR_t + 0.71AR(1) + \varepsilon_t \\ t\text{-}Stat: & \quad (6.73) \quad (3.09) \qquad (7.28) \end{array} \tag{4}$$

Adjusted R^2 = 0.63
D-W = 1.95
Prob F = 0.00
Akaike = -6.28
Prob BG(1) = 0.12
Prob BG(2) = 0.28.

The explanatory power of the equation, measured by adjusted R^2, jumped to 0.63 from initial 0.28 in the model without AR(1). Similarly the Akaike test improved to -6.28 from initial -5.55. We ran the regression through the White method to correct the standard errors for heteroskedasticity which had been identified in early experimentations. We also applied Breusch–Godfrey tests (BG) for testing residual autocorrelation since the existence of lagged dependent variable makes the Durbin-Watson (D-W) test less reliable.

The estimation results are similar to those of Bajo-Rubio (1998) for Spain, with Wald test not rejecting the null hypothesis of β =1. Therefore the coefficient on SR is not significantly different from one, which confirms, once again, the existence of cointegration between savings and investment rates.

For our short-run model we selected an EC specification as described in Jansen (1996), Jansen & Schulze (1996), and Pelagidis and Mastroyiannis (2003) and it is presented in equation (5).

$$\Delta IR_t = a + \beta\Delta SR_t + \gamma(SR_{t\text{-}1} - IR_{t\text{-}1}) + \delta SR_{t\text{-}1} + \varepsilon_t \tag{5}$$

Coefficient β measures the short-run response of investment to a unit change of savings. Coefficient γ indicates whether the two series are cointegrated, and in addition provides an estimate for the speed of adjustment of investment to the previous period's deviation from the long-run equilibrium. Significant non-zero values for γ imply that saving and investment rates are cointegrated.

One of the theoretical advantages of this specification is that a long-run, steady-state solution can be derived:

$$\alpha + \gamma\left(\overline{SR} - \overline{IR}\right) + \delta\overline{SR} = 0, \tag{6}$$

where bars denote long-run values. Coefficient δ gives information about the time series properties of the current account. If δ=0, the current account ($\overline{SR} - \overline{IR}$) equals some constant in the long-run. In other words, the current account is a stationary variable, fluctuating around a constant. If α=δ=0, then the current account fluctuates around zero. In both cases a one-to-one long-run relation exists between SR and IR, which is perfectly compatible with full capital mobility. Note that equation (2) can be also derived by equation (5), by setting β–δ =1 and γ =1 (Jansen, 1996; Jansen and Schulze, 1996).

The results of the regression estimation for equation (5) are presented below:

$$\begin{array}{lllll} \Delta IR_t = & 0.06 + & 0.80\Delta SR_t + & 0.27(SR_{t-1} - IR_{t-1}) & - 0.27SR_{t-1} + \varepsilon_t \\ \textit{t-Stat:} & (3.43) & (3.59) & (2.86) & (-2.36) \end{array} \tag{7}$$

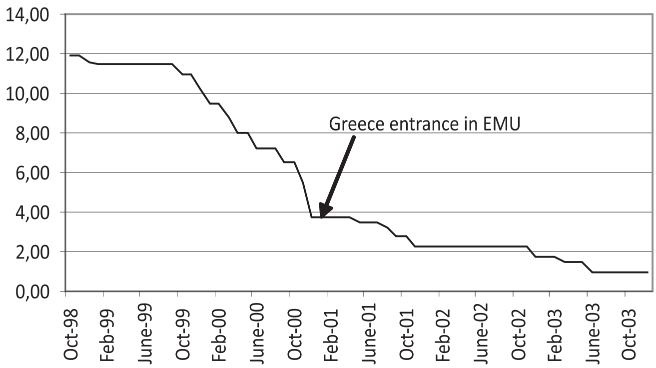
Adjusted R^2 = 0.30
Prob F = 0.00
D-W = 2.02
Prob BG(1) = 0.06
Prob BG(2) = 0.10
Prob White = 0.12.

All coefficient estimates are statistically significant at the 5 percent level and all but δ at the 1 percent level. The residual tests do not reveal any significant issue of serial correlation or heteroskedasticity and the diagnostic tests indicate that equation (7) is well specified. The economic interpretation of our results are firstly, that there is a short run positive correlation between changes in saving and investment, secondly, that the two variables are cointegrated, and finally that there is a deficit in the current account in the long run. The signs of the coefficients and our findings are consistent with those of Pelagidis and Mastroyiannis (2003).

As a next step, we have introduced dummy variables to account for different regimes in the economy. Specifically, we experiment with a structural break in January 2001, the date when Greece joined the EMU. Following January 2001 we would expect a significant increase in the mobility of capital as opposed to a more rigid framework experienced in the earlier period of our sample.

An aspect of this development, which also motivates our choice for regime change in 2001, is demonstrated in Figure 2. We observe a sharp de-escalation of the Central Bank's overnight rates from 12.00 percent in 1998 down to 3.75 percent in December 2000, to be harmonized thereafter with the European Central Bank (ECB) rates. Accordingly, the expectation would be for a more weak relation between investment and saving since 2001, due to the ability of domestic entrepreneurs to finance their investments from abroad and the alternative option of the domestic households to transfer their savings to the international capital markets.

Figure 2: Greece's Central Bank Overnight Deposit Rate (%)



Source: Bank of Greece, ECB

In our model we set D1 = 1 for the period 1995Q1 up to 2000Q4, and zero otherwise and D2 = 1 for the period 2001Q1 up to 2008Q4 and zero otherwise. The re-estimated equation is presented below:

$$\Delta IR_t = 0.06 + 0.92\mathrm{D1}\times\Delta SR_t + 0.67\mathrm{D2}\times\Delta SR_t + 0.26(SR_{t-1} - IR_{t-1}) - 0.26SR_{t-1} + \varepsilon_t \quad (8)$$
$$t\text{-}Stat \quad (3.13) \qquad (2.96) \qquad (2.00) \qquad (2.54) \qquad (-2.26)$$

Adjusted R^2 = 0.30
Prob (F) = 0.00
D-W = 2.04
Prob BG(1) = 0.06
Prob BG(2) = 0.11

Prob White = 0.24.

Similar to Jansen (1996), Bajo-Rubio (1998), Pelagidis and Mastroyiannis (2003) the coefficient of savings de-escalates over time (0.92 for the first period and 0.67 for the second). However, contrary to the majority of existing literature, which consistently demonstrates a statistically significant relation throughout the sample (albeit at reduced coefficient values), our model provides a coefficient for the late period (Dummy 2) which is marginally not significant (p-value of 0.051). This suggests that in the period following Greece's EMU enrollment, the international capital mobility increased to such a level that domestic saving might not be any longer the primary pre-requisite of domestic investment. This result also parallels the results reported by Mastroyiannis (2007).

The analysis so far provides descriptive statistics as well as econometric equations which we implemented to investigate the saving-investment relationship. As a next step, we develop a VAR model to investigate the dynamic interaction between investment and saving[3]. In addition, we suspect that the determination of both investment and saving involves other factors that may have a significant impact on both variables. Similar to Alexiou (2004), we accompany the development of our VAR model with the expansion of the set of our explanatory variables, so that a more precise picture emerges.

Therefore, we add two more variables on investment and saving, one monitoring the interest rates and one measuring profitability changes in the economy, thus constructing a four endogenous variable model. The three-month Treasury Bill rate of the Greek government is used as a proxy for interest rates since, according to the neoclassical theory, it serves as a means of equilibrating saving and investment (Alexiou, 2004). As a measure of profitability, we have used the return of the General Index of the Athens Exchange, as it represents the overall market performance. The aforementioned data are taken from the reliable and well-known financial database, Bloomberg.

Our target, while applying the VAR approach, is on discussing the decomposition of the variance of the variables in the system over various horizons. By subjecting all endogenous variables in the VAR model to standard

[3] For more on VAR models see Campbell (1991) and Sims (1980).

deviation shocks we can derive information about the relative significance of each random innovation to the variable in the VAR. The significance of this task rests on the magnitude of the percentage of the variance of each endogenous variable. A high percentage of variance over a long period implies that the variable is largely exogenous to the system. In contrast, a high percentage of variance that declines fairly quickly with time implies that the variable is significantly conditioned by the variables in the system (Alexiou, 2004). The general structure of our VAR model is:

$$A(L)y(t) = \varepsilon(t) \tag{9}$$

where:
$A(L)$ is an $m \times m$ matrix polynomial in the lag operator L;
$y(t)$ is the $m \times 1$ observations vector; and
$\varepsilon(t)$ is the $m \times 1$ vector of structural disturbances.

The variance decomposition of our model is presented in Table 2. This effectively separates the variation of each endogenous variable into the component shocks to the VAR, for periods from one to five lags.

Table 2: Variance decomposition of responses to innovation in VAR

	% Variance Decomposition Sav.			% Variance Decomposition Inv.		
Periods	Sav.	Inv.	Others	Sav.	Inv.	Others
1	100.0	0.0	0.0	22.6	77.4	0.0
2	93.8	4.0	2.2	19.8	77.5	2.7
3	91.9	4.3	3.8	18.1	77.2	4.7
4	90.4	5.7	3.9	16.9	77.8	5.3
5	88.5	7.4	4.1	15.9	78.1	6.0

Note: The rest of the variables is reflected by "others".

A review of Table 2 reveals that the portion of saving variance due to its own innovation remains relatively high (88.5 percent at 5th period). Furthermore, the contribution of investment in the variation of saving, although increased over all five periods, remains relatively low (7.4 percent in 5th period), whereas the rest of the factors (interest rates and profitability) are even less significant (4.1 percent in 5th period).

The portion of investment variance due to its own innovations remains almost unchanged throughout the period (77 percent to 78 percent), and lower than the saving variance due to its own innovations described above. Saving innovations appear more significant for explaining investment variance than investment innovations for saving. Similarly to saving variance decomposition, the interest rates and profitability do not contribute significantly in the variation of investments.

Alexiou (2004), who empirically investigated five EU countries, found similar results for France, whereas for countries like the UK, Belgium, Germany and the Netherlands he identified either a higher relative contribution of investment innovations to saving variance, or that the relationship was reversed over time. His argument, that different financial structures in different economies should be accountable for such patterns, applies also to Greece. Overall it seems that saving is more significant in affecting the behaviour of investment than investment in affecting the behaviour of saving.

4 Conclusions and Policy Implications

The high degree of correlation between national saving and investment rates, observed both for cross-sections of countries and for time series of individual countries, is one of the most stable empirical regularities in international macroeconomics.

The empirical investigation of the investment-saving relationship in the Greek economy is of interest for a number of reasons. Firstly, the efficiency of the economic policies depends on the level of capital mobility. Secondly, the case of Greece could serve as an example for new EU countries and other candidates of similar size that will face similar processes regarding their participation in international capital markets. Thirdly, Greece's EMU enrollment in 2001 allows us to examine whether structural breaks in the data can provide an answer to the "Feldstein-Horioka puzzle".

In this paper, the investment-saving correlation is examined within the context of an EC and VAR model, using Greek quarterly data for the period 1995Q1-2008Q4. The paper is motivated by the observation that none of the existing studies, pertinent to the Greek economy, use quarterly data in their empirical analysis, as well as a VAR approach. The usual short-run and long-run positive correlation has been identified, together with a persistency in the presence of current account deficit. In line with existing literature, a de-escalation of the magnitude of the correlation through time is demonstrated. Finally, our structural break reveals a marginally not significant relation since 2001 when Greece entered EMU.

This suggests that within the context of the harmonised EURO economic area and the subsequent rapidly developed capital mobility, Greece has enjoyed higher capacity of financing its domestic investments through its current account deficit than in the past. Note that according to NSSG (2007) a portion of 71 percent of the country's imports in 2007 came from other EU countries, mostly entailing no currency conversion. Current account balances (or imbalances) for Greece are gradually shifting to the economic dynamics of regional rather than international nature. This alleviated the importance of running balanced government budgets for the short-run, as a potential deficit could be offset by more sustained, than initially expected, foreign capital inflows, particularly in areas where Greece enjoyed an internationally competitive advantage, like tourism and shipping, or as the country went through major infrastructure and other capital build up. An example is the surge in the preparatory investments for the Olympic Games in Athens which took place in the period 2001 – 2004 (Kasimati and Dawson, 2009).

By further developing this relation through a VAR model, we identified a greater contribution of saving innovations in determining investment variance than the relative contribution of the investment innovations to saving variance throughout the entire period. This suggests that policies encouraging saving are still valuable for boosting investment in the economy. In addition, the evidence obtained indicates that the contribution of other variables –the interest rate and profitability– to saving and investment variance remain very low throughout all periods.

Finally, attention should be placed on the persistent and significant deficit in Greece's current account, since saving is almost half the size of the investment throughout our whole period. In the long-run this lack of competitiveness, no longer able to be remedied through a currency devaluation, could destabilise the Greek economy, particularly if accompanied by government budget deficits that further reduce overall saving in the economy. The problem could be more acute in a situation of significantly reduced ability of the country to borrow from the international markets due to increased public debt. This raises the issue of breaking down the saving / investment relation between the public and the private sector instead of aggregating as in our current study. The different dynamics of public versus private saving and a possible "crowding out" effect due to the surge in the public deficits could offer further insights into the Greek situation.

Relative to the efforts of Greece in meeting EMU requirements, policy makers should focus on further reforms targeted at attracting foreign investments. Although the required structural reforms are not within the scope of this paper, it must be noted that policy makers should focus on attracting foreign capital, in order not to rely mostly on domestic savings. Structural reforms, such as the reduction of taxation on foreign capital, the limitation of procedures for business registration, the ease of regulation of professional services, as well as the enhancement of labour market flexibility could help establish favourable conditions for capital inflows. These policy options could be significantly used to attract inflows, allowing the country to take advantage of the global financial markets.

Our empirical results add a small piece of evidence to the existing literature on the Feldstein-Horioka criterion, indicating that Greece has significantly increased its integration in the international capital markets since 2001. However, our findings are subject to two constraints. Firstly, the results may be fragile due to a less than adequate number of quarterly data observations. Secondly, a concern arises related to the possible impact of Greece's structural funds received from the EU on our findings. Therefore, future research is required to address the aforementioned issues.

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Dating the Greek Business Cycle: Is there Evidence on a Late 2000s Recessionary Regime for the Greek Economy?

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Abstract

In this paper we establish a chronology for the Greek business cycle from early 1970 to early 2010. Since there is no official business cycle dating in Greece, the provision of a robust and reliable chronology for Greek business cycles is a necessary tool for monitoring the developments in aggregate Greek economic activity. Within this framework and, in light of the late 2000s global recession, we address the question of whether there is evidence for the Greek economy experiencing a recessionary business cycle regime in the late 2000s. We apply the Bry and Boschan (1971) procedure and related algorithms modified by Harding and Pagan (2002, 2006). We use quarterly GDP as well as monthly data on selected indicators covering important sectors of Greek economic activity. We are able to outline stylised facts of the Greek business cycle for a time period of over 40 years of economic activity by providing the exact turning point dates and information on several business cycle and phase characteristics for Greece. Among other things, our results indicate that the Greek economy is undergoing a recessionary business cycle regime in the late 2000s.

1 Introduction

The developments in cyclical economic activity worldwide in the late 2000s, are evidence, once again, that recessions, as significant declines in the level of economic activity, remain a reality. As in similar occasions in the past, such developments tend to cause a revival of interest in issues related to the analysis and measurement of the recurrent but not periodic fluctuations in

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overall economic activity, i.e., business cycles. One important branch of these areas of interest refers to the provision of business cycle reference chronologies, which establish the turning points in general economic activity and, hence, provide the exact dating of cycles and their phases. More specifically, in accepting the classical business cycle definition by Burns and Mitchell (1947), which pictures expansions and recessions as the two distinct phases of the cycle, attention is directed toward the points in time at which the switches between phases take place. These switches, or turning points, present the limits or boundaries of business cycle phases and their grouping in time results in the so-called business cycle chronology. The significance of the derivation of the timing of the switches between expansions and recessions is multidimensional. It is related to practical applications such as economic series classification according to their timing or forecasting exercises. At the same time, the ability to obtain knowledge concerning the state of the economy is particularly useful for individuals, institutions, enterprises and not least for public authorities. In line with this argumentation, experts at the US National Bureau of Economic Research (NBER) determine, with considerable historical continuity, business cycle turning points on the basis of consensus. This chronology is basically considered official and has come to constitute the cornerstone for any reference and comparison with regard to the dating of the US turning points in general economic activity.

Nonetheless, the derivation of a reference business cycle chronology is not self-evident and does not emerge out of clear-cut procedures. In conjunction with difficulties related to data availability and reliability restrictions, official dating institutions are, in most cases, absent. Greece is not an exception and is furthermore characterised by a very limited number of relevant investigations on issues referring to the establishment of a robust business cycle chronology for Greek economic activity. Most of the related existing research is conducted within the context of deriving individual or aggregate chronologies for the European Union and Euro-zone countries. In order to fill this gap, the aim of the present work is to formally derive accurate business cycle turning points for Greek economic activity over a long historical time period. We apply different procedures for the dating of the Greek business cycle to check whether the results enforce the emergence of a consensus on the exact turning point dates. To our knowledge, no applications can be found in the related empirical literature directly applying alternative procedures for dating the

Greek business cycle. Our aim is to avoid relying solely on the popular but simplistic two-quarters[1] rule for business cycle phase identification. For that reason we apply three non-parametric procedures as introduced by Bry and Boschan (1971) and modified by Harding and Pagan (2002, 2006). Moreover, in order to address the argument of inadequacy of the use of any single series, such as GDP[2] or IP, we attempt to provide business cycle turning points which are determined by using the information contained in several single economic time series for the Greek economy. The time period investigated starts in January 1970 (or the first quarter of 1970 for quarterly data) and ends in March 2010 (or the first quarter of 2010 for quarterly data). Our results support the suggestion of a robust business cycle reference chronology for Greek economic activity across the total time period investigated. This chronology is consistent with widely accepted stylised facts of the historical Greek business cycle. The obtained turning points are further used to comment on specific business cycle characteristics, which are, also, in accord with internationally established features, such as asymmetry between expansions and contractions. Finally, the derived chronologies all confirm the fact that the Greek economy entered a recessionary regime during the year 2008 and through to March 2010, there is no evidence suggesting a recovery.

The rest of the paper is organised as follows. Section 2 provides a literature review. Section 3 outlines the methodology applied and also introduces the data used. Section 4 presents and discusses the results. Section 5 concludes.

2 Literature Review

Even though no official business cycle dating is provided in most countries, numerous empirical applications exist for most advanced economies which attempt to accurately establish business cycle chronologies. Such ap-

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[1] As Harding and Pagan (2003a, p. 22) indicate, some attribute this rule of two quarters of negative growth signalling the termination of an expansion to Arthur Okun (see, for example Harding, 1997), while this actually remains unclear. Others (for example, Layton and Banerji, 2003) attribute this rule to Shiskin.

[2] For a more recent discussion on the use of GDP for business cycle dating and, more generally, the conceptualisation of the cycle, see Layton and Banerji (2003).

plications are distinguished in terms of various factors pertaining, for example, to the underlying concept of the business cycle itself, distinct methodologies or varying data bases. Chronologies are established on the basis of the classical cycle or the growth cycle concept.[3] Procedures for dating business cycles vary from simple ad hoc rules or even graphical inspection to sophisticated parametric applications. A number of procedures rely on the popular NBER dating methodology, even though it is often criticised on the grounds of being non-transparent or reproducible, and subject to significant delays in announcements (see for example Chauvet and Piger, 2003). As a result, a number of business cycle analysts suggest and apply alternative, more transparent and consistent procedures for business cycle dating, on the basis of formal algorithms, which mostly involve automated procedures, or statistical models. As to the data used, single or multiple series may be preferred and frequencies may vary. At the same time, some applications rely on a single methodology for chronology derivation, while others consider comparative exercises more preferable. Furthermore, established chronologies may refer to single countries but also to groups of countries such as the European Union or the Eurozone groups.

With reference to simple rules, in Birchenhall et al. (2001), for example, a simple mechanical rule is applied to UK quarterly GDP over the sample 1963-1999 in order to obtain a set of acceptable turning points. Harding (1997) proposes a dating algorithm which uses terminator sequences and can be easily translated into statistical statements on the probability of peaks and troughs. The obtained dates for the Australian coincident index and the time period 1950-1997 are compared to the corresponding dates resulting from the application of the NBER procedure (obtained by Ernst Boehm). Mylonidis (2003) uses several criteria to obtain a recession chronology for Greek economic activity, on the basis of quarterly IP data and the time period 1962(q1)-2001(q4).

[3] In the present work the classical business cycle concept is chosen (see also Section 3). The focus in the present section is, hence, on related literature excluding references to growth cycle dating. This is done also to avoid the necessity to refer to issues such as the choice and/or the effects of detrending.

The use of the original or modifications of the Bry and Boschan (1971) (BB) automated algorithm for business cycle dating finds a great number of applications in the related literature. Artis et al. (1997) follow a simplified version of the BB procedure to establish business cycle chronologies for the G7 and most major European countries. They use IP data over the time period 1961-1993 to identify turning points and show, among other things, that business cycles generally exhibit asymmetry. Christoffersen (2000) uses monthly IP data from 1960 to 1998 for Finland, Norway, Sweden and Denmark (data from 1974) to date business cycle turning points for the Nordic countries. The BB algorithm is applied and the obtained chronologies indicate substantial differences among the investigated countries, especially in terms of the duration and frequency of contractions. With the aim of dating the British business cycle, Artis (2002) applies an algorithm, which is related to the BB procedure, on monthly GDP data for the UK and the time period 1974-2002. The dates identified by the selected procedure appear to correspond to the respective dates produced by the Economic Cycle Research Institute (ECRI). With the aim of forecasting turning points in the Belgian business cycle, Bodart et al. (2003) and Bodart et al. (2005) initially use quarterly real GDP data to provide a reference cycle chronology over the period 1980-2002 and 1980-2003, respectively, since there is no such universally accepted reference cycle for Belgium. For that purpose, the authors apply the quarterly version of the BB algorithm (BBQ) according to Harding and Pagan (2001). The same version is used also by Krolzig and Toro (2005) to detect business cycle turning points for a subset of six EMU member countries and the time period 1970-1996. In an attempt to establish the importance of nonlinearity in reproducing business cycle features, Morley and Piger (2005) apply a modified version of the BBQ algorithm on US quarterly real GDP data for the sample period 1948(Q4)-2003(Q2). The resulting turning point dates imply a significant improvement over the BBQ algorithm in matching the NBER dates and the produced business cycle features appear to be closer to the those using the NBER dates.

Among parametric procedures for business cycle dating, the Markov-switching (MS) model is mostly applied to identify business cycle turning points. Bodman and Crosby (2000) apply Markov-switching models to generate business cycle dates for the Canadian economy and the time period 1947-1997. Quarterly GDP data are used and the obtained chronology is compared with other existing chronologies for Canada. The results suggest similarity among chronologies obtained using distinct methodologies, while the constructed business cycle dates correspond closely to those resulting from the application of the simple 'two-quarters' rule. A dynamic Markov switching factor model is applied for Japan by Watanabe (2003) on different data sets of macroeconomic variables. For the time period 1975-2000, the obtained dates correspond to the reference dates of the Economic and Social Research Institute in the Cabinet Office. Using real GDP and employment data, Chauvet and Piger (2003) investigate the real-time performance of a Markov-switching model for replicating the NBER business cycle chronology over a time period of 40 years. On the basis of data that would have been available at the time the dates were initially established, the authors conclude that the applied model appears to capture the features of the NBER chronology accurately and swiftly. They stress this timing advantage, which can be very notable, especially when it comes to dating business cycle troughs. Again within a real-time but now a multivariate context, Chauvet and Piger (2007) compare the business cycle dating performance of a non-parametric algorithm and a parametric Markov-switching dynamic factor model (DFMS) and conclude that the DFMS model performs better. As a whole, they suggest that both approaches accurately identify turning point in real time, with dates close to those established by the NBER and significant improvements in the speed at which troughs are identified. Chauvet and Hamilton (2005) compare different formal quantitative algorithms for business cycle turning points identification. A univariate parametric representation and a multivariate MS approach are presented and implemented. They both appear to convey similar information, even though they are occasionally complementary. Golosnoy and Hogrefe (2009) propose a novel sequential approach for providing timely signals about changes of the business cycle phase and use monthly data for the US and the time period 1967-2008. The suggested procedure is found to be useful when compared to the DFMS approach and able to provide quick and precise warnings about business cycle peaks and troughs.

As indicated in the above, a number of studies apply, for reasons of comparison, different methodologies in order to determine business cycle turning points. In a review, Boldin (1994) compares the performance of five different dating procedures for the US business cycle on the basis of specific criteria in order to evaluate their usefulness. The author considers the NBER business cycle dating methodology, GDP growth rules, peaks and troughs of the Commerce Department's business cycle indicators, Stock and Watson's (SW) experimental business cycle indices and a Markov switching model for unemployment. The SW, MS, but also the NBER procedures appear to perform well. As a whole, the author concludes that none of the procedures are clearly superior and supports the view of complementarity of procedures in building a consensus. Layton (1996) and Layton (1997) compares the turning points obtained by the application of the MS model to those produced by the BB algorithm, using the monthly US and Australian Coincident index, respectively. In both cases, there is significant correspondence between the chronologies under examination. In an application for the Netherlands and the time period 1815-1913, Bonenkamp et al. (2001) compare different dating procedures on the basis of annual real GDP data. The BB algorithm is favoured over a naïve method in dating the classical business cycle. Harding and Pagan (2002) compare the non-parametric BBQ dating algorithm with the MS approach. On the basis of criteria such as transparency, robustness, simplicity and replicability, they conclude that the non-parametric method appears to be preferable.[4] In order to provide evidence against the use of a single series, such as GDP, and against the application of the simple 'two-quarters' dating rule, Layton and Banerji (2003) apply different dating procedures to different US data series. More specifically, on the basis of quarterly GDP, a constructed monthly GDP series and a constructed index of coincident economic indicators the authors apply the two-quarters rule and the BB procedure. In an attempt to compare alternative business cycle dating procedures for the Italian business cycle, Bruno and Otranto (2004) and Bruno and Otranto (2008) apply five different methodologies to obtain business cycle chronologies which are then compared with the official ISAE dating. The approaches are selected to cover both the parametric-non parametric and the direct-indirect procedure classification. It is shown that the differences in dating that are detected can be reduced significantly when the methods are complemented with the diffusion index. In investigating business cycle independency or synchronisation in the G7, Bodman and Crosby (2005) use three

[4] See the related debate with Hamilton, as expressed in the comment by Hamilton (2003) and the rejoinder by Harding and Pagan (2003).

different methods to construct business cycle chronologies and date recessions, in order to check the robustness of the conclusions drawn. The first is the one developed at the NBER, the second applies the simple rule of recession onset signaled by at least two successive quarters of negative growth in GDP and the third uses a two-regime Markov-switching model. McAdam (2007) applies three different dating algorithms in order to lend support to his analysis on the potential cycle synchronisation between the US, Japan and the Euro area. On the basis of quarterly real GDP data for the time period 1970-2003, the comparative application of the extension by Harding and Pagan of the BB algorithm, the two-quarters rule and the MS regressions leads to the conclusion that turning points are quite robust across methods. Schirwitz (2009) reviews and applies a number of different dating procedures for dating the German business cycle. Using quarterly GDP data for the years 1970-2006, she applies the two-quarters rule, the modified rule by Boldin, the BBQ algorithm and the MS approach. The results suggest that there is general agreement on the approximate timing of economic downturns for the German case.

The dating of business cycles is not confined to individual countries, but instead sometimes is extended to specific country groups. Harding and Pagan (2001) apply the non-parametric BBQ dating algorithm in order to construct business cycle information for the Euro area. The turning points for six Euro area countries are obtained in a first step using Euro area aggregate GDP data for the time period 1970-1998. In a second step, individual country GDP data are used to obtain turning points which are then aggregated to produce a reference cycle. The close correspondence of the results indicates that the business cycle is robust for the Euro area independently of whether it is determined through turning points in the aggregate measure or the aggregation of turning points (which is also the case for the US and Australia). Krolzig (2001) provides a chronology for the Eurozone business cycle on the basis of the Markov-switching approach. He uses aggregated and single-country Eurozone quarterly real GDP data for the sample period 1980-2000. Biscarri (2002) applies the BB algorithm (a modified version, as operationalised by Artis et al. (1997)) in order to locate turning points for a group of fourteen European countries and the US. He uses IP data and the period of examination, even though varying, is stretched in most cases over thirty years. In an exercise which aims, among other things, at dating the Euro area business cycle, Artis et al. (2003) use an non-parametric algorithm, on the basis of the theory of Markov chains, which is related to the BB dating rule in order to provide turning points for the Euro area and the main Euro area countries (see also Artis at al., 2004c).[5] Their analysis is based on two alternative measures of Euro zone GDP data, covering the 1970-2001 and 1980-2001 time periods, single countries GDP data starting from 1970 and monthly IP data with differing sample periods for the individual countries under examination. Adopting the same dating strategy (modified to deal with seasonal adjustment) as in Artis et al. (2003), Artis et al. (2004b) use IP data in order to characterise the business cycle for EMU accession countries. Artis et al. (2004a) identify and date a European business cycle using Markov-switching autoregressions. Using both IP and GDP data for the time period 1970-1996 and nine European economies, the authors offer the respective business cycle dating and find both chronologies to be consistent. Bengoechea and Perez-Quiros (2004) use, in a comparative turning points analysis, both the BB algorithm and the MS approach in order to date the Euro area business cycle. With the focus on defining the state of the economy and predicting in real time, they rely on the Euro area IP index and the Euro area Industrial Confidence indicator. Mönch and Uhlig (2005) produce a monthly business cycle chronology for the time period 1970-2002 and the Euro area (12 member countries as of January 2002). They apply the BB procedure, augmented with an amplitude/ phase-length criterion, on the basis of different monthly GDP series for the Euro area. The obtained results indicate that the dating decisions of the CEPR are well replicated, something that is also confirmed for US data and the NBER dating decisions. Anas et al. (2007) discuss and review different dating procedures and their classifications with the aim of suggesting a turning point chronology for the Eurozone. In their application, they choose a non-parametric algorithm, on the basis of the BB dating rule, and propose dating chronologies using aggregate IP, GDP and employment Eurozone data. With the aim of providing a monthly business cycle chronology for the EU15,

[5] In a related work by Proietti (2005), a dating algorithm is developed, also on the basis of a Markov chain. Its application is illustrated by using the monthly Italian index of IP for the period 1981-2002 and a synthetic index obtained via dynamic factor analysis by the use of four US coincident indicators for the time period 1959-2002.

Billio et al. (2007) reconstruct GDP and IP data back to 1970 and use various procedures to date turning points. Within this framework, the authors compare a non-parametric (BB algorithm), a univariate Markov-switching and a bivariate Markov-switching dating procedures and find reference dates very close to those estimated on the Euro area. Within the context of investigating issues related to the question of business cycle synchronisation, Chen (2007) uses both classical and modern business cycle dating approaches to identify business cycle turning points based on multivariate coincident macroeconomic variables. The procedures applied include the BBQ algorithm, the multivariate dynamic factor model and the multivariate dynamic factor Markov-switching model. Turning points are extracted both for the individual EMU countries (with the exception of Greece, Luxemburg and Ireland), where the dates obtained with the classical approach are preferred, and the Eurozone aggregate, for which the derived dates are not in all cases consistent with the dates produced by the CEPR business cycle Dating Committee. The question of potential business cycle synchronisation among Mediterranean countries is investigated by Medhioub (2009). To do that, three-regime switching models are applied on IP monthly indexes for France, Italy, Greece, Spain, Tunisia and Turkey and the time period 1994(01)-2007(12). Against this background, an explicit turning point chronology is given for Greece and the specific time period.

It should be finally noted, that while the applications on business cycle dating referring to the US and other advanced economies are numerous, similar references to developing economies are limited. For a sample of fifteen developing economies (Côte d'Ivoire, Malawi, Nigeria, South Africa, Zimbabwe, Chile, Colombia, Mexico, Peru, Uruguay, India, South Korea, Malaysia, Morocco and Pakistan), Rand and Tarp (2002) apply the BB procedure on IP data in order to identify business cycle turning points and refer to business cycle stylised facts. Du Plessis (2006) applies the BB algorithm in order to identify business cycle turning points for a group of selected developing economies (Hong Kong, Israel, Korea, Mexico, Peru, the Philippines and South Africa). He uses quarterly real GDP data but also other selected data series to date business cycle chronologies and comment on various business cycle stylised facts for the countries under examination. In an application for Colombia, Arango et al. (2008) use the BB algorithm to establish a business cycle chronology on the basis of IP data and for the time period 1980-2007.

3 Methodology and Data

In this work, we aim at dating the Greek business cycle for a time period of over forty years through the application of procedures which translate the elements inherent in the Burns and Mitchell (1947) business cycle definition and the procedures followed by the NBER business cycle Dating Committee into formal algorithms. To do that, and in order to focus on recessions rather than on growth retardations, against the background of the recent developments, we choose the concept of the classical business cycle. It should be noted that the dating of business cycles involves questions which are not clear at the outset and the answers may underlie a number of subjective choices. There is, for example, the question of the selection of the aggregate measure of economic activity or individual economic series to be used. Moreover, the issue of the dating criteria to be applied emerges.

With regard to the question of series and data selection, certain issues deserve to be noticed. In many cases, GDP or other single economic variables assumed to summarise economic activity are used to establish the reference cycle. With reference to GDP, this is intuitively appealing and also in accordance with the argument by Burns and Mitchell that GDP measures would be appropriate for reflecting and measuring aggregate economic activity (Burns and Mitchell, 1947, p. 72). Still, there are some important caveats in exclusively using GDP or individual series. The first refers to the non-availability of monthly GDP data. Moreover, there is the argument of the disadvantages of relying solely on the signals given by a single series, instead of a variety of variables, which reflect broad economic conditions. In this work, in order both to gain from the advantage of using GDP data and to confront criticism on relying on a single series, we resort to different applications on the basis of either GDP or multiple economic series. As to the dating criteria applied, we largely follow the rules included in the original procedures.

Three different approaches are applied in order to provide business cycle chronologies for the Greek economy. Consistency in the obtained dates will indicate independency of the results from the procedure applied. The approaches are based on automated algorithms with the advantage of rendering the included steps replicable and transparent, even though they still involve a certain degree of judgment. First, a monthly GDP series is constructed and the BB procedure is applied. Second, the BBQ algorithm is used on the basis of quarterly GDP data. Third, specific turning points in individual economic series are determined and then an algorithm according to Harding and Pagan (2006b) is used to provide an aggregate reference business cycle chronology. Using the obtained results, reference is made to specific business cycle characteristics to be investigated on the basis of the obtained chronologies. In the last part of the present section, the underlying data are presented.

3.1 Bry-Boschan Procedure with Monthly GDP Series

A very popular algorithm for business cycle dating is the non-parametric automated procedure introduced by Bry and Boschan (1971) for classical cycle turning points detection on the basis of monthly economic series. The algorithm introduced by Bry and Boschan largely replicates the expert system for turning points detection that was developed at the NBER and codifies the procedures applied by B&M. The key element of this approach is the location of the exact switch points from an expansion to a contraction and vice versa, which are then used to determine the phases of the business cycle. The detection of turning points is based on the identification of local minima and maxima in the path of the economic series using a general rule so that a peak and a trough, respectively, are identified if

$$\{y_t > y_{t-k}, y_t > y_{t+k}, k = 1,\dots, M\}, \quad (1)$$

$$\{y_t < y_{t-k}, y_t < y_{t+k}, k = 1,\dots, M\}. \quad (2)$$

To match the basic features of the Burns and Mitchell dating procedures, M is set to 5 for monthly data and several censoring rules[6] are imposed which concern the elimination of local turns and the constraints on phase and cycle

[6] As indicated by Harding (2003, p. 3-4), the most important reason for censoring turning points is to enhance the effect of nonlinearities. In the case, namely, of nonlinearities large changes are expected to differ significantly from small changes and nonlinearity is expected to show up in the path taken between successive turning points. In that sense, censoring is implemented in order to ensure that phases are sufficiently long so as to make any nonlinearity evident.

durations. Watson (1994) provides a programme implementation of the BB business cycle dating algorithm.[7]

As BB formulate it, “the programmed approach operates through a preliminary determination of cycles and a gradual narrowing down of neighbourhoods within which turning points are selected. The process involves several weighted and unweighted moving averages of varying flexibility”.[8] An outline of the essential steps of the procedure is presented in Table 1.

Table 1: Procedure for Programmed Determination of Turning Points

1. Determination of extremes and substitution of values.
2. Determination of cycles in 12-month moving average (extremes replaced).
A. Identification of points higher (or lower) than 5 months on either side.
B. Enforcement of alternation of turns by selecting highest of multiple peaks (or lowest of multiple troughs).
3. Determination of corresponding turns in Spencer curve (extremes replaced).
A. Identification of highest (or lowest) value within ±5 months of selected turn in 12-month moving average.
B. Enforcement of minimum cycle duration of 15 months by eliminating lower peaks and higher troughs of shorter cycles.
4. Determination of corresponding turns in short-term moving average of 3 to 6 months, depending on MCD (months of cyclical dominance).
A. Identification of highest (or lowest) value within ±5 months of selected turn in Spencer curve.
5. Determination of turning points in unsmoothed series.
A. Identification of highest (or lowest) value within ±4 months, or MCD term, whichever is larger, of selected turn in short-term moving average.
B. Elimination of turns within 6 months of beginning and end of series.
C. Elimination of peaks (or troughs) at both ends of series which are lower (or higher) than values closer to end.
D. Elimination of cycles whose duration is less than 15 months.
E. Elimination of phases whose duration is less than 5 months.
6. Statement of final turning points.

Source: Bry and Boschan (1971), p. 21.

[7] The GAUSS code for the implementation of the BB business cycle dating algorithm is available at www.princeton.edu/%7Emwatson/publi.html.
[8] See Bry and Boschan (1971), p. 2-3.

In accordance with the above, the procedure for turning points location as implemented by Watson consists of different steps. It starts with the identification and replacement of outliers by an average of neighbouring observations. In a second step and, on the basis of the series with adjusted extremes, turning points in 12-month moving averages are determined as the highest or lowest values within ±5 months. The condition of alternating turns is enforced, thereby, and in all the following steps by choosing the highest peak and the lowest trough in cases of no alternation. The third step consists of refining the identified turns by using the determined turns in a Spencer curve. The new dates are identified as the highest or lowest within ±5 months of the old dates and the condition of minimum cycle (P-to-P and T-to-T) duration of 15 months if enforced. In a fourth step, turning point dates are again refined by the use of a short-term moving average dependent on MCD (months of cyclical dominance), with turns identification as the highest or lowest within ±5 months of the selected turns in the Spencer curve. The fifth and final step of the procedure consists of the refinement of the turns using the original series. The new dates are identified as the highest or lowest within ±4, or MCD term (whichever is larger), of the selected turns in the chosen short-term moving average. To determine the final turning points, the elimination of specific turning points is undertaken in order to apply several censoring rules. More specifically, any turns within six months of beginning and end of the series, any peaks (and troughs) at both ends of the series which are lower (higher) than values closer to the end, any cycles with duration less than 15 months and, finally, any phases with duration less than 5 months are eliminated.

In the case of Greece, there is no monthly GDP series available. Such a series can be derived on the basis of interpolation methods. One prominent and often applied procedure for interpolation is the method proposed by Chow and Lin (1971).[9] The main underlying idea is to use the information con-

[9] Mönch and Uhlig (2005) test the relative performance of different interpolation methods. On the basis of bilateral likelihood ratio tests, they conclude that the best interpolation method for the set of series used is the Chow-Lin model (see p. 24). Billio, Caporin and Cazzavillan (2007) use the Denton (1971) disaggregation approach to produce monthly EU15 GDP series. Layton and Banerji (2003) adopt a procedure for the estimation of a monthly US GDP series on the basis of the monthly coincident economic indicators of economic activity used by ECRI (see p. 1794). Artis (2002) uses monthly GDP data supplied by the National In-

tained in related higher frequency series. In other words, a monthly GDP series is estimated given quarterly GDP data and monthly data on related series, on the basis of a regression in the related series to obtain the best linear unbiased estimates of the monthly GDP series.[10]

3.2 Quarterly Bry-Boschan Procedure with Quarterly GDP Data

On the basis of the BB dating algorithm which concentrates on monthly data, Harding and Pagan (2002, 2003a) develop and apply a variant to be used with quarterly economic series, which is known as BBQ. This procedure can be seen as a simplification of the BB procedure and relies on a quarterly version of the programmed implementation of the BB censoring code by Watson (1994) (see Harding and Pagan, 2003a, p. 3).[11] James Engel provides an algorithm for the implementation of the BBQ algorithm.[12]

In accordance with the basic idea behind the BB algorithm, the BBQ version looks for the local minima and maxima in the sample path of an economic time series y_t. The definition remains the same, as a local peak (trough) occurs at time t whenever $\{y_t > (<) y_{t\pm k}$, with $k=1,\ldots,K$. For quarterly data, k is set equal to 2, ensuring that a local maximum or minimum is found at t relative to the two quarters on either side, so that

$$peak\ at\ t = \{(y_{t-2}, y_{t-1}) < y_t > (y_{t+1}, y_{t+2})\} \tag{3}$$

$$trough\ at\ t = \{(y_{t-2}, y_{t-1}) > y_t < (y_{t+1}, y_{t+2})\}. \tag{4}$$

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stitute of Economic and Social Research constructed using a technique analogous to the Chow-Lin method. Miralles et al. (2003) test the performance of the Chow-Lin procedure for quarterly interpolation of annual data and conclude that in general robust estimates are generated. They note that in Spain, the Instituto Nacional de Estadística uses the Chow-Lin disaggregation method.

[10] See Appendix A for the exact derivation procedure.

[11] In investigating the econometric effects of censoring of turning points, Harding (2003) argues that a clear and transparent mathematical representation of what censoring does is needed, since the BBQ algorithm still embodies the “black box” approach to censoring.

[12] A GAUSS version of James Engel’s business cycle dating programmes can be found at www.ncer.edu.au/data.

As to the censoring procedures, they are maintained and, in addition, rules are found adapting to those in BB by the decision on the minimal length of cycles and phases in terms of quarters. Turning points are censored to ensure that peaks and troughs alternate and that each business cycle phase lasts a minimum of two quarters and each complete business cycle a minimum of five quarters.[13]

3.3 Aggregation of Turning Points in Individual Series

In following Harding and Pagan (2006b) (H&P), a number of single series can be used to obtain the reference cycle chronology, through "aggregation" of the specific turns in the individual series by the application of a non-parametric automated algorithm.[14]

In a first step, the specific turning points and cycles in the individual economic series are determined by the use of the BB algorithm for monthly series. Given t_i^P and t_i^T as vectors containing the dates to peaks and troughs, respectively, in the i th specific cycle, functions $\tau_i^P(t)$ and $t_i^T(t)$, respectively, are defined. These functions measure the distance in months from data t to the nearest peaks and troughs, respectively, in the i th specific cycle. In a following step, functions $\tau^P(t)$ and $\tau^T(t)$ are defined measuring the median distance from t to the set of nearest peaks and troughs, respectively. The *central dates of clusters of peaks* are then given by local minima in these functions and comprise dates at which the distance in months to the sets of nearest peaks and troughs are minimised. Vectors M^P and M^T are defined as the vectors of dates of local minima in $\tau^P(t)$ and $\tau^T(t)$, respectively, or in other words the vectors containing the dates of the clusters of peaks and troughs. In a last step, it is determined whether or not the peak (trough) nearest to the centre of that cluster is in that cluster, which is given under the conditions that it is not nearer to the centre of another cluster and it is less than a distance $\bar{d}$

[13] For the Greek case, these censoring rules are adjusted to eliminate phases and cycles with duration less than 3 and 6 quarters, respectively.

[14] This methodology is sometimes termed "indirect", as opposed to direct, where business cycle turning points are established on the basis of a constructed coincident indicator (see Bruno and Otranto, 2004). I thank Professor Don Harding for kindly providing the corresponding GAUSS code for the implementation of the specific algorithm.

from the centre of the cluster. With m_j^P and m_j^T being the j th elements of M^P and M^T, $C(m_j^P)$ and $C(m_j^T)$ represent the clusters of peaks and troughs centered on m_j^P and m_j^T, respectively.

As Harding and Pagan (2006b) indicate, in the case of not unique local minima, it may be necessary to break ties, in order to decide on the turning point. To do that, the algorithm looks at higher percentiles than the median until a unique local minimum is found. Moreover, one might want to implement several censoring rules in order to ensure that peaks and troughs alternate and impose restrictions on the minimum phase and cycle durations to maintain the NBER criteria.

3.4 Measuring Business Cycle Features

Provided a business cycle chronology has been established, the obtained dates can be used independently or in conjunction with the underlying series to provide information on specific business cycle features. Such features may refer to the complete cycles, running from a trough point to the next or from a peak point to the next, and/or to their phases, running from a trough point to the next peak point (expansion), and from a peak point to the next trough point (contraction). The focus of this application to the Greek business cycle will be on cycle and phase durations as well as amplitudes, but also on cumulative movements and excess cumulative movements within phases. These measures are calculated in order to provide information on the features of the length, depth and shape of business cycles and/or business cycle phases.

Since cycle and phase durations are measured on the basis of the obtained chronologies, all three procedures can be used to provide comparative duration measures, and, hence, cycle and phase lengths and their corresponding averages. We can denote D_i to be the duration of the ith phase, whether expansion or recession, which is defined by two consecutive turning points (trough-to-peak or peak-to-trough) that fall in periods t and $t+d$, returning $D_i=d$. The duration of a complete cycle can be easily calculated by the addition of the durations of two consecutive phases. For the measurement of phase amplitudes, cumulative movements and excess cumulative movements, the underlying data series is needed. The quarterly GDP series, denoted Y_t, and, hence, the results of the application of the BBQ dating procedure are chosen for this purpose. The amplitude and, hence, depth of the i th phase is denoted A_i and measured as $A_i = y_{t+d} - y_t = \Delta_d y_{t+d}$, where $y_t = \ln(Y_t)$.[15] In this case, the log has a natural interpretation as the approximate percentage change between trough (peak) and peak (trough) (see Harding and Pagan, 2006b, p. 6).

In order to combine phase duration and amplitude in a useful way, we follow Harding and Pagan (2002, 2006), Krolzig and Toro (2005) and Camacho et al. (2008) and consider a cycle phase as a triangle. The height of the triangle is considered to be the amplitude of the business cycle phase, the base stands for the duration and the hypotenuse gives the path of the series for the hypothetical case of a linear transition between two successive turning points. In that case, the triangle area offers an intuitive approximation to the cumulated gain (loss) in output from one turning point to the next. At the same time, this approximation allows the examination of the concavity or convexity, and, hence, shape of the cycle phase. The 'triangle approximation' to the cumulated movements is then given by the product $C_{Ti} = 0.5\ (D_i \times A_i)$. Nonetheless, the actual cumulative movements, C_i, may in practice differ from C_{Ti} and the measure of the 'excess cumulative movements', E_i, is used to calculate this difference, given by $E_i = (C_{Ti} - C_i + 0.5 \times A_i)$. Negative (positive) excess measures indicate that the actual cumulative movements, gains or losses, are larger (smaller) than the triangular approximation for expansions and contractions, respectively. At the same time, the above excess measure offers insights as to the abruptness with which the series enters in and exits from a phase. In that sense, great positive (negative) divergences from a triangle in the expansion phase reflect rapid (slow) recovery in the early part of an expansion, while, accordingly, great negative (positive) divergences from a triangle in the contraction phase indicate rapid (slow) decline in the early part of the contraction.[16]

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[15] In assuming that Y_t is positive for all t, one can work with $y_t = lnY_t$. This transformation, being monotonic, will not impact on the determination of turning points (see Harding and Pagan, 2003, p. 2).

[16] Note that 'positive' and 'negative' divergences in this context indicate greater gains and greater losses, which according to the above definition of E_i are signalled by a negative sign for expansions and contractions, respectively.

3.5 Data

In the present application for dating the Greek business cycle, both monthly and quarterly data are used, which are in all cases seasonally adjusted.[17] The time period investigated starts in January 1970 (or Q1) and ends in March 2010 (or Q1). Since monthly GDP data are not available, we take quarterly GDP data (constant prices) from the Quarterly National Accounts.[18] The respective GDP quarterly series is plotted in Figure 1 in Appendix B. For both the construction of a monthly GDP series via interpolation and the determination of specific cycles chronologies, several monthly data series are selected. Specific series are chosen as being related to GDP and expected to cover significant sectors of Greek economic activity and, hence, reflect the corresponding cyclical movements.[19] The series included are (a) the Industrial Production Index, taken from the OECD Main Economic Indicators Database, (b) the Turnover Index in Retail Trade which is deflated, and (c) the value of Imports (arrivals) which is deflated and indexed. The chosen series are plotted in Appendix B in Figures 2 to 4 and the constructed monthly GDP series is presented in Figure 5.

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[17] In cases of seasonally non-adjusted series, seasonal adjustment is conducted in EViews by the US Census Bureau X12 procedure. Note that one would expect a certain degree of sensitivity of the business cycle dating outcome depending on the seasonal procedure method employed on monthly data. However, it is beyond the scope of this paper to analyse the exact impact of alternative seasonal adjustment procedures on business cycle dating.

[18] Due to the latest and significant 2007 upward revision of GDP, official quarterly GDP data are provided by the General Secretariat of National Statistical Service of Greece and Eurostat back to 2000 only. For the construction of a continuous GDP series, we adjust the data backwards on the basis of the q-o-q percentage changes of the non-revised earlier quarterly data provided by Eurostat back to 1970.

[19] Series selection was to a significant degree dictated also by data availability considerations. Against this background, employment/unemployment and personal income data are not included. The alternative of a shorter time period including such time series was discarded on the basis of the intention to try to establish the validity and robustness of a business cycle chronology by focusing on long historical stylised facts of the Greek business cycle.

4. Results

4.1 Greek Business Cycle Chronology

The application of the dating procedures as outlined in Section 3 leads to three chronologies for the Greek business cycle and the time period January 1970-March 2010. These chronologies are presented in Table 2 and a first indication is the obvious consistency between the obtained turning point dates.

Table 2: Business Cycle Chronologies for Greek Economic Activity. January 1970-March 2010

BB Interpolated Monthly GDP		**BBQ** Quarterly GDP		**H&P Algorithm** Single Monthly Series	
Peak	**Trough**	**Peak**	**Trough**	**Peak**	**Trough**
M10 1973	M7 1974	Q4 1973	Q3 1974	M11 1973	M9 1974
M3 1980	M6 1981	Q1 1980	Q2 1983	M12 1979	M2 1981
M11 1981	M5 1983			M3 1982	M4 1983
M10 1985	M1 1987	Q4 1985	Q2 1987	M11 1985	M3 1987
M1 1990	M9 1990	Q1 1990	Q2 1991	M1 1990	M12 1992
M11 1991	M11 1992	Q1 1992	Q1 1993		
				M5 2000	M10 2001
M4 2008		Q3 2008		M4 2008	

The application of the three different algorithms suggests similar and, in some cases, identical dates for business cycle peaks and troughs. As a result, there is general agreement, with some exceptions, on the approximate timing of economic recessions and expansions for Greek economic activity for the time period under investigation which covers more than forty years. Differences in the underlying applications justify the deviations between the obtained chronologies. More specifically, both the BB algorithm with monthly GDP data and the H&P algorithm identify 6 full, even though not identical, business cycles, while the BBQ algorithm suggests 5 full business cycles. The beginning of a period of recession for the Greek economy in the year 2008 is confirmed in all cases, whereas disagreement abounds on the exact peak date and, hence, the exact point in time of entering the recessionary regime. The

BB algorithm with monthly GDP data and the H&P algorithm both indicate April 2008 as the peak month and imply that Greek economic activity entered the recessionary regime in May 2008. At the same time, the BBQ algorithm suggests the third quarter of 2008 as the peak quarter, implying that the fourth quarter of 2008 was the first quarter of the latest recession. Also, very importantly, the results indicate, independently of the procedure applied, that until March 2010, there have been no signs of recovery for the Greek economy which has not yet entered an expansionary regime.

As to the individual business cycles which the Greek economy is suggested to have experienced in the past forty years, we are able to outline stylised facts which also agree with the international and European experience.[20] The procedures applied identify the mid-1970s recession, which is associated with the first oil price shock, without exception and with significant agreement on the exact timing. The peak date is placed within the fourth quarter of 1973, with October or November suggested as the exact months for the turning point. The third quarter of 1974 is identified as the quarter of exiting the recession, and July or September are the proposed trough months. Note that the short duration of the specific recession for Greece is outlined by Biscarri (2002), who claims that the Greek economy was the first to recover from the crisis, compared to the other European countries under investigation.[21]

The applied dating methods do not fully agree on the exact dating of the recession of the early 1980s. While there seems to be a general consensus on the approximate timing of the beginning of a recession in the first quarter of 1980 (March 1980 as to the BB and December 1979 as to the H&P algorithm) and a recessionary period ending in the second quarter of 1983 (May 1983 as to the BB and April 1983 as to the H&P algorithm), there exist several points of disagreement. The first refers to the fact that the BBQ algorithm identifies one lasting recession from early 1980 to mid-1983, but the other two

[20] Note that there is also approximate agreement with recessionary regimes as identified in the literature for the EU and the Eurozone countries. See for example, Billio et al. (2007), Anas et al. (2007) and Chen (2007).

[21] The mid-70s recession is established in the literature for a number of countries worldwide and is always related to the 1974 oil price rises, even though in some countries the peaks predated these increases, as indicated by Artis et al. (1997).

methodologies distinguish between an approximate 1980-1981 and an approximate 1982-1983 recession. This fact, however, may be related to the short duration of the otherwise identified expansion beginning in 1981 and may emerge as a result of the involved censoring rules.[22] The second point of differentiation is related to the exact months of the obtained turning points, in the cases of the identified 'double' early 1980s recession, which do not fully coincide. It should be noted, that the case of a 'double' early 1980s recession does not seem more implausible, since also connected to the second oil price shock, and further agrees with the so called 'double-dip' recession identified for other European countries (see for example Biscarri, 2002[23]). Note the similarity with the results presented by Bruno and Otranto (2004) for Italy, who, depending on the procedure applied, find indications both for a single long early 1980s recession and two distinct recessions separated by a short recovery in the second half of 1981.

The 1986-1987 contraction is consistently identified by all three applications and in all cases the peak point is determined within the fourth quarter of 1985 (October 1985 as to the BB and November 1985 as to the H&P algorithm). The first and third month of 1987 are identified as the trough months by the BB and the H&P algorithm, respectively, while the BBQ method dates the second quarter of 1987 as the trough quarter. Once again, disagreement results from the three applications as to the single recession or the two recessions of the early 1990s. In the same sense, there is approximate agreement as to a peak point which is located in the first month of 1990 (the first quarter as to the BBQ method) and a trough point identified in November (BB algorithm) or December (H&P algorithm) 1992 or in the first quarter of 1993 (BBQ method). Nonetheless, while the H&P algorithm identifies one single 1990-1992 contraction, the other two methodologies distinguish between two different recessions. Note that Biscarri (2002) also identifies one

[22] With the imposed restriction of a minimum phase length of 3 quarters, an expansion phase with a duration of 2 quarters is eliminated. Relaxation of the respective rule to 2 quarters leads to the location of an expansion lasting through the second and third quarters of 1981.
[23] Note that according to the findings in Biscarri (2002), which are not in agreement with those presented here, Greece escaped the early 1980s recession and regained the synchronicity with the other European countries during the recovery from the recession of the 1990s.

single early 1990s recession for Greece, lasting three and a half years. Moreover, another basic difference refers to the fact that the BB algorithm identifies a very short 1990 recession, whereas the BBQ algorithm indicates a longer 1990-1991 recession. However, once again, this fact may be related to the short duration of the otherwise identified contraction beginning in 1990 and may emerge as a result of the involved censoring rules.[24] Similarly, the findings in Bruno and Otranto (2004) for Italy as to the early 1990s recession are also distinguished, since there are both indications of a single longer period recession from 1990 to 1993 and for a short recession in 1990 followed by another over the period 1992-1993.

Perhaps the more important point of deviation among the identified switch points refers to the early 2000s recessionary period, which according to the H&P algorithm, began in June 2000 and ended in October 2001. There are, however, no such findings on the basis of the BB and BBQ algorithms. According to Biscarri (2002), there is evidence of a deceleration of economic activity in Greece in the early 2000s, something that is also the case for other European countries, too. He argues, however, that there is ambiguity as to whether this incident qualifies as an “official” recession. Finally, there is important agreement among the BB and the H&P algorithms as to the peak date signalling the beginning of the late 2000s recession, which is found to be April 2008. As a result, May 2008 is identified as the month in which Greek economic activity entered the more recent recessionary regime. At the same time, the BBQ method identifies the third quarter of 2008 as the peak quarter and, hence, the fourth quarter of 2008 as the outset of the latest recessionary period for the Greek economy.[25] This is not a negligible deviation, which may involve a time period of six months, at the most, and certainly de-

[24] With the imposed restriction of a minimum phase length of 3 quarters, a contraction phase with a duration of 2 quarters is eliminated. Relaxation of the respective rule to 2 quarters leads to the location of a contraction lasting through the third and fourth quarters of 1990.

[25] Note that according to the announcement of the Euro Area business cycle Dating Committee on the determination of the 2008Q1 peak in economic activity, Greece belongs to the countries that reached their highest GDP values at the end of the available sample, at that time. As a result, it is argued that it cannot be said to have peaked based on GDP data alone. See http://cepr.org/press/Dating-Committee-Findings-31-March-2009.pdf.

serves further attention. However, since this phenomenon does not appear to repeat itself historically, one possible explanation would be the reliance on preliminary data.[26]

Having established consistent results on the basis of the three different applied procedures, we conclude that the business cycle peak and trough dates according to the BB algorithm can be said to accurately present a robust chronology for the Greek business cycle over the time period January 1970 to March 2010. We choose the specific chronology on the basis of considerations that relate to the obtained results on the early 1980s and early 1990s business cycles and business cycle phases. The derived monthly GDP data series together with the identified troughs, which are represented by vertical lines, are pictured in Figure 6 in Appendix B.

4.2 Greek Business Cycle Features

The derived business cycle chronologies can be used to provide important information on selected characteristics of the detected full business cycles and their phases. These are presented in Tables 3 and 4. Table 3 offers some indications on the durations of the detected full cycles and the related phases. Full cycles are examined both as cycles from one peak to the next (P to P) and from one trough to the next (T to T) and phases are investigated by distinguishing between expansions and contractions. Mean durations and standard deviations are also provided. The most striking characteristic pertains to the differences in duration between expansions and contractions. As measured by the BB and H&P algorithms, the mean duration of expansions amounts to 56.2 and 51.3 months, respectively; according to the BBQ method, expansionary regimes in Greek economic activity lasted 21.6 quarters on average. At the same time, contractionary regimes have been much shorter on average and lasted 12.8, 17.5 months and 6.2 quarters, according to the BB, H&P and BBQ algorithms, respectively. This indication confirms the internationally well established business cycle characteristic of asymmetry between expansions and contractions, which is reflected in expansionary

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[26] The problem and the potential impact of considerable data revisions on turning points identification is often cited in the related literature and is very significant.

Table 3: Durations of Identified Greek Business Cycles, January 1970-March 2010

BB Interpolated Monthly GDP				**BBQ** Quarterly GDP				**H&P Algorithm** Single Monthly Series			
Full BC Durations (months)		Phase Durations (months)		Full BC Durations (quarters)		Phase Durations (quarters)		Full BC Durations (months)		Phase Durations (months)	
P-P	T-T	Exp.	Contr.	P-P	T-T	Exp.	Contr.	P-P	T-T	Exp.	Contr.
77	83	68	9	25	35	22	3	73	77	63	10
20	23	5	15	23	16	10	13	27	26	13	14
47	44	29	18	17	16	11	6	44	47	31	13
51	44	36	15	8	7	3	5	50	69	34	16
22	26	14	8	66		62	4	124	106	89	35
197		185	12					95		78	17
M 69	44	56.2	12.8	27.8	18.5	21.6	6.2	68.8	65	51.3	17.5
SD 66.1	23.9	66.8	3.9	22.4	11.8	23.6	4	36	30.4	29.8	8.9

Notes: Phase and cycle information is provided only for completed phases and cycles. Average values and standard deviations (in months or quarters) are given in the last row.

regimes being significantly shorter than contractionary regimes. The calculated durations of expansions and contractions are also well distinguished in terms of standard deviations, which are 66.8 (months), 29.8 (months) and 23.6 (quarters) for expansions and 3.9 (months), 8.9 (months) and 4 (quarters) for contractions, according to the BB, H&P and BBQ algorithms, respectively. It is moreover observed, that the longest expansion, as identified by the BB and BBQ methods, lasted 185 months and 62 quarters, respectively, and is that, which was interrupted by the beginning of the most recent contraction of the year 2008. With reference to the recorded recessions, in excluding the ambiguous cases of the early 1980s and early 1990s ‘single’ or ‘double’ recessions, the longest recession does not exceed 18 months in duration. At the same time, the longest full cycles, whether measured from peak-to-peak or trough-to-trough, are identified from the BB and BBQ methods to concern the last recorded cycles. The respective durations of the peak-to-peak cycles amount to 197 months and 66 quarters, respectively, whereas the durations

Table 4: Amplitudes, Cumulated Movements and Excess Cumulated Movements of Identified Greek Business Cycle Phases. January 1970 (1970Q1)-March 2010 (2010Q1)

Amplitude (%)				Cumulated Movements (%)		Excess Cumulated Movements (%)	
BB Interpolated Monthly GDP		BBQ Quarterly GDP		BBQ Quarterly GDP		BBQ Quarterly GDP	
Exp.	Contr.	Exp.	Contr.	Exp.	Contr.	Exp.	Contr.
38.8	-21.0	35.8	-14.2	495.2	-23.6	-21.1	22.1
14.9	-13.7	12.4	-9.7	55.8	-71.5	20.3	-5.3
20.3	-16.4	13.1	-9.0	84.5	-34.8	-8.1	-11.9
20.1	-16.1	3.6	-1.3	6.9	-13.6	6.6	-297.5
24.3	-19.8	52.4	-4.8	1548.4	-11.6	6.3	4.2
59.9	-15.9						
Aver. 29.7	-14.7	24.6	-6.8	407.7	-26.7	0.8	-57.7

Notes: Phase information is provided only for completed phases. Average values are given in the last row. The excess cumulated movements are presented here in relation to the triangle.

of the corresponding trough-to-trough cycles cannot yet be calculated, since the turning point announcing the end of the current recession has not yet occurred.

Further information on Greek business cycle characteristics is offered in Table 4, where evidence is summarised on phase amplitudes, cumulative movements and excess cumulative movements within business cycle phases.[27] In terms of phase amplitudes, the amplitude of expansions is highest during the last and longest recorded expansion and reaches a level of 59.9% and 52.4%, based on the BB and BBQ algorithms, respectively. At the same time, the highest contraction amplitudes are -21.0% and -14.2% and

[27] The amplitude measures are offered both for the BB and the BBQ procedures for reasons of comparison. Cumulative and excess cumulative movements are calculated on the basis of the results of the BBQ application in order to rely on the available quarterly GDP figures. Related measures are not provided for the H&P algorithm results, since there is no single underlying data series.

refer to the 1973-1974 recessionary period. On average, expansion amplitudes are in both cases with 29.7% and 24.6% significantly higher than contraction amplitudes with -14.7% and -6.8%, signalling an asymmetry feature between expansions and contractions. The measures of cumulated movements imply that during expansions there have been significant cumulated gains of output when compared to the level before the turning point. Even though not negligible, the cumulated losses recorded for contractions are considerably lower. This is reflected in the values for the average cumulated movements, which amount to 407.7% and -26.7% for expansions and contractions, respectively. The calculated excess cumulated movements also provide distinct indications for expansions and contractions. More specifically, in three out of the five cases of expansions, the positive excess measures suggest that the actual cumulative movements, and, hence, the actual gain, are lower than the triangular approximation. As for contractions, in three out of the five cases the negative excess measures suggest that there is a much larger loss in output during recessions than measured by the triangular representation. The respective low and positive average measure for expansions indicates that, on average, there is no rapid growth observed when coming out of recession. In contrast, the high and negative average figure calculated for contractions suggests that there is, on average, rapid decline when coming out of expansion.

5 Conclusions

In the present work we apply different business cycle dating procedures in order to provide a robust reference chronology which locates the turning points in general, Greek economic activity. We do not rely solely on GDP data, but also take into account information included in individual economic series. The results indicate a significant degree of coherence among the located peak and trough dates as determined by the BB, the BBQ and the H&P automated dating algorithms. The dates provided by the interpolated monthly GDP series can be then safely considered as the established dates of the Greek business cycle reference chronology for the time period from January 1970 to March 2010. The located switch points identify the mid-1970s recession, the early 1980s ‘double’ recession, the mid-1980s recession and the early 1990s ‘double’ recession. More importantly, and with reference to the current economic developments, the beginning of a recessionary period for Greek overall economic activity in the late 2000s is confirmed. The month of April 2008 is dated as the peak month and, hence, the month of May 2008 presents the first month in the latest recessionary regime ending an expansion phase that lasted 185 months. The absence of any indication of recovery until March 2010 suggests that the Greek economy has not yet exited the contraction. The robustness of the derived reference chronology is enhanced by the confirmation of widely accepted business cycle stylised facts, such as the significant asymmetry characteristic between expansions and recessions. Durations as well as amplitudes indicate different behaviour during expansions than during contractions.

Once established, the reference chronology can form the base for further research on Greek business cycles. Such research may involve the construction of coincident and/or leading indicators, real-time detection of turning points and turning points forecasting but also the examination of business cycle synchronisation. These issues may all contribute to the better understanding and monitoring of the current and future state of economic activity in Greece and may facilitate and provide guidelines for conducting economic policy.

Appendix A

Chow-Lin Interpolation Method

According to Chow and Lin (1971),[28] it is assumed that the $3n$ monthly (with n quarters) observations of the series y_m to be estimated are related to the $3n$ monthly observations of the p related series, $x_1,\ldots,x_p$, via a regression of the form

$$y_m = X_m \beta + u_m \tag{1}$$

where y_m is $3n \times 1$, X is $3n \times p$ and the regression residuals follow a first-order autoregression $u_{m,t} = \alpha_m u_{m,t-1} + e_{m,t}$ for $t=1,\ldots,3n$, with zero mean and covariance matrix V_m. The latter has the form $V_m = A_m[\sigma^2/(1-\alpha_m^2)]$, where

$$A_m = \begin{bmatrix} 1 & \alpha_m & \alpha_m^2 & \cdots & \alpha_m^{3n-1} \\ \alpha_m & 1 & \alpha_m & & \alpha_m^{3n-2} \\ \alpha_m^2 & \alpha_m & 1 & & \alpha_m^{3n-3} \\ \vdots & & & \ddots & \vdots \\ \alpha_m^{3n-1} & & & \cdots & 1 \end{bmatrix}. \tag{2}$$

Letting C be the matrix that converts the $3n$ monthly observations into n quarterly observations, such as

$$C = 1/3 \begin{bmatrix} 1 & 1 & 1 & 0 & & & & \cdots & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & \cdots & 0 \\ \vdots & & & & & & & & \vdots \\ 0 & & & & & \cdots & 1 & 1 & 1 \end{bmatrix}, \tag{3}$$

the vector of n quarterly observations of the dependent variable will satisfy

[28] See Chow and Lin (1971) and Robertson and Tallman (1999). It corresponds to case two in Chow and Lin as regards the assumption for the residuals (see p. 374-375).

the regression model

$$y_q = Cy_m = CX_m\beta + Cu_m = X_q\beta + u_q, \tag{4}$$

with the covariance matrix of u_q being

$$V_q = CV_mC'. \tag{5}$$

According to Chow and Lin, the best linear unbiased estimator $\hat{y}_m$ of y_m is given by

$$\hat{y}_m = Ay_q = X_m\hat{\beta} + \hat{A}_m C'(C\hat{A}_m C')^{-1}\hat{u}_q. \tag{6}$$

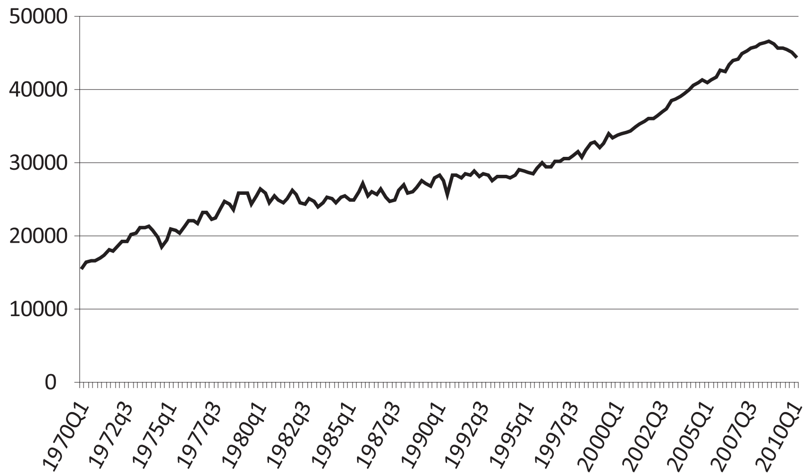
To obtain a consistent estimate of a_m, observe that the first-order autocorrelation coefficient of the quarterly residuals, a_q, is the ratio of the second element to the first element on the first row of matrix V_q. With the ratio being calculated as

$$\alpha_q = \frac{\alpha_m^5 + 2\alpha_m^4 + 3\alpha_m^3 + 2\alpha_m^2 + \alpha_m}{2\alpha_m^2 + 4\alpha_m + 3}, \tag{7}$$

i.e. a polynomial equation in a_m, a_m can be obtained as a unique solution to (7).

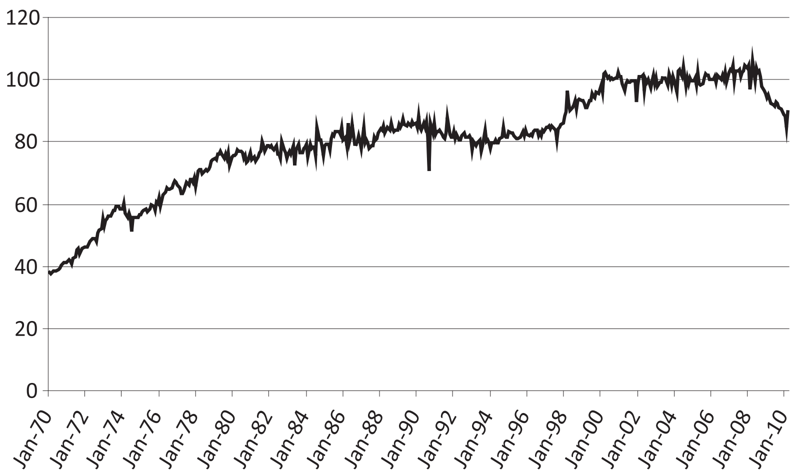
Appendix B

Figure 1: Quarterly GDP at constant (2000=100) prices, seasonally adjusted
Millions of €, 1970Q1-2010Q1



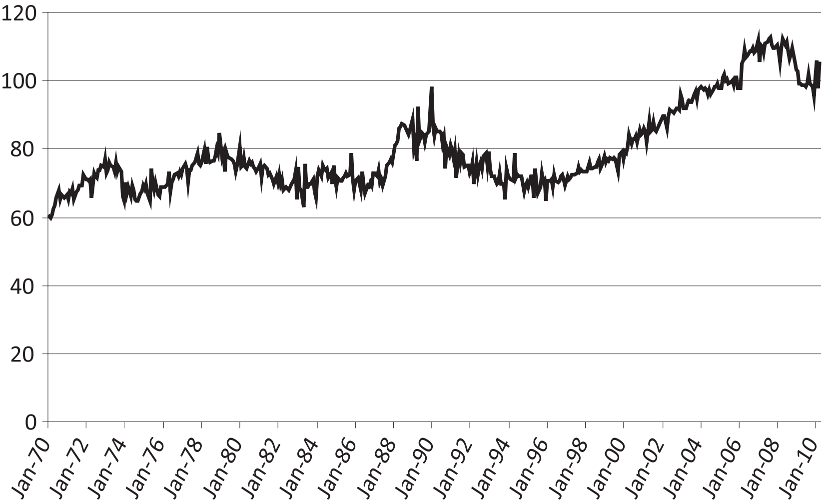
Source: Eurostat, General Secretariat of National Statistical Service of Greece and own calculations.

Figure 2: Monthly Industrial Production Index, seasonally adjusted
January 1970-March 2010



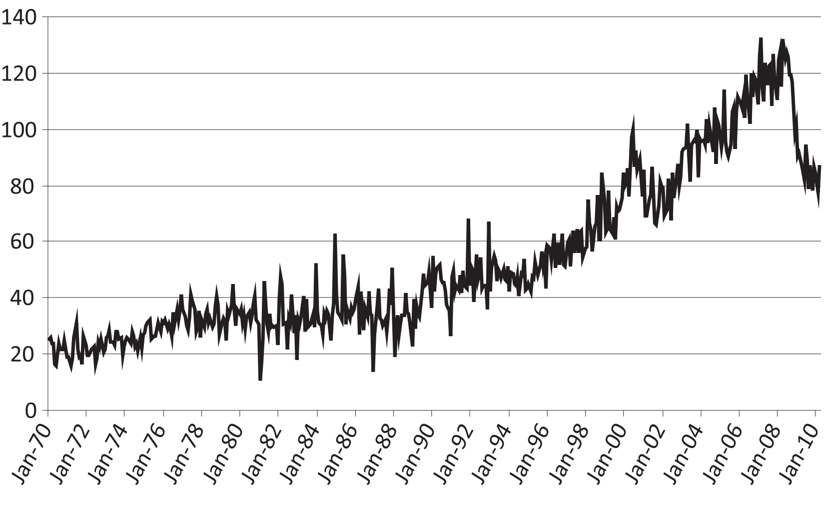
Source: OECD, Main Economic Indicators Database.

Figure 3: Monthly Volume Index in Retail Trade, seasonally adjusted
January 1970-March 2010



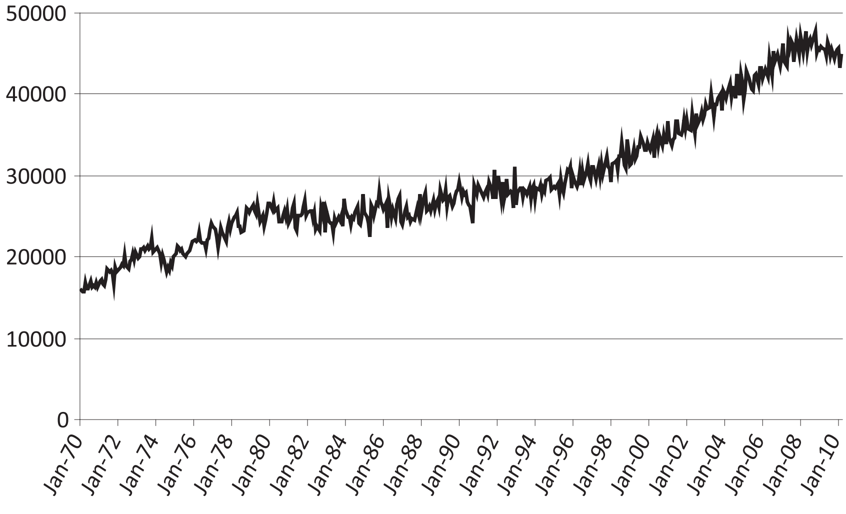
Source: General Secretariat of National Statistical Service of Greece and own calculations.

Figure 4: Monthly Index of Imports Value, seasonally adjusted
January 1970-March 2010



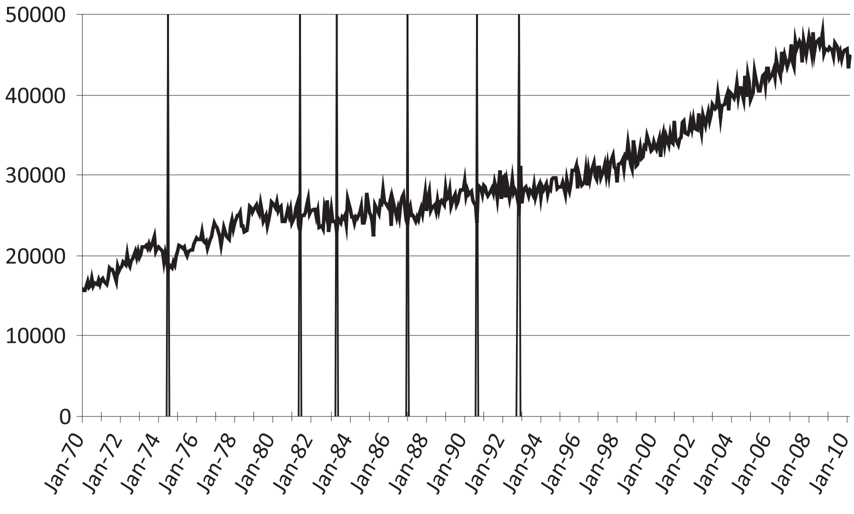
Source: General Secretariat of National Statistical Service of Greece and own calculations.

Figure 5: Monthly (derived) GDP at constant (2000=100) prices, seasonally adjusted, Millions of €, January 1970-March 2010



Source: Own calculations.

Figure 6: Monthly (derived) GDP and Greek Business Cycle Trough Months January 1970-March 2010



Source: Own calculations

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New Evidence on Stylized Facts of the Business Cycles in Euro Area Economies

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Abstract

This paper investigates the business cycle in eurozone economies, adopting different filtering methods. We detect static and long-run relationships between cyclical components of output, by using for the first, correlations, and for the second, the Autoregressive Distributed Lag (ARDL) model proposed by Pesaran, Shin and Smith (2001). The evidence indicates that there is a core group of countries whose members are strongly linked together, comprising Germany, France, Belgium, the The Netherlands and Austria. The results also imply that the German cycle is strongly linked with the Greek and Irish cycles; that the Spanish cycle is strongly linked with the French and Italian cycles; and that the Belgian cycle is strongly linked with the Finnish cycle.

1 Introduction

In this paper, we investigate business cycle relationships between countries within the European Union, particularly those in the eurozone. Studies over the last few years have reached the view that the business cycle is a purely monetary phenomenon, so it is both interesting and important to study a sample of those countries that have a common monetary policy and a single currency.

Because the eurozone economies have been having a hard time with recession recently, with some of them showing an upturn, there are key questions that need answering. How has output fluctuated in the eurozone over

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the period in question? To what extent is there co-movement across countries in the eurozone? Are the cycles of different countries interrelated? Is there a link between cycles? Which countries form the eurozone ‘hard core’? And are there long-run relationships between their economies?

We attempt to answer these questions in our analysis, which consists of two main parts. In Part One, we detect relationships between cyclical components of output in a static context, by means of cross-correlations. In Part Two, we investigate long-run relationships, by means of the autoregressive distributed lag (ARDL) approach recommended by Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001). We use quarterly data supplied by the OECD for the period 1960:1–2009:2 in respect of the following eurozone countries: France, Italy, Spain, the Netherlands, Greece, Belgium, Portugal, Austria, Finland, Ireland and Luxembourg. The variable used in our analysis is: Variable: Gross Domestic Product, millions of dollars, volume, fixed PPPs. We extract the cyclical component of the time series of variables by means of a number of different filters. All series, have been transformed into logarithms before being filtered.

Various authors have tried to investigate the business cycles in the European Union using different methodologies. Artis and Zhang (1997, 1999) examined whether the correlation between the business cycles in ERM countries and the cycle in Germany has increased since the formation of the ERM. Their results show that the cycles in the ERM countries are synchronizing more and more with the German cycle, suggestive of a 'European business cycle'. Lumsdaise and Prasad (2003), relying on results from seventeen OECD countries, find that especially after 1973, there is a clear European business cycle. Artis, Marcellino and Proietti (2004), too, find evidence for a distinct European business cycles, applying Markov Switching VAR models. Contrary to the above-mentioned results, Dickerson, Gibson and Tsakalotos (1998) find no evidence that the business cycles in the EU-12 have shown more correspondence since ERM. They suggest the existence of a commonality in the business cycles for the core countries which is not shared by the 12 EU members as a whole. Canova, Ciccarelli and Ortega (2007) identify a world cycle but demonstrate that, apart from an increase in synchronicity in the late 1990s, the evidence for a distinct European business cycle is weak. Finally, Wynne and Koo (2000) show that the cross-correlation between the business cycles of twelve US Federal Reserve districts is much higher than the cross-correlation of the business cycles of the 15 EU countries.

The paper is organized as follows. Section 2 reports evidence from static analysis. Section 3 presents econometric methods based on dynamic analysis, and illustrates their findings. The conclusions are presented in Section 4.

2 Static Analysis

2.1 Measuring the Business Cycle

We begin our analysis by examining business cycle relationships between countries. Our methodology resembles that of Kydland and Prescott (1990).

Our statistical tool here is cross-correlation between cyclical components of time series derived by means of various different filters. We estimate co-movements between cyclical components of output by the magnitude of the correlation coefficient $\rho(j)$, for $j = 0$. Depending on whether this coefficient is positive, zero or negative, we refer to the series as procyclical, acyclical, or countercyclical respectively. We denote degree of correlation by the adverbs 'strongly' ($0.5 \leq |\rho(0)| \leq 1$) and 'weakly' ($0.14 \leq |\rho(0)| \leq 0{,}5$); alternatively, a series may be contemporaneously uncorrelated ($0.0 \leq |\rho(0)| \leq 0{,}14$). The cutoff point 0.14 has been chosen because in our samples it corresponds to the value required to reject, at the 5% level of significance, the null hypothesis that the population correlation coefficient is zero in a two-sided test for bivariate normal random variables.

2.2 Removing Trends and Isolating Cycles—Filtering Methods

Before we can investigate business cycles in the eurozone, we must first remove trends and isolate the cycles. Isolation of cycles and removal of trends are interrelated concepts.[1] The main goal of detrending (methods) is intended as the process of making examined series (covariance) stationary. There are three main filters for removing a trend from a time series: these spring from the definition of the business cycle given by Lucas (1977).

The first two approaches to trend removal are detrending and differencing.

[1] For a time series, it is possible to obtain cyclical component/information by eliminating the permanent component (the trend). However, even after the separation of trend from cycle is accomplished, additional steps may be necessary to isolate cycles by frequency of their recurrence (Delong and Dave 2007).

The Nature of the Trend

For Nelson and Plosser (1982), a trend may be either deterministic or stochastic. An example of a deterministic trend is: $x_t = a + bt + \varepsilon_t$ (1) a series where there are the parameters a and b, and t is a linear trend and ε_t is white noise [$\varepsilon_t \sim n.i.d.(0, \sigma^2_\varepsilon$]. In this case, it is best to attempt linear detrending by regression. The calculated residuals are the detrended data. More generally, a time series may have a polynomial trend as $y_t = a_0 + a_1 t + a_2 t^2 + \ldots + a_n t^n + e_t$ where $\{e_t\}$= a stationary process. Detrending is accomplished by regressing $\{y_t\}$ on a deterministic polynomial time trend. Our study assumes a quadratic polynomial function of time.

Linear detrending cannot be used if a trend is stochastic. An example of a series with stochastic trend is the random walk process with a drift: $x_t = a_0 + x_{t-1} + \varepsilon_t$ where ε_t there is white noise [$\varepsilon_t \sim n.i.d.(0, \sigma^2_\varepsilon$]. Recursive substitution yields

$$x_t = x_0 + \alpha_0 t + \sum_{i=0}^{t-1} \varepsilon_{t-i}$$

We observe that the series contains both a linear deterministic trend $a_0 t$ and a stochastic trend $\sum_{i=0}^{t-1} \varepsilon_{t-i}$. Let us begin by differencing: $\Delta x_t = x_t - x_{t-1} = (1-L)\, x_t = a_0 + \varepsilon_t$. Clearly, the $\{\Delta y_t\}$ sequence is stationary. Our random walk is $I(1)$[2].

The third standard approach[3] to decomposing a series into a trend (permanent component) and a stationary component (cyclical) is that developed by Hodrick and Prescott (1984). Suppose now that we observe the values y_1 though y_T and want to decompose the series into a trend $\{\mu_t\}$ and a stationary component $y_t - \mu_t$. Consider the sum of the squares

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[2] An attractive property of an $I(1)$ is found in Beveridge and Nelson (1981) who suggest that $I(1)$ time series are decomposed into a permanent and a temporary (cyclical) component by applying the ARIMA methods. Therefore, the cyclical component is the difference between the observed value in each period and the permanent component.

[3] A quite large number of studies have used the HP filter as a detrending method. Fiorito and Kollintzas (1994) investigated and compared the stylized facts of business cycles in the G7. Blackburn and Ravn (1992) investigated the UK business cycles. Danthine and Girardin (1989) studied Swiss data and Backus and Kehoe (1992) compared the business cycle features both across different countries and in different periods of time.

$$\frac{1}{T}\sum_{t=1}^{T}(y_t-\mu_t)^2+\frac{\lambda}{T}\sum_{t=2}^{T-1}[(\mu_{t+1}-\mu_t)-(\mu_t-\mu_{t-1})]^2$$

where λ is a constant and T is the number of usable observations.

The problem is to select a sequence $\{\mu_t\}$ that will minimize this sum of the squares. In the minimization problem, λ is an arbitrary constant reflecting the 'cost' or penalty of incorporating fluctuations into the trend. Ravn and Uhlig (2002) finally defined the filter parameters as λ=1600: this must be adjusted, by multiplying it by the fourth power of the observation frequency ratios. Furthermore, the 'penalty parameter' was set by Hodrick and Prescott (1997) as *λ=1600* for the US quarterly data. Kydland and Prescott (1990) proposed the same value choice as a 'reasonable' choice[4] for quarterly data, noting that:

'[w]ith this value, the implied trend path for the logarithm of real GND is close to the one that students of the business cycle and growth would draw through a time plot of the series.'

We shall here adopt this value, as most recent studies have done.

The biggest advantage of the Hodrick and Prescott filter is that it can extract the same trend from all time series; many real business cycle models do indicate that all variables will have the same stochastic trend. However, their filter has been subject to severe criticism. Harvey and Jaeger (1993) showed that its use can generate arbitrary cycles, while Cogley and Nason (1995) proved that it can lead to business cycle periodicity, even if none is present in the original data.

The Baxter-King filter

Another standard way of extracting the business cycle component of a macroeconomic time series is the Baxter-King filter (1999).[5] For Baxter and

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[4] In the sense that the implied cyclical component largely agrees with 'conventional wisdom' about the US business cycle.

[5] This filter has been used in several studies. The most important among them are: Stock and Watson (1999a), who used this filter in order to examine the stylized facts about the business cycle of the Euro Area and how these compared to the U.S. and the individual countries forming the Euro Area; Benetti (2001), who argued that this filter was the most adequate for the analysis of stylized facts; and finally Massmann and Mitchell (2004), who examined the relationship between the business cycles of the 12 euro area countries.

King,[6] the 'ideal' detrending method meets six requirements: 1) the filter must extract a specified range of periodicities, leaving the properties of the extracted component unaffected; 2) the band-pass filter must not introduce phase shift, and the filter must not change the timing of the turning points in the series under analysis; 3) the filter must be an optimal approximation to the 'ideal' filter; 4) the filter must have trend-reducing properties; 5) the filter must yield business cycle components unrelated to the length of the sample period; 6) the method itself must be operational.

This removes low-frequency trend variation and smooth high-frequency irregular variation, while retaining the major features of business cycles.

The purpose of an ideal band pass filter is to isolate the components of a time-series that lie within a given range of frequencies. Economic theory can help to define these frequencies. In particular, since what we are interested in is how to extract the periodic components of an economic time series associable with the business cycle, the bands can be chosen to match prior notions of the duration of the business cycle.

Burns and Mitchell (1946) found that business cycles in the United Statεs lasted a minimum of 17 months and a maximum of 101 months, when measured peak to peak, or a minimum of 29 months and a maximum of 99 months, when measured trough to trough. Many studies have followed this range of frequencies, which we adopt in our own study. We also permit the upper bound on the length of the business cycle to exceed 32 quarters and to be 40 quarters. The reason for this is that it has been observed that economic cycles in the eurozone seem to last more than eight years. Given that there have been three recessions in the eurozone over the last thirty years, it is, we think, advisable to include 10-year frequencies as well in the cyclical components.

We have also adopted Baxter and King's (1999) approximation, setting the length of the moving average to 12 quarters. So as to widen the extent of the sample as much as possible, we permit 8 quarters as the length of the moving average.

When comparing the HP filter and the BK filter we should note that, although high-frequency noise is not actually amplified by the HP filter, much of it still gets past outside the business cycle frequency band. This problem

[6] They adopted the NBER definition of the business cycle, that is, 'classical' business cycles.

can be resolved by using the BK filter, though this also has a drawback—that it tends to underestimate the cyclical component.

2.3 The Findings of Static Analysis

Table I shows contemporaneous correlation coefficients of the cyclical components for each pair of countries, using different filters.

A glance is enough to show that business cycles in eurozone economies are interconnected. There is positive correlation between cycles, as confirmed by all filters. The extent of positive correlation in our sample, however, varies.

The countries fall into two groups. In Group One, the cycle of each member correlates strongly with the cycles of other countries in the group. We have detected three sub-groups within this first group: 1) Germany, France, the Netherlands, Belgium, Austria and Luxembourg; 2) France, Belgium, Spain (where we must make an exception for BP-detrended data) and Italy; and 3) France, Belgium and Finland.

In Group Two, each cycle correlates weakly with, or is wholly uncorrelated with, the cycles of the other countries. Here again we have detected three subgroups: 1) Greece, Portugal, the Netherlands, Finland and Spain; 2) Ireland, Italy, Greece and Luxembourg; and 3) Greece, Ireland and Finland.

To get down to details, when we look at cyclical behaviour in each country separately, we observe that in Germany the cyclical component of output behaves procyclically by comparison with the cyclical components of output in all the other countries.

The cycles of Germany correlate strongly with those of Austria, the Netherlands and Belgium, as we said earlier. Moreover, the cycles in Germany and Austria behave highly procyclically: an index of this is that the contemporaneous correlation coefficient is as high as 0.70. But the correlation between Germany and Finland, and Germany and Ireland, is only weakly positive.

In France, output behaves procyclically in comparison to output in all countries. The contemporaneous correlation coefficient of France is higher in respect of Italy, Belgium, Austria and Luxembourg.

The output of Italy moves along in the same direction as most other countries. The cycles of Italy have a strong positive correlation with those of Spain, France and Belgium, and a weak correlation with those of Greece, Finland and Ireland.

Table I: Cross Correlations in output between

		France	Italy	Spain	Netherlands	Greece	Belgium	Portugal	Austria	Finland	Ireland	Luxembourg
Germany	HP	0.6057	0.4122	0.3842	0.6397	0.4479	0.6398	0.4157	0.6869	0.3831	0.4113	0.6091
	BK (6, 32, 8)	0.5202	0.4697	0.4126	0.6324	0.4708	0.6234	0.4388	0.6427	0.2872	0.1218	0.5695
	BK (6, 32, 12)	0.5701	0.3811	0.3758	0.7121	0.5364	0.6451	0.4262	0.7077	0.2721	0.2711	0.6375
	BK (6, 40, 8)	0.5243	0.4678	0.4179	0.6371	0.4830	0.6320	0.44	0.6462	0.2953	0.1363	0.5808
	BK (6, 40, 12)	0.5822	0.3721	0.3709	0.7255	0.5564	0.6531	0.4274	0.7206	0.2704	0.3009	0.6515
	TQ	0.5545	0.5534	0.5624	0.7085	0.3867	0.6481	0.7351	0.6847	0.0153	0.3703	0.7404
	DS	0.4543	0.2822	0.1512	0.4758	0.2292	0.3877	0.2968	0.44171	0.2745	0.1301	0.1867
France	HP		0.5723	0.5593	0.5171	0.2610	0.7244	0.5752	0.6616	0.5425	0.4517	0.6381
	BK (6, 32, 8)		0.7277	0.6001	0.5152	0.2450	0.7165	0.488	0.6544	0.5032	0.1106	0.615
	BK (6, 32, 12)		0.6404	0.6779	0.5390	0.3419	0.7509	0.5986	0.7158	0.5775	0.3619	0.697
	BK (6, 40, 8)		0.7233	0.6042	0.5152	0.2542	0.7181	0.4972	0.6608	0.5109	0.124	0.6223
	BK (6, 40, 12)		0.6241	0.6920	0.5465	0.3715	0.7629	0.6251	0.7331	0.5922	0.4166	0.715
	TQ		0.8137	0.9339	0.8594	0.9097	0.9551	0.7454	0.8997	0.6535	0.645	0.2985
	DS		0.4137	0.2195	0.3455	0.1277	0.4672	0.3016	0.3605	0.1819	0.1145	0.1663
Italy	HP			0.5256	0.3668	0.1332	0.6077	0.4444	0.4203	0.421	0.4143	0.4295
	BK (6, 32, 8)			0.4463	0.5794	0.1166	0.6780	0.5067	0.5471	0.2699	0.3541	0.439
	BK (6, 32, 12)			0.4730	0.5180	0.1300	0.6210	0.4628	0.4113	0.3353	0.2461	0.4081
	BK (6, 40, 8)			0.4510	0.5782	0.1161	0.6780	0.5085	0.5443	0.2776	0.3674	0.4386
	BK (6, 40, 12)			0.4807	0.5103	0.1339	0.6103	0.459	0.3842	0.3512	0.3157	0.4077
	TQ			0.7653	0.7212	0.6771	0.8044	0.7093	0.736	0.5587	0.5592	0.3974
	DS			0.3253	0.1688	0.1269	0.4860	0.3607	0.3466	0.2422	0.142	0.2129
Spain	HP				0.2425	0.1436	0.5881	0.4667	0.4563	0.4947	0.5097	0.5671
	BK (6, 32, 8)				0.2066	0.1026	0.4874	0.2809	0.4016	0.3813	0.1925	0.5583
	BK (6, 32, 12)				0.3081	0.1872	0.5589	0.4802	0.4732	0.4113	0.3791	0.6233
	BK (6, 40, 8)				0.2096	0.1072	0.4913	0.2943	0.4062	0.3843	0.207	0.5648
	BK (6, 40, 12)				0.3276	0.1979	0.5772	0.5123	0.4873	0.4193	0.4149	0.6363
	TQ				0.8588	0.8508	0.9217	0.7177	0.8337	0.5418	0.5742	0.4016
	DS				0.1445	0.2353	0.4531	0.3942	0.176	0.239	0.1393	0.2044

Netherlands	HP	0.1333	0.5707	0.3061	0.5024	0.3111	0.3426	0.4696
	BK (6, 32, 8)	0.2130	0.7370	0.4032	0.6044	0.2762	0.0429	0.5245
	BK (6, 32, 12)	0.3085	0.7223	0.3371	0.6297	0.3136	0.3175	0.5641
	BK (6, 40, 8)	0.2244	0.7380	0.4043	0.6094	0.2875	0.0636	0.5316
	BK (6, 40, 12)	0.3363	0.7203	0.3322	0.6365	0.3224	0.3691	0.5755
	TQ	0.7616	0.8972	0.7936	0.8394	0.3937	0.3905	0.4505
	DS	0.0243	0.3078	0.2166	0.2331	0.2516	0.0683	0.1257
Greece	HP		0.2932	0.2949	0.336	0.2006	0.1676	0.28
	BK (6, 32, 8)		0.2778	0.2339	0.2437	0.0652	0.0258	0.2466
	BK (6, 32, 12)		0.3395	0.3513	0.3856	0.1256	0.1575	0.2939
	BK (6, 40, 8)		0.2887	0.2435	0.2583	0.0732	0.0342	0.2562
	BK (6, 40, 12)		0.3569	0.3761	0.4284	0.1399	0.1885	0.3129
	TQ		0.8686	0.5689	0.8158	0.6251	0.6019	0.0225
	DS		0.2145	0.229	0.1547	0.1368	0.0303	0.0746
Belgium	HP			0.5923	0.7023	0.6147	0.4543	0.6586
	BK (6, 32, 8)			0.5357	0.6443	0.4492	0.0713	0.5811
	BK (6, 32, 12)			0.5621	0.7178	0.5696	0.2907	0.6529
	BK (6, 40, 8)			0.5426	0.6554	0.4633	0.086	0.588
	BK (6, 40, 12)			0.5758	0.7368	0.5753	0.3411	0.6691
	TQ			0.8025	0.9406	0.5827	0.6605	0.3843
	DS			0.4457	0.431	0.2774	0.2003	0.3039
Portugal	HP				0.5652	0.4085	0.3086	0.4556
	BK (6, 32, 8)				0.5954	0.1429	-0.021	0.3145
	BK (6, 32, 12)				0.62	0.3119	0.2593	0.4481
	BK (6, 40, 8)				0.5996	0.1524	-0.0075	0.3267
	BK (6, 40, 12)				0.6267	0.3438	0.3109	0.4734
	TQ				0.7918	0.337	0.6436	0.6106
	DS				0.2855	0.2279	0.1024	0.2138

Table I (continued)

		France	Italy	Spain	Netherlands	Greece	Belgium	Portugal	Austria	Finland	Ireland	Luxembourg
Austria	HP									0.5222	0.338	0.585
	BK (6, 32, 8)									0.3924	-0.1492	0.5063
	BK (6, 32, 12)									0.4471	0.1121	0.5744
	BK (6, 40, 8)									0.4	-0.1961	0.516
	BK (6, 40, 12)									0.4623	0.172	0.5947
	TQ									0.5286	0.5901	0.393
	DS									0.2239	0.0977	0.1854
Finland	HP										0.4585	0.4454
	BK (6, 32, 8)										0.2276	0.3661
	BK (6, 32, 12)										0.3156	0.3927
	BK (6, 40, 8)										0.2324	0.3773
	BK (6, 40, 12)										0.3366	0.2418
	TQ										0.4401	-0.0532
	DS										0.1811	0.153
Ireland	HP											0.3971
	BK (6, 32, 8)											0.1009
	BK (6, 32, 12)											0.2418
	BK (6, 40, 8)											0.0224
	BK (6, 40, 12)											0.2893
	TQ											0.15
	DS											0.1325

Source: OECD.

Note: HP: Hodrick-Prescott Filter, BK: Baxter-King Filter, DS: First Differences of logged variables.TQ: cycles are residuals from a quadratic trend.

The contemporaneous correlation coefficient of the Netherlands is relatively low in respect of Portugal and Spain, whereas the strongest correlation of the Belgian business cycle in Belgium is with the business cycle in the Netherlands, Austria, Portugal and Luxembourg.

It is noticeable that the behaviour of Greece, Ireland and Finland seems weakly correlated with, or uncorrelated with, the majority of the eurozone countries.

The Greek cycles fail to correlate with these of Italy, Ireland and Spain, and cycle correlation with other countries is only weakly positive. There is one exception: the German cycle and the Greek cycle appear to have fairly strong links.

The 'worst' behaviour in respect of cycle correlation is Ireland's. Lastly, Finland's cyclical components of output show the weakest (lowest) correlation with a majority of countries, the French cycle excepted.

3 Dynamic Analysis

3.1 ARDL Bounds Testing Procedure

Two major time series techniques have been developed for testing for long-run equilibrium relationships between variables: by Johansen (1988) and by Pesaran, Shin and Smith (2001).[7] In our paper, we shall adopt the second of these.

Pesaran et al. (2001) develop a technique to test for the existence of a long-run relationship between variables irrespective of whether these are $I(1)$ or $I(0)$. The major advantage of this test is that no matter whether the explanatory variables are exogenous or not, the long run parameters—with appropriate asymptotic inferences—can be obtained by applying OLS to an autoregressive distributed lag (ADL) model with appropriate lag length. Their approach is essentially to estimate an unconstrained dynamic error correction representation for the variables involved and then test whether or not the lagged levels of the variables are significant. In other words, the test of Pe-

[7] We should note that the Pesaran method uses a single reduced form equation in contrast with the Johansen method, where for the investigation of long-run equilibrium relationship it uses a system of equations.

saran et al. (2001) consists of estimating the following conditional error correction model (ECM):

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{p} \varphi_i x_{it-1} + \sum_{i=1}^{m} \theta_i \Delta y_{t-i} + \sum_{j=1}^{m} \sum_{i=1}^{p} \omega_{ij} \Delta x_{it-j} + \varepsilon_t \tag{1}$$

where y_t, x_{it} stand for the business cycles of eurozone countries, $p + 1$ is the number of these countries, and m is the number of lags (four here).

The procedure is an F-test for the joint significance of the coefficients of the lagged variables levels in (1) (so that H_0: $\gamma = \varphi_t = 0$, for all $i = 1,2,...p$). Two asymptotic critical value bounds provide a test for co-integration when the independent variables are $I(d)$ (where $0 \le d \le 1$): a lower value assuming the regressors are $I(0)$, and an upper value assuming purely $I(1)$ regressors. If the test statistics exceed their upper critical values in each case, we can reject the null hypothesis, namely that there is no long-run relationship. If the test statistics fall below the lower critical values, the null hypothesis should be accepted. If the statistics lie within their bounds in each case, no firm conclusion can be drawn.

The next step is to calculate long-run parameters of variables (a_0, β_{jt} and a_i), making an estimate by OLS on the unrestrained ADL model:

$$y_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{p} \sum_{i=0}^{n} \beta_{ji} x_{jt-i} + \varepsilon_t \tag{2}$$

where $\varepsilon_t \sim IID(0, \sigma^2)$.

The long-run values for coefficients can be calculated using:

$$\alpha_0^* = \frac{\hat{\alpha}_0}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 - \dots\dots - \hat{\alpha}_m}, \quad \beta_{ji}^* = \frac{\hat{\beta}_{j0} + \hat{\beta}_{j1} + \dots\dots + \hat{\beta}_{jn}}{1 - \hat{\alpha}_1 - \hat{\alpha}_2 - \dots\dots - \hat{\alpha}_m}$$

3.2 The Findings of the Dynamic Analysis

We shall now apply the econometric methods recommended by Pesaran, Shin and Smith (2001) to test for the existence (or non-existence) of long-run relationships between countries' output cycles. The next step will be to estimate long-run parameters, should the hypothesis of the existence of long-run correlation be confirmed.

Since the assessment of long-term relationships depends heavily on variables' stationarity properties, we need to address the variables' order of integration with care. We shall therefore use HP-detrended data predicted to be stationary.[8]

We begin with a general dynamic model (1) comprising the cycles of every eurozone economy except Luxembourg. PSS methods enable us to test for co-integration with a maximum of eleven variables only. Therefore, we have chosen to leave out the smallest country of the eurozone.

Table II reports the results of the F-test together with the 5% critical bounds. We observe that there is evidence to support long-run relationships between the cycle of each country and the cycle of all the other ten countries. The null hypothesis (no long-run correlation) can be accepted for Spain, Finland and Italy, with four lags.

The estimated long run parameters are given in Table III. In this and the following tables, the countries in the first column are taken as a dependent variable, and the countries in the top row are taken as explanatory variables of the ADL model run in each case.

In the first of the eleven groups of the table, where the dependent variable is the cyclical component of Germany's output, we observe close positive long-run relationships between Germany and the Netherlands, and between Germany and Austria. This positive relation is also maintained, though at a less striking level, where the leader variables are the Netherlands and Austria.

The German and Finnish cycles have negative relationships, no matter whether the leader is Germany or Finland. The same negative relation can be observed between the German and Spanish cycles, and between the German and Portuguese cycles. The relationships between Germany and Ireland, and Germany and Belgium, are also positive.

France has a positive relationship with a majority of countries, excepting that with the Netherlands (-0.06). There is a positive long-run equilibrium relationship between the French and Portuguese cycles, which strengthens when Portugal is the leader.

[8] The results of the augmented Dickey-Fuller test for unit roots confirm our expectations. The null hypothesis of non-stationarity of the cyclical component is rejected in every case.

Table II: F-statistics for testing the existence of a long-run relationship

		cyGermany	cyFrance	cyItaly	cySpain	cyNetherlands	cyGreece	cyBelgium	cyPortugal	cyAustria	cyFinland	cyIreland
cyi	Lags: 2	5.17	4.60	4.56	*3.24*	4.9	5.35	7.72	4.2	4.62	*1.83*	4.25
	Lags: 3	4.17	3.98	4.04	2.95	4.7	3.74	5.41	5.6	4.45	*2.64*	5.28
	Lags: 4	3.71	3.61	*2.58*	*2.88*	4.66	3.22	3.09	3.96	4.07	*3.22*	5.06

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=10 and 95 per cent level of confidence are (2.02; 3.24).

		cyFrance, cyNetherlands, cyBelgium, cyAustria, cyLuxembourg		cyGermany, cyNetherlands, cyBelgium, cyAustria, cyLuxembourg		cyGermany, cyFrance, cyBelgium, cyAustria, cyLuxembourg		cyGermany, cyNetherlands, cyFrance, cyAustria, cyLuxembourg		cyGermany, cyNetherlands, cyBelgium, cyFrance, cyLuxembourg		cyGermany, cyNetherlands, cyBelgium, cyAustria, cyFrance
cyGermany	Lags: 2	6.00	cyFrance	6.38	cyNetherlands	8.41	cyBelgium	10.34	cyAustria	8.95	cyLuxembourg	6.96
	Lags: 3	5.26		6.47		6.06		8.63		9.11		8.79
	Lags: 4	5.61		6.01		4.28		4.50		6.29		8.02

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=5 and 95 per cent level of confidence are (2.62; 3.79).

		cyItaly, cySpain, cyBelgium		cyFrance, cySpain, cyBelgium		cyItaly, cyFrance, cyBelgium		cyItaly, cySpain, cyFrance
cyFrance	Lags: 2	9.82	cyItaly	9.74	cySpain	6.40	cyBelgium	13.75
	Lags: 3	7.85		9.50		8.03		9.97
	Lags: 4	8.11		6.71		7.62		7.22

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=2 and 95 per cent level of confidence are (3.23; 4.35).

		cyFinland, cyBelgium		cyFrance, cyFinland		cyFrance, cyBelgium
cyFrance	Lags: 2	12.09	cyBelgium	11.24	cyFinland	5.40
	Lags: 3	11.63		18.92		8.04
	Lags: 4	10.42		25.48		8.05

Notes: The F-statistic is used to test for the joint significance of the coefficients of the lagged levels in the ARDL-ECM. Critical value bounds for the present specification with constant, no trend, p=2 and 95 per cent level of confidence are (3.79; 4.85)

Table III: Long-run coefficients

	ADL (m, n; 10)	Intercept	Germany	France	Italy	Spain	Netherlands	Greece	Belgium	Portugal	Austria	Finland	Ireland	AIC
Germany	ADL (4, 0; 10)	0.0000		0.0891	-0.0727	-0.2221	0.4196	0.0429	0.1441	-0.0347	0.4217	-0.1465	0.3898	-6.9010
France	ADL (3, 1; 10)	-0.0002	0.0143		0.1162	0.1163	-0.0615	0.0143	0.2253	0.0841	0.1400	0.0120	0.0199	-7.1540
Italy	ADL (4, 0; 10)	0.0002	-0.0826	0.1391		0.1063	0.0443	0.0490	0.2244	0.1044	-0.1117	-0.0095	0.1832	-6.8690
Netherlands	ADL (2, 3; 10)	-0.0004	0.2009	0.1114	0.1529	-0.0178		-0.0950	-0.0639	-0.1108	0.2711	0.0512	0.0141	-6.7040
Greece	ADL (3, 2; 10)	0.0002	0.6860	0.3040	-0.4158	0.0297	-0.0429		-0.2818	-0.0169	0.3185	0.0182	0.1650	-5.9130
Belgium	ADL (3, 0; 10)	0.0000	0.0141	0.0755	0.0582	0.0706	0.1509	0.0118		0.0858	0.1489	0.0754	0.0240	-7.9230
Portugal	ADL (4, 0; 10)	-0.0003	-0.3388	0.2649	-0.1441	0.2202	0.1762	0.4172	0.3744		-0.0181	0.0480	0.1072	-6.5070
Austria	ADL (4, 0; 10)	0.0000	0.2749	0.1772	-0.0731	-0.0422	0.0142	0.0048	0.1955	0.1224		0.0725	-0.0179	6.9590
Ireland	ADL (4, 0; 10)	-0.0002	0.0227	0.0871	0.1696	0.1984	0.0790	-0.0378	-0.0298	0.0115	-0.0415	0.0726		-6.2950

	ADL (m, n; 3)	Intercept	Germany	France	Netherlands	Belgium	Austria	Luxembourg	AIC
Germany	ADL (2, 3; 3)	0.0001		-0.0757	0.5573	0.0178	0.4170	0.1312	-6.8300
France	ADL (4, 2; 3)	-0.0001	0.0716		-0.1321	0.5694	0.1352	0.1110	-7.1700
Netherlands	ADL (4, 1; 3)	-0.0005	0.3970	0.3108		0.0963	0.1195	-0.0255	-6.5230
Belgium	ADL (3, 1; 3)	0.0000	0.0051	0.2444	0.1548		0.2384	0.0823	-7.8510
Austria	ADL (3, 1; 3)	-0.0001	0.2988	0.2397	-0.0201	0.2995		0.0193	-6.9600
Luxembourg	ADL (3, 1; 3)	-0.0002	0.3916	0.4593	-0.0052	0.3192	0.0510		-7.1400

	ADL (m, n; 3)	Intercept	France	Italy	Spain	Belgium	AIC
France	ADL (2, 3; 3)	-0.0003		0.0401	0.2405	0.5685	7.1423
Italy	ADL (4, 2; 3)	0.0003	0.2177		0.1848	0.1326	-6.9253
Spain	ADL (4, 1; 3)	0.0001	0.2460	0.0356		0.2888	-6.9749
Belgium	ADL (3, 1; 3)	-0.0001	0.5194	0.0986	0.1078		-7.7393

	ADL (m, n; 2)	Intercept	France	Belgium	Finland	AIC
France	ADL (2, 0; 2)	-0.00015		0.75610	0.04353	-7.0480
Belgium	ADL (3, 0; 2)	-0.00030	0.48884		0.13745	-7.7430
Finland	ADL (4, 0; 2)	-0.00032	0.16371	0.53421		-6.0761

Notes: AIC is Akaike Information criteria for model selection in the ADL specification.

In the third group, where the dependent variable is Italy, we find a positive relationships between Italy's and Belgium's cyclical components of output. The relationships between France and Spain, and between Portugal and Ireland, are also positive. The long-run equilibrium coefficient is at its highest value between the Italian and Belgian cycles, reaching 0.22.

Furthermore, we find that there is a strong relationship between the cyclical components of output of Greece and Germany, where the long-run parameters coefficient is 0.686, when the leader is Greece. The same behaviour is observed between the Greek and French cycles. Moreover, the relation between the cyclical component of Greece and that of Portugal is positive; the value of the long-run parameter is 0.41 when the leader is Portugal.

Examining the seventh group, we find that when Belgium is the leader we have a positive long-run relationship with the other countries, with the highest value achieved between Belgium and the Netherlands.

Finally, there is also a positive long run relationship between the Irish and Spanish cycles, as well as between the Irish and Italian cycles.

The next step is to bring in those groups of countries in the static analysis, where members of a group have strong contemporaneous correlation, then try to test whether the results of static analysis are confirmed in the dynamic context. Table II shows the results of the test for the existence of long-run equilibrium relationships among the countries in each group examined. All the F-values are significant, so there is evidence for long-run relationships within these groups.

Table III reports the estimated long-run coefficient. The results imply strong positive relationships between the French and Belgian cycles; between the German and Dutch cycles; between the German and Austrian cycles; between the Austrian and Belgian cycles; and between the Finnish and Austrian cycles when Finland is the leader.

Thus there can be observed the existence of a core or nucleus of countries closely bonded together—Germany, Belgium, Austria, France and the Netherlands—and close links between one eurozone country and specific others—France with Spain, and Greece with Germany.

4 Summary of the Findings

The purpose of this paper has been to study the cyclical components of output for the euro area countries using static and dynamic analysis. We have found that business cycles in eurozone countries are interconnected. The results indicate the existence of long-run relationships between cycles for the majority of the estimated group in the euro area, except for Spain, Finland and Italy with four lags. Moreover, the evidence also implies that the German cycle is strongly linked with the Greek and Irish cycles; that the Spanish cycle is strongly linked with the French and Italian cycles; and that the Belgian cycle is strongly linked with the Finnish cycle.

We conclude, finally, that there exists a core of countries closely bonded together—Germany, Belgium, Austria, France and the Netherlands— and close links between one eurozone country and specific others—France with Spain, and Greece with Germany.

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A Toolkit for the Study of Fiscal Policy in Greece[1]

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Abstract

We study fiscal policy in general equilibrium in Greece. To this end, we employ a rather standard dynamic stochastic general equilibrium model augmented with a public sector. After calibrating the model to the Greek economy, we use it to address a number of key issues related to fiscal policy.

1 Introduction

Modern macroeconomic theory starts with the view that growth, cycles and policy need to be studied jointly. The same theory uses artificial model economies that, although simple, can mimic important aspects of the behaviour of actual economies through time. A distinguishing feature of these

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model economies is that economic outcomes do not occur arbitrarily but instead arise as the outcome of agents' dynamic decision problems. As Lucas (1976) established, to understand growth, cycles and policy, one needs to use dynamic model economies consistent with rational behaviour and general equilibrium.

Calibration is part of our effort to get quantitative answers. This approach means that we first set as many parameter values as possible according to the balanced-growth path conditions of the model economy, then use this model to generate simulated time series; in turn, we confront these generated time series with analogous statistics from the actual economy under study and, finally, use the simulated model to do various (policy) experiments. Kydland and Prescott (1982) and Long and Plosser (1983) first illustrated the promise of this approach. Nowadays, the methods of this approach (the so-called real business cycle (RBC) research) are widely used in work on fiscal and public finance policy, monetary economics, international economics, labour economics, asset pricing, political economy, etc. In contrast to early RBC studies, recent macroeconomic models include market imperfections, policy failures, several shocks, etc. These models, known as dynamic stochastic general equilibrium (DSGE) models, are established as the laboratory in which modern macroeconomic theory and policy are conducted (for reviews, see e.g. Cooley and Prescott 1995, King and Rebelo 1999, Rebelo 2005, McGrattan 2006, Kydland 2006).

With few exceptions, applied macroeconomic research based on micro-founded DSGE models is limited in Greece.[2] Hence, there are not many reliable quantitative answers to questions related to the macroeconomic effects of changes in fiscal (spending-tax) policy instruments. This paper tries to fill the gap through a study of fiscal policy in general equilibrium in Greece. Note

[2] DSGE models with fiscal policy in Greece include Kollintzas and Vassilatos (2000), Angelopoulos et al. (2009) and Papageorgiou (2009). The present paper builds upon the work of Papageorgiou (2009). Differences from these papers are made clear below. By contrast, there is a large literature on the effects of fiscal policy in other countries (see e.g. Christiano and Eichenbaum (1992), Baxter and King (1993), McGrattan (1994), Braun (1994), Chari et al. (1994), Jonsson and Klein (1996), Malley et al. (2007, 2009) and many others). Recent papers by e.g. Ratto et al. (2009), Cogan et al. (2009) and Uhlig (2009) use DSGE models to quantify fiscal policy multipliers and evaluate the stimulus plans used to counter the current crisis.

that such studies are particularly topical these days. During the 2008-9 crisis, governments all around the world followed massive fiscal stimulus packages to counter the financial and economic crisis. At the heart of the problem of any type of fiscal action is the effectiveness of active fiscal policy in boosting economic activity as measured by fiscal policy multipliers. The latter can only follow from a DSGE model.

The model is as follows. We incorporate a public sector into the core structure of the neoclassical growth model. In particular, we assume that the government spends on public consumption services that provide direct utility to households, public investment that augments public infrastructure capital used by firms, and transfer payments that increase households' income. To finance these three categories of public spending, the government uses taxes on labour income, capital income and private consumption. In addition, it can issue government bonds. All independent fiscal policy instruments can follow stochastic processes. The model is calibrated to the Greek economy over the period 1960:1–2005:4. This means, among other things, that, in our policy experiments, we depart from an initial position which mimics the data averages in Greece over the period of study.[3]

Our main results are as follows. First, the model does quite well in reproducing some key stylized facts of the Greek economy. In particular, it produces a long-run solution for macroeconomic variables that is close to their averages in the data and can also explain the Greek business cycle in terms of statistics like volatility, persistence and co-movement of macroeconomic variables. Secondly, variance decomposition analysis suggests that a significant portion of macroeconomic volatility is caused by fluctuations in fiscal policy instruments. This applies in particular to changes in effective tax rates on labour and capital income. Thirdly, government spending multipliers—both short- and long-run—are small: in most cases, they are less than one, which

[3] Kollintzas and Vassilatos (2000) model the Greek economy as a small open economy with transaction costs in foreign markets. They introduce stochastic government spending but do not take into account fluctuations in distorting taxes. Angelopoulos et al. (2009) focus on rent seeking in a number of euro countries, Greece included. As said, the present paper builds upon the work of Papageorgiou (2009). Nevertheless, none of the above DSGE papers has studied fiscal policy multipliers and the importance of the tax-spending mix for macroeconomic performance.

is hardly a "multiplier" effect. Further rises in government investment spending have a relatively large multiplier, but the size of the latter is sensitive to the public finance instrument used to satisfy the government budget constraint. Actually, the financing decision is crucial to the effectiveness of all types of government spending. Fourthly, the long-run solution shows that the current fiscal pattern is not sustainable, in the sense that eventually public spending will have to fall and/or tax rates to rise relative to their values in the data to be able to get a well defined long-run equilibrium.

We are aware that the model used is very stylized—assuming away a number of frictions and shocks that are typically found to be important in the data (see e.g. Christiano et al. 2005, and Smets and Wouters 2003, 2007). Thus, the quantitative implications should be treated cautiously. However, we believe that useful insights can be gained from this type of work that can, at the very least, serve as a benchmark for the understanding of fiscal policy in Greece. In Greece, we have spent too much time debating the merits of fiscal expansion versus fiscal consolidation, but have failed to provide quantitative answers to questions related to the effectiveness of different policy instruments and the extra benefits/costs that policy changes may have. We need a lot more applied research based on calibrated or estimated micro-founded DSGE models. We hope the present paper contributes to this need.

The rest of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 presents calibration and the long run. Section 4 studies transitional dynamics and the power of the model to explain the cycle. Section 5 presents impulse response functions and dynamic multipliers. Section 6 closes the paper.

2 The Theoretical Model

The economy consists of a large number of identical households and firms, as well as a government. Households consume, work and save in the form of capital and government bonds. They also receive profits in the form of dividends. Firms produce a homogeneous product by using capital, labour and public infrastructure. Households and firms act competitively. The government levies taxes on income from labour and capital, as well as on consumption. It then uses its revenues from taxes and bond issue to finance public consumption that provides utility to households, public investment that augments public infrastructure and lump-sum transfers that increase households' income.

2.1 Households

In each period, there is a large number, N_t, of identical households indexed by the superscript *h*. The population size grows according to $N_{t+1}=\gamma_n N_t$, where $\gamma_n \geq 1$ and $N_0>0$ given. Let $u(C_t^h, L_t^h)$ denote each household's instantaneous utility function, where C_t^h and L_t^h are respectively total consumption services and leisure time at *t*. This function is increasing and concave. We assume $C_t^h \equiv C_t^{hp}+\vartheta \bar{G}_t^c$, where C_t^{hp} is private consumption and $\bar{G}_t^c$ is average (per household) public consumption goods and services provided by the government at *t*. Thus, public consumption goods and services influence the private utility through the parameter $\vartheta \in [-1, 1]$.[4]

The objective of the household is to maximize expected lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^{*t} u\left(C_t^h, L_t^h\right) \tag{1}$$

where E_0 is an expectations operator and $\beta^* \in (0,1)$ is the discount factor. The instantaneous utility function is assumed to be of the form:

$$u\left(C_t^h, L_t^h\right) = \frac{\left[\left(C_t^h\right)^{\gamma}\left(L_t^h\right)^{1-\gamma}\right]^{1-\sigma} - 1}{1-\sigma} \tag{2}$$

where $\gamma \in (0,1)$ is a preference parameter and $\sigma \geq 0$ is a measure of risk aversion. The household is endowed with one unit of time in each period and divides it between work effort, H_t^h, and leisure, L_t^h. Thus, the time constraint in each period is $L_t^h + H_t^h \leq 1$.

Each household can save in the form of capital, I_t^h, and one-period government bonds, D_t^h. It receives labour income, $w_t Z_t H_t^h$, capital income, $r_t^k K_t^h$, and interest income from bonds, $r_t^b B_t^h$, where w_t is the wage rate per efficient unit of labour hours, $Z_t H_t^h$, r_t^k is the return to capital, K_t^h, and r_t^b is the return

[4] If $\vartheta > 0$, private and public consumption are substitutes (e.g. private security and state police). If $\vartheta < 0$, private and public consumption are complements (e.g. low quality public education requires additional time and money for private courses). If $\vartheta = 1$, there is perfect substitutability.

to government bonds, B_t^h. The variable Z_t is labour augmenting technology that grows according to $Z_{t+1}=\gamma_z Z_t$, where $\gamma_z \geq 1$ and $Z_0 > 0$ given. The household also receives dividends, Π_t^h, and average (per household) lump-sum government transfers, $\bar{G}_t^{tr}$. Thus, the within-period budget constraint is:

$$\left(1+\tau_t^c\right)C_t^{h^p} + I_t^h + D_t^h \leq \left(1-\tau_t^l\right)w_t Z_t H_t^h + \left(1-\tau_t^k\right)\left(r_t^k K_t^h + \Pi_t^h\right) + r_t^b B_t^h + \bar{G}_t^{tr} \quad (3)$$

where $0 \leq \tau_t^c < 1$ is the tax rate on consumption, $0 \leq \tau_t^l < 1$ is the tax rate on labour income and $0 \leq \tau_t^k < 1$ is the tax rate on capital income.

The motions of capital and bonds for each household are given by:

$$K_{t+1}^h = \left(1-\delta^p\right)K_t^h + I_t^h - \frac{\xi}{2}\left(\frac{K_{t+1}^h}{K_t^h} - \gamma_n\gamma_z\right)^2 K_t^h \quad (4a)$$

$$B_{t+1}^h = B_t^h + D_t^h \quad (4b)$$

where $\delta^p \in (0,1)$ is the depreciation rate of private capital stock and $\xi \geq 0$ is a parameter capturing adjustment costs on investment. This specification implies that adjustment costs are absent in steady state.

The household chooses the paths $\left\{C_t^{h^p}, L_t^h, H_t^h, I_t^h, D_t^h, K_{t+1}^h, B_{t+1}^h\right\}_{t=0}^{\infty}$ to maximize (1)-(2) subject to constraints (3)-(4), initial conditions for K_0^h, B_0^h, and non-negativity constraints for C_t^{hp}, H_t^h, L_t^h, K_{t+1}^h, B_{t+1}^h. In doing so, it acts competitively by taking prices and policy variables as given. Appendix A presents the first-order conditions.

2.2 Firms

In each period, there is a large number, N_t, of identical firms indexed by the superscript f (for simplicity, the number of firms equals the number of households). Each firm produces a homogeneous product, Y_t^f, by using capital, K_t^f, labour services, H_t^f, and average (per firm) public capital, $\bar{K}_t^g$. The firm's production function is:

$$Y_t^f = A_t\left(K_t^f\right)^{a_1}\left(Z_t H_t^f\right)^{a_2}\left(\bar{K}_t^g\right)^{a_3} \quad (5)$$

where $a_i \in (0,1)$, $i = 1,2,3$ is the output elasticity of private capital, labour and public capital respectively and A_t is total factor productivity whose motion is specified below. We assume constant returns to scale to all three inputs so that $a_1 + a_2 + a_3 = 1$.

The objective of the firm is to maximize profits:

$$\Pi_t^f = Y_t^f - r_t^k K_t^f - w_t Z_t H_t^f \tag{6}$$

The firm chooses K_t^f and H_t^f to maximize (6) subject to (5) and non-negativity constraints for $K_t^f, H_t^f \geq 0$. In doing so, it acts competitively by taking prices and policy variables as given. Appendix B presents the static first-order conditions.

2.3 Government Budget Constraint

The within-period government budget constraint in aggregate terms is:

$$B_{t+1} + \tau_t^c \sum_{h=1}^{N_t} C_t^{h^p} + \tau_t^l w_t Z_t \sum_{h=1}^{N_t} H_t^h + \tau_t^k \sum_{h=1}^{N_t} \left(r_t^k K_t^h + \Pi_t^h \right) = G_t^c + G_t^{tr} + G_t^i + \left(1 + r_t^b\right) B_t \tag{7}$$

where G_t^c, G_t^{tr}, G_t^i are respectively total government consumption, total government transfers and total government investment at time t, and B_{t+1} is the end-of-period total stock of new bonds issued by the government.

Government investment augments the stock of public capital whose motion is:

$$K_{t+1}^g = \left(1 - \delta^g\right) K_t^g + G_t^i, \quad K_0^g > 0 \text{ given} \tag{8}$$

where $\delta^g \in (0,1)$ is the depreciation rate of public capital stock.

2.4 Exogenous Stochastic Variables

The exogenous stochastic variables are total factor productivity, A_t, and the six independent policy instruments, $G_t^c, G_t^{tr}, G_t^i\ \tau_t^l\ \tau_t^k\ \tau_t^c$. It is more convenient to define $s_t^c \equiv \frac{G_t^c}{Y_t}$, $s_t^{tr} \equiv \frac{G_t^{tr}}{Y_t}$ and $s_t^i \equiv \frac{G_t^i}{Y_t}$, which are the three categories of government spending as shares of output. Then, it is assumed that A_t, s_t^c, s_t^{tr}, $s_t^i\ \tau_t^l\ \tau_t^k\ \tau_t^c$, follow univariate stochastic $AR(1)$ process of the form:

$$\ln A_{t+1} = (1-\rho_A)\ln A_0 + \rho_A \ln A_t + \varepsilon^a_{t+1} \tag{9a}$$

$$\ln s^c_{t+1} = (1-\rho_g)\ln s^c_0 + \rho_g \ln s^c_t + \varepsilon^g_{t+1} \tag{9b}$$

$$\ln s^{tr}_{t+1} = (1-\rho_{tr})\ln s^{tr}_0 + \rho_{tr} \ln s^{tr}_t + \varepsilon^{tr}_{t+1} \tag{9c}$$

$$\ln s^i_{t+1} = (1-\rho_i)\ln s^i_0 + \rho_i \ln s^i_t + \varepsilon^i_{t+1} \tag{9d}$$

$$\ln \tau^l_{t+1} = (1-\rho_l)\ln \tau^l_0 + \rho_l \ln \tau^l_t + \varepsilon^l_{t+1} \tag{9e}$$

$$\ln \tau^k_{t+1} = (1-\rho_k)\ln \tau^k_0 + \rho_k \ln \tau^k_t + \varepsilon^k_{t+1} \tag{9f}$$

$$\ln \tau^c_{t+1} = (1-\rho_c)\ln \tau^c_0 + \rho_c \ln \tau^c_t + \varepsilon^c_{t+1} \tag{9g}$$

where $A_0, s^c_0, s^{tr}_0, s^i_0, \tau^l_0, \tau^k_0, \tau^c_0$, are the means, $\rho_A, \rho_g, \rho_{tr}, \rho_i, \rho_l, \rho_k, \rho_c$ are the first-order correlation coefficients, and $\varepsilon^a_{t+1}, \varepsilon^g_{t+1}, \varepsilon^{tr}_{t+1}, \varepsilon^i_{t+1}, \varepsilon^l_{t+1}, \varepsilon^k_{t+1}, \varepsilon^c_{t+1}$ are the i.i.d. shocks of the autoregressive processes.

2.5 Decentralized Competitive Equilibrium

We solve for a decentralized competitive equilibrium (DCE) in which (i) households maximize welfare (ii) firms maximize profits (iii) all constraints are satisfied and (iv) all markets clear. We first need to transform the components of national income into per-effective units to make them stationary. Thus, for any economy-wide variable $X_t \equiv (Y_t, C_t, I_t, D_t, K_t, K^g_t, G^c_t, G^{tr}_t, G^i_t)$, we define $x_t \equiv \dfrac{X_t}{N_t Z_t}$. The only exception is hours of work defined as $h_t \equiv \dfrac{H_t}{N_t}$. Then, the stationary DCE can be summarized by the following equations (we now drop superscripts for households and firms):

$$\frac{(c^p_t + \vartheta s^c_t y_t)}{y_t} = a_2 \frac{(1-\tau^l_t)}{(1+\tau^c_t)} \frac{\gamma}{(1-\gamma)} \frac{(1-h_t)}{h_t} \tag{10a}$$

$$\frac{\left[\left(c_t^p+\vartheta s_t^c y_t\right)^{\gamma}\left(1-h_t\right)^{(1-\gamma)}\right]^{1-\sigma}}{\left(1+\tau_t^c\right)\left(c_t^p+\vartheta s_t^c y_t\right)}\left[\frac{\partial i_t}{\partial k_{t+1}}\right]= \\ =\beta E_t\left[\frac{\left[\left(c_{t+1}^p+\vartheta s_{t+1}^c y_{t+1}\right)^{\gamma}\left(1-h_{t+1}\right)^{(1-\gamma)}\right]^{1-\sigma}}{\left(1+\tau_{t+1}^c\right)\left(c_{t+1}^p+\vartheta s_{t+1}^c y_{t+1}\right)}\left(\left(1-\tau_{t+1}^k\right)a_1\frac{y_{t+1}}{k_{t+1}}+\frac{\partial i_{t+1}}{\partial k_{t+1}}\right)\right] \tag{10b}$$

$$\frac{\left[\left(c_t^p+\vartheta s_t^c y_t\right)^{\gamma}\left(1-h_t\right)^{(1-\gamma)}\right]^{1-\sigma}}{\left(1+\tau_t^c\right)\left(c_t^p+\vartheta s_t^c y_t\right)}=\beta E_t\left[\frac{\left[\left(c_{t+1}^p+\vartheta s_{t+1}^c y_{t+1}\right)^{\gamma}\left(1-h_{t+1}\right)^{(1-\gamma)}\right]^{1-\sigma}}{\left(1+\tau_{t+1}^c\right)\left(c_{t+1}^p+\vartheta s_{t+1}^c y_{t+1}\right)}\left(1+r_{t+1}^b\right)\right] \tag{10c}$$

$$\gamma_n\gamma_z k_{t+1}=\left(1-\delta^p\right)k_t+i_t-\frac{\xi}{2}\left(\frac{\gamma_n\gamma_z k_{t+1}}{k_t}-\gamma_n\gamma_z\right)^2 k_t \tag{10d}$$

$$\gamma_n\gamma_z k_{t+1}=\left(1-\delta^p\right)k_t^g+s_t^i y_t \tag{10e}$$

$$y_t=A_t\left(k_t\right)^{a_1}\left(h_t\right)^{a_2}\left(k_t^g\right)^{a_3} \tag{10f}$$

$$y_t=c_t^p+i_t+s_t^c y_t+s_t^i y_t \tag{10g}$$

$$\gamma_n\gamma_z b_{t+1}-\left(1-r_t^b\right)b_t+\tau_t^c c_t^p+\tau_t^l a_2 y_t+\tau_t^k\left(a_1+a_2\right)y_t=\left(s_t^c+s_t^{tr}+s_t^i\right)y_t \tag{10h}$$

where

$$\beta\equiv\beta^*\gamma_z^{\gamma(1-\sigma)-1}$$

$$\frac{\partial i_t}{\partial k_{t+1}}=1+\xi\left(\frac{\gamma_n\gamma_z k_{t+1}}{k_t}-\gamma_n\gamma_z\right)$$

$$\frac{\partial i_{t+1}}{\partial k_{t+1}}=\left(1-\delta^p\right)+\xi\left(\frac{\gamma_n\gamma_z k_{t+2}}{k_{t+1}}-\gamma_n\gamma_z\right)\frac{\gamma_n\gamma_z k_{t+2}}{k_{t+1}}-\frac{\xi}{2}\left(\frac{\gamma_n\gamma_z k_{t+2}}{k_{t+1}}-\gamma_n\gamma_z\right)^2$$

$$w_t=a_2\frac{y_t}{h_t}$$

$$r_t^k = a_1 \frac{y_t}{k_t}$$

We thus have a system of eight nonlinear dynamic equations in $\{y_t, c_t^p, i_t, h_t, k_{t+1}, k_{t+1}^g, r_t^b, b_{t+1}\}_{t=10}^{\infty}$. This is given the paths of technology, $\{A_t\}_{t=0}^{\infty}$, and the six policy instruments, $\{\tau_t^l, \tau_t^k, \tau_t^c, s_t^c, s_t^{tr}, s_t^i\}_{t=0}^{\infty}$. To solve this system, we will linearly approximate it around its long-run solution. The latter is defined as the situation in which stationary variables remain unchanged and there are no shocks (see Appendix C for the long-run DCE).

3 Calibration and Long Run

3.1 Calibration

The above model is calibrated to the Greek economy. The data source is the OECD Economic Outlook, unless otherwise stated. The data set comprises quarterly data at constant 1995 prices and covers the period 1960:1–2005:4.[5]

For the series hours of work to be compatible with the model economy, it is assumed that the time endowment is (365/4) $\times$ (15 hours per day)=1369 hours per quarter. Then, the average value of per capita hours of work is found to be h =0.20. The steady state values of the tax rates on capital income, labour income and consumption are set equal to their average values over the period 1960–2005 from quarterly constructed effective tax rates. Then, the long-run effective tax rate on consumption is τ_0^c = 0.19 and the long-run effective tax rates on labour and capital income are τ_0^l = 0.21 and τ_0^k = 0.19 respectively. As in most cases, the curvature parameter in the utility function, σ, is set equal to 2. The preference parameter, ϑ, which measures the degree of substitutability/complementarity between private and public consumption is set equal to zero (see also e.g. Christiano and Eichenbaum 1992). The value of population growth, γ_n, is computed from population data and is found to

[5] Data for hours of work in the OECD Economic Outlook is available only on annual frequency over the period 1983-2005. Prior to 1983 the series are taken from Christodoulakis et al. (1997). To derive quarterly observations, annual series are interpolated. Moreover, quarterly series for private and public capital stocks are generated using a perpetual inventory method. For details, see Papageorgiou (2009).

be 1.0014. The growth rate of technological process, γ_z, is set equal to 1.005, which is the average quarterly growth rate of real per capita GDP in the USA. Following the study of Kollintzas and Vassilatos (2000), the two capital depreciation rates, δ^p and δ^g, are set equal to 0.007 and 0.0078 respectively (implying 2.79% and 3.12% annually). The initial levels of labour technological process, Z_0, and total factor productivity, A_0, are set equal to 1, since they are scale parameters. The value of the adjustment cost parameter, ξ, is chosen to pin down as closely as possible the relative volatility of private investment to output; this gives ξ =10.4780. Given the long-run value of private investment to GDP, i/y, which is set equal to its average value in the data, the time discount factor, β, and the ratio of private capital to GDP, k/y, are jointly calibrated from the steady state version of the Euler equation for private capital and the law of motion of private capital accumulation. Their values are found to be β = 0.9883 and k/y = 15.7364 respectively. The preference parameter, γ, which is the welfare weight of consumption relative to leisure, is calibrated from the optimality condition for labour supply, with a labour allocation equal to 20% of time. Given the value of β, the Euler equation for government bonds implies a steady state quarterly value for the real interest rate on public debt equal to 0.0119 (4.75% annually). The steady state version of the law of motion of public capital accumulation implies a steady state quarterly value of the public capital-to-GDP ratio equal to k^g/y = 2.3995.

One issue raised when computing the labour and capital shares in output is how to treat the income earned by the self-employed; see also Cooley (1995). In practice, the income of the self-employed is a combination of labour and capital income. However, in the National Accounts, there is no distinction between labour and capital income earned by the self-employed and all of their income is treated as capital income. In order to estimate a proxy for their labour income, we assume that the opportunity cost of being a self-employed person is the labour income that would have been earned had she/he been working as an employee. Such an opportunity cost can be measured by the average wage rate. Working in this way, the share of labour income, a_2, is found to be 0.60 (details are in Papageorgiou 2009). In turn, following e.g. Baxter and King (1993), the exponent of public capital in the production function, a_3, is set equal to the mean share of public investment, s_0^i, which is 0.034 in the data. The capital share is then residually calibrated as $a_1 = 1 - a_2 - a_3$ and its value is 0.3660.

The autoregressive parameters, ρ_g, ρ_{tr}, ρ_i, ρ_l, ρ_k, ρ_c, are estimated via OLS regressions of their respective stochastic processes. The same applies to their standard deviations, σ_g, σ_{tr}, σ_i, σ_l, σ_k, σ_c. The values of s_0^c, s_0^{tr}, s_0^i are set equal to their respective mean values in the data. Concerning the persistence and volatility of the Solow residual, we choose ρ_A and σ_A so that the actual and simulated series have the same variance and first-order serial correlation (see also e.g. Correia et al. 1995, Greenwood and Huffman 1991).

Table 1 summarizes all the above values used in the numerical solutions.

Table 1: Calibration

Parameter or variable	Description	Value	Source
a_2	Labour elasticity in production	0.60	Data
a_3	Public capital elasticity in production	0.034	Set equal to s_0^i
a_1	Private capital elasticity in production	0.3660	Calibrated as 1-a_2-a_3
γ_n	Population growth rate	1.0014	Data
γ_z	Growth rate of labour augmenting technology	1.005	Set
δ^p	Private capital quarterly depreciation rate	0.0070	Set
δ^g	Public capital quarterly depreciation rate	0.0078	Set
A_0	Long run aggregate productivity	1	Set
Z_0	Initial level of technological process	1	Set
ξ	Capital adjustment cost parameter	10.4780	Set
σ	Curvature parameter in the utility function	2	Set
ϑ	Substitutability between private and public consumption in utility	0	Set
γ	Consumption weight in utility function	0.2889	Calibrated from (C5)
k/y	Private capital to output ratio	15.7364	Calibrated from (C1)-(C2)
k^g/y	Public capital to output ratio	2.3995	Calibrated from (C6)
β	Time discount factor	0.9883	Calibrated from (C1)-(C2)
s_0^c	Government consumption to output ratio	0.1469	Data
s_0^i	Government investment to output ratio	0.0340	Data
s_0^{tr}	Government transfers to output ratio	0.1636	Data
τ_0^l	Tax rate on labour income	0.21	Data
τ_0^k	Tax rate on capital income	0.19	Data
τ_0^c	Tax rate on consumption	0.19	Data

Table 1 (continued)

Parameter or variable	Description	Value	Source
ρ_A	Persistent parameter of A_t	0.6700	Set
ρ_g	Persistent parameter of s_t^c	0.9493	Estimation
ρ_{tr}	Persistent parameter of s_t^{tr}	0.9830	Estimation
ρ_i	Persistent parameter of s_t^i	0.9757	Estimation
ρ_l	Persistent parameter of τ_t^l	0.9937	Estimation
ρ_k	Persistent parameter of τ_t^k	0.9662	Estimation
ρ_c	Persistent parameter of τ_t^c	0.9480	Estimation
σ_A	Standard deviation of innovation ε_t^a	0.0171	Set
σ_g	Standard deviation of innovation ε_t^g	0.0289	Estimation
σ_{tr}	Standard deviation of innovation ε_t^{tr}	0.0392	Estimation
σ_i	Standard deviation of innovation ε_t^i	0.0467	Estimation
σ_l	Standard deviation of innovation ε_t^l	0.0152	Estimation
σ_k	Standard deviation of innovation ε_t^k	0.1166	Estimation
σ_c	Standard deviation of innovation ε_t^c	0.0242	Estimation

3.2 Long-run Solutions

Using the parameter values reported in Table 1 in the long-run DCE equation system, we now solve for the economy's long run. We first examine the benchmark case in which the annual long-run debt-to-GDP ratio is set equal to 0.64 (this implies a quarterly value of 2.56) which is the average value in the data over 1970–2005, and choose the long-run value of government transfers as share of GDP, s_0^{tr}, to be residually determined to satisfy the government budget constraint. Table 2 reports the long-run solution of our model economy in this case. The same table also reports the average values of the model's endogenous variables in the data. The results suggest that the model's long-run solution is in line with most of data averages.

We next do a number of policy experiments. We recalculate the long-run solution when we set the annual long-run debt-to-GDP ratio equal to 0.8 (the average value in the data over the recent sub-period 1980–2005) and allow, one-by-one, one of the other policy instruments to adjust to satisfy the government budget. Thus, starting again with government transfers as share of

Table 2: Data averages and long-run model solution

Variable	Description	Data averages	Long-run solution
c/y	Consumption to output ratio	0.6472	0.6091
i/y	Private investment to output ratio	0.21	0.21
h	Hours at work	0.20	0.2099
k/y	Private capital to output ratio	15.7364	15.7364
k^g/y	Public capital to output ratio	2.3995	2.3995
r^b	Real return to government bonds	0.011	0.0119
b/y	Public debt to output ratio	2.56	2.56
s_0^{tr}	Government transfers to output ratio	0.1636	0.1228
TR/y	Total tax revenues to output ratio	0.2916	0.3177

Notes: (i) Quarterly data over 1960:1-2005:4 (ii) b/y has been computed from annual series as $4\times(b/y)$ over the period 1970-2005 (iii) Data average for r^b over 1998:1-2005:4 (iii) Quarterly series for private and public capital stocks were generated using a perpetual inventory method.

GDP, s_0^{tr}, as the residually determined variable, we then experiment in turn with government consumption as share of GDP, s_0^c, government investment as share of GDP, s_0^i, the labour income tax rate, τ_0^l, the capital income tax rate, τ_0^k, the consumption tax rate, τ_0^c, and public debt as a share of output, b/y, as residually determined variables. In all these regimes, the exogenous policy instruments are set at their data averages. Results are reported in Table 3. Numbers in bold indicate the value of the endogenous public finance policy variable under each regime.

There are two messages from Table 3. First, inspection of the solutions implies that the current fiscal pattern is not sustainable, in the sense that eventually public spending will have to fall and/or tax rates to rise relative to their average values in the data in order to be able to get a well defined long-run equilibrium. Secondly, when we compare alternative non-lump-sum policy instruments as ways of satisfying the long-run government budget constraint, public finance choices are important to macroeconomic performance. Specifically, the choice between transfers and public debt is trivial; as expected, they are equivalent in terms of the real allocation and generate the same, best possible outcome in terms of long-run output (1.3410). By contrast, when we have to choose among non-lump sum policy instruments as the residually determined policy instrument, the public finance choice ceases

Table 3: Long-run solutions

Policy Experiments	s_0^{tr}	s_0^c	s_0^i	τ^l	τ^k	τ^c	b/y	c/y	i/y	k^p/y	h	y
Data Averages (Quarterly Data 1980-2005)	0.19	0.1522	0.0320	0.26	0.23	0.20	3.20	0.6868	0.1844	15.2656	0.2033	
1. s_0^{tr} endogenous (Benchmark case)	**0.1625**	0.1522	0.032	0.26	0.23	0.20	3.20	0.6314	0.1844	13.8180	0.2173	1.3410
2. s_0^c endogenous	0.19	**0.1293**	0.032	0.26	0.23	0.20	3.20	0.6543	0.1844	13.8180	0.2113	1.3039
3. s_0^i endogenous	0.19	0.1522	**0.0091**	0.26	0.23	0.20	3.20	0.6543	0.1844	13.8180	0.2113	1.2160
4. τ^l endogenous	0.19	0.1522	0.032	**0.3076**	0.23	0.20	3.20	0.6314	0.1844	13.8180	0.2062	1.2725
5. τ^k endogenous	0.19	0.1522	0.032	0.26	**0.2951**	0.20	3.20	0.6470	0.1688	12.6496	0.2131	1.2393
6. τ^c endogenous	0.19	0.1522	0.032	0.26	0.23	**0.2436**	3.20	0.6314	0.1844	13.8180	0.2113	1.3039
7. b/y endogenous	0.19	0.1522	0.032	0.26	0.23	0.20	**-0.0704**	0.6314	0.1844	13.8180	0.2173	1.3410

Notes: (i) Quarterly data over the period 1980:1-2005:4 (ii) In each policy experiment, one of the fiscal variables is endogenous in the long-run and the rest are equal to their data averages. Numbers in bold indicate the value of the endogenous fiscal variable.

to be trivial. The worst choice, in terms of GDP, is public investment that gives 1.1260 for long-run output. The second-worst is the capital income tax rate, being followed by the labour income tax rate.

3.3 Long-run Fiscal Multipliers

In this subsection, we allow each type of government spending as share of output to increase by 1 percentage point of GDP (for instance, the share of government consumption rises from 0.1522 in the data to 0.1622), while allowing one of the other policy instruments to adjust residually to satisfy the long-run DCE. Results are reported in Table 4. Numbers in bold indicate the value of the endogenous policy instrument under each regime. We also report the starting position of the economy (benchmark case).

We first study the case in which rises in public spending are financed by lump-sum taxes or equivalently by reductions in lump-sum transfers. In this fictional case, a rise in public investment spending increases long-run output from 1.3410 to 1.3784 implying a multiplier of 0.08 in terms of $(\Delta Y/Y)/(\Delta G/G)$, which is the relatively modern measure of multiplier,[6] or a multiplier of 2.4992 in terms of $\Delta Y/\Delta G$, which is the more traditional measure of multiplier.[7] A similar rise in public consumption spending increases long-run output from 1.3410 to 1.3578 implying a multiplier of 0.1587 in terms of $(\Delta Y/Y)/(\Delta G/G)$ or a multiplier of 1.0429 in terms of $\Delta Y/\Delta G$.[8]

When we need to resort to distorting public finance policy instruments, the best recipe is to increase government investment and finance this by a rise in consumption taxes (in this case, long-run output rises from 1.3410 to 1.3613 implying a multiplier of 0.0457 in terms of $(\Delta Y/Y)/(\Delta G/G)$ or a multiplier of 1.427 in terms of $\Delta Y/\Delta G$). The next best tax policy is to finance the same rise in government investment by higher labour taxes (in this case, long-run output rises from 1.3410 to 1.3480 implying a multiplier of 0.0165 in terms of $(\Delta Y/Y)/(\Delta G/G)$ or a multiplier of 0.5158 in terms of $\Delta Y/\Delta G$). Increases in public investment financed by higher capital income taxes are counterproductive (long-run output falls from 1.3410 to 1.3324) implying a negative mul-

[6] See e.g. Cogan et al. (2009), Uhlig (2009) and references therein.

[7] See e.g. Baxter and King (1993) and references therein.

[8] Recall that $G_t^i, s_t^i Y_t$ where $i \equiv (c, i, tr)$.

Table 4: Long-run fiscal policy and multipliers

Policy Experiments	s_0^{tr}	s_0^c	s_0^i	τ^l	τ^k	τ^c	b/y	c/y	i/y	k^p/y	h	y
Data averages (quarterly data 1980-2005)	0.19	0.1522	0.032	0.26	0.23	0.20	3.20	0.6868	0.1844	15.2656	0.2033	
s_0^{tr} residually determined (bench-mark case)	0.1625	0.1522	0.032	0.26	0.23	0.20	3.20	0.6314	0.1844	13.8180	0.2173	1.3410
1. s_0^c increases and τ^l is endogenous	0.1625	0.1622	0.032	**0.2808**	0.23	0.20	3.20	0.6214	0.1844	13.8180	0.2151	1.3279
2. s_0^c increases and τ^k is endogenous	0.1625	0.1622	0.032	0.26	**0.2584**	0.20	3.20	0.6282	0.1776	13.3082	0.2181	1.3125
3. s_0^c increases and τ^c is endogenous	0.1625	0.1622	0.032	0.26	0.23	**0.2193**	3.20	0.6214	0.1844	13.8180	0.2173	1.3410
4. s_0^c increases and s_0^{tr} is endogenous	**0.1505**	0.1622	0.032	0.26	0.23	0.20	3.20	0.6214	0.1844	13.8180	0.2200	1.3578
5. s_0^i increases and τ^l is endogenous	0.1625	0.1522	0.042	**0.2808**	0.23	0.20	3.20	0.6214	0.1844	13.8130	0.2151	1.3480
6. s_0^i increases and τ^k is endogenous	0.1625	0.1522	0.042	0.26	**0.2584**	0.20	3.20	0.6282	0.1776	13.3082	0.2181	1.3324
7. s_0^i increases and τ^c is endogenous	0.1625	0.1522	0.042	0.26	0.23	**0.2193**	3.20	0.6214	0.1844	13.8180	0.2173	1.3613
8. s_0^i increases and s_0^{tr} is endogenous	**0.1505**	0.1522	0.042	0.26	0.23	0.20	3.20	0.6214	0.1844	13.8180	0.2200	1.3784
9. s_0^i increases and s_0^c is endogenous	0.1625	**0.1422**	0.042	0.26	0.23	0.20	3.20	0.6314	0.1844	13.8180	0.2173	1.3613

Notes: (i) Quarterly data over the period 1980:1-2005:4 (ii) Government spending as share of GDP is exogenously increased by 1 percentage point (e.g. s^c increases from 0.1522 to 0.1622) and one of the tax rates is endogenously determined to absorb this extra spending. The public debt-to-GDP ratio is set at 3.2 or 0.8 annually.

tiplier. Increases in public consumption spending are also counterproductive (long-run output falls) when they are financed by higher labour and capital taxes, or output neutral (zero multiplier) if financed by higher consumption taxes. Finally, notice that a rise in public investment spending financed by lower public consumption spending increases long-run output from 1.3410 to 1.3613 implying a multiplier of 0.0457 in terms of $(\Delta Y/Y)/(\Delta G/G)$ or a multiplier of 1.427 in terms of $\Delta Y/\Delta G$ (thus, in our model, higher consumption taxes work like lower public consumption spending).

Summing up, focusing on cases in which further rises in government spending are financed by distorting tax revenues, government consumption has a negative, or zero, long-run multiplier depending on the way it is financed; further rises in government investment spending can have a multiplier effect (i.e. a value of multiplier higher than one) only when they are financed by rises in consumption taxes or by cuts in government consumption spending. Thus, only public investment can help to stimulate the economy in the long run, but its effectiveness depends critically on public finance choices. These results are qualitatively similar to those in e.g. Baxter and King (1993, section V).

4 Transitional Dynamics and Descriptive Power of the Model

4.1 Linearization and Approximate Dynamics

Equations (10a)–(10h), which describe the DCE of the model economy, are linearized around their steady state. Variables in the log-linearized system are expressed as percentage deviations from their respective steady state values, $\hat{x}_t \equiv \ln x_t - \ln x_t$, where x denotes the steady-state value of any variable x_t. As Appendix D shows, the final system is a first-order stochastic difference equation system in nine variables, where there are three state and six jump variables. This system is solved using the generalized Schur decomposition method proposed by Klein (2000). We report that when we use the calibrated parameter values in Table 1, we find that all eigenvalues are real and there are three eigenvalues with absolute value less than one, so that the model exhibits saddlepath stability. Combined with the single long-run solution, this implies a unique convergent solution. We now study the implications of this solution along the transition path.

4.2 Descriptive Power of the Model Economy

The descriptive power of the model is evaluated by comparing the second moment properties generated by the model to those in the actual Greek data over the period 1960:1–2005:4. Tables 5, 6 and 7 summarize respectively results for standard deviations, first-order autocorrelations and cross-correlations with output. This is for both the actual and the simulated series.[9]

Table 5: Relative volatility $x \equiv \sigma_x / \sigma_y$

Variable x	Actual Data	Simulated Data
Private consumption, c	0.6056	0.4630
Private investment, i	2.9147	2.9152
Hours of work, h	0.5703	0.5856
Labour productivity, y / h	0.9943	0.5366
Real wage per hour, w	1.0709	0.5366
Private capital, k	0.2074	0.1029
Public capital, k^g	0.2157	0.1205
Standard deviation of output, σ_y	0.0268	0.0268

Notes: Quarterly data over the period 1960:1-2005:4 All variables are in logs and have been detrended with the H-P filter with a smoothing parameter of 1600.

Table 5 reveals that the model does well in predicting the variability of most variables. The volatilities of investment and hours of work are the same as those in the data. The volatility of private consumption is also well captured. On the other hand, the volatilities of productivity and real wage compensation produced by the model are less volatile than those in the data. Finally, the model correctly predicts that private and public capital stocks fluctuate much less than output.

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[9] The model has been simulated 2000 times, with each simulation being 284 periods long, where the first 100 observations have been discarded to ensure that the simulated series start from an ergodic distribution. To get the business cycle behaviour of the series, both the actual and simulated data were logged and then filtered by using the Hodrick-Prescott filter with a smoothing parameter of 1600. The moments summarizing the cyclical behaviour are computed from the filtered data and averaged across the 2000 simulations. For details, see Papageorgiou (2009).

Table 6: Persistence $\rho\ (x_t, x_{t-1})$

Variable x	Actual Data	Simulated Data
Output, y	0.52	0.52
Private consumption, c	0.87	0.57
Private investment, i	0.92	0.54
Hours of work, h	0.68	0.58
Labour productivity, y / h	0.43	0.53
Real wage per hour, w	0.79	0.53
Private capital, k	0.95	0.92
Public capital, k^g	0.96	0.94

Note: See Table 5.

Table 6 illustrates that the model produces satisfactory results for the first-order autocorrelation of hours of work, labour productivity and the two forms of capital stock. The persistence generated by the model for private consumption and investment is high (although not as high as in the data), in contrast with Kollintzas and Vassilatos (2000) whose model predicted zero value for the autocorrelation coefficient of private investment.

As Table 7 reports, the model does well in reproducing the co-movement properties of most variables in terms of signs and, to some extent, magnitude. The exceptions are hours of work and real wages, where the model pre-

Table 7: Co-movement $\rho\ (y_t, x_{t+i})$

Variable x	Actual Data					Simulated Data				
	$i = -2$	$i = -1$	$i = 0$	$i = 1$	$i = 2$	$i = -2$	$i = -1$	$i = 0$	$i = 1$	$i = 2$
Output, y	0.15	0.52	1	0.52	0.15	0.21	0.52	1	0.52	0.21
Private consumption, c	0.43	0.49	0.53	0.43	0.28	0.11	0.37	0.78	0.42	0.18
Private investment, i	0.45	0.53	0.54	0.47	0.36	0.22	0.50	0.94	0.48	0.18
Hours of work, h	0.16	0.28	0.30	0.26	0.34	0.23	0.50	0.90	0.47	0.19
Labour productivity, y / h	0.06	0.36	0.83	0.37	-0.05	0.14	0.43	0.88	0.46	0.19
Real wage per hour, w	0.37	0.32	0.21	0.11	-0.02	0.14	0.43	0.88	0.46	0.19
Private capital, k	-0.16	-0.01	0.12	0.24	0.32	-0.32	-0.12	0.24	0.42	0.49
Public capital, k^g	0.12	0.19	0.25	0.30	0.31	-0.12	-0.05	0.08	0.15	0.17

Note: See Table 5.

dicts strong, instead of weak, correlation between these two variables and GDP. Kollintzas and Vassilatos (2000) also stress this issue and argue that this is caused by highly centralized labour markets, while Lapatinas (2009a) provides evidence of high labour adjustment costs in the Greek economy. The model, however, is more successful in terms of the relation of current output with past and future hours of work and real wages. The model also manages to reproduce the behaviour of average productivity, as well as the way in which past and future consumption and investment are related to current output.

Summing up, the model does quite well in reproducing the key stylized facts of the Greek business cycle.

5 Impulse Response Functions and Dynamic Multipliers

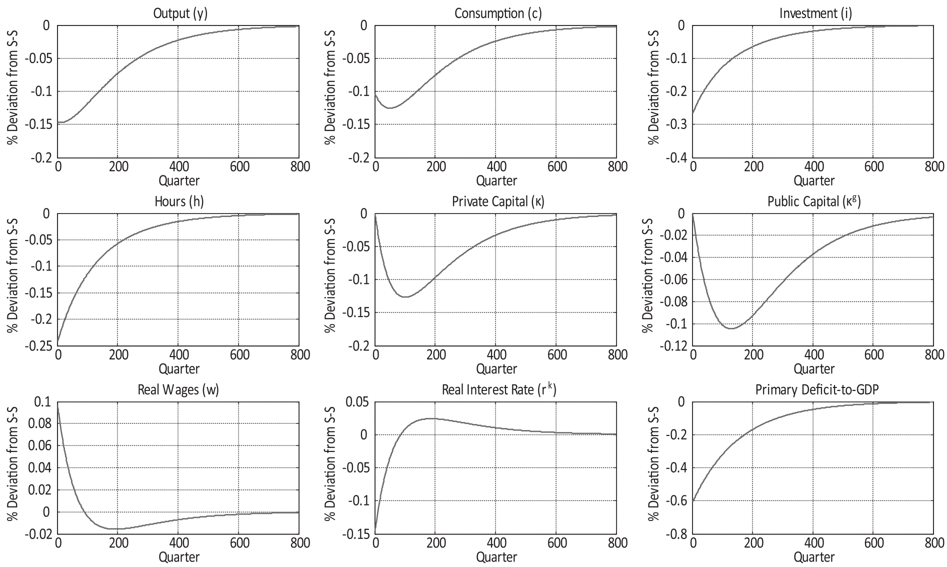
This section studies the dynamic response of the economy to temporary unitary increases in the innovations of exogenous fiscal policy variables—namely, labour and capital income tax rates, consumption tax rates, government consumption as share of output, and government investment as share of output. In all experiments that follow, departing from the Greek economy, the residual policy instrument is public debt, i.e. all policy changes are met by changes in public debt along the transition path as well as in the long run. Thus, we focus on the least distorting public finance way.

5.1 Impulse Response Functions

We first illustrate the response of key macroeconomic variables to a 1% temporary increase in each fiscal policy instrument. We study one instrument at a time.

Figure 1 displays the response of some key endogenous macroeconomic variables to a temporary increase in the labour income tax rate. A temporary increase in the labour income tax rate causes a negative wealth effect that induces current consumption and leisure to fall (and thus current labour supply to rise). But, at the same time, the higher tax rate reduces the net return to labour inducing an intra-temporal substitution effect that leads households to reduce labour supply and consumption on impact. As the impulses show, the latter substitution effect dominates the former wealth effect, so that labour supply and hours of work fall. So does private consumption. Lower

Figure 1: Response to a temporary 1% increase in the labour income tax rate

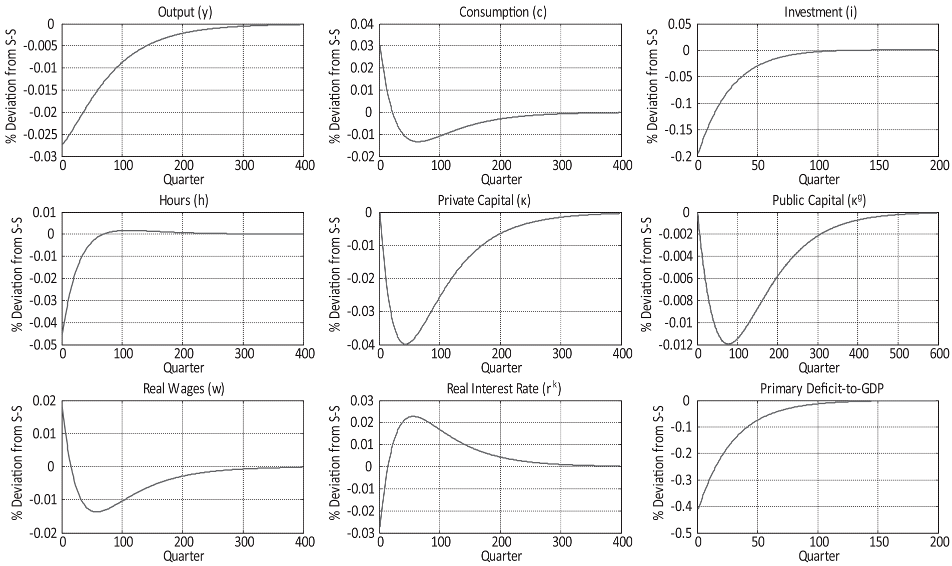


hours of work shift down the marginal product of capital so that investment also falls (this further reduces the marginal product of labour and hours of work). Output decreases owing to lower labour and capital. Eventually, with a temporary shock, the economy converges back to its initial long run.

Figure 2 shows the response of some key endogenous macroeconomic variables to a temporary increase in the capital income tax rate. A temporary increase in the capital income tax rate has a negative wealth effect that pushes households to decrease current consumption and leisure (and thus increase labour supply). However, the results are dominated by the fall in the net return to capital which reduces private investment and capital over time. The fall in investment produces an inter-temporal substitution effect that leads households to increase consumption and leisure (and thus decrease labour supply) on impact. The latter effect dominates the negative wealth effect so that hours of work fall and consumption rises in the short run. Even though hours or work slightly increase after some time, output falls all the time owing to lower capital. Eventually, the economy returns to its initial long run.

It is important to point out that temporary increases in labour tax rates

Figure 2: Response to a temporary 1% increase in the capital income tax rate

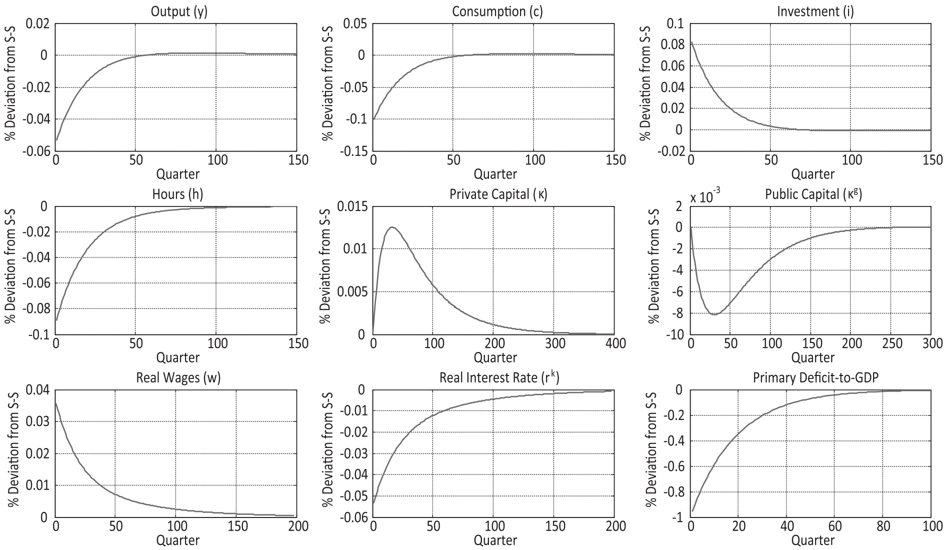


produce quantitatively bigger and more persistent adverse effects on output than temporary increases in capital tax rates. This is explained by the intra-temporal effect on labour supply and the higher autoregressive coefficient of the labour income tax rate.[10] This result is consistent with the findings of e.g. Braun (1994) for the U.S. economy.

Figure 3 shows the response of some key endogenous macroeconomic variables to a temporary increase in the consumption tax rate. There is again a negative wealth effect that pushes households to decrease current consumption and leisure (and thus increase labour supply). At the same time, the higher consumption tax rate induces an intra-temporal substitution ef-

[10] By contrast, it can be shown that a permanent increase in the capital tax rate reduces private investment and capital by more than a permanent increase in the labour tax rate. This is mainly justified by the strong inter-temporal substitution effect induced by higher tax rates on capital, which leads to high levels of current consumption, low investment and hence little capital in the future. See Papageorgiou (2009) for both transitory and permanent changes in fiscal policy instruments.

Figure 3: Response to a temporary 1% increase in the consumption tax rate

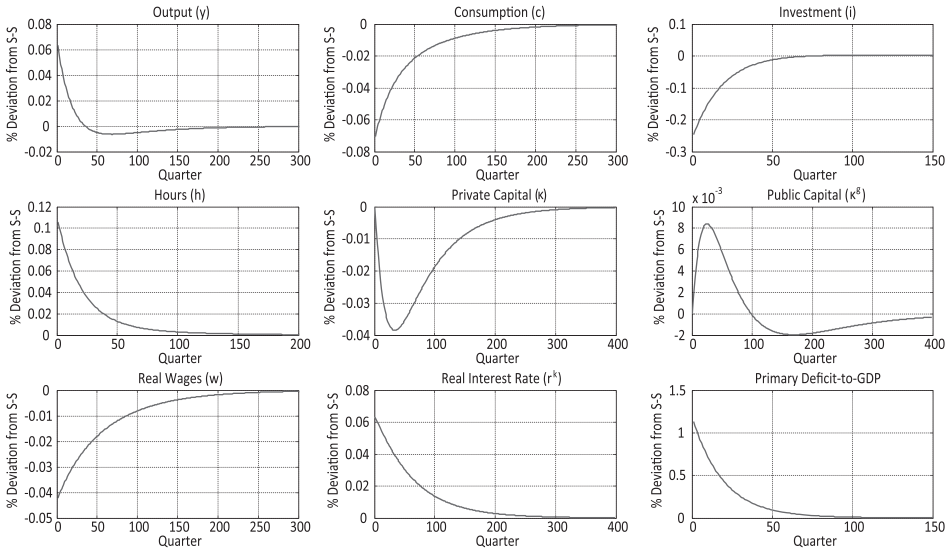


fect that leads households to reduce labour supply and consumption on impact. As the impulses show, the latter substitution effect dominates the former wealth effect, so that labour supply and hours of work fall, together with private consumption. Thus, this is as with labour taxes. However, since now there are no direct adverse effects on the returns to productive factors as we had before with income taxes, the drop in private consumption allows for an increase in private investment and capital on impact. As a result, the adverse effects on hours of work, consumption and output are milder than above with income taxes. Eventually, the economy converges back to its initial long run.

Figure 4 shows the response of some key endogenous macroeconomic variables to a temporary increase in the share of government consumption to output. A temporary increase in the output share of government consumption implies a drain in social resources that crowds out private consumption and investment. Since leisure falls, jointly with private consumption, labour supply and hours of work rise.[11] Note that a higher interest rate induces an

[11] Gali et al. (2007) show that the interaction of rule-of-thumb consumers (for which consumption equals labour income) and sticky prices can generate an increase in private consumption in response to a shock in government consumption.

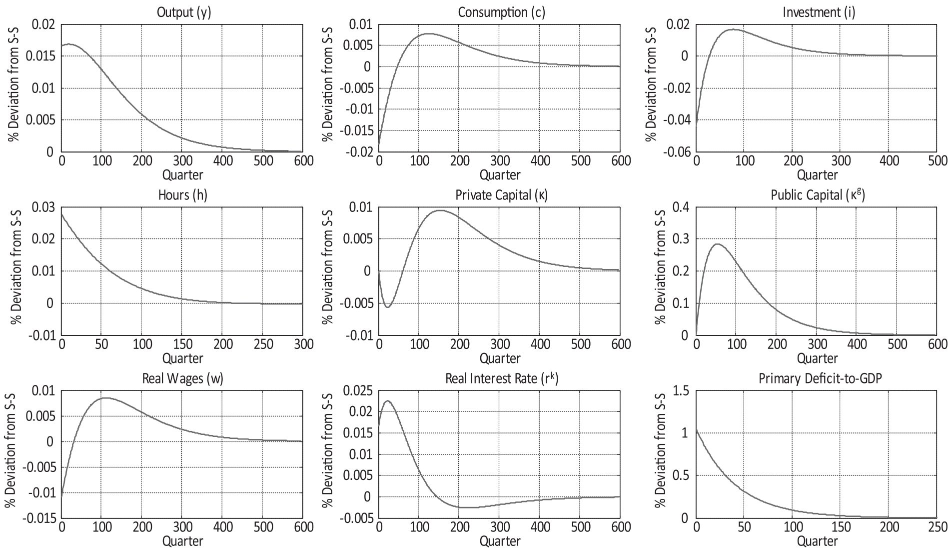
Figure 4: Response to a temporary 1% increase in the share of government consumption



inter-temporal substitution effect leading to a further drop in current consumption and leisure—and thus a further increase in current labour supply and hours of work. Nevertheless, the impact of more hours of work on the future marginal product of capital is small, so that investment falls all the time. The increase in aggregate demand, coming from the initial rise in pubic consumption, and the increase in hours of work raise output on impact, but, in the following years of transition, the low level of private capital leads to a decrease in output so that output convergences to the initial equilibrium from below. Eventually, the economy returns to its initial long run.

Figure 5 displays the response of key endogenous macroeconomic variables to a temporary increase in the share of government investment to output. The effects of a temporary rise in the output share of public investment implies a drain in social resources as in the case of a rise in public consumption, but now there are also supply-side effects, as a higher stock of public infrastructure leads to higher marginal products of private inputs, capital and labour. As a result, while private consumption and private investment fall on impact, as in the case of a rise in public consumption, they both rise in the later years. Output is above its initial level all the time. Eventually, the economy converges back to its initial long run.

Figure 5: Response to a temporary 1% increase in the share of government investment



5.2 Dynamic Fiscal Multipliers

We now use the simulated impulse response functions presented above to provide numbers for dynamic fiscal multipliers. Thus, departing from the long run, we shock each policy instrument by 1% temporarily and then report the percentage deviation of output from its long-run value (results for other endogenous variables are available upon request) and the resulting value of the associated dynamic fiscal multiplier. As in the previous subsection, we focus on the case in which the residual public finance policy instrument is "lump sum" (this means that if results are biased, this is on the side of overestimating the size of dynamic multipliers).

Results for output over time as percentage deviation from its long-run value are reported in Table 8.[12] These results imply that the most effective fiscal policy instrument to stimulate output is a reduction in the labour income tax rate. A reduction in capital income and consumption tax rates also

[12] A negative sign of changes in tax rates means that an increase (resp. decrease) in the tax rate decreases (resp. increases) output.

Table 8: Percentage deviation of output from long run (as a result of temporary shocks to fiscal policy instruments)

Quarters	1	4	8	12	40	∞
1% increase in s^c	0.0635	0.0518	0.0389	0.0287	-0.0023	0
1% increase in s^i	0.0166	0.0166	0.0167	0.0168	0.0165	0
1% decrease in τ^l	-0.1458	-0.1463	-0.1467	-0.1469	-0.1431	0
1% decrease in τ^k	-0.0273	-0.0268	-0.0261	-0.0253	-0.0190	0
1% decrease in τ^c	-0.0535	-0.0448	-0.0352	-0.0275	-0.0035	0

Note: See Table 5.

help to stimulate output, but their effects are smaller than under cuts in labour income taxes; the same applies to increases in government investment. Notice that increases in government consumption lead to a boost in output at the beginning, but there is a reduction in these benefits over time and eventually the initial stimulus comes at the cost of output contraction further down the road (output will eventually fall after 40 quarters). The resulting public spending multipliers are small. For instance, a 1% temporary rise in public consumption spending increases output by 0.0635% on impact. This implies an output multiplier of 0.0597 in terms of $(\Delta Y/Y)/(\Delta G/G)$ or 0.4066 in terms of $\Delta Y/\Delta G$. A similar temporary rise in public investment spending implies a multiplier of 0.0163 in terms of $(\Delta Y/Y)/(\Delta G/G)$ or 0.4790 in terms of $\Delta Y/\Delta G$. For similar quantitative results in other economies, see e.g. Cogan et al. (2009) and Uhlig (2009).

6 Variance Decomposition

This section quantifies the contribution of fiscal shocks to macroeconomic fluctuations. The total variances of the forecast errors of the endogenous variables are decomposed into fractions explained by innovations in technology, government consumption as share of output, government investment as share of output, the labour tax rate, the capital tax rate and the consumption tax rate. The methodology used is described in Appendix E. Here we report the key findings for GDP variability.

In Table 9, the variances of output, consumption, investment, hours of work, labour productivity and capital are decomposed into the fractions ex-

Table 9: Variance decomposition

		% variance explained by innovations in:					
	Quarters Ahead	Technology	Government Consumption	Government Investment	Labour Tax Rate	Capital Tax Rate	Consumption Tax Rate
Output, y	1	96.4849	0.5721	0.1014	0.8333	1.7242	0.2841
	4	92.8013	1.0172	0.2195	1.8007	3.6444	0.5167
	12	83.5646	1.6278	0.5640	4.6050	8.7628	0.8757
	40	66.0918	1.4783	1.4825	11.9241	18.1512	0.8720
	∞	**44.6190**	**1.0861**	**3.1266**	**30.8019**	**19.7779**	**0.5885**
Private consumption, c	1	78.3895	3.4767	0.6164	2.0981	10.4771	4.9422
	4	67.0382	5.6632	1.0035	3.8396	15.0150	7.4406
	12	52.6083	9.3545	1.6196	8.3966	17.8164	10.2047
	40	40.0025	12.0603	1.7038	22.2443	15.0025	8.9866
	∞	**18.0742**	**6.2083**	**2.0496**	**49.3762**	**20.4830**	**3.8087**
Private in-vestment, i	1	87.7200	1.0622	0.0881	0.3416	10.7052	0.0830
	4	77.5436	1.8515	0.1520	0.6805	19.6285	0.1439
	12	61.0598	2.8797	0.2251	1.4520	34.1620	0.2213
	40	49.2386	3.0814	0.2126	3.1762	44.0585	0.2327
	∞	**46.2362**	**2.9138**	**0.5421**	**6.8526**	**43.2356**	**0.2198**
Hours of work, h	1	68.5446	5.1199	0.9078	7.4565	15.4290	2.5422
	4	50.6149	7.7452	1.5070	12.6284	23.7007	3.8039
	12	30.8550	9.8920	2.3824	21.0609	31.0727	4.7371
	40	19.3785	9.0515	3.3695	35.6420	28.4247	4.1339
	∞	**13.2443**	**6.4069**	**3.0082**	**54.6932**	**19.7735**	**2.8739**
Labour productivity, y/h	1	94.5576	0.8858	0.1571	1.2901	2.6695	0.4398
	4	90.5729	1.7185	0.2862	2.4783	4.1411	0.8030
	12	83.8813	3.7296	0.5188	5.2204	5.1340	1.5159
	40	73.1536	6.7011	0.5443	8.3016	9.2616	2.0378
	∞	**49.8232**	**5.9459**	**3.3708**	**7.5179**	**31.8629**	**1.4794**
Private capital, k	1	87.7200	1.0622	0.0881	0.3416	10.7052	0.0830
	4	78.4233	1.7957	0.1478	0.6424	18.8510	0.1397
	12	53.4700	3.5255	0.2790	1.6406	40.8133	0.2715
	40	20.0006	4.6538	0.2586	4.7369	70.0017	0.3483
	∞	**7.6340**	**2.9410**	**1.0810**	**25.8099**	**62.3235**	**0.2107**
Public capital, k^g	1	20.0010	0.1186	79.2913	0.1727	0.3574	0.0589
	4	11.3183	0.1193	87.8860	0.2031	0.4130	0.0603
	12	3.9407	0.1012	95.1546	0.2550	0.4946	0.0539
	40	0.9307	0.0489	97.8864	0.4209	0.6812	0.0319
	∞	**0.3906**	**0.0145**	**95.2036**	**3.0266**	**1.3530**	**0.0117**

plained by various shocks. This table can be read as follows: for each variable, each line shows the fraction of variance explained by the exogenous shocks in the corresponding quarter. For example, in the first quarter, 96.4849% of the variance of output is explained by innovations in technology, 0.5721% is explained by innovations in government consumption as share of output, 0.1014% is explained by innovations in government investment as share of output, 0.8333% is explained by innovations in the labour tax rate, 1.7242% is explained by innovations in the capital tax rate and 0.2841% is explained by innovations in the consumption tax rate.

The results in Table 9 suggest that changes in fiscal variables play a significant role in the fluctuation of endogenous macroeconomic variables. More specifically, the contribution of the tax rates on labour and capital income in the variance of output is found to be high. In the limit, 44.619% of the variance of output is explained by innovations in technology, while 30.80% is explained by innovations in the labour tax rate and 19.7779% by innovations in the capital tax rate. Government consumption and investment as shares of output and the tax rate on consumption contribute less (1.0861%, 3.1266% and 0.5885% respectively). However, for short-time horizons, it is innovations in technology that play the key role. Thus, while fluctuations in the tax rates on labour and capital are important for the total variance of output, they are less important over shorter horizons (1–12 quarters).

It should be noted that similar results are found in McGrattan (1994) for the US economy. She reports that 28% of the variance of output is explained by innovations in government consumption and 27% by innovations in the labour tax rate, while only 41% is explained by innovations in technology (TFP). In a similar line, Jonsson and Klein (1996), in a study for the Swedish economy, find that only 23% of total output variance is explained by productivity shocks, while 52% is explained by innovations in government spending and 6% by innovations in the consumption tax rate.

Summing up, variability of fiscal policy variables (especially, variability of labour and capital income taxes) is responsible for a large part of macroeconomic volatility. Papageorgiou (2009) studies variance decomposition of all endogenous variables and finds that the same applies to almost all macroeconomic variables and not only GDP.

7 Concluding Remarks and Possible Extensions

This paper has examined the role of fiscal policy in growth and cycles in Greece by using a relatively standard dynamic stochastic general equilibrium model. Of course, our calibrated model remains too stylized and should be further developed. For instance, it should be expanded to include real and monetary frictions ranging from price and wage rigidities to imperfect competition in product and labour markets. It should also be expanded to include a more realistic public sector in the sense that public employees are an important fraction of the labour force in Greece. Finally, following the recent tradition, it would be interesting to estimate the DSGE model economy rather than simply to calibrate it. We leave these extensions for future research.

Appendices

Appendix A: Households

The first-order conditions include the budget constraints and:

$$\frac{u_{l_t^h}}{u_{C_t^{h,p}}}=\frac{\left(1-\tau_t^l\right)}{\left(1+\tau_t^c\right)}w_t Z_t \tag{A1}$$

$$\begin{aligned}&\frac{u_{C_t^{h,p}}}{\left(1+\tau_t^c\right)}\left[1+\xi\left(\frac{K_{t+1}^h}{K_t^h}-\gamma_n\gamma_z\right)\right]=\\&=\beta^* E_t\left[\frac{u_{C_{t+1}^{h,p}}}{\left(1+\tau_{t+1}^c\right)}\left(\left(1-\tau_{t+1}^k\right)r_{t+1}^k+\left(1-\delta^p\right)+\xi\left(\frac{K_{t+2}^h}{K_{t+1}^h}-\gamma_n\gamma_z\right)\frac{K_{t+2}^h}{K_{t+1}^h}-\frac{\xi}{2}\left(\frac{K_{t+2}^h}{K_{t+1}^h}-\gamma_n\gamma_z\right)^2\right)\right]\end{aligned} \tag{A2}$$

$$\frac{u_{C_t^{h,p}}}{\left(1+\tau_t^c\right)}=\beta^* E_t\left[\frac{u_{C_{t+1}^{h,p}}}{\left(1+\tau_{t+1}^c\right)}\left(1+r_{t+1}^b\right)\right] \tag{A3}$$

$$\lim_{t\to\infty}\beta^{*t}E_0 u_{C_t^{h,p}}K_{t+1}^h=0 \tag{A4}$$

$$\lim_{t\to\infty}\beta^{*t}E_0 u_{C_t^{h,p}}B_{t+1}^h=0 \tag{A5}$$

where (A1) is the intratemporal condition for work time, (A2)-(A3) are Euler equations for K_{t+1}^h and B_{t+1}^h respectively, and (A4)-(A5) are transversality conditions.

Appendix B: Firms

The first-order conditions of this simple problem are:

$$r_t^k = a_1 \frac{Y_t^f}{K_t^f} \tag{B1}$$

$$w_t = a_2 \frac{Y_t^f}{Z_t H_t^f} \tag{B2}$$

which equate factor returns to marginal products.

Appendix C: Long-run DCE

$$\frac{k}{y} = \frac{a_1\left(1-\tau_0^k\right)}{\frac{1}{\beta}-\left(1-\delta^p\right)} \tag{C1}$$

$$\frac{i}{y} = \left[\gamma_n\gamma_z - \left(1-\delta^p\right)\right]\frac{a_1\left(1-\tau_0^k\right)}{\frac{1}{\beta}-\left(1-\delta^p\right)} \tag{C2}$$

$$r^b = \frac{1-\beta}{\beta} \tag{C3}$$

$$\frac{c^p}{y} = 1-\left[\gamma_n\gamma_z - \left(1-\delta^p\right)\right]\frac{a_1\left(1-\tau_0^k\right)}{\frac{1}{\beta}-\left(1-\delta^p\right)} - s_0^c - s_0^i \tag{C4}$$

$$h = \frac{a_2\left(\frac{\gamma}{1-\gamma}\right)\left(\frac{1-\tau_0^l}{1+\tau_0^c}\right)}{\frac{c^p}{y} + \vartheta s_0^c + a_2\left(\frac{\gamma}{1-\gamma}\right)\left(\frac{1-\tau_0^l}{1+\tau_0^c}\right)} \tag{C5}$$

$$\frac{k^g}{y} = \frac{s_0^i}{\gamma_n\gamma_z - \left(1-\delta^g\right)} \tag{C6}$$

$$y=A_0\left[\left(\frac{a_1\left(1-\tau_0^k\right)}{\frac{1}{\beta}-\left(1-\delta^p\right)}\right)^{a_1}\left(\frac{a_2\left(\frac{\gamma}{1-\gamma}\right)\left(\frac{1-\tau_0^l}{1+\tau_0^c}\right)}{\frac{c^p}{y}+\vartheta s_0^c+a_2\left(\frac{\gamma}{1-\gamma}\right)\left(\frac{1-\tau_0^l}{1+\tau_0^c}\right)}\right)^{a_2}\left(\frac{s_0^i}{\gamma_n\gamma_z-\left(1-\delta^g\right)}\right)^{a_3}\right]^{1-a_1-a_3} \tag{C7}$$

$$\frac{b}{y}\left(\gamma_n\gamma_z-\frac{1}{\beta}\right)+\tau_0^c\frac{c^p}{y}+\tau_0^l a_2+\tau_0^k\left(a_1+a_3\right)=s_0^c+s_0^{tr}+s_0^i \tag{C8}$$

which is a system of eight equations in eight unknowns y, c^p, i, h, k, k^g, r^b, b.

Appendix D: Linearized System

The linearized DCE equations constitute a second-order stochastic difference equation system in 8 unknowns, namely, $\left\{\hat{y}_t,\hat{c}_t^p,\hat{i}_t,\hat{h}_t,\hat{k}_t,\hat{k}_t^g,\hat{r}_t^b,\hat{b}_t\right\}$, of the form $E_t\left(A_2\hat{x}_{t+2}+A_1\hat{x}_{t+1}+A_0\hat{x}_t+B_1\hat{z}_{t+1}+B_0\hat{z}_t\right)=0$, where $\hat{x}_t=\left[\hat{y}_t,\hat{c}_t^p,\hat{i}_t,\hat{h}_t,\hat{k}_t,\hat{k}_t^g,\hat{r}_t^b,\hat{b}_t\right]'$, $\hat{z}_t=\left[\hat{A}_t,\hat{s}_t^c,\hat{s}_t^{tr},\hat{s}_t^i,\hat{\tau}_t^l,\hat{\tau}_t^k,\hat{\tau}_t^c\right]'$ and A_2, A_1, A_0, B_1, B_0 are constant matrices of dimension 8×8, 8×8, 8×8, 8×7 and 8×7 respectively. To transform the system into a first-order one, we use an auxiliary variable denoted as $k2$, where $k2_t\equiv k_{t+1}$ or $k2_{t+1}\equiv k_{t+2}$, so that we increase the dimension of the system adding an extra equation, $k2_t-k_{t+1}=0$. Thus, the system becomes a first-order stochastic difference system in 9 unknowns, $E_t\left(A_1\hat{x}_{t+1}+A_0\hat{x}_t+B_1\hat{z}_{t+1}+B_0\hat{z}_t\right)=0$, where $\hat{x}_t\equiv\left[\hat{y}_t,\hat{c}_t^p,\hat{i}_t,\hat{h}_t,\hat{k}_t,\hat{k}_t^g,\hat{r}_t^b,\hat{b}_t,\hat{k2}_t\right]'$, $k2_t\equiv k_{t+1}$, $\hat{z}_t=\left[\hat{A}_t,\hat{s}_t^c,\hat{s}_t^{tr},\hat{s}_t^i,\hat{\tau}_t^l,\hat{\tau}_t^k,\hat{\tau}_t^c\right]'$ and A_1, A_0, B_1, B_0, are constant matrices of dimension 9×9, 9×9, 9×7 and 9×7 respectively. Note that $\hat{z}_{t+1}$ can be substituted into the system from the respective $AR(1)$ process of the exogenous state variables, $\hat{z}_{t+1}=R\hat{z}_t+\varepsilon_{t+1}$ (hence $E_t\hat{z}_{t+1}=R\hat{z}_t$). Thus, the system can be rewritten as $E_t\left(A_1\hat{x}_{t+1}+A_0\hat{x}_t+\tilde{B}\hat{z}_t\right)=0$, where $\tilde{B}=B_1R+B_0$, which is a first-order stochastic difference equation system in nine variables, where there are three state variables $\left(\hat{k}_t,\hat{k}_t^g,\hat{b}_t\right)$ and six jump variables $\left(\hat{y}_t,\hat{c}_t^p,\hat{i}_t,\hat{h}_t,\hat{r}_t^b,\hat{k2}_t\right)$. The system is solved using the generalized

Schur decomposition method proposed by Klein (2000). The general solution of the above system can be written as:

$$\hat{d}_t^c = M\hat{k}_t^s + N\hat{z}_t \tag{D1}$$

$$\hat{k}_{t+1}^s = P\hat{k}_t^s + Q\hat{z}_t \tag{D2}$$

$$\hat{z}_{t+1} = R\hat{z}_t + \varepsilon_{t+1} \tag{D3}$$

where $\hat{d}_t^c$ is the vector of jump variables, $\hat{k}_t^s$ is the vector of endogenous state variables, $\hat{z}_t$ is the vector of exogenous state variables, and M, N, P, Q are constant matrices of dimension 6×3, 6×7, 3×3 and 3×7 respectively. When we use the calibrated parameter values in Table 1, we find that all eigenvalues are real and there are three eigenvalues with absolute value less than one, so that the model exhibits saddlepath stability. Combined with the single long-run solution, this implies a unique solution.

Appendix E: Variance Decomposition

Variances of the forecast errors of the endogenous variables are decomposed assuming that shocks are temporary (see also e.g. Jonsson and Klein, 1996). Let $\hat{x}_t$ be an $n_x \times 1$ vector of endogenous variables expressed as percentage deviations from the steady state, ε_t be an $n_\varepsilon \times 1$ vector of i.i.d. shocks and Σ be the diagonal covariance matrix of exogenous shocks. Let $c_{i,j,s}$ be a vector whose elements correspond to the response after s periods of the endogenous variable $\hat{x}_{i,t}$ to a one-period (i.e. temporary) shock $e_{j,t}$ occurred in period t, where $\hat{x}_i$ is the i 'th element of $\hat{x}_t$ and ε_j is the j 'th element of ε_t. The total variance of the forecast error of the i 'th element of $\hat{x}_t$ for a time horizon h is (see Canova, 2007):

$$Var\left(\hat{x}_{i,t+h} - E_t\left[\hat{x}_{i,t+h}\right]\right) = \sum_{j=1}^{n_\varepsilon} \sum_{s=0}^{h-1} c_{ij,s}^2 \sigma_{jj}^2 \tag{E1}$$

where σ_{jj}^2 is the diagonal element of Σ that corresponds to the variance of the j'th element of ε_t. The share of total variance of the forecast error can be decomposed as:

$$R_{ij,h} = \frac{\sigma_j^2 \sum_{s=0}^{h-1} c_{ij,s}^2}{\sum_{j=1}^{n_\varepsilon} \sum_{s=0}^{h-1} c_{ij,s}^2 \sigma_j^2} \tag{E2}$$

which shows the fraction of the h-step ahead forecast error variance in $\hat{x}_{i,t}$ attributed to shock $\varepsilon_{j,t}$. It can be calculated for short-run and long-run movements in $\hat{x}_{i,t}$ by varying the forecast time horizon h.

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Government Bond Yield Spreads in the EMU: The Case of Greece

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Abstract

The creation of the European Monetary Union (EMU) was expected to be accompanied with a reduction (if not virtual elimination) in the yield differences (spreads) of EMU country government bonds of similar characteristics. In this paper, we examine the medium term driving factors of the yield differentials between Greek and German long-term government bonds. Our main goal is to distinguish the liquidity factors from the credit risk component regarding these yield differences. Through the use of quarterly data and utilizing two alternative measures of bond spreads, we find that these yield differences are driven by an international risk factor. Furthermore, the credit risk factor, which we proxy via debt-to-GDP ratios is not statistically significant for the yield spreads.

1 Introduction

A view once shared by both economists and market analysts was that the birth of the European Monetary Union (EMU) would be accompanied by a permanent drastic reduction (if not virtual elimination) in the differences between yields-to-maturity of euro-denominated government bonds with similar characteristics[1] (hereafter yield differences) issued by EMU member

[1] E.g. length of maturity, whether the yield is indexed or not, if there is a developed secondary market etc.

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countries.[2] In particular, each individual EMU country's government bonds yields were expected to converge to those of the corresponding German government bond. The German "Bund" is considered the de facto benchmark bond for the following reasons: it has had consistently the lowest yields amongst EMU countries; the disproportionate size of the German economy vis-á-vis the rest of the EMU member countries; and Germany has traditionally exhibited fiscal discipline, at least during the last decades. These stylized facts explain why credit rating agencies (e.g. Moody's) have consistently rated the German bonds with the highest possible (positive) grade.[3]

Contrary to these expectations, in recent years there has been a departure from the (relatively) low yield differences, as these differences have increased and fluctuated. In particular, at the beginning of 2008 (1/1/2008) the yield difference between the Greek 10-year government bonds at fixed rate and the corresponding German securities was 30 basis points (b.p.)[4] while at the end of 2008 it was 300.3 b.p.[5] In 2009, these yield differences remained high and continued to exhibit similar acute fluctuations.

Yield differentials are of particular importance for policy makers owing to the sheer magnitude of (nominal) government debt, which is usually serviced through the issuing of government bonds. Furthermore, for EMU countries, as monetary policy is conducted by the ECB and central banks are independent (Maastricht Treaty, 1992[6]), monetary policy cannot be used to reduce the real level of debt.[7]

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[2] These yield differences are sometimes referred to simply as "spreads". Favero et al. (1997) is considered the seminal paper regarding this issue for the EMU area.

[3] The 10-year German government bonds have held stable AAA ratings for many years (S&P since 17/03/1983, Moody's since 05/07/2000 and Fitch since 10/08/1994).

[4] Basis point(s) is a unit that is equal to 1/100th of 1%, and is used to denote the change in a financial instrument. It avoids the ambiguity between relative and absolute discussions about rates. For example, a "1% increase" from a 10% interest rate could refer to an increase either from 10% to 10,1% (relative), or from 10% to 11% (absolute).

[5] However, we must note that this is the result of both an increase in the interest rates of Greek government bonds and the reduction in the interest rates of German government bonds.

[6] Article 7 of the Protocol "On the Statue of the European System of Central banks and the European Central Bank".

[7] I.e. a government cannot "inflate-away" its outstanding nominal debt (Missale, 1999). In an article for the UK newspaper The Guardian (2/12/2008), Rogoff argues in favour of the FED

In countries where government debt exceeds GDP (e.g. Greece), even a tenth of a percentage point spread (10 b.p.) could increase government outlays by more than 0.1% of GDP (in the medium term). Higher bond yields imply higher debt servicing costs, which can be regarded as markets imposing discipline on national governments' fiscal policies. In particular, Bayoumi et al. (1995) argue that positive debt levels are accompanied by increases in yield differences. These increases as considered reflect the effort from markets to exercise a disciplinary influence on budgetary policies. Wyplosz (2006) argues that as the government bond yield differences in the EMU era have remained relatively low (under 5%[8]), markets do not expect any country to exit the EMU.

The question arises as to what drives these yield differences. For the pre-EMU era, various authors have identified four main driving factors (Beetsma and Bovenberg, 1999; Favero, 1997; Wyplosz, 2006).

- Exchange rate movements and exchange rate risks.
- Tax treatments and capital movement restrictions.
- Liquidity of the issued securities.
- Credit (or default) risks.

With the creation of the EMU, the first two factors were eliminated; however, the latter remain valid. In other words, the risk premium (in our case, yield difference) of an EMU member state's government bond is expected to be the sum of liquidity factor and credit default components.

In the early stages of the EMU, researchers and market analysts argued that yield differentials were (and would remain) exclusive to liquidity factors (e.g. Favero et al., 1999). These liquidity factors are mainly related to the characteristics of both the securities issued and the markets in which they are traded. In particular, the higher the liquidity of a security, the lower are the associated transaction costs; therefore, one would also expect lower yields. Even if government bonds are denominated in the same currency (e.g. in

creating a 6% inflation rate "…effectively writing down all non-indexed debts... fortunately, creating inflation is not rocket science. All central banks need to do is to keep printing money to buy up government debt." Although Rogoff is referring to domestic rather than government debt, there is an obvious trend regarding the use of monetary policy for the manipulation of the real value of securities.

[8] This is an ad hoc benchmark initiated by Wyplosz (2006).

euros) and have the same characteristics (e.g. 10-year maturity with a fixed interest rate), they might still be regarded as imperfect substitutes if secondary markets do not exist, or are imperfect, and this will lead to differences in yields.

The liquidity of government bonds depends primarily on local (country) factors, mostly on the security issuing process. In recent years, various EMU member country public debt management agencies have introduced measures to increase the liquidity of their issued securities through the creation of repurchase programs, the ability of second round purchasing, the use of interest-rate swaps, participation and/or creation of specialized electronic trading platforms (such as the EuroMTS platform[9]) etc.

In the relevant empirical literature, liquidity factors are taken into consideration. However, most authors conclude that liquidity factors play only a minor role in explaining government bond yield differences (Bernoth et al., 2006; Favero et al., 2007). For example, Codogno et al. (2003) find that only for France is liquidity the most important factor in explaining yield differences between the (euro) government bonds issued by EMU countries vis-á-vis German government bonds. For most of the other countries, the authors conclude that yield differences are caused by international risk factors.[10] Bernoth et al. (2006) argue that liquidity premiums do not exist in the EMU era and conclude that the government debt-to-service ratio is the main factor driving yield differentials.

Regarding credit risks, they reflect the market's assessment of the creditworthiness of the borrower (sovereign issuer)—that is, the possibility of default. In terms of EMU member state government bonds, the fiscal situation of the issuing country is used as a proxy. In other words, the level and dynamics of government debt are regarded as the main sources of credit risk.

In the EMU, the levels and dynamics of government debt are regulated through the Stability and Growth Pact (SGP), which has the goal of bringing

[9] EuroMTS is the company that manages a pan-European electronic trading platform for government and quasi-government Eurobenchmark bonds (bonds denominated in euros with at least €5 billion in outstanding size). Another popular electronic trading system is Brokertec. Greek government bonds are traded on the Bank of Greece electronic market (HDAT) and on EuroMTS (eligible issues).

[10] We shall explore the international risk factor later on.

about fiscal discipline and—most importantly for the purposes of this paper—convergence and synchronization of fiscal deficits. An expected consequence of this policy would be a reduction (if not elimination) of credit risk for EMU member country securities. However, it appears that in recent years the SGP has not brought about the desired creditworthiness: therefore, government bonds of different EMU countries are not perfect substitutes and exhibit yield differences.

In particular, many countries exhibit deficit-to-GDP ratios that are above the 3% limit stated by the SGP whereas the punitive actions by the European Commission have been characterized as “lax”[11] by many market analysts. In 2008, the number of Member States with a (nominal) deficit above 3% of GDP increased to eleven (from just two in 2007), while the projection for 2009 is for 20 (out of 27) EU member countries to have a (nominal) deficit of over 3%; it is expected that in 2010 only Bulgaria, Cyprus, Luxembourg and Finland will fulfill the 3% criteria (EC 2009).

In the relevant literature there has been a series of papers indicating that (expected or actual) increases in fiscal deficits lead to an increase in the interest rates of long-term government bonds (in levels, not differences). In particular, Thomas and Wu (2009) show that a 1% point increase in projected fiscal deficit in five years leads to an increase of 30–60 b.p. on long-term interest rates; while Bernoth et al. (2006) examine 14 EU countries and conclude that a debt-service ratio of 5% above Germany's leads to an increase of yield differences (spreads) by 32 b.p.[12]

Whether yield differences are attributable to liquidity or credit risk factors has important implications for the appropriate policy measures that need to be undertaken to reduce these differences. If these differentials are caused by liquidity factors, then the focus must be on issuing strategies and options and/or on the institutional framework of public debt management agencies. On the other hand, if credit risks are mostly to blame, then fiscal discipline is

[11] There is widespread criticism that the Council of Ministers failed to apply sanctions against France and Germany while fines against Portugal and Greece were never applied. On this basis, in 2002 the acting European Commission President R. Prodi described the SGP as "stupid" (although necessary). Furthermore, the 2005 reform of the SGP was partly has been characterized as a “watered down” version of the original pact.

[12] For a full list of relevant papers see Haugh et al. (2009, Table 1).

necessary in order to lower these differences. In addition, the underlying case for yield differentials has important implications as to whether a single EMU-wide bond is desirable. If liquidity factors are the main cause of the yield differentials then such a bond would bring about efficiency. However, if the yield differentials are caused by credit risk then such a security would lead to inefficient allocation of funds and potentially irresponsible fiscal policies. Beetsma and Bovenberg (1999) argue that the creation of the EMU has led to more debt accumulation by member countries because of the decreased costs of debt servicing. In this framework, a single EMU-wide bond could lead to very high government fiscal deficits as the power of markets would diminish and a default or exit of a single country from the monetary union would be very costly for the other union members.

This paper examines the empirical determinants of the yield differences between Greece's and Germany's euro-denominated (benchmark) government bonds. In particular, the aim of the paper is to distinguish the liquidity factors and credit risk components of these spreads. In section 2 we present some of the data and discuss them; in section 3 we present the results of our basic model, while section 4 concludes.

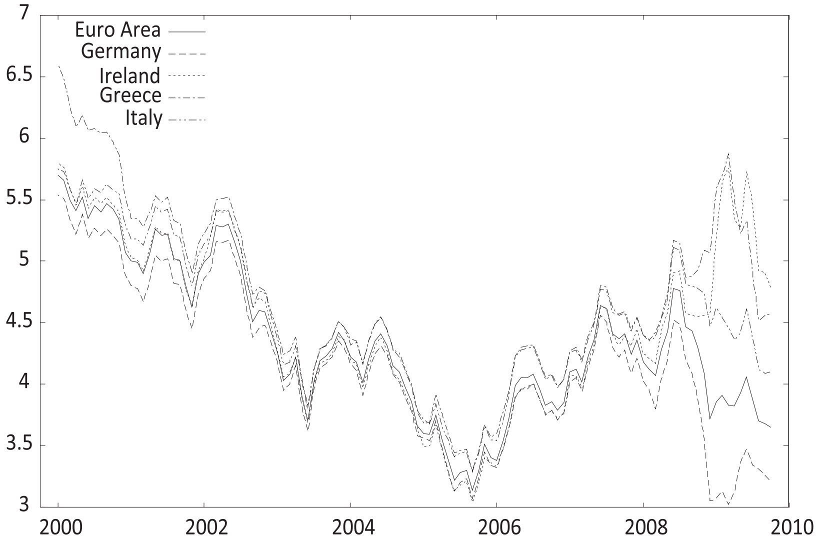
2 Developments Regarding EMU Yield Differentials

As noted earlier, market analysts expected a convergence of the yields of EMU member country government bonds of similar characteristics, with minor differences mostly caused by liquidity factors. As we can see in Figure 1, this expectation was realized at least from the beginning of the EMU until roughly 2008, where the yield differences of long term bonds remained relatively low.

Departing from this trend, since the beginning of the financial crisis in August 2007, the yields of long term bonds of most EMU countries exhibited high volatility with acute increases mainly in the first 10 months of 2008, only to return to their pre-crisis (if not lower) levels. However, Greece and Ireland stand out as exceptions as both their yields and their yield differences have actually increased compared to their pre-crisis levels.

Figure 1 presents the levels of long term government bond yields in absolute levels. In relative terms—that is, in terms of yield differences of each country's government bond vis-á-vis the German bond—since late 2007 all

Figure 1: Long term bond yields of selected EMU countries (2001:01-2009:10)



Notes: Monthly data. Long term government bond yields - Monthly average (NSA). Long term government bond yields refer to central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years. The yields of the rest of the EMU countries reside between the Euro Area (changing composition) average and that of Greece and were not presented here in order to reduce clutter.
Source: Eurostat.

EMU countries experienced increases[13] ranging from 30 b.p. (France) to 300 b.p. (Greece). This mostly stems from the fact that the German yield experienced a dramatic decrease (almost 50%). This has been interpreted as a "flight to safety" from investors responding to the financial and liquidity turmoil of the time, who consider the German bond as risk-free.

Regarding yield differences for Greece, there has been a sharp increase since late 2007 (Figure 2). However, as already mentioned, this increase is mostly caused by the drop in the yields of the German government bonds rather than an increase in the yields of the corresponding Greek bonds (Figure 3). Unlike most of the EMU country members, on average, the yields of Greek (and Irish) long-term government bonds actually increased during the period under study (Figure 4).

[13] Compared to the average yield differences for 2007.

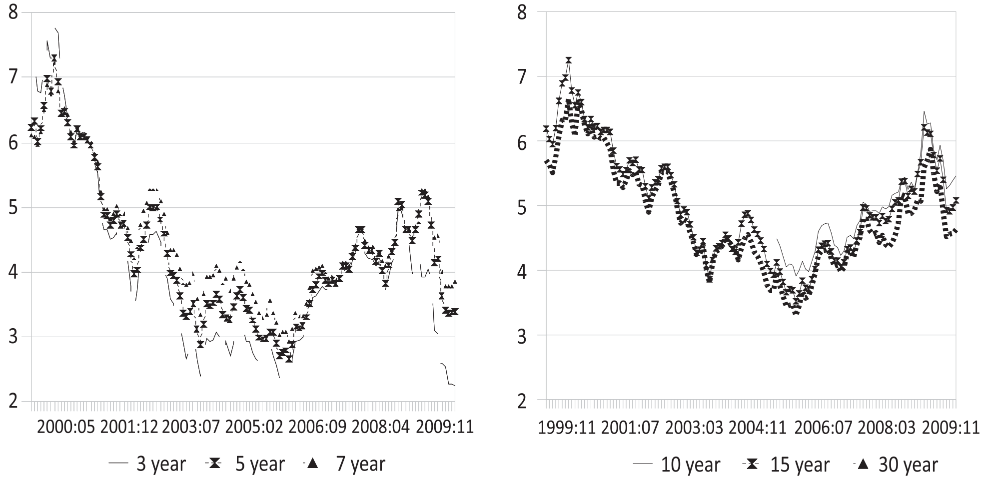
Figure 2: Yield spread on composite government bonds between Greece and Germany (03/01/2000– 13/11/2009)

Source: Bloomberg.

Figure 3: Yields of composite government bonds for Greece and Germany (03/01/2000– 13/11/2009)

Source: Bloomberg.

Figure 4: Yields of (composite benchmark) Greek government bonds by maturity (monthly averages, 1999:03–2009:11).



Source: Bank of Greece.

The deteriorating condition of the fiscal situation in Greece has been considered as a potential (major) factor for the increase of Greece's yield differences. Due to the abrupt increases in both debt-to-GDP ratio and general government deficits, various credit agencies (e.g. Moody's, S&P) have downgraded (or have issued such warnings that they will downgrade) Greece as a sovereign issuer.[14] Credit ranking downgrades are indicators of increased credit risk.

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[14] Regarding the accumulation and servicing of Greece's government debt there are two distinct time periods during the past decade. The first one starts from 2000 where Greece experienced high GDP growth rates (+4.0% annually on average), primary government surpluses during the first few years of this period, yields to maturity on government bonds steadily decreased until 2005 and there were substantial revenues from privatizations. These factors contributed in a decrease of government debt by 7.8% of GDP during 2000-2007. However, during 2008 there was a substantial increase in net government lending, while GDP growth slowed down to 2.0% which was accompanied with a slight increase of the average Greek government bond yield (4.2% to 4.4%) which lead to an increase of government debt by 3.6% of GDP, bringing the total to 99.2% of GDP. For 2009, GDP growth is expected to be negative accompanied with a sharp decrease in government revenues, while yields of

Government securities play a major role in Greece's economy due to the magnitude of government debt. In particular, for 2008 Greece's GDP has been estimated at 239,141 million euros while government debt was 237,161 million euros (99.2% of GDP) with the government deficit at 7.7% of GDP (see Table 1).[15]

However, most empirical studies do not find any (statistical) evidence that fluctuations in the debt-to-GDP ratio have any effect on a country's long-term bond yields or for its yield difference with Germany. In Figure 5 we provide simple scatter graphs which show that even if there is such an effect, it is very minor. We shall revisit this issue in the empirical analysis.

Another unique feature of Greece's deficit and debt dynamics is that Greece is facing the prospect of an ageing population which will inflict fiscal

Table 1: GDP, government deficit/surplus and debt for Greece (million euros)

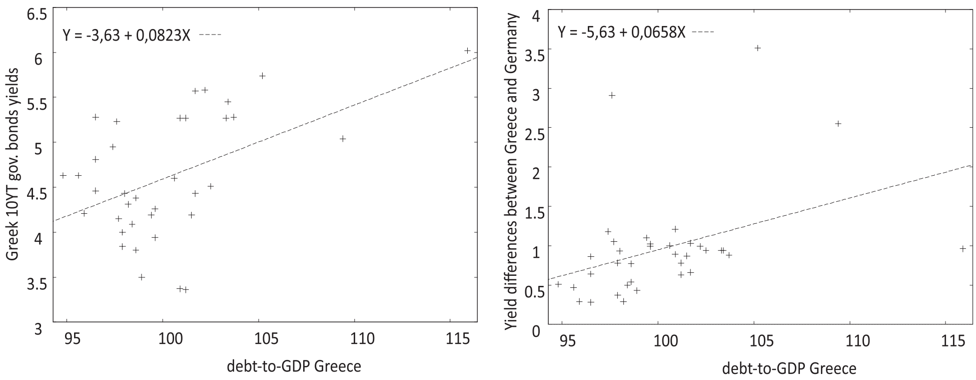
	2005	2006	2007	2008
GDP mp (million euros)	195367	210459	226437	239141
Government deficit (-) / surplus (+)	-10068	-6110	-8287	-18507
% of GDP	-5.2	-2.9	-3.7	-7.7
Government expenditure % of GDP	43.8	42.9	44.4	48.3
Government revenue % of GDP	38.5	39.7	40.4	40.6
Government debt (million euros)	195421	204423	216401	237196
% of GDP	100.0	97.1	95.6	99.2

Source: Eurostat.

government long term securities increased dramatically. Furthermore, debt-to-GDP increased dramatically to 12.7% (from7.7% in 2008) resulting in an increase of Greece's debt to GDP ratio to 111.5% at the end of June 2009. In a report issued in October 2009, the (central) Bank of Greece warns that yield differences might increase if the fiscal stabilization program is viewed as insufficient by the markets. Furthermore, in the same report there is a warning that such yields may increase internationally due to the large fiscal deficits that exist in many countries.

[15] Source: Eurostat news release 14/9/2009. However, there is a note in the release that "Eurostat has expressed a reservation on the data reported by Greece due to significant uncertainties over the figures notified by the Greek statistical authorities." Such reservations (for definition see article 15 (1) of EU Council Regulation 479/2009) seem to be regularly expressed when concerning macroeconomic (mostly fiscal) data for Greece.

Figure 5: Yields, yield differences and Greece's debt-to-GDP ratio (2000:Q1–2009:Q2), with least squares fit



Source: Blooomberg and Eurostat.

pressures caused by increased pension liabilities. In particular, during the 2010–2050 period, it is expected that Greece's future pension liabilities are expected to increase by 12% of GDP. Haugh et al., (2009) find that around 30 b.p. in the yield differences between Greece and Germany could be explained by the future pension liability factor for the period 2005:2–2009:2.[16] However, in the context of the analysis presented, this factor would contribute to higher yield differences in (average) levels but not on (i.e. quarter-on-quarter) fluctuations which are the main focus of this paper.

Regarding liquidity factors, during the recent years there has been a shift in the characteristics of Greek government securities issued from short-term variable rate to long-term fixed rate bonds: therefore, they are more comparable to the corresponding German bonds. In particular, 48% of outstanding central government debt is long term (over 5 years),[17] 75.6% is fixed rate,[18]

[16] The authors also find that the future pension liabilities factor also contributes to the yield differences of Belgium, Ireland, Portugal and Spain although to a lesser extent than for Greece.

[17] The average maturity for these securities gradually increased from 4.8 years in 2004 to 8.8 years in 2008.

[18] The proportion of fixed rate (benchmark) government bonds increased from 8% in 2000 and 48% in 2001, to around 80% since 2003.

92.2% is trade-able and 99.6% is denominated in Euros (30/09/2009, Central Government Debt). These bonds are (also) traded in secondary electronic markets. Furthermore, there have been various institutional and operational changes in public debt administration in accordance with the (non-compulsory) guidelines of various international organizations (e.g., the IMF and World Bank).

3 Estimation and Results

Following the relevant literature we attempt to distinguish the liquidity from the credit risk component through an empirical estimation.[19] As certain aspects of these two factors are of a permanent nature (e.g. total government debt), we focus on the fluctuations of the yield differentials rather than their actual levels.

Data were retrieved from the AMECO, Bank for International Settlements, Bloomberg, FED, Eurostat and Reuters/Thomsom Datastream databases. Owing to the limited availability of high frequency macroeconomic data, we have utilized quarterly data for the period 2000:Q3–2009:Q2. The lower frequency series were converted to quarterly data by taking end-of-period observations.[20] We examine only the EMU era in order to exclude exchange rate risks and to focus on common denominated government bonds and also because many of the smaller economies' (e.g. Spain, Greece, Portugal) convergence processes to EMU were accompanied by acute reductions in inflation and yield rates, which would significantly distort our results.

We focus on the 10-year fixed rate (euro denominated) government bonds which are considered as the benchmark securities and serve as a major source for (re-)financing debt for both Greece and Germany. In our main regression, we utilize the yield differences of these bonds as our dependent variable. As for the examined explanatory variables, we proxy credit risk through the use

[19] We must note that the (following) model used in the estimations is not based on an analytical theoretical model, but rather on stylized facts regarding the relevant (bond) markets.
[20] Alternatively we used period averages and/or medians which did not result in changes in the achieved qualitative results.

of the (general government) debt-to-GDP ratio differences for Greece and Germany.[21]

As an independent variable we include the spread between Moody's Seasoned AAA US corporate bonds and the yield on 10-year US government bonds, as well as the spread on US interest rate swaps and 10-year US government bonds as proxies for (exogenous) international measures of risk.[22] This inclusion is the result of (a-theoretical) empirical evidence that sovereign bond spreads are mainly determined by US government bonds (see Codogno et al., 2003). These measures of international risk aversion have been identified in the relevant literature as the common factor that drives euro area government bond yield differences.[23]

We proxy the liquidity factor through the overall outstanding volume of sovereign debt (Gómez-Puig, 2006) which indicates (secondary) market size.[24] This measure of liquidity has been used extensively in the relevant literature and also remains popular amongst market participants, as larger markets infer that securities are traded more frequently and therefore information costs are lower.[25]

First we estimate our basic model with the yield difference as the dependent variable. Several alternative equations are presented in Table 2.

As for the obtained results presented in Table 2, we conclude that the debt-to-GDP spread ratio(s) are (statistically) insignificant, the international factor is significant, the liquidity factor is significant for the majority of the

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[21] Alternatively, we used growth rates of debt-to-GDP (in mil. euros) which did not result in changes in the achieved qualitative results. Utilizing the US corporate and government bonds spread instead of a euro corporate bonds, reduces the likelihood that the risk variable is endogenous to the dependent variable.

[22] Furthermore, US corporate bond spreads have been identified to be highly correlated with both global and the US default rate (Favero, 1997).

[23] However, Greece is not included in most of the relevant studies.

[24] Gómez-Puig (2006) suggests that "..all (EMU) countries may have experienced a decrease in their relative liquidity that has been translated into higher adjusted spreads." Amongst others, Economidis and Siow (1998) argue that there is a positive relationship between liquidity and market size.

[25] Other possible measures of the liquidity of bonds are search costs, bid-ask spreads, trading volumes, turnover ratios, trading intensities and depth of futures markets (Codogno et al., 2003). Although bid-ask spreads are more commonly used, they are not available for the generic 10-year government bonds used in this paper.

Table 2: Determinants of Greek-German 10YT fixed rate government bond yield differences

Dependent variable: Greek-German 10-year government bond yield spreads	(1)	(2)	(3)	(4)	(5)
Constant	-1.611* (0.9311)				0.6540 (1.059)
Credit risk (debt-to-GDP ratio spread)	0.03239 (0.02656)	-0.01198 (0.007134)			-0.03908 (0.03041)
International risk aversion (Moody's 10YT AAA corporate bonds – US government 10YT bonds)	0.8276** (0.1251)	0.9646** (0.09999)	0.9324** (0.1127)	0.6284** (0.1036)	0.6034** (0.1096)
International risk aversion (spread of Euro and US interest rate swaps)	-1.650** (0.3297)	-1.856** (0.3173)	-1.939** (0.3872)	-1.064** (0.3375)	
Liquidity factor (outstanding government securities)	0.7605** (0.3658)	1.031** (0.3415)	0.6049 (0.3806)	0.1808 (0.2968)	0.09816 (0.2896)
First lag of dependent variable				0.5202** (0.1031)	0.6842** (0.1185)
Time trend	0.03361** (0.009893)	0.01809** (0.004296)			0.003291 (0.01180)
Alternative credit risk proxy (debt-to-GDP ratio of Greece)			0.002683 (0.002215)	8.816e-05 (0.001734)	
Obs. (n)	35	35	35	35	35
Adj. R^2	0.8179	0.9353	0.0000	0.9468	0.8422
Log-likelihood (LnL)	-3.640	-5.354	-12.670	-1.919	-1.129

Notes: Dependent variable is the yield difference between the composite Greek and German 10-year fixed rate government bonds. Sample period is 2000:4-2009:2. Standard errors in parentheses. * indicates significance at the 10 percent level, ** indicates significance at the 5 percent level, *** indicates significance at the 1 percent level.

models tested (not presented here) and that there is strong indication of a time trend.

From Table 2 we see that the Greek-German debt-to-GDP spread ratio is statistically insignificant as an explanatory variable for the Greek-German yield differences. Furthermore, in equation 3 we substitute the spread with the debt-to-GDP ratio for Greece and arrive at similar conclusions.[26] Regarding

[26] A battery of similar estimations was conducted without major alterations in the presented qualitative results.

the debt-to-GDP ratios, as previously mentioned, these are used as a comprehensive measure (proxy) for credit risk and they are found not to be statistically significant, which is a common theme in the relevant empirical literature. However, there are several limitations when using this measure. Due to data availability, we use the end (historic) reported debt-to-GDP ratios and not the estimated or provisional data available at the time. In other words, there might be a discrepancy between the data we use (final, revised data) and the data available at the time. Furthermore, market participants tend to be forward-looking when evaluating securities. Heppke-Falk and Huefner (2004) find that expected budget deficit is significant in explaining the risk premium on German and French sovereign bonds. Haugh et al. (2009) proxy government credit risk through forecast averages for the following five years regarding government net lending (national accounts definition) as percentage of GDP (OECD Economic Outlook 85 database). However, in both studies the time span in examination is very limited.[27] Furthermore, the proxy used by Haugh et al. would most likely be useful to compare long term differences in levels of yield differences and not period-on-period fluctuations of these differences.

Daily data on yield differences indicate that markets (seemingly instantaneously) respond to news regarding Greece's debt-to-GDP and other fiscal variables. However, with the available data, these responses seem to be limited to very short time periods and not (at least not yet) showing up as medium/long-term trends. For example, new information regarding a deterioration of Greece's deficits or total debt (“bad news”) is sometimes accompanied by an acute positive change in the yield differences. However, during the first months of 2009 the deficit for Greece was expected to be around 5% of GDP for 2009, and yield differences were about 300 b.p. During the last months of 2009, although the deficit for Greece was revised to 12.7%, the yield differences were about 140–170 b.p. Although the projected

[27] It would be a tedious task to try to estimate market sentiment for the state of the future fiscal situation for every period as there is no consensus as to how to conduct such an exercise. Credit agency ratings could be used, but they remain relatively unchanged for long periods, e.g. during the period 2001–2008 the SandP rating for Greek sovereign bonds have changed three times (Fitch ratings four times, Moody's ratings two times and RandI ratings two times).

deficit more than doubled, the yield differences were cut in half: this puts in doubt the intuition that yield differences reflect (or only reflect) the fiscal situation of Greece.[28]

Regarding the results from the estimated equations, we conclude that the overall outstanding volume of sovereign debt, which is out proxy for the liquidity factor, is statistically significant. On this issue there is some ambiguity in the relevant literature. Bernoth et al. (2006) argue that the monetary union has eliminated liquidity premiums in the Euro Area while other authors (e.g. Codogno et al., 2003) find that the liquidity factor remains important for some of the smaller EMU countries, and Gómez-Puig (2006) argues that the average EMU spreads have increased as liquidity has decreased. In our case, the estimation indicates that the yield differences under examination are also affected by the relative size of the two markets. In other words, as the Greek government bond market is smaller and therefore less liquid (e.g. Economidis and Siow, 1998), this produces a (numerically) positive (qualitative negative) effect on the yield differences.

Finally, our estimation indicates that both measures of international risk aversion are statistically significant. This is a common finding in the relevant literature (e.g. Codogno et al., 2003)—that is, that yield differences in the Euro Area are driven by a common factor which has been identified as an international risk aversion.[29] This is consistent with the "flight to safety" discussion of the previous section.

Having identified the international risk factor as an important driving force, and following Codogno et al. (2003), we also utilize a different measure of spreads as our dependent variable. In particular, we use the relative asset swap which is defined as the difference between yield differences between Greece and Germany and the interest rate (10-year) swap yields between the Euro Area and the USA. The difference between swap rates of different currencies cancels both the market risk (as this is shared among all Euro Area countries) and the counter-party risk, therefore, the swap spread ends up being an appropriate measure of the exchange rate factor of the total

[28] In other words, "bad news" appears to be trend stationary (and not unit root).

[29] However, to the best of our knowledge, the driving factors of this international risk aversion and its exact connection with government bond spreads has not been thoroughly explored.

yield spread (Le Conte, 2009). In many previous studies this last term consisted of the yield differences of swaps of the (EMU) country in question vis-á-vis German swaps. However, our analysis focuses on the EMU era and as of 1999, swap contracts for all EMU countries were denominated in euros and therefore there was a single yield curve. This is the reason why the yield of the swap for USD is used.[30] Several alternative equations are presented in the Appendix (Table 3). The qualitative results from these estimations do not differ from those discussed above (Table 2).

Table 3: Determinants of Relative Asset Swap

Dependent variable: relative asset swap	(1)	(2)	(3)
Constant	1.436** (0.5757)	1.452** (0.5551)	1.223** (0.5365)
Credit risk (debt-to-GDP ratio spread)	-0.01530 (0.02159)	-0.01538 (0.02123)	0.0005045 (0.01799)
International risk aversion (Moody's 10YT AAA corporate bonds – US government 10YT bonds)	-0.3810** (0.1745)	-0.3710** (0.1566)	-0.3559** (0.1583)
International risk aversion (spread of Euro and US interest rate swaps)	0.07394 (0.5293)		
Liquidity factor (outstanding government securities)	0.5495 (0.5253)	0.5896 (0.4323)	
First lag of dependent variable	0.8354** (0.1594)	0.8244** (0.1363)	0.8166** (0.1380)
Obs. (n)	35	35	35
Adj. R^2	0.4870	0.5038	0.4900
Log-likelihood (LnL)	-17.080	-17.100	-18.150

Notes: Dependent variable is the difference between the yields of the composite Greek and German 10-year fixed rate government bonds and the 10-year interest rate swaps between Greece and the US. Sample period is 2000:4-2009:2. Standard errors in parentheses. * indicates significance at the 10 percent level, ** indicates significance at the 5 percent level, *** indicates significance at the 1 percent level.

[30] For a further discussion on this topic see Lo Conte (2008).

4. Summary

In this paper we utilize quarterly data to identify the main (medium-term) driving factors regarding yield differences between Greek and German (composite) 10-year fixed rate euro-denominated government bonds. Counterintuitively, but in line with the relevant literature, our preliminary empirical estimation shows that the credit risk factor (as proxied through the debt-to-GDP ratio spread) is not statistically significant. Furthermore, our proxy for the liquidity factor also shows that issues of liquidity remain important. Finally, we conclude that the international risk aversion factor is the most important driving force for the Greek-German government bond yield differences. Various studies arrive to this result for the majority of EMU countries. Future research entails using higher frequency data (i.e. monthly) so as to examine short-run driving factors regarding these yield differences.

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PART II
LABOUR MARKETS AND EARNINGS DISTRIBUTION

The Economic Crisis and the Labour Market

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Abstract

The aim of this paper is to measure the impact of the economic crisis and to estimate the additional effects due to the deterioration of the economic situation in Greece, with particular focus on the labour market. In the first part we attempt to outline the profile of the worker who has lost his/her job during the crisis. In order to piece together the puzzle that reveals the picture of that worker, we first identify him/her as an unemployed person and then go back in time, trying to find him/her as an employed person. Subsequently, using a Logit model we attempt to estimate the probability that a worker loses his job, compared with another worker, taking into account the individual characteristics (demographic and employment-related) of each one of them. In the second part of the paper, we model the Greek economy in recession considering two alternatives versions of the labour market, one assuming wage flexibility and another assuming wage rigidity. We move on to investigate the additional second-round effects due to households' uncertainty and negative expectations regarding the difficult times ahead. The methodological approach adopted relies on a multi-sectoral general equilibrium model of the Greek economy.

1 Introduction

The global economy is going through its most severe crisis since World War II. The first signs of the crisis emerged in the summer of 2007, when several international banks faced serious liquidity problems originating from the

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mortgage markets. The crisis intensified during the second half of 2008, in particular after the collapse of US investment bank Lehman Brothers.

As a result of this crisis, a considerable number of countries experienced a dramatic drop in output and a strong increase in unemployment. According to the OECD (2009a), between end 2007 and end 2010, unemployment in OECD countries is projected to rise by 25 million persons, which represents about 10 per cent of the labour force and is an all-time high.

In Greece, the gradual fall of annual GDP growth from 4.0% in 2007 to -1.3% in 2009[1] is leading to an increase in the unemployment rate from 8.3% in 2007 to 9.5% in 2009 (OECD 2009b).

These developments in the Greek economy tend to create an adverse environment, characterised by the entrenchment of negative expectations among business firms and households, potentially leading to a further deterioration in macroeconomic prospects. The aim of this paper is to provide an analytical investigation of these possible adverse effects, focusing on the labour market.

In the following sections, the paper provides: a brief overview of the structure of the labour market; a description of the statistical data on the variables used; a summary description of the relevant regulatory framework; a more detailed profile of workers who have lost their jobs during the economic crisis; an econometric analysis of the probability that a worker loses his job; and finally, an investigation into the additional second-round effects of these negative expectations over the period ahead, using a multi-sectoral general equilibrium model.

2 The Statistical Data and Variables Used

In order to identify the determinants of crisis-induced unemployment, we have used the Greek Labour Force Survey conducted by the Hellenic Statistical Authority (HSA) on a quarterly basis since 1998 (previously conducted annually, in the second quarter of each year). The key objective of the survey is to collect very detailed employment and unemployment data for household

[1] According to the Hellenic Statistical Authority (HSA) in May 2010, the decline in GDP for 2009 was -2% while for 2010 it is expected to be between -3% and -4%.

members aged 15 and over. Specifically, the survey aims: (i) to map the labour market status of persons aged 15 and over, nation-wide and broken down by region, gender, age and skills; (ii) to examine the structure of the labour force (employed/unemployed persons) by sector of economic activity, occupation, status in employment, hours of work, etc.; (iii) to monitor the duration of unemployment, in relation to gender, age, skills, location of residence and certain characteristics of the unemployed person's last employment, such as sector of activity and occupation; (iv) to examine the labour market status of household members one year earlier, the existence of any second job, etc.

According to the design of the survey, the area unit is defined as a set of neighbouring buildings, one or more building blocks typically including at least 80 private addresses (inhabited dwellings). The households in each area unit are divided into three subgroups, s1, s2 and s3. *Each household in the survey sample (and in one of the s1, s2 and s3 subgroups) is interviewed in six consecutive quarters*. Once the households of s1 have been interviewed for six times (i.e. after one year and a half), they are rotated out of the sample, replaced by those in s2 and so on, until households in s3 have completed six interviews too, in which case a new area unit and a new list of households will be selected.

It is worth noting that every year the LFS is accompanied by specifically targeted surveys, such as the surveys on child and old-age care (2005), on the transition from work to retirement (2006), work accidents and health and safety at work (2007) and on the employment of immigrants (2008).

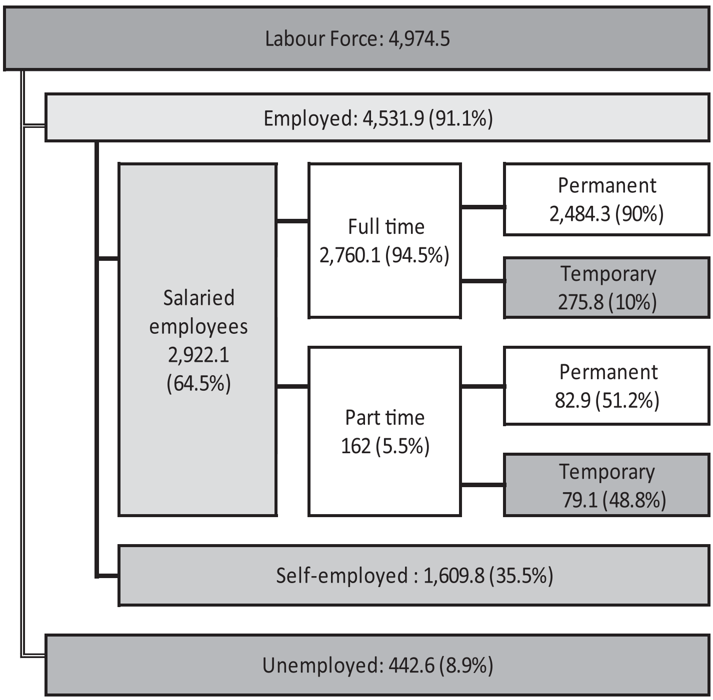
The LFS questionnaire asks unemployed persons mostly about their current situation rather than about their last job, if any. This results in incomplete information about previous employment, such as firm size, length of time in last job, pay, social security provider, etc.

Nevertheless, the fact that households in the LFS are interviewed for six consecutive quarters—i.e. the panel character of the data—has helped us partly make up for these information gaps. We followed a two-step procedure. In the first step, we compiled an inventory of persons who lost their jobs during the economic crisis (i.e. after the first half of 2008), on the basis of raw data from the recent four quarterly LFSs. In the second step, we cross-checked this inventory with earlier LFSs and identified a large number of the same persons, only this time recorded as employed. For example, a worker shown by the LFS to have lost his/her job in the 2nd quarter of 2009 was identified as having a job in earlier quarterly rounds of the LFS. The identification of a currently unemployed person as a worker in the earlier period has enabled us to obtain a more complete picture of the population under examination.

2 The Structure of the Greek Labour Market

According to the latest Labour Force Survey (2009 Q2), the Greek labour force comprised 4.974.5 thousand persons, of which 4,531.9 thousand (90.9%) were employed and 442,6 thousand (9.1%) were unemployed. Among employed persons, 64.5%, i.e. 2,922.1 thousand were employees (white-collar or blue-collar workers), of which 94.5% worked on a full-time basis. Of the full-time workers almost 90% had a permanent job. Among part-time workers, 51.2% had permanent contracts, while the remaining 48.8% (79.1 thousand) had temporary contracts (Figure 1).

Figure 1: Labour force by employment status (Greece, total) (2009 Q2, in thousands)



Source: Labour Force Survey, 2009:Q2, Hellenic Statistical Authority.

Figure 2 shows the structure of the labour market by sector, branch of activity and employment status. As illustrated by the figure, the tertiary sector accounts for 67.2% of employment, following by the secondary and primary sectors with shares of 21.1% and 11.6% respectively. The branches with the largest shares in employment are retail and wholesale trade (18.3%), education and health (12.3%), agriculture and related activities (11.7%), manufacturing (11.4%), public administration and defence (8.4%), construction (8.1%) and hotels-restaurants (7.0%). Among employees, 74.3% work in the tertiary sector, primarily in education or health (17%), retail and wholesale trade (15.1%) and manufacturing (13%). By contrast, 54.3% of the self-employed (including family workers) work in the tertiary sector, 30% work in the primary sector (mostly in family agricultural units) and finally 15.7% work in the secondary sector.

Figure 2: Persons employed by sector of activity (2009 Q2, in thousands)

	Salaried employees	Self-employed	Total employed
Education, Human health	497 (17%)	60.7 (3.8%)	557.7 (12.3%)
Wholesale and retail trade	439.8 (15.1%)	388.4 (24.1%)	828.2 (18.3%)
Manufacturing	380.5 (13%)	135.4 (8.4%)	515.9 (11.4%)
Public administration and defence; compulsory social security	378.6 (13%)	–	378.6 (8.4%)
Construction	251.4 (8.6%)	115.1 (7.1%)	366.5 (8.1%)
Information and communication, Transportation e.t.c.	225.6 (7.7%)	76.3 (4.7%)	301.9 (6.7%)
Hotels and restaurants	190.2 (6.5%)	124.7 (7.7%)	314.9 (7.0%)
Real estate activities, Financial and insurance activities	167.1 (5.7%)	34.3 (2.1%)	201,4 (4,4%)
Other service activities	166.8 (5.7%)	63.6 (4%)	230.4 (5.1%)
Professional, scientific and technical activities	106.5 (3.6%)	125.7 (7.8%)	232.2 (5.1%)
Electricity, gas, steam and water supply,mining	71.7 (2.5%)	2.7 (0,2%)	74.4 (1.6%)
Agriculture, forestry and fishing	46.8 (1.6%)	482.8 (30%)	529.6 (11.7%)
Primary sector	44.8 (1.6%)	482.8 (30%)	527.6 (11.6%)
Secondary sector	703.6 (24.1%)	253.2 (15.7%)	956.8 (21.1%)
Secondary sector	2,171.7 (74.3%)	873.9 (54.3%)	3,045.6 (67.2%)

Source: Labour Force Survey, 2009:Q2, Hellenic Statistical Authority.

Figure 3 shows the breakdown of employees by business size and branch of activity. 44.3% of employees work in businesses with staff of 0–10 persons and 28.5% in larger businesses employing 11–19 persons. A significantly smaller proportion of employees work in larger businesses. Among the branches that feature high concentration of employment in small businesses (with fewer than 10 employees), we can identify retail and wholesale trade (57.5%), manufacturing (35.5%), construction (75.6%) and finally hotels and restaurants (67.4%). It should be noted that these branches are particularly vulnerable to cyclical developments. In the branches of 'education and health' and 'public administration and defence', the relative majority of employees, 35.9% and 34.9% respectively, work in units of 11–19 persons.

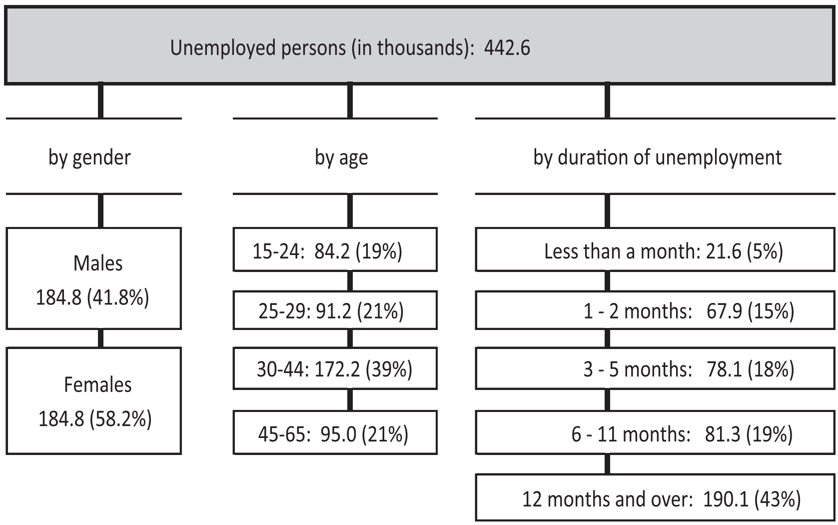
Figure 4 provides a graphic representation of unemployment. Out of the total unemployed persons, 58.2% are female, 39% are aged 30–44 years and 42% are long-term unemployed (out of work for over 12 months).

Figure 3: Percentage share of salaried employees working at the local unit of the enterprise by sector of activity

	0 to 10 persons	11 to 19 persons	20 to 49 persons	50 persons or more
Education, Human health	30.5	35.9	15.5	18.1
Wholesale and retail trade	57.5	25.2	9.4	7.9
Manufacturing	35.5	29.8	13.9	20.7
Public administration and defence; compulsory social security	15.7	34.9	16.3	33.1
Construction	75.6	17.4	3.2	3.7
Information and communication, Transportation e.t.c.	32.2	33.8	11.7	22.3
Hotels and restaurants	67.4	20.6	6.8	5.1
Real estate activities, Financial and insurance activities	35.4	37.2	12.9	14.5
Other service activities	80.1	12.0	3.3	4.6
Professional, scientific and technical activities	57.5	24.9	8.3	9.4
Electricity, gas, steam and water supply,mining	16.5	35.5	14.9	33.1
Agriculture, forestry and fishing	82.6	8.4	6.6	2.4
	44.3	**28.5**	**11.3**	**15.9**

Source: Labour Force Survey, 2009:Q2, Hellenic Statistical Authority.

Figure 4: Unemployed persons by gender, age and duration of unemployment (2009 Q2)



Source: Labour Force Survey, 2009:Q2, Hellenic Statistical Authority.

3 The Institutional Framework and Recent Measures for the Labour Market

As is well-known, Greece's employment protection legislation is quite strict compared with other industrialised countries (OECD 2009b). Key aspects of this legislation are the following:

- Restrictions on layoffs/dismissals (laws on multiple/group layoffs). Businesses employing 20 to 200 persons may dismiss up to 4 persons per month; those employing over 200 persons may dismiss 2% of their staff and not more than 30 employees per month.
- Statutory severance payments in the event of dismissal are quite generous and subject to less strict eligibility criteria than in other EU countries.
- The regulations on working times, leave and part-time employment shape an overly restrictive framework, which can be a significant factor hampering the functioning of enterprises.
- The institutional framework governing wage bargaining often leads to an equalisation of wages across industries or firms characterised by different labour productivity rates.

This legal framework reduces the flexibility of the labour market, in particular for larger firms which cannot easily circumvent these rules. On the other hand, larger firms can take advantage of economies of scale due to their size, have easier access to bank credit and can put more resources into research and development and staff training. These advantages and their relatively easy access to credit enable them, during a recession, to retain higher staff numbers than the economic conditions would have justified—labour hoarding (see OECD, 2009a). By contrast, during an upturn in activity, this restrictive legal framework acts as a counter-incentive for firms to speed up hirings, thereby prolonging the process of restoring the unemployment rate to its pre-downturn level (“unemployment persistence”, see Demopoulos 1997).

Small firms can more easily avoid legal constraints and thus enjoy an "illegal" flexibility (see Karakioulafi 2005), which often leads to significant cost savings that support their viability. But these firms face difficulties in accessing the banking system and are therefore often underfinanced (see Giannitsis et al. 2009); their financing problems are exacerbated in times of economic crisis. This, coupled with undercapitalisation, gradually erodes their resilience and leads to unavoidable staff reductions and ultimately even to their closure.

During the recent crisis, two successive Greek governments have taken action to mitigate the negative effects of crisis on the labour market (Bank of Greece, 2009). This action includes:

- Measures to support employment: these are focused on small enterprises (employing 10 to 49 persons) and micro-enterprises (up to 9 persons), helping them to preserve jobs over the next 18 months.
- Government guarantees for business loans: these are addressed to enterprises of all sectors and sizes, and the level of guarantee coverage is up to 70% of the loan.
- A lending programme for small and micro-enterprises, implemented by TEMPME under a government guarantee for a part of the loan (about 80%).
- A programme has been launched and is being implemented, as part of the National Strategic Reference Framework 2007–2013, to ensure bank financing to small and micro-enterprises in the sectors of manufacturing, tourism, trade and services.
- Indirect support to the building industry, involving lending and other types of financing, with government guarantees for up to 25% of the value of

housing loans to be granted until 31 December 2010. Also, the programme "Save energy at home" subsidises projects aimed at improving the energy efficiency of residential buildings, for up to 30–50% of total expenditure per building.

These measures are primarily aimed at supporting small and micro enterprises, which account for 72.8% (44.3% plus 28.5%) of salaried employment in Greece (see Figure 3) and face serious difficulties in their access to the banking system in times of credit crunch (such as the current banking crisis). The measures also seek to support the cyclical sectors that are most strongly hit by the economic crisis, in particular the construction sector which is connected with a large number of other sectors and occupations.

4 The Unemployed of the Economic Crisis

This section of the paper will attempt to delineate the profile of the persons who lost their jobs as a result of the economic crisis. The data reported are calculations based on raw (average) data from four successive LFS rounds and refer to the demographical and labour characteristics of these new unemployed.

Table 1: Profile characteristics of persons who lost their jobs

	Unemp. persons	Percentage share		Unemp. persons	Percentage share
Age			***Level of Education***		
- 15 – 24	8,164	12.2	- Received a post-graduate qualification	754	1.1
- 25 – 34	26,008	38.7	- Received a university degree	6,607	9.8
- 35 – 44	18,717	27.9	- Received a third-level technical - vocational institution degree	12,027	17.9
- 45 – 54	11,349	16.9	- Completed secondary level education	22,416	33.4
- 55 – 64	2,929	4.4	- Completed the third stage of 6-year secondary education	10,307	15.3
65+	22	0.0	- Completed primary education	14,596	21.7
	67,190	100.0	- Have not completed primary education	183	0.3
			- Attended no school at all	301	0.4
				67,190	100.0

Source: Calculations based on primary LFS data, Hellenic Statistical Authority.

Table 2: Profile characteristics of persons who lost their jobs

	Unemp. persons	Percentage share		Unemp. persons	Percentage share
By Sector			***Ownership status of enterprise***		
A. The less cyclical sectors	25,517	38.0	- Public sector	4,794	7.1
B. The four most cyclical sectors			- Legal Entities of Public Law or Legal Entities of Private Law controlled by State and Public Organizations	2,644	3.9
- Manufacturing	6,390	9.5	- Municipal or communal enterprises	3,372	5.0
- Construction	11,102	16.5	- Public enterprises	961	1.4
- Wholesale and retail trade	7,455	11.1	- State banks or banks managed by the government	87	0.1
- Hotels and restaurants	16,726	24.9	- Enterprises managed by the government	467	0.7
			- Private enterprises	54,866	81.7
Status in employment			***Working for this employer***		
- Employers	349	0.5	- less than 2 years	55,680	82.9
- Own account workers	2,536	3.8	- 3 to 6 years	4,835	7.2
- Salaried employees	63,150	94.0	- 7 to 10 years	3,118	4.6
- Unpaid family workers	1,155	1.7	- 11 years or longer	3,557	5.3
Organization of principal insurance			***Job permanent or temporary (salaried employees)***		
- Social Insurance Organisation (IKA)	44,829	66.7	- Permanent	25,133	39.8
- National Agricultural Insurance (OGA)	2,431	3.6	- Temporary	38,014	60.2
- Civil Servants Fund	656	1.0	***Intensity of employment***		
- OAEE	2,759	4.1	- full-time	57,612	85.7
- Other Insurance Funds	8,215	12.2	- part-time	9,578	14.3
- Uninsured persons	7,361	11.0	***Monthly allowances (salaried employees)***		
- Persons ignores/ Not answered	940	1.4	- less than 499 €	8,486	12.6
Number of persons at the local unit of the enterprise			- 500 - 699 €	12,949	19.3
- 1 to 10 persons	42,423	63.1	- 700 - 999 €	31,923	47.5
- 11 to 19 persons	12,654	18.8	- 1000 - 1299 €	10,806	16.1
- 20 to 49 persons	5,056	7.5	- 1300 € or more	3,025	4.5
- 50 persons or more	7,057	10.5			

Source: Calculations based on primary LFS data, Hellenic Statistical Authority.

The number of the new unemployed (see Table 1) reached 67,190 (average of four quarters). Most of these (79.8%) are aged between 15–44 years, with a high concentration (38.7%) in the 25–34 age group. About one third (33.4%) have secondary education skills and high percentages have finished elementary education and post-secondary technical education (21.7% and 17.9% respectively). The majority (94%) of the new unemployed (see Table 2) formerly worked under in salaried jobs and 81.7% worked in the private business sector. 82.9% of unemployed people had very little previous work experience (up to 2 years), while 85.7% worked under full employment contracts and 60.2% had a temporary job.

Most of the new unemployed (66.7%) were insured with IKA (Greece's leading social security provider) while uninsured employment represented a significant 11%, most likely accounted for by small and micro-enterprises (see above for the "illegal" flexibility of such enterprises).

Around two-thirds (62%) of the new unemployed (see Table 2) come from sectors that exhibit a strong cyclicality—typically tourism and construction—while 81.9% come from small and micro-enterprises employing up to 19 persons. 79.4% earned less than €1,000 from their last job, with a high concentration (47.5%) in the range €700–€999.

For various reasons, not least because of uncertainty (see Table 3), 14.1% of unemployed persons had been looking for another job before they actually remained jobless.

Table 3. Magnitude of workers insecurity relating to their employment outlook

	Unemp. persons	Percentage share
Not looking for a new job	58,414	86.9
Persons who are working but are looking for alternative employment:		
- There is risk or certainty of loss or termination of present job	*1,511*	*2.2*
- Actual job is considered as a transitional job	1,048	1.6
- Actual job does not correspond to his/her qualification	288	0.4
- Looking for an additional job to add more hours to those worked in present job	1,177	1.8
- Looking for a job with more hours worked than in present job	2,276	3.4
- Wishes to have better working conditions	1,989	3.0
- Other reasons	488	0.7
	67,190	100.0

Source: Calculations based on primary LFS data, Hellenic Statistical Authority.

5 The Determinants of the Transition from Employment to Unemployment

Many of the characteristics of workers who lost their jobs in 2009 were pointed out in the previous section. An important question that now arises refers to the factors that influence an employee's probability of losing his/her job, all other factors remaining equal.

Econometric investigation focuses on salaried employment—employees in the private sector only, or alternatively all employees including those in the public sector.[2] These employees were divided into two groups. The first group comprises those who keep their jobs throughout the period; the second group comprises workers who lose their jobs and become unemployed (in the next quarter, half-year or year).

Next, the question we try to answer is whether there are any particular characteristics of the worker who loses his/her job during the economic crisis. That is, can any of such characteristics as age, skills, years of work experience, business size, level of pay, type of employment (part-time or full-time) etc., be a factor in job security (or insecurity)? Are the worker's concerns about his/her employment confirmed and for this reason the worker looks for another job?

This question can be answered using a multivariate Logit model. Underlying this model is the assumption that an individual's probability of moving from employment to unemployment depends on the interaction of a number of socio-economic and demographical factors.

As a reference group in the estimation of the model we take a worker who is aged 46 to 55, is employed outside the four most cyclical sectors (manufacturing, construction, trade and tourism), has worked with the last employer for more than 11 years with monthly earnings ranging from €1,000 to €1,500, works in a local unit that employs more than 10 persons, has secondary school education and a full-time employment position. Finally, the worker of the reference group is not seeking another job as a result of perceived job insecurity.

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[2] These groups therefore exclude the self-employed, unpaid helpers in family businesses, the unemployed, as well as inactive persons.

The estimates reported are the odds ratios that measure the marginal effect caused by a change in one characteristic of the reference group when the other characteristics remain unchanged. More specifically, the numerator of the odds ratio is derived by dividing the probability that a worker with specific characteristics (all the characteristics of the reference group excluding the one examined) will move from employment to unemployment by the probability that he will not. The denominator of the odds ratio is given by dividing the corresponding probabilities for the reference group. An odds ratio higher (lower) than one suggests that, ceteris paribus, a change in the specific characteristic of the reference group would lead to an increase (decrease) in the probability of becoming unemployed. The model was estimated for all the five latest quarterly LFS rounds, after filling the information gaps as mentioned earlier.

The estimation results are reported in Table 4. It becomes clear from the table that the probability of unemployment for a worker who fears losing his/her job and is therefore looking for a new job is significantly higher than for those who are not so worried and thus are not seeking another job. In this case we can say that the worker's concerns are well-grounded, because either the company has warned of a likely layoff or because the worker does not expect a renewal of his/her contract. These results are particularly robust when we consider all employees,[3] while for employees in the private sector they cease to be statistically significant after the third quarter of 2008.

Regarding the sectors of economic activity, workers in the construction, manufacturing and tourism sectors (the most cyclical ones) face a higher probability of losing their jobs, in comparison with the reference group; the converse is found for the trade sector, where the probability is lower in comparison with the reference group (although trade is also one of the most cyclical sectors). Job losses in the construction sector are important, given that building activity has been on a declining path and the industry is linked to a number of other sectors. According to HSA data, the volume of building activity fell by 25.7% between September 2008 and September 2009 and stood

[3] Probably this is because the "all employees" aggregate includes employees working in the public sector or local authorities under temporary contracts (e.g. as trainees), who fear losing their jobs when their contracts expire.

17.1% lower at the end of 2008 than one year before. The problems in this sector began in 2006, before the financial crisis and the subsequent economic recession. Consequently, the probability of losing one's job in the construction industry is high. The manufacturing sector also faces significant problems. The average index of manufacturing production fell by 11.8% in the January–October 2009 period compared with the corresponding period of 2008. This fall is much stronger if oil products are excluded, as in several non-oil manufacturing sub-sectors output which contracted by more than 20%. The job loss probability of an employee in the tourism sector is, for certain periods, higher than in any other sector considered. However, at the end of the reviewed period, the corresponding probability for the tourism sector is significantly lower. Finally, it should be noted that the estimates for these three most cyclical sectors may give values greater than one (higher probability), yet workers in the trade sector seem to face lower job loss probabilities in comparison with even the less cyclical sectors. This estimate remains robust in all quarters.

Turning to the years of work with the last employer, the following broad points can be made: i) the years of experience seem to be an important factor in maintaining the job; ii) the probabilities calculated are greater than for any other independent variable (e.g. skills); iii) probabilities increase significantly from one quarter to the next; iv) values for "all employees" workers are higher in comparison with "private sector employees" only. In particular, workers in the private sector with experience of less than two years are 16.8 times more likely to lose their jobs than the reference group, i.e. workers with a seniority of over 11 years. For total workers, the corresponding probability is double and takes the value of 35.9. On the other hand, for workers with seniority of 3–6 years (or 7–10 years) the probability of losing their jobs is 3.5 times (or 4.1 times) higher in comparison with the reference group in the private sector; considering total employees, this probability increases to 5.5 times (or 5.6 times).

As far as age is concerned, we can observe an inverted U-shaped relationship between age and the probability of unemployment in the coming quarters: the job loss probability is indeed smaller for younger persons in the first and second age groups and for older workers (56+) compared with the reference group (46-55 years). At the same time, the probabilities found for the upper and lower extreme age groups are relatively small in comparison with the age groups of 26–35 and 36–45 years.

Regarding the level of pay, the probability is statistically significantly greater for low-paid workers. Specifically, workers who are paid up to €1,000 are significantly more likely to lose their jobs in comparison with the reference group comprising workers paid from €1,000 to €1,500. By contrast, higher-paid workers can feel more secure, because their job loss probability is significantly lower than that of the reference group. These results are consistent with the above result, given that highly-paid workers tend to have more years of experience.

The size of the local unit of the firm appears to play a role in maintaining the job or not. Looking at the employees of the private sector only, the job loss probability of persons working in units with less than 10 employees is lower than that of the reference group (units with more than 10 employees). This pattern was fully reversed for the last quarter, implying higher job loss probabilities for workers in small units than for workers in larger ones. This could mean that small businesses initially maintained employment, taking advantage of their characteristic flexibility, but later their serious financing problems forced them to let go of staff. By contrast, larger firms initially seem to respond more quickly; at a later stage—as mentioned above—are often able to hoard labour, i.e. to maintain the number of employees at a higher level than economic conditions would justify.

Workers with low skills (i.e. those who have merely completed compulsory education) are more likely to lose their jobs in comparison with those who have finished secondary education. On the other hand, employees with a university degree or even postgraduate degrees, for the most part of the period had significantly lower job loss probabilities than employees with a lower level of education. However, in the last quarter the odds seem to reverse for workers with higher education.

Finally, part-time workers are more likely to lose their jobs in comparison with workers with full-time employment. The features that make this type of employment more flexible suggest that in the initial phase of the recession employers can easily dismiss those employees, who are primarily used to meet seasonal peaks in demand rather than permanent and long-term needs.

Table 4: Probability of unemployment estimated by Logit model *(Probability of moving from employment to unemployment)*

	Employees Private Sector					Total Employees				
	2008[a]	2008[b]	2008[c]	2008[d]	2009[a]	2008[a]	2008[b]	2008[c]	2008[d]	2009[a]
Sectors of activity [The less cyclical sectors]										
Manufacturing	1.879	1.120	1.462	1.140	1.347	1.664	1.124	1.181	1.029*	1.059
Construction	1.939	1.847	2.290	2.377	1.828	1.715	1.825	1.884	2.171	1.461
Wholesale and retail trade	n.s.	0.885	1.244	0.870	0.807	0.855	0.862	n.s.	0.782	0.668
Hotels and restaurants (tourism)	1.382	3.300	5.861	3.015	1.159	1.145	3.036	4.445	2.612	0.936
Subjective estimation										
Fears losing his/her job	2.238	2.638	n.s.	1.122	0.656	6.310	5.154	2.997	2.798	2.633
Age [46 to 55 years]										
Less than 25 years	0.587	0.531	0.461	0.442	0.637	0.726	0.636	0.507	0.479	0.652
26 to 35 years	0.683	0.719	0.646	0.778	0.900	0.769	0.807	0.705	0.807	0.957
36 to 45 years	0.973**	1.138	1.035	0.807	0.780	0.975**	1.060	0.965	0.829	0.791
More than 56 years	0.392	n.s.	0.613	0.494	0.912	0.421	0.864	0.541	0.559	0.936*
Years of work with the last employer [over 11 years]										
Less than 2 years	4.329	5.507	7.410	8.127	16.847	7.795	9.759	12.853	15.353	35.968
3 to 6 years	1.544	1.265	1.283	1.440	3.571	2.271	1.925	1.898	2.353	5.479
7 to 10 years	0.683	0.892	0.849	1.308	4.233	0.961**	1.294	1.177	1.915	5.610
Level of pay [1,000 - 1,500 €]										
Less than 500€	1.809	1.515	1.353	1.411	1.261	1.694	1.460	1.575	1.627	1.415
500 to 1,000 €	1.264	1.086	1.122	1.199	1.171	1.439	1.275	1.281	1.376	1.234
1,500 € or more	n.s.	0.183	0.458	0.747	0.524	n.s.	0.131	0.320	0.548	0.464

Size of the local Unit [10 persons or more]										
Less than 10 persons	0.906	0.701	0.846	0.913	1.296	0.760	0.663	0.768	0.852	n.s.
Level Education [Completed secondary level education]										
Completed the third stage of 6-year secondary education	1.483	1.435	1.362	1.342	1.295	1.552	1.514	1.336	1.273	1.251
University degree or even postgraduate degrees	1.030*	0.965	0.696	0.929	1.570	1.122	1.019*	0.665	0.845	1.296
Full-time or Part-time [full-time]										
Part-time	1.521	1.541	0.948	1.554	3.256	1.593	1.648	0.790	1.631	2.896
Constant	0.006	0.010	0.009	0.007	0.001	0.004	0.006	0.007	0.004	0.001
Nagelkerke R Square	0.082	0.138	0.203	0.141	0.124	0.129	0.171	0.228	0.182	0.172

Source: Calculations based on primary LFS data. Hellenic Statistical Authority.
* statistically significant 5%,
** statistically significant 10%,
n.s. non statistically significant.

6 Expectations, Economic Climate and the Labour Market

Since early 2009, the impact of the financial crisis and the subsequent economic recession has been visible in the Greek economy. In the third quarter of 2009, GDP dropped by 1.7%, while for 2009 as a whole a reduction of 1.3% (OECD 2009b) or by slightly less (-1.1%) (European Economy 2009) is projected, compared with uninterrupted growth averaging 3.9% annually in the period 2002–2008. As already mentioned, several economic indicators provide a vivid picture of the current economic situation, such as the index of industrial production, the construction index, the retail trade volume index, etc. Against this background, unemployment rose significantly in 2009. Based on the latest available data, the unemployment rate (Q3 2009) rose to 9.3% of the labour force, from 8.9% in the second quarter of 2009, as mentioned above.[4]

Rising unemployment, business closures caused by financial problems, the freezing of wages and the expected cuts in benefits and bonuses, the low earnings of new recruits (cf. the so called “700 euro generation” or even “400 euro generation”), the government’s efforts to expand tax revenues in order to finance the high fiscal deficits, with the introduction of new tax scales and other tax changes pending, public expenditure constraint and restrictive fiscal policies, all change the psychological climate, add to workers’ uncertainty and anxiety about the future and are a cause of concern for households. These most likely respond by moderate and conservative purchases and by increasing their savings, in preparation for the bad times ahead. *The reduction in activity and consumption is pervasive. Banks do not lend, businesses do not invest, consumers do not spend. Everything shows that we are at the beginning of a major economic recession* (Krugman 2009).

We can use various indicators to gauge these concerns. One such indicator is, as already mentioned, the number of workers seeking another job because they fear losing their current job. This fear is caused by rising unemployment and the resulting uncertainty and insecurity. lately, from quarter to quarter, this number has been growing. In the autumn of 2008 (Q3), 9.5 thousand employees were looking for a job. By autumn 2009, this number

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[4] According to the HSA the unemployment rate in February 2010 was 12.1%.

had increased to 18.2 thousand.[5]

Another, more general measure is the economic sentiment indicator, based on individual confidence indicators for industry, constructions, retail trade, services and households (European Commission, Business and Consumer Survey Results). This indicator averaged 88.9 (below 100) for Greece in 2008, before falling sharply to 42.9 in March 2009. However, the change of government and increased expectations for a shift in policy orientation led to an improvement in the indicator (71.7 in October 2009). Although this could be seen as a sign of a possible recovery of the Greek economy after the elections, the indicator records a deterioration in economic sentiment over the first ten months of 2009 compared with the corresponding period of 2008. It should be noted that over the next period a further deterioration in this indicator would seem likely, due to the impact of the adverse climate for the Greek economy prevailing in the international arena (European Commission, IMF, rating agencies). *As a result of these uncertainties, the negative expectations could persist for a long time despite the falling prices of goods, services and financial assets, leading to persistently subdued demand and protracting or even worsening the crisis* (Skidelsky 2009).

In this section we examine how the negative expectations can put an additional burden on an already bad economic situation. Our methodological approach is based on a macroeconomic multi-sectoral general equilibrium model of the Greek economy's adjustment to a situation of recession and crisis such as the one in which it found itself in late 2008. The model belongs to the broader category of neo-classical general equilibrium CGE[6] models, first

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[5] The number was 21.2 thousand in the fourth quarter of 2009.

[6] The CGE model is a numerical representation of the key relationships within a Walrasian general equilibrium system, as developed by the Arrow-Debreu general equilibrium theorem. The ancestry of modern empirical research on CGE modelling goes back to Johansen's model. The theoretical framework of the CGE requires that markets clear through prices. However, empirical applications of the CGE model do not always assume clearing through prices. Instead, researchers often use non-neoclassical assumptions of market rigidities and imperfections, in an attempt to capture the macroeconomic forces at work in the real world. In these cases, some of the markets in the model may clear through price adjustment, while other markets may incorporate endogenous price-setting (as in traditional macroeconometric models that assume excess supply), which ensures a quantity-adjusted equilibrium, or may even incorporate rigidities for specific prices.

introduced by Johansen (1960) and then applied to the analysis of both developing and developed countries (see Dervis, de Mello and Robinson 1982; Robinson 1988; Shoven and Walley 1984, 1992; Gunning and Keyzer 1995; Capros et al., 1997).

We consider two alternative versions of the labour market,[7] In the first version, the labour market for the self-employed undergoes neoclassical adjustment, i.e. the average nominal wages for each type of work are adjusted to restore equilibrium of labour supply and demand; nominal wages in turn are endogenously determined by real wages. In the second case, we assume Keynesian adjustment, i.e. nominal wages for one or more given segments of the labour market remain stable in the short term (perhaps as a result of labour negotiations or other reasons causing rigidity), and employment is determined endogenously. Such an assumption could lead to an unintended rise in unemployment for the given segment(s), well above the assumed steady-state unemployment, which is consistent with the fundamentals of the Greek economy for the year under review.[8]

In both these approaches, the labour market for the self-employed is adjusted in a neoclassical manner. We could alternatively consider a case where

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[7] For a detailed description of the CGE model constructed, see Zografakis and Mitrakos (2008) and Zografakis et al. (2008, 2009). This model draws statistical data from a social accounting table constructed in 2004 and updated in 2008.

[8] There is strong disagreement among the various schools of economic thought regarding the most appropriate rule of labour market adjustment. However, after the financial crisis, the shortage of bank liquidity, the decline in reduce production as a result of subdued demand, we are witnessing a transformation of industrial relations in most parts of the world: in order to avoid losing their jobs, workers may more easily accept, temporarily, flexible forms of employment or even work rotation arrangements (temporary layoff), with corresponding downward adjustments of their wages. It should also be noted that some firms, trying to buy time to adjust to the new situation, introduce work rotation schemes and mandatory leaves, eliminate overtime work and decide temporary layoffs or temporary suspension of business. Thus, between November 2008 and June 2009 a total number of 2,708 employees were temporarily laid off, while by December 2008 work rotation schemes had been introduced in 23 companies (INE-GSEE, 2009). This flexibility would have been unthinkable a few years ago, even in countries such as Germany or France, with more flexible and adaptable labour markets. In Greece, employers and employees in many firms, mainly export-oriented, have “agreed” on work rotation and part-time work, so that such firms can adapt to the shrunken foreign demand.

certain segments of the labour market appear to be more flexible than others, for example the low- and high-skill segments, and assume that the more flexible segments —presumably these are the higher-skill ones—can adjust to prices, while the lower-skill segment, possibly the one with higher trade union penetration, adjusts to changes in employment. However, in the current circumstances of the Greek economy, the shadow cast by the economic recession seems to pervade all types of organised employment. It is thus reasonable to accept, temporarily, a closure rule between the price adjustment and (nominal) wage adjustment of the market for salaried employment.

In particular the model identified six groups of employees by sector of economic activity, and for each group (or any type of work) the corresponding equilibrium wage adjusts depending on supply and demand. The first four groups comprise salaried workers classified according to their nationality[9] (Greeks and immigrants) and skills (low and high). The other two groups refer to self-employed Greeks—low- and high-skilled respectively. All these workers are classified in fifteen types of households, according to a social accounting table that has been constructed. The first type refers to households whose head is an immigrant, distinguished further by income size, into poor, medium and rich households. The other types are exclusively Greek households divided into agricultural, non-agricultural and non-working. Non-agricultural households are further classified depending on the skills of the head (low- or high- skilled), while all the above types of Greek households are distinguished according to the level of income, just like the households of migrants. It should be noted that the skills of employees are measured by educational attainment. Those who have completed up to secondary education are characterised as persons with low skills. Those who have completed

[9] The distinction between native and foreign-born workers and the respective classification of households seems appropriate, given the significant differences between these sections of the population. In 2008, according to Zografakis and Mitrakos (2008), Greece had about 1.2 million immigrants (whether legal or illegal). Of this total, an estimated 537–645 thousand were employed, while nearly one out of two (namely 290 thousand) had some type of insurance (244 thousand were insured with IKA). A part of uninsured immigrant workers are illegal immigrants who do not qualify for insurance, while a considerable part are legal immigrants whose employers, illegally, employ them without insurance, motivated by low labour cost considerations.

tertiary education, including people who have post-graduate studies, are identified as high-skilled. Also, the distinction between low, medium and rich households is based on the average per capita expenditure equivalent, where poor households are defined as those spending less than 60% of the median total expenditure, rich households are those over 120% and the medium households are those falling in between.

The scenarios that we considered can be classified into two categories.

- In the first category we simulated the Greek economy in a state of economic recession (for both versions of the labour market). The recession was caused either by low (external) consumption demand or by low (domestic) investment demand. More specifically, we assumed: (i) a 25% decline in households' investment in housing, i.e. one out of four households postpone the planned purchase of a new house either because of the dire economic situation or because of the tight supply of housing credit from banks; (ii) a decline in foreign demand for domestic manufactured goods, i.e. Greek exporters across all sectors facing growing difficulties in promoting their products to foreign markets; and (iii) a decline in foreign demand for domestic tourism services, leading to a reduction of about 25% in tourism receipts. The empirical results of this scenario in the two alternative versions of the labour market are reported in the first two columns of the tables below, where S1 refers to full flexibility and S2 to Keynesian adjustment of the labour market.
- In the second category, we simulated the Greek economy with an additional exogenous intervention. This is the case when households, because of their uncertainty, are forced to adjust their preferences by limiting their consumption spending. In other words, in the context of an adverse economic climate, households prefer to save money to meet potential future needs (such as payment of increased taxes, lower earnings due to cuts in benefits, unemployment, etc.–see above). The empirical results of this scenario, in the two alternative versions of the labour market, are reported in the third and fourth columns of the tables below, where P1 refers to full flexibility and P2 to Keynesian adjustment of the labour market. In columns P1 and P2, the results measure the additional impact further to those reported in columns S1 and S2. To derive the overall impact, we have to add the results of scenarios S1 and P1 for a fully flexible market and S2 and P2 for a Keynesian labour market. The exogenous intervention we assumed was a mild

one, with private consumption declining by 3% in real terms.

Table 5 shows changes in key macroeconomic aggregates, in real terms (i.e. the percentage deviations from the initial pre-crisis equilibrium values – columns S1, S2– and the percentage deviations from the equilibrium values during the economic crisis –columns P1, P2). It should be noted that we assume that there is not any other exogenous intervention.

Table 5: Change in key macroeconomic aggregates (Percentage changes at constant prices)

	S1	S2	P1	P2
GDP at market prices	**-1.0**	**-2.0**	**-1.0**	**-1.6**
Private Investments	-12.5	-11.5	-5.1	-3.9
Exports (Total)	-1.7	-3.6	2.1	0.8
Imports (Total)	-7.7	-5.0	-5.9	-4.0
Private Consumption	-0.4	-0.4	-3.2	-3.1
Consumer Price Index	-15.9	-7.5	-11.5	-5.7
Real Wages - Total	**-2.3**	**5.5**	**-1.4**	**4.2**
General government deficit increases (percentage points of GDP)	**3.1**	**1.8**	**1.8**	**1.3**

Source: Calculations based on CGE model.

Low demand for domestic manufactured goods and services has significant effects, causing real GDP[10] (at market prices) to drop by 1% and 2% respectively. The lack of flexibility in the labour market results in an increase in real wages due to the fall in prices, although nominal wages are assumed to remain stable. The larger decline in domestic prices in version S1 leads to a smaller reduction in exports and a larger reduction in imports, since now the domestically produced goods and services are relatively less costly than the foreign ones. The above adjustment is the main cause of the smaller fall in GDP in comparison with version S2. However, in the flexibility version, a de-

[10] These results are consistent with the actual figures, according to which the drop in GDP for 2009 should be between these two estimates. Also, these estimates are slightly weaker compared with those initially reported (Zografakis and Mitrakos 2009).

cline in real wages of 2.3% is recorded, in comparison with an increase of 5.5% in the rigidity version. The additional negative effect due to uncertainty is shown in columns P1 and P2, indicating an expected further decline in GDP of 1% and 1.6% respectively, depending on the version of the labour market. The further fall of prices, due to low demand for domestically produced goods, improves competitiveness and increases exports. Finally, the general government deficit ratio increases by a further 1.8 and 1.3 percentage points of GDP.

Table 6 illustrates the changes in real wages by employment status (employees/self-employed) and by skills (low/high). With full flexibility of wages (S1), the reduction in real wages is larger in low-skilled workers compared with high-skilled workers, without significant differences in relation to employment status. With Keynesian rigidity, employees (that is, those who will not lose their jobs, as we will see below) will clearly benefit from higher real wages (as a result of lower prices, assuming nominal wage rigidity). Thereafter, the deteriorating economic situation due to uncertainty (P1) leads to a further decline in real wages, but this time the decline is stronger for high-skilled workers.

Table 7 shows the corresponding changes in employment. Total employment appears to fall by 62.5 thousand persons in the flexibility version (S1) and by 182.2 thousand in the rigidity version (S2). Job loss among immigrants is proportionately higher in version S2, where 20% of the lost jobs were held by immigrants, compared with 16% in version S1. It also seems that the self-employed, although retaining their flexibility in both versions, would lose 17.6

Table 6: Change in real wages by employment status and skills

	S1	S2	P1	P2
Real wages employees				
Low-skilled workers	-2.6	7.5	-1.2	5.7
High-skilled workers	-1.6	7.5	-1.3	5.7
Real wages self-employed				
Low-skilled workers	-2.9	-1.1	-1.5	-0.1
High-skilled workers	-2.6	0.3	-1.8	0.5

Source: Calculations based on CGE model.

thousand jobs in the neoclassical, flexible labour market version, compared with zero losses in version S2.

The lower employment of the self-employed in the version of flexible wages comes mainly from the labour supply side. The decline in the real wage, as we will see below, leads to a fall in the supply of these categories of workers. This lower supply can be regarded as a kind of voluntary "unemployment." It also appears that low-skilled workers are in a worse situation, since they bear the brunt of job loss. It is interesting to note the small increase in the employment of high-skilled self-employed persons. This is attributable to the small rise in the real wages of these workers, leading to a slight increase in their total supply.

These estimated results are consistent with the actual facts, as recorded in the latest Labour Force Survey for the third quarter of 2009, suggesting that, compared with the corresponding survey of 2008, the number of unemployed persons increased by 110 thousand.

Anxiety and uncertainty can compound the effects of the economic crisis, causing the number of unemployed to increase further by between 30 and 102 thousand (versions P1 and P2 respectively). This further increase in unemployment would exacerbate the already adverse climate and lead to even gloomier expectations on the part of households; the latter would attempt to cope with the new situation by increased cautiousness and by refraining from purchases, which would perpetuate the spiral.

Table 7: Change in employment (in thousands of persons)

	S1	S2	P1	P2
Employment	**-62.5**	**-182.2**	**-30.4**	**-102.5**
Immigrants	**-10.0**	**-37.2**	**-3.2**	**-16.1**
Employees	**-34.9**	**-140.7**	**-18.1**	**-86.5**
Low-skilled workers	-25.3	-101.2	-11.1	-58.0
High-skilled workers	-9.7	-39.5	-7.0	-28.5
Self-employed	**-17.6**	**-4.3**	**-9.0**	**0.1**
Low-skilled workers	-13.8	-4.8	-6.6	-0.6
High-skilled workers	-3.8	0.4	-2.4	0.7

Source: Calculations based on CGE model.

The sectoral breakdown of the effects of recession on employment, shown in Table 8, suggests that the largest job losses are observed in the sectors of construction, trade and tourism-leisure. By contrast, other industries seem to experience a slight increase in employment in the full flexibility version. The data on sectoral employment are, of course, closely related to output data.

In the version of nominal wage rigidity (S2 and P2), employment declines in the primary sector (agriculture, etc.). This is because farmers, in the face of subdued demand for their products, cannot afford to pay their immigrant workers (the majority of workers in the primary sector are immigrants) with the same wages as before. In addition, we have made the rather strict assumption that the immigrants cannot accept lower pay. In the uncertainty scenario, the trade sector suffers the largest job losses.

Table 8: Change in employment by sector activity (in thousands of persons)

	S1	S2	P1	P2
Agriculture, forestry and fishing	3.5	-11.0	-3.3	-12.5
Mining, Electricity, Water	-0.2	-2.2	-0.3	-1.6
Food and Beverage Manufacturing	2.8	-3.0	0.2	-3.6
Textile manufacturing	2.3	-1.6	1.0	-1.6
Wood, furniture,, paper,, printing and publishing	-0.5	-3.3	0.1	-1.6
Intermediate Good Manufacturing	-2.5	-8.5	1.9	-2.0
Capital Goods Manufacturing	-0.7	-4.5	-0.3	-2.6
Construction	-40.8	-52.5	-6.9	-12.6
Wholesale and retail trade	-18.2	-40.5	-14.5	-27.5
Tourism Services, Recreation	-8.3	-19.5	-0.1	-7.0
Transport, Communications	-0.5	-8.7	1.6	-3.8
Real estate activities				
Other Market Services	-7.2	-16.2	-5.8	-11.1
Public Administration	5.5	-5.6	-0.5	-7.1
Education	0.5	-0.9	-1.5	-2.2
Health	1.9	-4.2	-2.0	-5.8
Total	-62.5	-182.2	-30.4	-102.5

Source: Calculations based on CGE model.

Table 9 shows the effect of the recession scenario (S1, S2) and the effect of uncertainty (P1, P2) on the real disposable incomes of different groups of households. As long as population data remain unchanged in the simulations, the percentage changes in the table can be considered as changes in households' per capita real disposable income. The households facing higher labour losses are expected to come under stronger pressure in terms of income. Indeed, agricultural and non-agricultural low-skilled households seem to lose more income, and the losses are significantly higher for the poor and medium-income low-skilled households whose predominant source of income is low-skilled labour. However, across all groups of households, the poor households are those that face the greatest financial stress and by far the highest losses in income. This means that whatever version is prevailing, inequality and poverty will increase, as the number of households below the poverty line will rise. It should be noted that, although the real wage in the rigidity version is increased significantly, yet the households see their real incomes decline. This is due to higher unemployment, most notably among low-skilled workers. Therefore, irrespective of the choice between rigidity and flexibility, the losses remain the same for households as a whole. However, the losses are more strongly felt in households relying for their income on the wage of a low-skilled breadwinner.

The additional losses because of uncertainty vary significantly, depending on the version considered. In the flexibility version (P1), the declines in real incomes for households as a whole are double those obtained under the other version (P2). Moreover, the medium-income households now appear to suffer far more than the poor and rich households. Finally, in both scenarios, the households headed by a high-skilled worker are better-off than the other households.

These results were tested for sensitivity to the assumptions of the model. A set of assumptions that seem to play a crucial role refers to the individual elasticities that determine the labour market. Since all the production relations in the model belong in the class of CES functions, the way to simulate a more flexible demand for labour is to assume higher elasticities of the CES functions. The results of the model do not seem to be very sensitive to the assumed substitution elasticities between domestic and imported goods (Armington elasticities) or the transformation elasticities between domestic and exported goods. Experiments in which the elasticities were set at half or twice

Table 9: Impact on real disposable incomes of households (Percentage changes at constant prices)

	S1	S2	P1	P2
Agricultural households	**-4.8**	**-4.2**	**-2.5**	**-1.8**
- Poor	-5.6	-4.7	-2.8	-1.8
- Middle Income	-5.2	-4.3	-3.2	-2.2
- Rich	-2.0	-2.9	0.4	-0.3
Urban low-skilled households	**-6.0**	**-4.6**	**-2.9**	**-1.3**
- Poor	-6.1	-4.1	-2.9	-1.0
- Middle Income	-7.0	-5.2	-3.3	-1.5
- Rich	-2.6	-2.7	-1.5	-0.5
Urban high-skilled households	**-0.9**	**0.3**	**-0.7**	**1.2**
- Poor	-4.4	0.2	-2.5	1.3
- Middle Income	-0.4	0.8	-1.1	1.7
- Rich	-1.4	-0.3	-0.3	0.6
Non - working households	**-1.8**	**-3.6**	**-1.1**	**-1.3**
- Poor	-3.5	-4.7	-1.7	-2.3
- Middle Income	-1.9	-3.7	-1.6	-1.3
- Rich	-0.1	-2.8	1.0	-0.5
Total households	**-3.2**	**-3.1**	**-1.7**	**-0.8**
- Poor	-4.5	-4.2	-2.1	-1.6
- Middle Income	-3.7	-3.5	-2.2	-0.9
- Rich	-1.3	-1.8	-0.1	0.0

Source: Calculations based on CGE model.

their baseline prices have not been found to produce significantly different results from those of the baseline scenario.

7 Conclusions

The recession hitting the Greek economy is having adverse effects on virtually all groups of households, whether poor, medium-income or rich. The labour inputs with low human capital are the most severely hit. The recession spreads across almost all sectors of activity, but is taking the heaviest toll on the construction, trade, manufacturing and tourism sectors. These assessments are consistent with the current picture of the labour market as reflected in the Labour Force Surveys. According to our results, workers are more likely to lose their jobs if they work in some of the more cyclical sectors (construction, tourism, manufacturing), if they have few years of work with the last employer, if they are aged between 46 and 55, if they are low-paid and, last but not least, if they are low-skilled. It should be pointed out that these results refer to higher probabilities, without necessary implying that other employees, with different demographical (age, education etc.) or labour characteristics, are not at risk. The first part of this paper attempts to delineate, as accurately as possible, the profile of workers who lose their jobs.

The economic recession also hits government finances, by causing a loss of valuable revenues and, at the same time, a growth in fiscal deficits. The problem becomes more acute if the high fiscal deficits are accompanied by a high public debt, necessitating a mobilisation of resources from the private sector to finance the public sector.

In this paper we considered two scenarios:

- An economic recession scenario assuming two alternative types of labour market functioning:
  - ✓ When the labour market cannot easily adjust (Keynesian rigidity), workers who keep their jobs seem to benefit, insofar as their real wages increase. However, in this case, those who lose their jobs suffer the greatest losses. These persons are so many that we can observe a significant decline in the aggregate real income of all households. Some household members who kept their jobs may have seen an increase in their real wages; yet there are some other members in the same households who are now without work. Typically, if the household head is high-skilled the other working members of the households have a similar level of skills. A similar pattern seems to apply to households headed by a low-skilled worker. Since the most jobs lost are low-skill jobs, in the scenario of rigid labour market, the low-skilled households suffer more, relative to higher-skilled households, i.e. whose head has a higher level of education. Finally, the real income of households whose head is a farmer or a pensioner (non-worker) declines significantly.
  - ✓ When there is more flexibility in wages, the effects of the recession are allocated more fairly. The number of workers who lose their jobs is now considerably smaller, while the others who remain employed incur a cost in the form of lower real wages. In the full flexibility version, even the

high-skilled households shoulder part of the cost of the crisis, while for households headed by an inactive person (including a pensioner) the cost of the crisis is less in comparison with the rigidity version. In both versions, the low-skilled workers are the most strongly affected. As a result, the poor households face the greatest threat. It is important to note that in the full flexibility version the decline in the real incomes of the poor households is more than double the decline in the income of the rich households. This difference is rather less pronounced in the rigidity version.

- A scenario of a further burden on the economy because of uncertainty. The size of the assumed exogenous intervention does not significantly affect the size of the impact. It can start with a weak restraint on consumption expenditure on the part of households, but then can avalanche, with successive downward readjustments of expectation about the future economic outlook. The size of the impact varies depending on the adopted assumptions for the labour market. These results are due to the changing sentiment of households. If the households' fears materialise (e.g. higher taxes) their uncertainty about tomorrow becomes a certainty, and then consumer behaviour will start from a persistently lower base every next time.

In both versions, the government is burdened by higher deficits. The effort to reduce deficits within an adverse economic environment becomes very difficult and complicated.

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Size and Cyclicality of Worker Flows in Greece

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Abstract

In this paper I use the Labour Force Survey to examine worker gross flows in Greece. I analyse the size and cyclicality of the flows between employment, unemployment and inactivity, and decompose contribution of job separation and job finding rates to variation of unemployment rate. Even though Greek labour market displays dynamism, as employment increased substantially during the examined period, its flows are relatively low, rather stable and cyclically countercyclical. Both job separation and job finding rate are relevant to unemployment rate fluctuation.

1 Introduction

The aggregate labour market indicators—like employment, unemployment and inactivity rate, as well as their dynamic changes—are determined by the inflow and outflow of workers between the main labour market statuses. Thus, the understanding of worker flows is crucial for the understanding of the evolution of these labour market stock variables, as well as for the business cycle fluctuations. Also, the magnitude of worker flows allows us to measure the flexibility of an economy, as its size indicates how its economic agents respond to labour market opportunities and economic shocks, as well as how quickly the economy adjusts to technological and structural changes.

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Such flows appear to be at the heart of the functioning of market based economies, which involve a continuous movement of workers every day through hirings to fill new positions or to replace previous employees on continuing works, while other workers quit or are dismissed. Presumably, labour markets without a minimum level of worker flows inevitably become inefficient. Moreover, the size and structure of worker flows over time indicates how allocation of workers over changes over the business cycle—that is, its cyclical behaviour. It has different policy implications whether the employment increase at the upturn comes from the pool of unemployed, or from those not participating in the labour market moving into employment. Likewise, worker flows show whether the decline in employment, during a recession, comes from firings or from a fall in hirings. Apart from the examination of worker flows for the whole economy, it is also valuable to analyse such flows at other levels such as gender, education, or age; special attention has been paid to employment dynamics by economic activity sector—that is, the so-called labour turnover.

The examination of these issues, which in the literature are described as labour market dynamics, has proceeded with the development of theoretical models to explain the behaviour of gross job and worker flows (e.g. Mortensen and Pissarides, 1994; Caballero and Hammour, 1994; Pissarides, 2000 for an extended survey), as well as with many empirical studies documenting the stylized facts of the labour market flows in various countries and their implications for the study of business cycles. However, certain aspects of these issues remain still unclear, as evidence seems to be too contradictory to specific theoretical propositions, and more information is needed on different countries and industries, or cyclical conditions. Partly this situation stems from the subject and quality of data used. The analysis of labour market dynamics requires proper and sufficient statistical data, which are not always available. The frequently repeated observation of the same economic agents (workers or firms) through time, that is longitudinal or panel data from the firms' and workers' side, is necessary to undertake such analyses properly. A close but imperfect data substitute is the so-called recall data, where workers currently report their previous labour market status.

In this paper we examine worker flows for Greece, a small open economy with relatively strict labour market regulations—as indicated by employment protection legislation (OECD 2009)—which in recent decades has displayed rather poor labour market performance in terms of employment and unemployment. The unemployment rate, as well as the long term unemployment rate (with duration of a year or longer) follow a similar pattern and have remained consistently high (Figure 1). The unemployment rate, after a rapid and substantial rise from about 4 per cent in the early 1980s, levelled at around 8 per cent until the early 1990s when a new rise led to two-digit percentages in the mid-1990s. It peaked at 12.7 per cent in 2000 then declining until 2008 to 7.6 per cent when it started rising anew. This unemployment evolution seems to follow a negative, even loose, relationship with GDP growth, which after several years of near-stagnation was significantly positive from the mid-1990s to 2008. Over the same period, the employment rate of the working age population, which by European standards remains relatively low at almost 62 per cent in 2009, has displayed a gradual rise since the early 1990s (Figure 2). On the other hand, during the period examined there were also substantial institutional changes. Greece targeted and joined the European Monetary Union, in January 2002 introduced the Euro as its currency and abolished traditional economic policy tools like exchange rates and monetary policy. Employment protection legislation, as well as industrial relations regulations, however, has remained unchanged in recent decades

Figure 1: Unemployment evolution

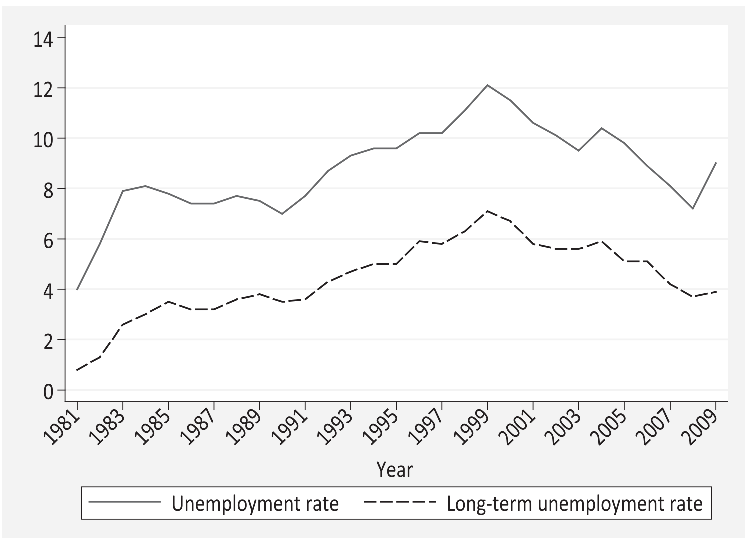


Figure 2: Employment rate

and remarkably stricter than in many OECD countries (Allard, 2005; Venn 2009). In this context, the Greek case offers an opportunity to examine the size and evolution of worker flows in a small open economy with a highly regulated labour market during a period of remarkable structural changes and variable economic conditions. It is hard to locate any recent systematic studies on labour mobility in Greece.

The contribution of this paper, using data derived from the Greek Labour Force Survey (LFS), is twofold. First, we establish a number of stylised facts of labour market flows in Greece over the past years by providing evidence on the extent and evolution of worker flows in Greece and by examining whether these flows are related to the observed evolution of the main labour market variables. Secondly, following recent literature on unemployment decomposition, we examine the relative role of unemployment inflows and outflows in observed unemployment changes.

The data used are constructed from the LFS. As is well known, the LFS is a widely used survey (among others) for the estimation of employment and unemployment rates. Thus, our worker flow estimates are consistent with the existing aggregate labour market indicators. LFS remained an annual survey carried out during spring of each year for the period 1981–1998. In January 1998 it became a quarterly survey and since 2004 it has turned into a quarterly rotated panel survey. In this last phase (since first quarter of 2004) data match LFS respondents between quarters—showing changes in their labour market states, thus allowing compilation of worker flows between employment, unemployment and inactivity during this period. Moreover since 1988 the LFS has contained a recall question providing information on the "labour market status one year before the surveyed week'. This information is used here to generate a variable that indicates whether the individual declares himself employed, unemployed or inactive twelve months previously. Comparing this variable with the economic activity state in the surveyed week produces annual worker flows series, which are examined in the empirical section to describe workers' labour market flows and to identify their possible regularities.

The rest of the paper proceeds as follows. Section 2 presents briefly the theoretical background of the paper paying attention to the expected relations of worker flows and the functioning of the labour market, as well as to the indicators used for worker flows. Section 3 establishes the size, evolution and cyclical properties of the annual worker flows. Section 4 repeats the same task using the quarterly worker flows. Section 5 attempts to decompose unemployment changes into unemployment inflows, the so-called "ins", and unemployment outflows, the so-called "outs". Finally section 6 summarises and concludes.

2 Theoretical Framework

The theoretical background for analysing worker flows lies within the search and matching models developed mainly by Mortensen and Pissarides (e.g. Mortensen and Pissarides, 1994). Such models emphasize that the heterogeneity of workers and jobs, the information imperfections about the personality of potential trading partners and the role of low mobility cause labour market frictions, which affect job creation and job destruction. Apart from explaining labour market performance, these models try to predict the relationship between various worker flows and the evolution of the economic cycle—that is, whether the flows between employment, unemployment and inactivity are procyclical or countercyclical.

Search models usually consist of three components. First, a specification of firms' labour demand—expressed in terms of job destruction and job creation—through which all worker flows come. Job creation and job destruction are determined by wages, as well as by the job shifts that follow a procyclical pattern for the former and a countercyclical pattern for the latter. Secondly, a well-behaved matching function indicating that the number of jobs formed per unit of time is the outcome of the trade process between workers (seeking employment) and firms (posting vacancies) and depends upon the stock of unemployed and vacancies. And thirdly, a wage setting equation which shows that wages depend upon the probability of finding a job when unemployed. In this context, anything that improves the efficiency of the match of unemployed with vacancies, and/or reduces the exit rate from employment, is likely to reduce the level of unemployment which equates inflows and outflows for a given level of vacancies. On the contrary, if the matching process becomes less efficient or the exit rate from employment increases, a higher unemployment rate is necessary to equate inflows and outflows from unemployment.

Putting the above three components of search models together, it is expected that the number of workers moving from employment to unemployment or inactivity would be countercyclical, while the movement from unemployment to employment would be procyclical. Pissarides (2000), using the standard search model, assuming that individuals enjoy more leisure when out of the labour force than when searching for a job, infers that flows from inactivity into both employment and unemployment would be procyclical, as labour market tightness rises and the employment rate increases. Finally, Pissarides, developing a model of job search, specifies the movement from unemployment to employment in response to a shock in aggregate activity and concludes that the hazard rate from unemployment to employment should be procyclical, while the flow from unemployment to employment may be countercyclical.

Our analysis of labour market dynamics uses some fundamental equations describing the evolution of the stock of employed (E) and unemployed (U) whose sum corresponds to the labour force (L). When the pool of inactive people (I) is added to the other two stocks we get the total working age population, (N):

$$E + U + I = N \tag{1}$$

The level of those in employment at the end of period t equals the number of people in employment at the start of the period plus those entering from the other states minus those employed becoming unemployed or inactive:

$$E_{t+1} = E_t + M_t^{UE} + M_t^{IE} - S_t^{EU} - S_t^{EI} \quad (2)$$

where M is the hiring flow from the pool indicated by the superscript and S is the separations flow. In order to evaluate changes in employment rate caused by inflows and outflows this equation is usually normalized by the total working age population, getting next equation, which shows that gross workers flows determine the change in the employment rate.

$$\frac{E_{t+1} - E_t}{N_t} = \frac{M_t^{UE}}{N_t} + \frac{M_t^{IE}}{N_t} - \frac{S_t^{EU}}{N_t} - \frac{S_t^{EI}}{N_t} \quad (3)$$

Alternatively equation (2) can be written in terms of hiring (h) and separation (s) rates, which indicates that employment change is determined by the rate at which workers move into and out of employment, independent of the size of the pool from which they came, i.e. the so called probabilities of hazard rates.

$$\frac{E_{t+1}}{E_t} - 1 = h_t^{UE} + h_t^{IE} - s_t^{EU} - s_t^{EI} \quad (4)$$

An equation similar to (2) applies for the evolution of unemployment:

$$U_{t+1} = U_t + S_t^{EU} - M_t^{UE} + G_t^{IU} - G_t^{IU} \quad (5)$$

where G represents the movement between unemployment and inactivity. Likewise here we can focus either on the gross flows of unemployed or on their transition or hazard rates shown in equation (6) and (7) respectively:

$$\frac{U_{t+1} - U_t}{N_t} = \frac{S_t^{EU}}{N_t} - \frac{M_t^{UE}}{N_t} + \frac{G_t^{IU}}{N_t} - \frac{G_t^{IU}}{N_t} \quad (6)$$

$$\frac{U_{t+1}}{U_t} - 1 = -h_t^{UE} + s_t^{EU} \frac{E_t}{L_t} \frac{L_t}{U_t} + \frac{G_t^{IU} - G_t^{UI}}{L_t} \frac{L_t}{U_t} \quad (7)$$

While earlier empirical studies use the flows perspective (Blanchard and Diamond, 1990; Bleakley, Ferris and Fulhrer, 1999; Burda and Wyplosz, 1994), recent studies have focused more on the transition or hazard rates (Fujita and Ramey, 2007; Shimer, 2007). The two points of view are complementary in the analysis of labour market and in the next two sections we explore both measures to examine worker flows (Diagrams 6 and 8).

3 Annual Worker Flows

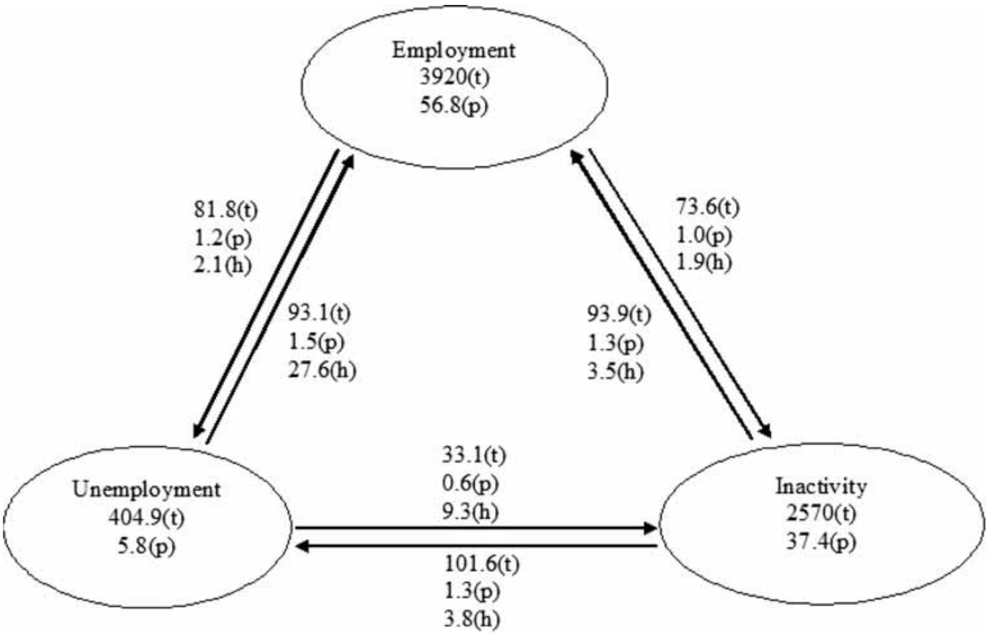
3.1 Average Gross Flows

Here we use a recall question in the LFS to derive a long series of annual worker flows. Data from the 1988 LFS onward contain a question that seeks to ascertain the economic activity status of the individual twelve months prior to the survey week. Even though the wording of the question has slightly changed over time, it is possible to construct a variable indicating whether the individual was employed, unemployed or inactive twelve months previously. Comparing this variable with their labour market state in the survey week, we get annual gross flows series. Such series allow the estimation of the size of worker flows, as well as their cyclical patterns. Clearly, these measures do not capture short -term transitions taking place within each year—for example, persons moving from inactivity to employment, perhaps via unemployment in a short space of time, and then back to inactivity within a year. Consequently they represent lower bounds of actual worker flows.

Figure 3 draws on tabulations from the LFS to summarise the average annual worker flows over the period 1988–2009 between unemployment, employment and labour force exit (inactivity). For each flow, it shows the total number of people that changed state, in thousands—the so called movers (t), the number of movers as a percentage of the working age population 15–64 (p), and the average transition probability or hazard rate (h) from one labour market state to another, defined as the ratio of those who change state to the previous stock.

According to Figure 3, almost 480 thousand persons changed labour market state from one year to the next during the 1988–2009 period. That is, almost 7 per cent of the working age population changes employment status in an average year. The noticeable feature of the data is the size of gross flows compared to net flows. For example, employment over the examined period

Figure 3: Average annual worker flows 1988-2009



increased by 44.4 thousand per year. However, annual employment inflows were on average 187 thousand and employment outflows were 155 thousand. Consequently, it can be argued that small changes in gross worker flows can shift total employment. The encouraging point of the examined period is that annually almost 45 thousand persons are added to the stock of employment. This indicates that in the Greek economy, as in others, there is not a fixed number of jobs: rather, total employment can increase remarkably. The employment increase coming from unemployment inflows is somewhat smaller than that stemming from inactive persons, who join employment directly without passing through unemployment. This indicates that the inactive category is an important source of labour supply. Likewise, almost half of those moving out of employment go into inactivity. Thus, worker employment flows, even small, are observed in both of the other two labour market states that is, between employment and unemployment, as well as between employment and inactivity.

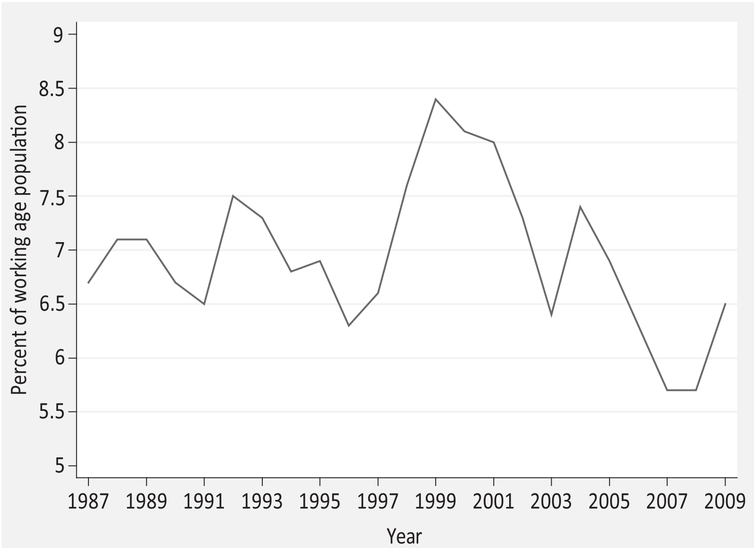
How do these numbers compare with those in other countries? While cross-country comparisons for many reasons are not easy, Greek numbers seem rather low compared to those of other countries, where worker flows are much higher. For the USA, for example, almost 8 per cent of the working age population change employment status on a monthly basis (Davis, Faberman and Haltiwanger, 2006: 10), while for the UK the corresponding number is 7 per cent on a quarterly basis (Bell and Smith, 2002). Moreover, Burda and Wiplosz (1994: Table 1) present annual unemployment and employment inflows and outflows in 1987 which are much higher than those in Figure 3, here. According to Burda and Wiplosz, each of the unemployment inflows or outflows in 1987 is higher than the stock of unemployed in all the examined countries. Similarly, employment inflows and outflows represent a significant percentage of the pool of employed. Even countries with strong labour market regulation, such as France or Japan, display worker flows much higher than those in Figure 3. OECD (2009) also provides measures of worker flows for its 22 member states showing that Greece displays the lowest annual hiring and separation rates over 2000–2005. If we consider the size of gross flows between employment, unemployment and inactivity as an indicator of labour market flexibility, we could argue that the labour market in Greece is much less flexible than that in many other countries.

The averages of Figure 3 say very little about the pattern of worker flows movement in the examined period. Thus the next step is to consider the pattern concentrating on their cyclical features.

3.2 Evolution of Annual Worker Flows

A first indicator of the evolution of labour market flows is to see how the sum of flows taken together changes over time (Figure 4). This aggregate index might be interpreted as a rough indicator of total labour market dynamism. The first point is that this index does not display substantial variation. For many examined years, gross worker flows are between 6.5 and 7.5 per cent of the working age population. Only over 1998-2001 did they exceed 7.5 per cent reaching a peak of 8.4 per cent in 1999 and then declining until 2008 when they were 5.8 per cent. Thus, we can argue that aggregate labour market dynamics do not show a clear and systematic direction. Despite significant structural changes that took place during the examined period, the Greek labour market essentially keeps worker flows rather low, stable and in recent years actually declining. A reduction of worker flows in Greece in the period

Figure 4: All worker flows

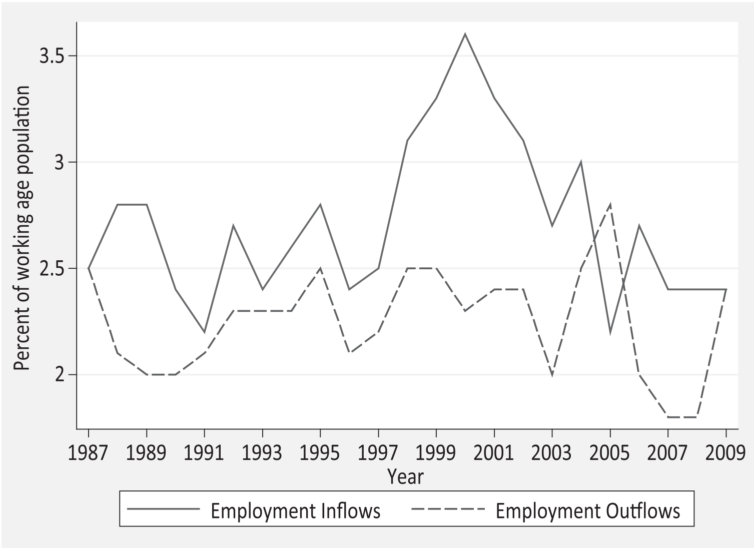


1996–2004 compared to 1985–1995 is also documented by Boeri and Calibaldi (2009: Table 4) using alternative annual mobility indexes.

If we consider the worker inflows and outflows to the three labour market states, it is also clear that there are not any visible major trends. Many of them during the examined period constitute a small and rather stable percentage of the working age population. Despite this rather stable pattern, it seems that the main causes of the changes in worker flows are the flows into and out of unemployment. The employment inflows, which are higher than employment outflows (Figure 5), follow a pattern similar to that of unemployment outflows (Figure 6). Employment outflows turn out more stable over time and driven mainly by outflows to unemployment, while employment outflows to inactivity are lower and less variable. Finally, outflows from inactivity even though small and rather stable ,display a declining pattern for both components.

The consistent increase in the employment rate over the examined period (Figure 2) was accompanied by employment inflows displaying higher mean value and fluctuation (SD=0.36) than those for employment outflows (SD=0.25) (Figure 5). Thus, in an accounting sense, employment rise stems

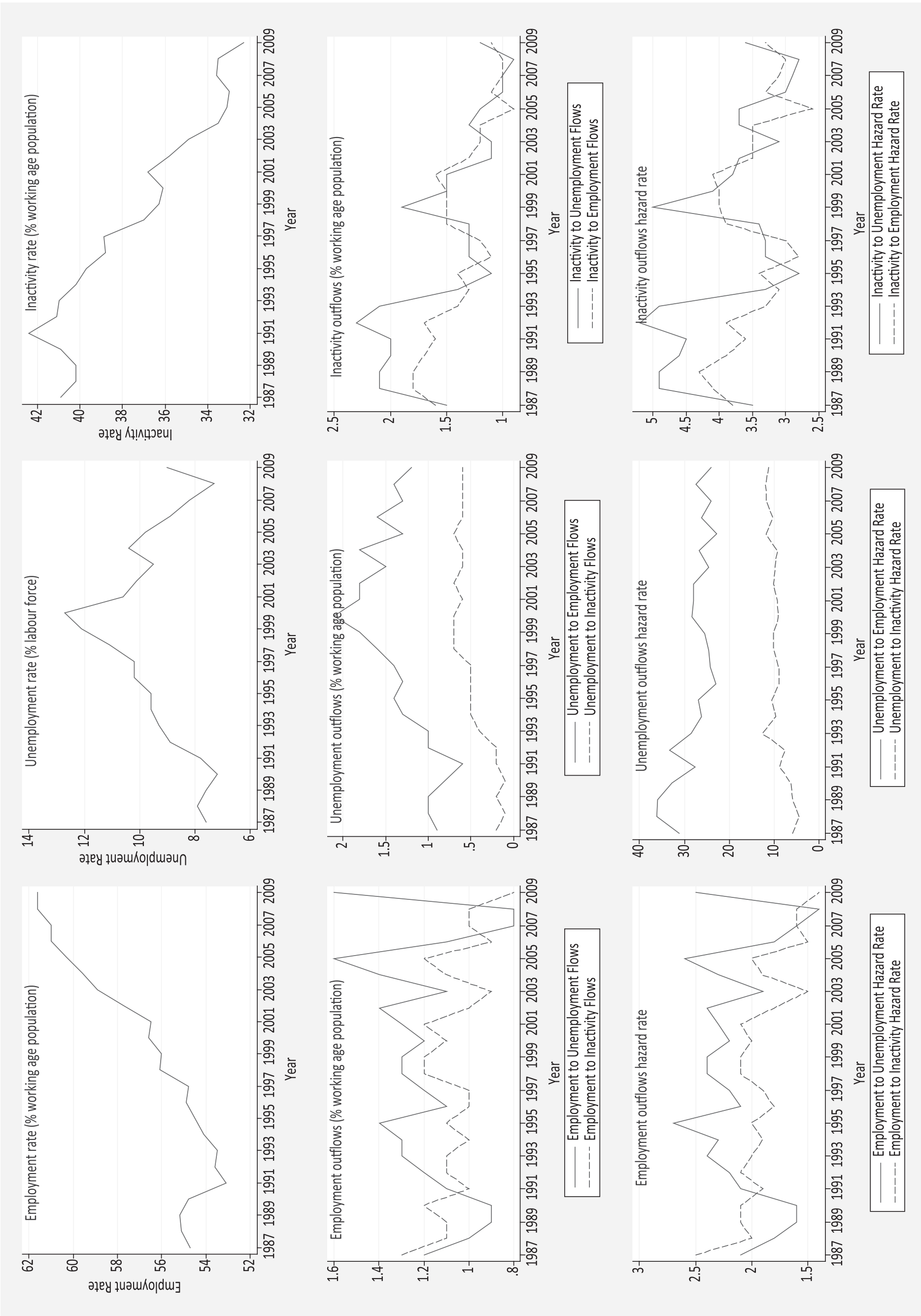
Figure 5: Employment inflow and outflow rates



from higher employment inflows than outflows. At phase value the size of these flows shows that job creation is more important than job destruction in explaining the observed employment rate growth.

Rather similar conclusions are drawn when the transition probabilities between the three pools by previous labour market state, i.e. the hazard rate, are examined (Figure 6, last row). In this case stability at rather low rates is also the rule. It is worth mentioning that the probability of moving from unemployment to employment has remained consistently rather low and even declining. Only 27.6 per cent on the average of those who were unemployed last year declare employed at the survey week. Likewise only 4 per cent of the employed move a year later to the other two pools, half of which to inactivity, the vast majority presumably being retired. Thus there are small movements between employment and unemployment demonstrating the dual character of Greek labour market. These low flows combined with the high long tern unemployment rate indicate that unemployment in Greece is a rather stagnant pool with low flows in and out and long duration. A reasonable explanation seems to be the strict employment protection legislation in Greece.

Figure 6: Annual labour market stocks, gross flows and hazard rates



3.3 Cyclical Properties of Labour Market Flows

The theoretical literature on worker flows identifies them as cyclical and correlated with the level of economic activity. While there are many indicators of the business cycle, in this paper we use the unemployment and employment rate, as derived from the same data set. The correlations with unemployment and employment rates of worker flows and their hazard rates are reported in Table 1. It turns out that inflow and outflow rates of examined pools are either countercyclical or insignificant. As the economy downturns, that is, as the unemployment rate rises, more workers lose their jobs and become unemployed. Also, more unemployed persons find jobs or flow out of the labour market. When the correlation between the unemployment rate and worker flows is insignificant, the correlation of the employment rate and worker flows usually turns out to be significant. According to the correlation of employment rate and worker flows in economic upturns, as the labour market becomes tighter, fewer people move from employment to inactivity, while inactivity outflows decline. Given the previously mentioned low and

Table 1: Correlation of annual labour market flows and hazard rates with (un)employment rate 1988–2009

	Gross flows		Hazard rates	
	Unemployment rate	Employment rate	Unemployment rate	Employment rate
E→U	0.58*	0.04	0.59*	-0.19
E→I	0.01	-0.42*	-0.12	-0.69**
U→E	0.87**	0.41	-0.61*	-0.44*
U→I	0.85**	0.60**	0.48**	0.50*
I→E	-0.35	-0.72**	-0.09	-0.38
I→U	-0.37	-0.71**	-0.19	-0.53**
→E	0.61*	-0.11		
E→	0.50*	-0.16	0.37	-0.51*
→U	-0.07	-0.65**		
U→	0.90**	0.49*	-0.52**	-0.24
→I	0.83**	0.34		
I→	-0.38	-0.74*	-0.17	-0.53**

**, * significance at 1% and 5% respectively.

stable character of many worker flows, the loose correlations of Table 1 are not surprising. It seems, however, that the systematic action takes place through the unemployment level. Similar patterns of worker flows are also visible in the UK (see Bell and Smith, 2002; Gomes, 2009).

Turning to the cyclical properties of transition or hazard rates (right part of Table 1), the picture is not very clear. Considering the unemployment rate as an index of the economic cycle, the transition from employment to unemployment, as well as from unemployment to inactivity, is countercyclical, while the job finding rate of unemployed is procyclical. In other words, in downturns it becomes more difficult for the unemployed to find a job, while the employed are more likely to lose their jobs. If, however, the employment rate is considered as the economic cycle indicator, the transitions of the unemployed to employment turn out to be countercyclical, while those to inactivity are procyclical. Since the employment rate during the examined period follows an upward trend, it seems that the unemployment rate performs relatively better as an indicator of the economic cycle.

4 Quarterly Worker Flows

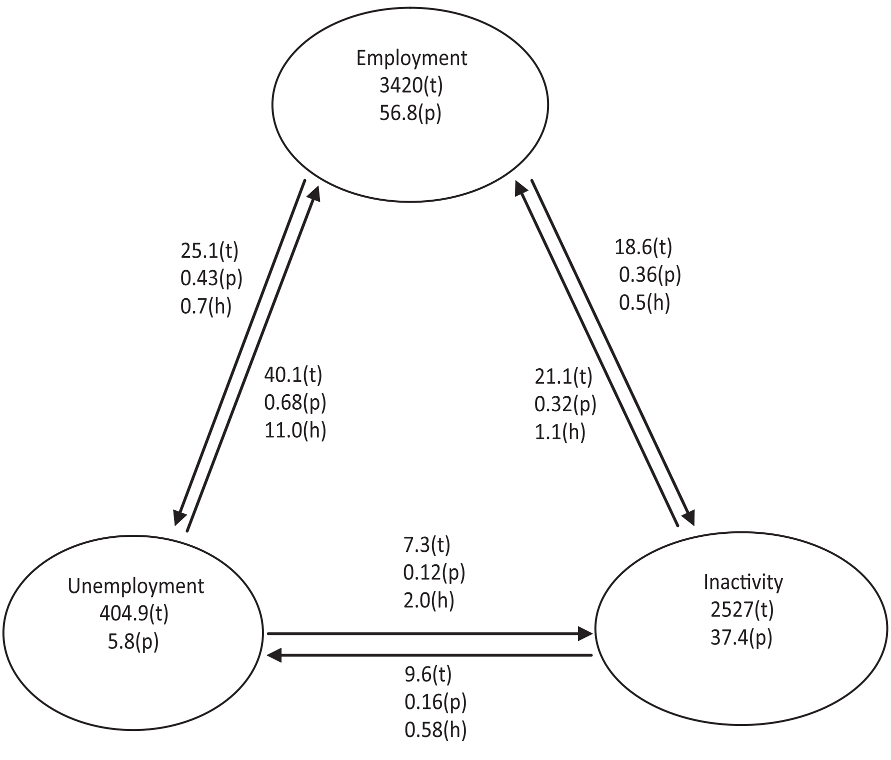
Quarterly worker flows for Greece can be constructed for the period 2004:Q1 to 2009:Q2 by matching adjacent panel LFS surveys. In this period, the LFS samples around 30,000 households for six successive quarters. The sample is split into six waves and in every quarter one wave leaves the survey and a new wave enters. In this way we can observe the changes in the labour market state of about 85 per cent of the households that take place in the survey and thus calculate worker flows. These quarterly worker flows are considered more precise than the annual recall data that are based on subjective classification of the labour market status one year earlier. Moreover, quarterly data capture short term transitions that are missed in annual data. The resulting mean values of quarterly worker flows are seasonally adjusted by taking a four quarter moving average of all series to remove the sharp movements of the initial data.

The average quarterly worker flows over the period 2004:Q1–2009:Q2 are summarized in Figure 7 in a way similar to that in Figure 4. Since our data are derived from a six wave rotated panel, the estimates shown are lower than those observed by about 15 per cent. The data in Figure 7 show that around

2 per cent (to be more precise, 2.07 per cent) of those in the working age population for two successive quarters will change labour market state in a three month period. This percentage is much lower than the 7% estimated worker flows for the UK (Bell and Smith, 2002) on a quarterly basis and around 5-7% for the USA on a monthly basis (Blanchard and Diamond, 1990; Fallick and Fleischman, 2004). Compared with the corresponding numbers for Spain and Portugal, countries considered the most rigid in the Eurozone, the hazard rates of Figure 7 turn out generally smaller (Bover et al., 2000), indicating that labour market flows in Greece are weaker than in the Iberian labour markets.

The structure of the quarterly worker flows shown in Figure 7 is similar to the pattern of the annual worker flows of Figure 3 but at lower values. Over the sample period there was on average a net increase in employment of 17,529 in every quarter. This increase is the result of remarkably higher employment inflows than outflows (61.2 and 43.7 thousand respectively). Again,

Figure 7: Average quarterly worker flows 2004:Q1–2009:Q2



the unemployment state displays higher flows with the employment than inactivity state. Finally, it is striking that the rather small transition rate from unemployment to employment is only 11 per cent, reaffirming that on average a small percentage of the unemployment pool moves to employment within any quarter.

As in the case of annual worker flows, we look at the time pattern of quarterly worker outflows of the three labour market pools during the examined period, as shown in Figure 8. Over the period for which longitudinal data are available, the employment rate increased steadily, while unemployment and inactivity rates also declined steadily (top part of Figure 8). These changes seem to support the proposition that labour market conditions were improving during this period.

The employment increase reflects the fact that outflows from unemployment or inactivity to employment are higher than outflows of employment. If we assume that the flows were initially in a steady state, the employment increase should be the result of rising inflows compared to outflows. In the same fashion, unemployment declined because its outflow to employment was higher than inflows to unemployment from the other two labour market states. It is also worth mentioning that outflows from inactivity to employment are higher than those to unemployment, which was not the case for the longer period of annual flows examined previously. It seems that in recent years more people have become employed without passing through the unemployment state.

The picture of transition rates from each labour market state to the other two is rather similar to the corresponding gross flows of all three labour market states during the examined period, indicating their parallel movements.

Attempts to identify potential cyclical properties of quarterly labour market flows are shown in Table 2, which like Table 1 presents the correlation with unemployment and employment rate of gross flows and hazard rates during the period 2004–2009. The emerging picture is rather similar to that of the annual flows, even though the time span of longitudinal data is the quarter instead of the year, while they pertain only to the last six years of the examined period. Inflows and outflows of all stocks are countercyclical or insignificant taking either the unemployment or employment rate as an indicator of the business cycle. When the economy declines there seems to be more movement between labour market pools. Inflows into inactivity in-

Figure 8: Labour market stocks, gross flows and hazard rates 2004–2009

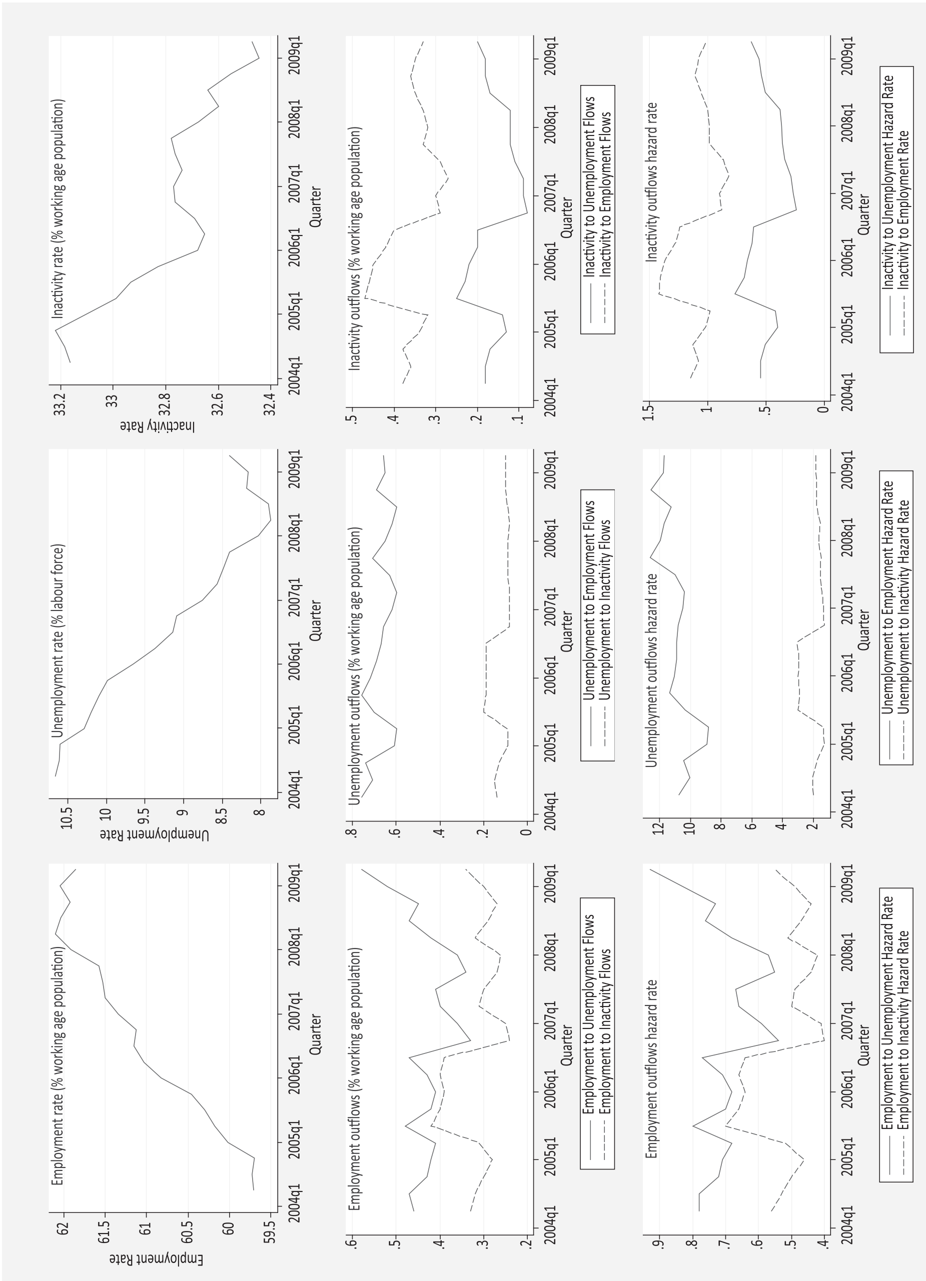


Table 2: Correlation of quarterly labour market flows and hazard rates with the (un)employment rate 2004:Q1–2009:Q2

	Gross flows		Hazard rates	
	Unemployment rate	Employment rate	Unemployment rate	Employment rate
E→U	0.04	0.01	0.17	-0.17
E→I	0.37	-0.29	0.44*	-0.36
U→E	0.52*	-0.48*	-0.69*	0.70**
U→I	0.53*	-0.45*	0.30	-0.22
I→E	0.46*	-0.40	0.43*	-0.36
I→U	0.37	-0.29	0.35	-0.27
→E	0.54*	-0.48*		
E→	0.24	-0.16	0.35	-0.27
→U	0.21	-0.14		
U→	0.57**	-0.52*	-0.40	0.45*
→I	0.46*	-0.38		
I→	0.43*	-0.35	0.40	-0.32

**, * significance at 1% and 5% respectively.

crease, more inactive find a job, while more unemployed move to inactivity or to employment.

The transition rate between unemployment and employment is procyclical. On the other hand, the probability of moving from employment to inactivity, as well as the transition from inactivity to employment, is countercyclical. In other words, during recession it is harder for the unemployed to find a job, the employed are more likely to lose their jobs, and inactive persons are more likely to enter employment.

5 The Ins and Outs of Unemployment

The interesting question of what drives unemployment changes has attracted much empirical and theoretical work. In principle, the cyclical variation in unemployment can be attributed either to changes in the rates of unemployment inflow—the so-called "ins"—or to changes in outflows from it—the so-called "outs". The early studies of labour market flows by Darby Haltiwagner and Plant (1986), Blanchard and Diamond (1990) and Davis and

Haltiwagner (1992) posited the 'conventional wisdom' that recessions are driven by high job loss rates or, equivalently, by high unemployment inflow rates. Recent papers challenge this view, presenting evidence that unemployment dynamics in the USA are driven by a time varying job finding rate while the unemployment inflow rate is close to acyclical (Shimer, 2005, 2007; Hall, 2005). Davis, Faberman and Haltiwanger (2006) present new empirical research supporting the view that recession starts with higher separations, while others argue that both flows play a role in US unemployment fluctuations (Elsby, Michaels and Solon, 2007; Fujita and Ramey, 2007).

The ongoing debate about the role of hirings and separations focuses on the use of different methodological perspectives and utilized data. In what follows we use standard methods to measure the role of job finding and job separation rates in the Greek unemployment variation, as proposed in recent literature.

The starting point for the examination of the role job finding f (the number of individuals who are unemployed in quarter t-1 and employed in quarter t divided by unemployment in t-1) and job separation s (individuals who are employed in quarter t-1 and unemployed in quarter t divided by employment in t-1) on the variation of unemployment is the following equation of the steady state unemployment u_t^{ss} derived from equation (7) on the assumption that there is no labour force growth or workers joining from outside the labour force (Yashiv, 2006):

$$u_t^{ss} = \frac{s_t}{s_t + f_t}$$

Shimer (2007), arguing that it is reasonable to approximate observed and steady state unemployment, separates the effect of the job finding rate by constructing a counterfactual unemployment rate. Keeping the job separation rate at its sample average calculates unemployment caused by job finding (denoted u_t^f). Likewise, Shimer constructs the series for unemployment, if the job finding rate was at its sample average (denoted u_t^s).

$$u_t^f = \frac{\bar{s}}{\bar{s} + f_t}, \; u_t^s = \frac{s_t}{s_t + \bar{f}}$$

Shimer's decomposition has faced severe criticism in the sense that different mean values for s and f can produce different answers. Elsby et al. (2007) present a more usual decomposition derived by log differentiating the steady state unemployment equation.

$$d\ln u_t^{ss} \approx (1-u_t^{ss})[d\ln s_t + d\ln f_t]$$

As u_t^{ss} is small, changes in the log of the job finding and job separation rates convert almost one to one into changes in the log unemployment. Thus, to evaluate the importance of each we have to compare the volatility of the log of job finding and job separation rates.

Fujita and Ramey (2007) propose a different approach to decompose steady state unemployment. By linearising steady state unemployment around the previous period steady state u_{t-1}^{ss}, the following expression is derived

$$\frac{u_t^{ss}-u_{t-1}^{ss}}{u_{t-1}^{ss}} = (1-u_{t-1}^{ss})\frac{s_t - s_{t-1}}{s_{t-1}} - (1-u_{t-1}^{ss})\frac{f_t - f_{t-1}}{f_{t-1}}$$

which is the breaking down of percentage change of the steady state unemployment rate into percentage changes on job finding and job separation rates. Thus, this equation may be summarised as:

$$du_t^{ss} = du_t^f + du_t^s$$

The variance of the percentage change of the steady state equilibrium unemployment may be written as the sum of the covariance between du_t^{ss} and du_t^f and the covariance between du_t^{ss} and du_t^s:

$$Var(du_t^{ss}) = Cov(du_t^{ss}, du_t^f) + Cov(du_t^{ss}, du_t^s)$$

Table 3 presents the decomposition of the de-seasonalised quarterly unemployment rates during the period 2004-Q1–2009-Q2 using these three methods. The results for the alternative methodologies seem consistent in the sense that all give a greater role for the job separation rate than for job finding in the unemployment variability. However, this advantage is not much higher than the values of the job finding rate. Thus, both examined flows seem to account for variation of unemployment.

The same decomposition calculations were carried out for the annual unemployment flows and the results are shown in Table 4. While this exercise is based on data with very wide time span, the estimates of Table 4 reaffirm that both flows account for the unemployment variation, with job separation displaying somewhat higher contribution. It should also be noticed that the methods used here ignore the role of flows between unemployment and inactivity in explaining unemployment variation.

Table 3: Unemployment decomposition
LFS 2004:Q1–2009:Q2 (quarterly data)

	Shimer	Elsby et al.	Fujita & Ramey
u^{ss}	0.009316	0.159138	0.025475
f	0.006026	0.102383	0.008842
s	0.007816	0.137544	0.015626

Table 4: Unemployment decomposition
LFS 1987–2009 (annual data)

	Shimer	Elsby et al.	Fujita & Ramey
u^{ss}	0.018	0.213	0.088
f	0.014	0.166	0.034
s	0.014	0.197	0.047

6 Summary and Discussion

The purpose of this paper is to present evidence on the Greek labour market flows using data from the LFS. The incentive is to speculate whether worker flows might influence the poor labour market performance (defined as consistently high unemployment and low employment rates). Although the paper is descriptive in nature and the evidence initial and partial, it shows that worker flows are rather low. This is consistent with a stagnant pool of the unemployed (with small flows in and out) and long duration. A logical explanation is the role of relatively strict employment protection legislation. While such legislation reduces worker firings, it also discourages hirings and leads to longer unemployment duration.

Almost 7 per cent of the working age population turns out to change employment status in the average year in the period 1988–2009. During the same period, employment has increased by almost 44,000 annually. This employment increase was accompanied annually by 187,000 employment inflows and 155,000 employment outflows. The employment increase coming from unemployment inflows is somewhat smaller than that from inactive persons, who join employment directly without passing through unemployment. These developments show that in Greece, contrary to common opinion, there is not a fixed number of jobs: total employment increases remarkably, and the inactive population is a significant source of labour supply.

Worker flows do not display clear time trends. Stability is the rule and in recent years flows were actually declining. The probability of moving from unemployment to employment stayed consistently low—only 27 per cent of those who were unemployed the previous year emerge as employed the next year—indicating the duality of the Greek labour market between unemployed and employed.

The cyclical properties of worker flows (movers as a percentage of working age population) even though uncertain are countercyclical. As the economy declines, more people lose their jobs and become unemployed, while more unemployed flow out of the labour market or find a job. When the labour market upturns, fewer people move from employment to inactivity, and inactivity outflows decline.

The average quarterly worker flows between employment, unemployment and inactivity over the period 2004–2009 (as derived from successive matched LFS waves) amount to only 2.07 per cent of the working age population, which is much lower than in other countries. The structure and cyclical properties of quarterly flows is rather similar to that of the annual flows.

Even though unemployment fluctuation is rather limited, alternative compilations of unemployment flows show that both the job finding rate and job separation rate are important determinants of this fluctuation.

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Evidence on Inter-industry Wage Differentials in Greece

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Abstract

This paper documents the size of raw and conditional inter-industry wage differentials in Greece in 2006. As there is little recent evidence on inter-industry wage differentials in Greece the paper seeks to fill this gap. In addition, it looks for explanations of conditional inter-industry wage differentials as reflecting differences in unobserved ability, working conditions and the potential for rents. The results show that both non-competitive and competitive factors are at work. There is a positive association between, on the one hand, an industry's rents and an industry's structure, and, on the other hand, the size of conditional wage differentials. In addition, competitive explanations such as the risk of accidents at work —which have in general been snubbed in the literature— also contribute to explaining these differentials. Finally, unlike in other applications on this subject, the rank correlation of inter-industry wage differentials across occupations is found to be low perhaps due to the existence of occupational-level collective agreements. This low correlation doesn't permit the outright rejection of the unobserved ability hypothesis.

* This paper forms part of work conducted in the context of the ESCB Wage Dynamics Research Network (WDN). Thanks are due to Ana Lamo for making available most of the STATA code used in this paper, to the Hellenic Statistical Authority (ELSTAT) for providing the Structure of Earnings Survey (SES) data and supporting information, and to Theodora Kosma for her participation in the initial stages of this project. Comments received at a presentation of earlier versions of this work at a WDN meeting and a KEPE conference in Athens, as well as by an anonymous referee for this volume are gratefully acknowledged. Thanks are also due to Sylvia Baudet von Gersdorff for editorial assistance. Opinions in this paper reflect the views of the author and do not necessarily coincide with those of the Bank of Greece. The usual disclaimer applies.

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1 Introduction

One of the striking facts when browsing the table of average wages across industries, regularly published by the Social Security Fund IKA, is that of the premiums above the average wage paid to men working in oil refining and air transport (82 and 63 per cent respectively).[1] Of note is that the premiums are also observed in other countries.[2] The gap can be interpreted as principally reflecting the pay of operators who are involved in complex refining jobs, and of pilots who work under hazardous conditions. Above average wages are, however, also reported in other industries in which working conditions do not appear as onerous.

The obvious question would then be whether such premiums are paid to compensate for productive characteristics of the individuals involved. Most studies on this issue find that inter-industry wage differentials remain even after conditioning on both employer (working conditions) and employee (productivity) observed features (see, *inter alia*, Krueger and Summers 1988; Goux and Maurin 1999; Carruth *et al.* 2004).

Remaining inter-industry wage differentials are often attributed to unobserved ability. By definition, however, this is a hypothesis very difficult to test for. The best test so far appears to be that based on individuals moving across industries—a test applied by, amongst others, Krueger and Summers (1988) and Murphy and Topel (1987).[3] An alternative test is based on the size of wage differentials across occupations within an industry or alternatively on the rank correlation of inter-industry wage differentials across occupations (Dickens and Katz 1987, Krueger and Summers 1988). The hypothesis is based on the premise that unobserved ability is unlikely to be found in all occupations. Notwithstanding the cross-sectional variation in the job content of the same occupation (Levenson and Zoghi 2006) if premiums are paid to all occupations in an industry or alternatively if the correlation of industry rankings

[1] See, for example, Table I.3, p. 36-39, IKA-ETAM *Monthly Statistical Employment Bulletin*, Dec. 2007.

[2] See Du Caju *et al.* (2010) and Rycx *et al.* (2008) for recent evidence on European cross-country industry differentials.

[3] This test is also not free of shortcomings; looking only at movers across industries might introduce selectivity bias.

across occupations is high, this can be used as evidence against the unobserved ability hypothesis. Yet another, although similar in spirit, test is based on an idea put forward by Martins (2004); Martins argues that if premiums are equalising differences in ability then premiums for those at the top end of the distribution are likely to be higher than for those at the bottom end of the income distribution.

Premiums that cannot be explained by compensating (for observed or unobserved ability) differentials and which persist over time are consistent with the existence of rents. The extent and the reasons for which these are shared between employers and employees vary;[4] appeal has been made to efficiency wage arguments (fairness considerations, need to combat turnover or shirking; see Akerlof and Yellen 1986) as well as to institutional factors (e.g. the relative bargaining power of unions). Despite increasing data availability and methodological progress, the issue of inter-industry wage differentials still appears to be ridden with questions (Mortensen 2003).[5]

From a macro perspective and for policy purposes, it is important to establish whether a competitive or a non-competitive labour market is behind inter-industry wage differentials. Differentials at one point in time could, for example, result from short-term immobility of labour across sectors. Sectoral immobility of labour could, in turn, result from lack of information about the wage structure by employers and job applicants alike or from high mobility costs (Layard *et al*. 2005). Understanding the driving forces behind these differentials could also contribute to the discussion about the optimal level at which bargaining should take place. Furthermore, resolving the puzzle related to the specific interpretation invoked to explain a non-competitive labour market would appear to have implications for *inter alia* human resource management practices.

Ideally, one would have to use longitudinal matched employer-employee data to investigate the issue of inter-industry wage differentials. In this instance, however, we only have matched employer-employee data for 2006. Our purpose is threefold: first, to get a feel for the extent of cross-industry

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[4] See, Manning (2010) for an up to date survey on rent sharing.

[5] See Theocarakis (2010) for a critical review of the neoclassical approach to explaining such puzzles.

wage dispersion in Greece. Secondly, to document the size of conditional inter-industry wage differentials in Greece; and thirdly, to investigate possible reasons behind these differentials, such as rent sharing, working conditions and unobserved ability. The hypothesis of unobserved ability is the most difficult to investigate and is thus tested only in an indirect way.

The paper is organised as follows. Section 2 succinctly describes the data used; Section 3 documents the institutional features of wage formation in Greece, illustrates the extent of cross-industry wage dispersion and presents raw and conditional inter-industry wage differentials for Greece in 2006. Section 4 investigates the consistency between these conditional differentials and the unobserved ability hypothesis and correlates conditional differentials with data on working conditions. Section 5 looks at non-competitive explanations for these differentials. Finally, Section 6 summarises and concludes.

2 Information on the Data Used

While the administrative (IKA) data are the best source of wage information available, as they provide full coverage of private sector employees,[6] the data contain little information on employer and employee features. Instead, the source of the earnings information used here is a rich matched employer-employee dataset—the Structure of Earnings Survey (SES)—for 2006.[7] The SES is a standardized firm-level survey, conducted since 2002 with a 4-year frequency, in a large number of European countries.[8] In Greece, the survey is carried out by the Hellenic Statistical Authority (ELSTAT) and covers plants belonging to firms with 10 or more employees. The sampling frame used was the companies' register maintained by ELSTAT. This was stratified by region (4 levels according to NUTS I), two-digit level NACE rev. 1.1. (53 sectors in 2006), and size—number of employees in each plant (7 levels). The survey sample

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[6] That is, of those not evading social security contributions.

[7] The survey was also conducted in 1995 and 2002 but with different sectoral coverage. The survey has no known longitudinal dimension with respect to either firms or employees.

[8] In a number of countries, Greece included, the survey was carried out on a pilot basis in 1995. Details of the history, survey regulations and Eurostat publications from the survey can be found at http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/ses

includes a combination of a random draw from the pool of firms with fewer than 100 employees and a census of larger firms. Within each sampling unit, employees are selected randomly. The final sample includes a total of 3,040 plants and 47,883 employees.

The SES contains individual earnings data, detailed human capital and demographic information per worker as well as information on employers' features and job attributes. The 53 sectors surveyed account for around 90 per cent of total economy value added. The remaining 10 per cent is accounted for by the primary sector and public administration which have not been surveyed. A comparison of the sectoral distribution of employment in the sample with that in the economy as a whole (restricting ourselves to firms with over 10 employees) suggests that most sectors are fairly accurately represented. Only a few sectors are either under-represented (education and health) or over-represented (retail trade, financial intermediation).[9]

The survey questionnaire collects information on a number of remuneration items for each individual in the sample: total gross monthly earnings in a specific month (October), gross annual earnings in the survey year, overtime earnings in October, monthly allowances for shift work, night work, and weekend work. On the basis of the available information, four earnings variables are constructed: gross annual earnings (aY), gross monthly earnings (mY), gross hourly earnings (gross earnings in the reference month over total hours paid for, hY) and the hourly wage rate (gross earnings net of overtime pay over regular hours paid for, hW). The results in this paper refer only to the fourth variable mentioned above, the hourly wage rate (hW), to avoid confounding a labour supply decision (hours) with the product of a labour supply and a labour demand interaction.

Employer attributes and features include the geographical location of the observation unit (13 administrative regions), the two-digit NACE rev 1.1. sector of the firm's principal economic activity, the form of economic and financial control of the firm (private, public), the number of employees in the firm (in 8 brackets), the type of collective agreement enforced in the firm (e.g. national, sectoral etc.) and the main market (domestic or international) for the

[9] A shortcoming of the survey design is that the size brackets, over which the population has been stratified, don't vary by sector.

firm's products. Definitions and descriptives of the variables used in the analysis are presented in Section A of the Appendix.

The employee-related data include demographic features (gender, age) and productivity related information (education level, length of service with the firm, type of employment contract, occupation). Two pieces of information important for wage determination are, however, missing—citizenship and marital status. The importance of citizenship in wage determination is documented elsewhere (see, *inter alia*, Demoussis *et al.* 2008), while marital status results in an automatic (10 per cent) adjustment of the base wage.

In this paper a sub-sample of the database is used. The sectors excluded are those with fewer than 5 plants[10] and those known as non-market services (*Education*-80; *Health Services*-85; *Other community, social and personal service activities*-90 to 93).[11] As a result, 41 two-digit NACE rev.1.1 sectors are used—representing 73 per cent of the economy's value added in 2006. In most other studies of inter-industry wage differentials, the percentage of the economy covered is lower since rarely is information on all service sectors available. Individuals with missing earnings information or who were thought to be outliers, on the basis of the available earnings information, have been excluded.[12] Furthermore, to reduce sample heterogeneity arising from differences in marital status, only individuals aged between 25 and 64 are used in the analysis. Following the reasoning above, the data used in the analysis consist of 2,480 firms with a total of 29,053 employees. Each firm has between 1 and 714 employees.

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[10] As a result the following two-digit NACE rev 1.1. sectors are excluded: *Mining of Coal and Lignite* (10), *Extraction of Crude Petroleum and Natural Gas* (11), and *Mining of Metal Ores* (13). According to the Business Register maintained by ELSTAT each of these sectors comprises a very small number of firms (18, 36 and 53 firms respectively).

[11] *Non-market services* have been excluded for two reasons: first, they are not adequately represented in the sample since the sample design didn't allow for size brackets to vary by industry, and second, because rents in these sectors are more difficult to define (see Carruth *et al.*, 2004).

[12] Individuals with a monthly salary (excluding overtime pay and premium pay for shift work) lower than 80 per cent of the minimum salary in 2006 or over 20 times the minimum salary have been excluded.

3 Wage Dispersion in Greece: What do Standard Earnings Equations Reveal?

According to Mortensen (2003) "Observable worker characteristics that are supposed to account for productivity differences typically explain no more than 30 percent of the variation in compensation across workers...: Mortensen refers to the residual 70 per cent not explained by workers' characteristics as *wage dispersion*. This section first presents the institutional characteristics of wage formation in Greece. Then, it illustrates the extent to which workers' characteristics—both demographic (gender, age, region) and productive (education level, tenure, occupation)[13]—explain differences in wage rates across individuals. It then investigates the extent to which employer characteristics (industry and size) reduce wage dispersion.

3.1 Institutional Characteristics of Wage Formation

Wage formation in Greece is to a large extent shaped by collective pay agreements signed at the sectoral or occupational level. Sectoral-level agreements specify pay scales according to grades dependent on a number of easily observable and quantifiable employee characteristics—occupation, length of job experience, broad educational level and job function. A pay adjustment for marital status and onerous working conditions is applicable to all scales. No differentiation is made for employer features. Sectoral agreements are dominant for salaried employees. For occupations not covered by sectoral agreements, workers are covered by occupational agreements. The wage levels specified by sectoral and occupational agreements constitute binding minima. Agreements are concluded following bargaining between employer organisations and primary and/or secondary-level trade union organisations and cover all workers represented by the organisations involved. Agreements are extendable to the whole sector if employer organisations party to the agreement employ 51 per cent of the employees in the sector.[14] Further bargaining can take place at firm level.

[13] Whether occupation can be regarded as a proxy for skill is a contentious issue - see, for example, Levenson and Zoghi, 2006.

[14] The extension is not automatic; it requires either a ministerial decision or a request by an employers' association or a labour union.

3.2 Wage Determination in Practice: The Role of Demographic and Productivity Features of Employees

The national and sectoral-level collective agreements specify minima. Thus, in practice, wages can deviate from these, introducing an element of wage variation.

Table 1 presents OLS coefficient estimates of the following wage specification:

$$\ln hw_i = \alpha + x_i\beta' + e_i \qquad (1)$$

i is the individual employee, hw is the hourly wage rate, x is the matrix of demographic and productive characteristics (gender, age, region, education level, tenure and occupation), and e is the residual.

Since the analysis is based on survey data, we fit the regression using sampling (probability) weights to reflect the probability of each individual being selected in the sample. The reported standard errors have been corrected for possible heteroscedasticity arising from a firm-level pay policy by clustering firm observations together. Given the differences across gender in the raw inter-industry wage differentials, reflecting *inter alia* the gender occupational segregation and the differing occupational composition of each industry, and in order to allow for possible differences across gender in the coefficients on certain right-hand side variables, specification (1) has been estimated separately for men and women.

The coefficient estimates in the first column conform to expectations: the hourly wage rate for women is on average 12 per cent less than that for men, there is a quadratic relationship between wages and age and between wages and tenure. Individuals in regions outside Attica are paid less on average than those located n Attica. Individuals educated to higher levels and those in more skilled occupations are better remunerated. Columns (2) and (3) suggest that returns to more skilled occupations are higher for women than for men. However, contrary to expectations (see, *inter alia*, Magoula and Psacharopoulos 1999 and Papapetrou 2007 for results for Greece; Dougherty 2003 for a survey of US results), the coefficients show mostly higher returns to education and tenure for men than for women—results that hold even when no occupational dummies are included. The results also suggest the existence of occupational segregation: men in clerical and sales occupations get paid less

Table 1: Basic wage specification – OLS weighted estimates[1]
Dependent variable: ln *hwi*

	All	Men	Women
Female	-0.124*** (0.00768)		
Age	0.0386*** (0.00244)	0.0464*** (0.00323)	0.0296*** (0.00335)
Age^2	-0.0351*** (0.00306)	-0.0435*** (0.00398)	-0.0261*** (0.00433)
Tenure	0.00192*** (0.000171)	0.00191*** (0.000187)	0.00185*** (0.000234)
$Tenure^2$	-0.000114*** (0.0000363)	-0.000114*** (0.0000412)	-8.80E-05 (0.0000581)
Northern Greece	-0.138*** (0.0179)	-0.133*** (0.0201)	-0.145*** (0.0201)
Central Greece	-0.169*** (0.0183)	-0.170*** (0.0212)	-0.165*** (0.0228)
Aegean islands, Crete	-0.134*** (0.0282)	-0.126*** (0.0338)	-0.152*** (0.0282)
Primary	-0.108*** (0.0175)	-0.111*** (0.0216)	-0.0759*** (0.016)
Lower High School	-0.0720*** (0.0139)	-0.0731*** (0.0162)	-0.0515*** (0.0167)
Technical	0.0144 (0.0198)	0.0165 (0.0232)	-0.0031 (0.0214)
College	0.0907*** (0.0201)	0.0836*** (0.0281)	0.0933*** (0.023)
Tertiary	0.143*** (0.0224)	0.156*** (0.0244)	0.115*** (0.0293)
University graduate	0.277*** (0.0187)	0.303*** (0.0241)	0.231*** (0.0241)
Post-graduate	0.480*** (0.0343)	0.514*** (0.0442)	0.419*** (0.0445)
Managerial	0.427*** (0.0369)	0.388*** (0.0403)	0.633*** (0.0522)
Professional	0.122*** (0.0295)	0.0996*** (0.0347)	0.286*** (0.0374)
Technician	0.0733*** (0.026)	0.0760*** (0.0275)	0.199*** (0.0382)

Table 1 (continued)

	All	Men	Women
Clerical	-0.0194 (0.0208)	-0.0671*** (0.0232)	0.150*** (0.0287)
Sales	-0.0822*** (0.0209)	-0.0886*** (0.0240)	0.0492* (0.0277)
Craft	-0.00976 (0.0317)	-0.00758 (0.0331)	0.0469 (0.0307)
Unskilled	-0.164*** (0.0189)	-0.165*** (0.0202)	-0.0404 (0.0262)
Constant	1.016*** (0.0485)	0.851*** (0.0634)	0.958*** (0.0688)
Industry dummies	No	No	No
Observations	29,053	18,172	10,881
Cluster (firms)	2,480	2,371	2,156
R^2	0.517	0.509	0.497

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.
1 The reference group is an individual living in Attica, having completed upper high school and working as a plant operator.

than plant operators whereas the opposite is true for women (amongst which, however, only a few are plant operators).

3.3 Wage Determination in Practice: The Role of Employer Characteristics

Table 1 suggests that wage dispersion, following Mortensen's definition, amounts to around 50 per cent. While this extent of wage dispersion is still high it is lower what Mortensen reports. Conditioning further on employer characteristics (industry, type of collective agreement enforced, size and ownership), we estimate the following specification:

$$\ln hw_i = \alpha + x_i\beta' + z_i\gamma' + s_i\delta' + u_i \qquad (2)$$

where z is the matrix of employer characteristics (size, collective agreement enforced, ownership), s is the matrix of (k–1) industry dummies (where k is the complete set of industries used in the analysis), and u_t is the residual.

The results from estimating (2), presented in Table 2, suggest that employer characteristics reduce wage dispersion by another 6 to 7 per cent. The contribution of employer characteristics is thus non-negligible.

Browsing Table 2 we note that employer characteristics in general appear to be orthogonal to employee features already included in Table 1: only regional dummies to some extent appear to be affected by the introduction of the additional variables.

Turning to the variables introduced in Table 2 it is clear that the coefficients on the size dummies conform to the findings in the empirical literature

Table 2: Extended wage specification – OLS weighted estimates[1]
Dependent variable: ln *hwi*

	All	Men	Women
Female	-0.107*** (0.00708)		
Age	0.0353*** (0.00220)	0.0424*** (0.00281)	0.0270*** (0.00324)
Age^2	-0.0308*** (0.00269)	-0.0383*** (0.00342)	-0.0225*** (0.00412)
Tenure	0.00168*** (0.000124)	0.00165*** (0.000149)	0.00164*** (0.000169)
Tenure^2	-0.000147 (0.0000314)	-0.000153*** (0.0000383)	-0.000102** (0.0000461)
Northern Greece	-0.0827*** (0.0136)	-0.0774*** (0.0156)	-0.0909*** (0.0158)
Central Greece	-0.0931*** (0.0162)	-0.0937*** (0.0195)	-0.0888*** (0.019)
Aegean islands, Crete	-0.0611*** (0.0209)	-0.0497* (0.0259)	-0.0806*** (0.0249)
Primary	-0.0958*** (0.0111)	-0.0908*** (0.0131)	-0.0845*** (0.0131)
Lower High School	-0.0582*** (0.00937)	-0.0525*** (0.0109)	-0.0544*** (0.0137)
Technical	0.0112 (0.0125)	0.016 (0.0131)	-0.00381 (0.0201)
College	0.0599*** (0.0145)	0.0604*** (0.0194)	0.0585*** (0.0182)
Tertiary	0.116*** (0.0169)	0.135*** (0.0199)	0.0761*** (0.0217)

Table 2 (continued)

	All	Men	Women
University graduate	0.232*** (0.0191)	0.274*** (0.0242)	0.163*** (0.0212)
Post-graduate	0.411*** (0.0345)	0.458*** (0.0443)	0.320*** (0.0398)
Managerial	0.466*** (0.0303)	0.440*** (0.0335)	0.609*** (0.0493)
Professional	0.149*** (0.0250)	0.132*** (0.0297)	0.269*** (0.0344)
Technician	0.0893*** (0.0177)	0.0918*** (0.0199)	0.184*** (0.0296)
Clerical	-0.0207 (0.0133)	-0.0556*** (0.0150)	0.100*** (0.0239)
Sales	-0.0153 (0.0159)	-0.00951 (0.0198)	0.0660*** (0.0249)
Craft	0.0205 (0.0156)	0.0192 (0.0154)	0.0680*** (0.0257)
Unskilled	-0.139*** (0.0120)	-0.126*** (0.0131)	-0.0670*** (0.0236)
Private sector	0.0144 (0.0245)	0.0127 (0.0261)	0.0183 (0.0259)
National agr.	-0.0213 (0.0141)	-0.0220 (0.0154)	-0.0216 (0.0154)
Sectoral/Local agr.	0.0349 (0.0295)	0.0658** (0.0322)	-0.00672 (0.0387)
Firm agr.	0.0599** (0.0233)	0.0483* (0.0252)	0.0767*** (0.0265)
Plant agr.	0.0589 (0.0560)	0.0649 (0.0740)	0.057 (0.0480)
Other type of agr.	-0.0104 (0.0293)	-0.0206 (0.0278)	0.00406 (0.0369)
10-19 emp.	-0.125*** (0.0160)	-0.140*** (0.0176)	-0.100*** (0.0228)
20-49 emp.	-0.0847*** (0.0125)	-0.0942*** (0.0146)	-0.0676*** (0.0159)
50-99 emp.	-0.0246 (0.0135)	-0.0229 (0.0161)	-0.0304* (0.0179)
250-499 emp.	0.00777 (0.0166)	0.00294 (0.0190)	0.014 (0.0230)

Table 2 (continued)

	All	Men	Women
500-999 emp.	0.0306* (0.0177)	0.0523** (0.0222)	0.00107 (0.0189)
1000+	0.0911*** (0.0243)	0.109*** (0.0284)	0.0651** (0.0254)
Constant	1.053*** (0.0529)	0.870*** (0.0626)	1.065*** (0.0749)
Ind. Dummies	Yes	Yes	Yes
Observations	29,053	18,172	10,881
Clusters (firms)	2,480	2,371	2,156
R^2	0.579	0.574	0.569

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.
1 The reference group is an individual living in Attica, having completed upper high school and working as a plant operator in a plant with 100-249 employees enforcing a sectoral collective agreement.

(see Oi and Idson 1999 for evidence from some OECD countries; Daouli *et al.* 2010 for Greece). Wages increase with firm size; firms with over 1,000 employees pay wages that are 9.1 per cent higher than those paid in firms with 100–249 employees. Firm ownership appears to have no impact on wages, perhaps because public ownership in the sectors included in the analysis is not prevalent.[15] Finally, coefficients on the type of collective agreement enforced suggest that individuals in plants with a firm-level collective agreement are paid around 6 per cent more than those in which only the sectoral collective agreement holds.

In all three regressions reported in Table 2, industry dummies (the coefficients of which are not reported in Table 2) are jointly significant and around half of these dummies are individually significant. Industry dummies in the regression capture differentials with respect to an excluded industry. Following Zanchi (1995), we disentangle the coefficients on industry dummies and express these as deviations from an employment-weighted average wage

[15] Note, however, that in 2006 in a few sectors, namely in *Transport and communication* and *Financial intermediation*, a few large firms were still under public sector influence.

while also adjusting standard errors. Coefficients with respect to the industry average wage (and the adjusted standard errors) are presented in Table B2 in the Appendix and in Figure 1. Figure 1 illustrates both conditional differentials, arising from the estimates of the regression in Table 2, and raw differentials, arising from a regression of wages only on industry dummies, by gender.[16] Raw differentials (also presented in Table B1 in the Appendix) range between +61 per cent in oil refining and -29 per cent in clothing manufacturing. Conditional differentials do, as expected, fall within a narrower band (+42 per cent in air transport to -18 per cent in retail trade) compared to raw differentials. The employment-weighted standard deviation of conditional differentials is less than half (9.5 per cent) that of raw differentials (21.1 per cent) suggesting that worker and employer characteristics go a considerable way in explaining inter-industry wage differentials. Conditional differentials do, however, show a similar pattern to raw differentials; the Spearman rank correlation coefficient between the two is very high (0.86, see Table 3).

By way of comparison with other countries, we note that according to the analysis for two earlier points (roughly mid-1990s and early 2000s) in Du Caju *et al*. (2010), inter-industry wage differentials in Greece are somewhere around the middle of the eight European countries analysed.[17] However, for Greece, conditioning on demographic and productivity-related characteristics of the individuals and on employer characteristics has the largest impact in reducing the standard deviation of inter-industry wage differentials.

The existence of inter-industry wage differentials even after controlling for all these characteristics suggest that other forces (e.g. rents to be shared between workers and employers, union strength) might be at play.

The interesting question at this point is why conditional differentials exist. The next sections attempts to "test" whether inter-industry wage differentials differ by occupation and to correlate conditional differentials with data on working conditions and with firms' ability to pay.

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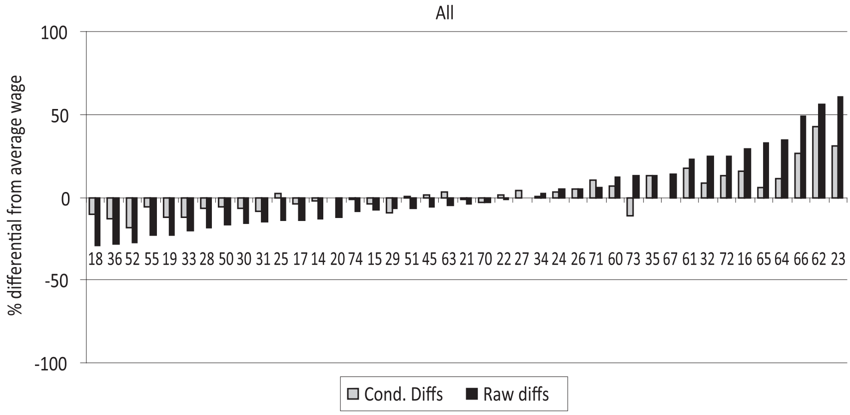
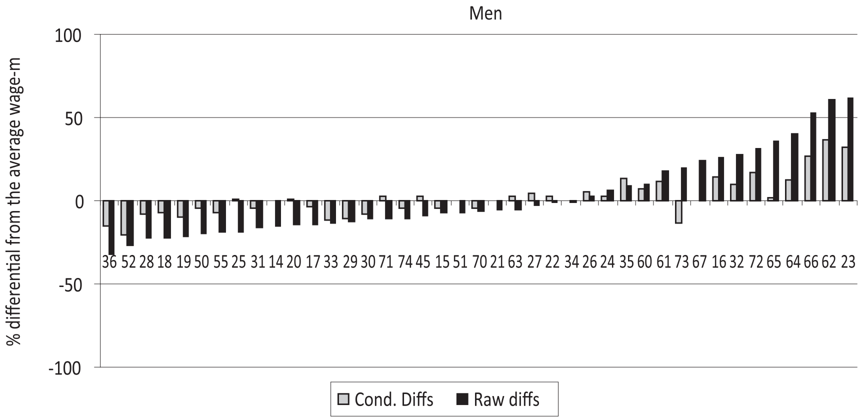
[16] The data that go into Figure 1 can be found in Tables B1 and B2 in the Appendix.

[17] The eight countries are Belgium, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, and Spain. Belgium shows the lowest raw and conditional wage differentials while Hungary and Spain exhibit the highest.

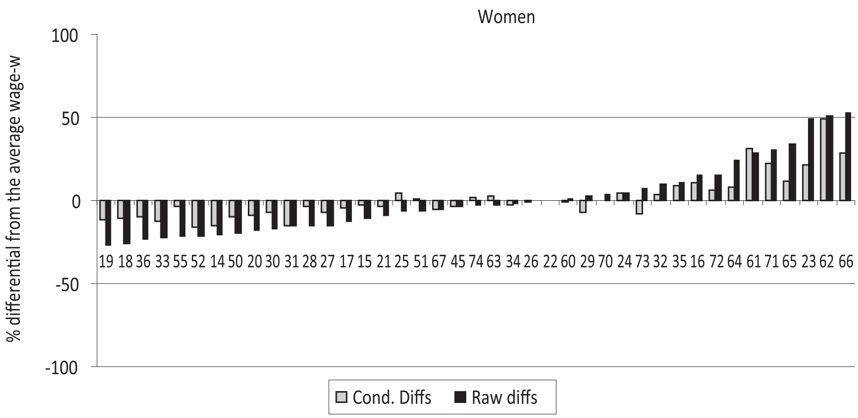
Figure 1: Percentage raw and conditional gaps from an average wage



Source : Authors' estimates & calcs. using SES 2006.



Source : Authors' estimates & calcs. using SES 2006.



Source: Authors' estimates & calcs. using SES 2006.

Table 3: Spearman rank correlation coefficients of raw and conditional differentials

		Raw			**Conditional**		
		All	Men	Women	All	Men	Women
Raw	All	1.00					
	Men	0.97***	1.00				
	Women	0.93***	0.87**	1.00			
Conditional	All	0.86***	0.80***	0.82***	1.00		
	Men	0.82***	0.78***	0.74***	0.97***	1.00	
	Women	0.78***	0.73***	0.87***	0.88***	0.79***	1.00

Source: Calculations on the basis of SES data and regression results reported in Tables B1 and B2 in the Appendix.

4 Are Conditional Wage Differentials Consistent With a Competitive Labour Market?

4.1 Correlation of Conditional Inter-industry Wage Differentials Across Occupations

Dickens and Katz (1987) and Krueger and Summers (1988) both find that industry wage differentials are remarkably similar across occupations; Krueger and Summers report a rank correlation of 0.79 between industry wage differentials of blue and white collar occupations. Their finding appears to suggest that industry wage differentials do not reflect unmeasured ability, since there is no reason for which unmeasured ability should be similar across all occupations within an industry.

Repeating the same exercise here, for men only, we estimate equation (2) for each of the following six occupations—professional, technicians, clerical, sales, craft and unskilled.[18] The rank correlation coefficients of the inter-industry wage differentials across occupations are generally low (see Table 4) with the sole exception of the correlation between craftsmen and unskilled

[18] The 8 one-digit ISCO-88 occupations have been aggregated in 5 groups *Professional* and *Managerial staff* have been merged into one group while *Craft workers* and *Plant operators* have also been merged together.

Table 4: Spearman rank correlation coefficients of conditional inter-industry wage differentials across occupations

	Professional	Technicians	Clerical	Sales	Craft	Unskilled
Professional	1.00					
Technicians	-0.059	1.00				
Clerical	0.22	0.53***	1.00			
Sales	0.35**	-0.021	0.20	1.00		
Craft	0.14	0.097	0.17	0.24	1.00	
Unskilled	0.15	0.25	0.25	0.39**	0.75***	1.00

Source: Calculations on the basis of SES data and coefficient estimates from estimating equation (2) by occupation (regression results not reported in this paper).

workers.[19] Furthermore, the summary indicator of the overall dispersion of industry wages—the standard deviation of the industry wage differentials—varies by occupation.

These results, which could be due to the existence of occupational-level bargaining in addition to industry and firm-level bargaining, constitute implicit evidence against rejecting the unobserved ability hypothesis.[20]

4.2 Correlation of Conditional Inter-industry Wage Differentials With Working Conditions

Conditional wage differentials compensating for variation in the quality of work are compatible with a competitive labour market. Previous research (e.g. Pencavel 1972, Krueger and Summers 1988) argues that if wage differentials reflect diversity of working conditions, quit rates should be positively related to wages. In fact, Krueger and Summers find the opposite to be true. We have no systematic information on quit rates across industries but instead

[19] Differentials are calculated here using only the 37 industries for which all occupations were available.

[20] On the other hand, running the test proposed by Martins (2004)—outlined in the Introduction of this paper—for Greece and another 7 European Union countries (see Du Caju *et al.*, 2010) leads to the conclusion that the unobserved quality hypothesis cannot be accepted.

we use direct information on the quality of work from the regular Labour Force Survey (LFS) as well as the ad hoc module of the 2007 LFS on *Accidents at work and work-related health problems*. The variables tried were those measuring the extent to which employees in each industry work in shifts, have to work at night or during the weekend, the incidence of work accidents, the occurrence of accidents resulting in injury, the frequency of such accidents, work-related stress causing psychic health problems, and the self-assessed risk of a work accident.

The model to be estimated has the form:

$$\hat{\delta}_j = \overline{q}_j + \overline{\varepsilon}_j \qquad (3)$$

$$\overline{\varepsilon}_j \approx N(0, \sigma^2 / N_j) \qquad (4)$$

where $\hat{\delta}_j$ are the coefficients on the industry dummies from equation (2) expressed as the difference from an employment-weighted average wage, N_j are the number of observations on which each industry's average is based, used as weights in the estimation, and the $\overline{q}_j$ are the variables capturing the average quality of work in industry j.

Variables related to working patterns (shift work, night work, weekend work) were not found to be significant and thus are not reported. The results reported in the first column of Table 5 show that the incidence of accidents is associated with lower wages: this appears to contradict the compensating differentials argument. It could, however, reflect the fact that in manual occupations, which are generally lower paid, the incidence of injuries is the highest and a selection bias is present; higher ability individuals are more likely to be employed in industries with fewer accidents at work.[21] The risk of an accident, also used in the regression, might be a better indicator of the potential dangers with which workers are faced. In fact, the results show a positive

[21] Layard *et al.* (2005) advise against use of variables on working conditions without appropriate controls for ability. Here the wage differentials which constitute the dependent variable have been conditioned on observed ability through the education dummies. Thus, any selection bias, which cannot be ruled out, would arise from unobserved ability.

association between the risk of an accident, as perceived by the employees, and the size of the differential. Finally, stress at work appears to be a factor that, conditional on the other variables in the regression, is compensated for. Industries in which workers are exposed to more stress pay higher wages. The above results as well as the fact that the standard deviation of the predicted values from the estimation reported in column (1) is much lower than that of the dependent variable suggests that the hypothesis that differentials reflect working conditions cannot be rejected outright.

5 Conditional Inter-industry Wage Differentials and the Potential for Rents

A significant part of the dispersion in average conditional industry differentials remains unexplained even after controlling for working conditions (note that the adjusted R^2 of the regression discussed above, and reported in Col. (1) of Table 5, is 0.15). The next task is to find if there is any association between the conditional wage differentials, rents and the potential for rents. Rents are proxied through the (log of) industry net operating surplus per employee one year prior to the survey.[22] The potential for rents is proxied through variables on industry structure. Industry structure is captured through the number of firms in an industry, the share of small firms (<5 employees) in the total number of firms, and the 5-firm concentration ratio in terms of sales (an inverse measure of product market competition).

The results presented in columns (2)–(3) of Table 5 confirm that there is a significant relationship between the potential for rents, actual rents and inter-industry wage differentials. Industries in which market power is concentrated in a few firms (i.e. with a high five-firm concentration ratio, CR5) are likely to have higher wages. A positive association is also found between the extent of rents in an industry and the wage differential. The share of small firms in the industry and the number of firms in the industry, while not highly significant, provided similar results as those mentioned above.

[22] The one-year lag is taken to avoid endogeneity; higher wages are likely, *ceteris paribus*, to result in lower rents.

Table 5: Interpreting conditional wage differentials
Dependent variable: $\hat{\delta}_j$

	Working conditions only	Add CR5	Add rents
	(1)	(2)	(3)
Incidence of accidents	-1.074* (0.65)	-0.97* (0.51)	-1.47*** (0.51)
Risk of accident	0.22** (0.086)	0.22*** (0.069)	0.35*** (0.096)
Stress	0.56* (0.30)	0.57** (0.25)	0.70*** (0.26)
CR5	—	0.17** (0.074)	0.16*** (0.059)
ln *NOSEt*	—	—	0.037*** (0.012)
Constant	-0.13* (0.074)	-0.17** (0.070)	-0.57*** (0.17)
R^2	0.15	0.36	0.53
Obs.	41	40	37

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

6 Summary and Conclusions

Raw inter-industry wage differentials in Greece in 2006 range from over +60 per cent for oil refining to less than -20 per cent for clothing manufacturing. These differentials partially reflect the demographic and productivity characteristics of the individuals employed in these industries: over half of the employees in oil refining have continued their studies beyond upper high school, compared with only 15 per cent in clothing manufacturing. Employer features (size, type of collective agreement applied) also explain part of these differentials—for example, firms in oil refining are in general much larger than those in clothing manufacturing. However, even after conditioning on a number of employee and employer characteristics, inter-industry wage differentials remain. The analysis undertaken in this paper suggests that the unobserved ability hypothesis cannot be rejected since conditional inter-industry wage differentials across occupations do not appear closely correlated—a result compatible with the multiple structure of wage bargaining (occupational and industry) that exists in Greece. Furthermore, there appears to be an association between inter-industry wage differentials and quality of work (stress levels and risk of accident). These results do not, however, negate the importance of the existence and potential for rents in explaining industry wage differentials; we find evidence of a close correlation between rents and industry structure, on the one hand, and industry wage differentials on the other.

Appendix

A. Variable definitions and descriptives

Table A1: Definitions of the variables used in the analysis

Variable	Definition
SES Variables	
Hourly wage rate (Hw)	Gross monthly earnings in October 2006 (net of overtime pay) divided by the total number of regular hours paid for.
Age	Mid-point of 5-year age intervals between 25 and 64 years old.
Tenure	Length of time with the current employer (in months).
NUTS I regions	4 regions: Northern Greece; Central Greece; Attica; Aegean islands and Crete.
Education	Highest education level achieved (8 levels).
Occupation	One-digit occupational classification following the International Standard Classification of Occupations (ISCO-88).
Firm ownership	Private sector firms: firms in which over 50% of the share capital held by the private sector.
Level of collective agreement	Six different levels are distinguished: national, sectoral, sectoral-local, firm, plant, other.
Size	Firms have been grouped in the following 7 size brackets in terms of total employment: 10-19; 20-49; 50-99; 100-249; 250-499; 500-999;1000+
Labour Force Survey variables (2007 Ad hoc labour force survey)	
Accidents	Occurrence of an accident resulting in injury at work during the last year (Variable 96; 1=yes, 0=no).
Stress	Exposure to time pressure or overload that could adversely affect mental well being (Variable 113; 1=yes, 0=no).
Risk of accident	Exposed to risk of accident at work (Variable 118; 1=yes, 0=no).
Industry structure and performance variables	
CR5	5-firm concentration ratio in terms of sales (*Source*: ICAP Database)
Gross operating surplus per employee	(*Source*: OECD STAN Database)

Table A2: Descriptives of the variables used in the analysis (means and standard deviations of variables in Table 1)

	All		Men		Women	
	Mean	*St.dev*	*Mean*	*St.dev*	*Mean*	*St.dev*
ln hw_i	2.098	0.460	2.163	0.476	1.993	0.412
Female	0.381	0.486				
Age	39.079	9.631	40.035	9.790	37.528	9.157
Age^2	16.199	7.879	16.986	8.139	14.922	7.260
Tenure (in months)	111.829	94.181	116.353	98.488	104.485	86.233
Tenure^2	213.754	325.789	232.373	349.647	183.526	280.191
Attica	0.728		0.712		0.753	
Northern Greece	0.188	0.390	0.194	0.395	0.177	0.382
Central Greece	0.054	0.226	0.060	0.238	0.044	0.206
Aegean islands, Crete	0.031	0.172	0.034	0.180	0.026	0.159
Upper HS	0.423		0.369		0.511	
Primary	0.104	0.305	0.119	0.324	0.078	0.269
Lower HS	0.125	0.330	0.147	0.355	0.088	0.283
Technical	0.070	0.255	0.090	0.286	0.037	0.189
College	0.062	0.242	0.057	0.233	0.071	0.256
Tertiary	0.072	0.258	0.074	0.261	0.069	0.254
University	0.134	0.340	0.131	0.338	0.138	0.345
Post-graduate	0.010	0.101	0.011	0.107	0.008	0.091
Plant operators	0.132		0.199		0.025	
Managerial	0.036	0.186	0.045	0.206	0.022	0.146
Professional	0.105	0.306	0.102	0.302	0.109	0.312
Technician	0.115	0.319	0.111	0.314	0.121	0.326
Clerical	0.257	0.437	0.179	0.383	0.385	0.486
Sales	0.127	0.333	0.094	0.291	0.182	0.386
Craft	0.115	0.319	0.161	0.368	0.039	0.195
Unskilled	0.113	0.316	0.110	0.313	0.117	0.321

Source: SES 2006.

Table A3: Descriptives of the variables used in the analysis (means and standard deviations of variables in Table 2 not appearing in Table 1)

	All		**Men**		**Women**	
	Mean	*St.dev*	*Mean*	*St.dev*	*Mean*	*St.dev*
Nace14	0.0038	0.0616	0.0051	0.0713	0.0017	0.0412
Nace15	0.0732	0.2605	0.0765	0.2657	0.0680	0.2517
Nace16	0.0042	0.0649	0.0061	0.0777	0.0012	0.0352
Nace17	0.0198	0.1392	0.0194	0.1378	0.0205	0.1415
Nace18	0.0238	0.1523	0.0121	0.1094	0.0427	0.2021
Nace19	0.0035	0.0591	0.0038	0.0612	0.0031	0.0556
Nace20	0.0047	0.0681	0.0062	0.0785	0.0021	0.0462
Nace21	0.0096	0.0977	0.0118	0.1078	0.0062	0.0782
Nace22	0.0259	0.1587	0.0242	0.1536	0.0286	0.1666
Nace23	0.0086	0.0922	0.0108	0.1032	0.0050	0.0707
Nace24	0.0291	0.1681	0.0294	0.1690	0.0286	0.1666
Nace25	0.0115	0.1067	0.0126	0.1114	0.0098	0.0985
Nace26	0.0223	0.1478	0.0299	0.1702	0.0101	0.1002
Nace27	0.0090	0.0944	0.0125	0.1113	0.0032	0.0567
Nace28	0.0272	0.1627	0.0356	0.1854	0.0136	0.1156
Nace29	0.0166	0.1278	0.0203	0.1409	0.0107	0.1027
Nace30	0.0018	0.0423	0.0015	0.0383	0.0023	0.0481
Nace31	0.0074	0.0858	0.0086	0.0923	0.0055	0.0742
Nace32	0.0042	0.0645	0.0050	0.0707	0.0028	0.0528
Nace33	0.0028	0.0524	0.0022	0.0470	0.0036	0.0602
Nace34	0.0036	0.0601	0.0049	0.0697	0.0016	0.0399
Nace35	0.0119	0.1086	0.0169	0.1290	0.0038	0.0615
Nace36	0.0166	0.1278	0.0177	0.1317	0.0149	0.1212
Nace45	0.0602	0.2378	0.0735	0.2610	0.0385	0.1923
Nace50	0.0262	0.1596	0.0342	0.1817	0.0132	0.1140
Nace51	0.1246	0.3303	0.1323	0.3388	0.1122	0.3156
Nace52	0.0944	0.2924	0.0613	0.2399	0.1482	0.3553
Nace55	0.0590	0.2357	0.0460	0.2096	0.0801	0.2715

Table A3 (continued)

	All		**Men**		**Women**	
	Mean	*St.dev*	*Mean*	*St.dev*	*Mean*	*St.dev*
Nace60	0.0308	0.1727	0.0437	0.2045	0.0097	0.0980
Nace61	0.0036	0.0602	0.0044	0.0661	0.0024	0.0490
Nace62	0.0077	0.0874	0.0073	0.0851	0.0084	0.0911
Nace63	0.0276	0.1637	0.0264	0.1603	0.0295	0.1692
Nace64	0.0567	0.2313	0.0597	0.2370	0.0519	0.2217
Nace65	0.0782	0.2685	0.0617	0.2406	0.1051	0.3067
Nace66	0.0039	0.0627	0.0023	0.0477	0.0067	0.0813
Nace67	0.0037	0.0608	0.0039	0.0622	0.0034	0.0586
Nace70	0.0030	0.0548	0.0028	0.0532	0.0033	0.0572
Nace71	0.0044	0.0665	0.0042	0.0647	0.0048	0.0693
Nace72	0.0103	0.1012	0.0103	0.1007	0.0105	0.1019
Nace73	0.0068	0.0820	0.0059	0.0767	0.0081	0.0899
Nace74	0.0576		0.0472		0.0745	
Private sector	0.8592	0.3478	0.8553	0.3518	0.8656	0.3411
Sectoral agr.	0.4773		0.4709		0.4877	
National agr.	0.3665	0.4819	0.3683	0.4823	0.3637	0.4811
Sectoral/Local agr.	0.0150	0.1218	0.0164	0.1270	0.0128	0.1126
Firm-level agr.	0.0853	0.2793	0.0935	0.2912	0.0719	0.2584
Plant-level agr.	0.0043	0.0656	0.0047	0.0685	0.0037	0.0606
Other agr.	0.0515	0.2210	0.0462	0.2098	0.0602	0.2378
100-249 emp.	0.2111		0.2118		0.2099	
10-19 emp.	0.0751	0.2635	0.0767	0.2660	0.0725	0.2593
20-49 emp.	0.1261	0.3320	0.1321	0.3386	0.1164	0.3207
50-99 emp.	0.1128	0.3163	0.1143	0.3182	0.1102	0.3132
250-499 emp.	0.1279	0.3340	0.1336	0.3403	0.1185	0.3232
500-999 emp.	0.1023	0.3030	0.1023	0.3031	0.1023	0.3030
1000+ emp.	0.2449	0.4300	0.2292	0.4203	0.2703	0.4441

1 For description of the sectors see Table B1 below.
Source: SES 2006.

Table A4: Descriptives of the variables used in Table 5

Variables	Mean	St.dev
Incidence of accidents (percentage employees who had an accident)	2.48	2.30
Risk of accident (percentage employees in risk of accident)	23.17	16.61
Stress (percentage employees stressed)	16.40	4.89
CR5 (share of sales accounted for by 5 largest firms)	23.04	22.94
ln *NOSE t-1* (logarithm of net operating surplus per employee in EUR)	9.85	1.056

B. Detailed results

Table B1: Estimated wage differentials - no controls (deviation from average employment weighted wage)

Sector	Raw differentials		
	All	Men	Women
14 (Other) mining and quarrying	-0.13 (0.041)	-0.16 (0.045)	-0.20 (0.047)
15 Food products and beverages	-0.079 (0.026)	-0.071 (0.027)	-0.10 (0.030)
16 Tobacco products	0.29 (0.12)	0.26 (0.12)	0.15 (0.18)
17 Textiles	-0.13 (0.033)	-0.14 (0.043)	-0.12 (0.051)
18 Clothing	-0.29 (0.034)	-0.22 (0.075)	-0.26 (0.030)
19 Leather	-0.23 (0.067)	-0.22 (0.078)	-0.26 (0.043)
20 Wood and cork	-0.12 (0.10)	-0.14 (0.11)	-0.18 (0.10)
21 Paper	-0.043 (0.036)	-0.056 (0.041)	-0.087 (0.061)
22 Printing and publishing	-0.015 (0.039)	-0.013 (0.047)	-0.0008 (0.041)
23 Coke, petr. prod. & nuclear fuel	0.61 (0.039)	0.61 (0.032)	0.48 (0.072)
24 Chemical and chemical prods.	0.053 (0.037)	0.060 (0.045)	0.040 (0.037)
25 Rubber and plastic products	-0.14 (0.037)	-0.18 (0.035)	-0.067 (0.068)
26 Other non-metallic mineral prods.	0.053 (0.072)	0.026 (0.080)	-0.0009 (0.060)
27 Basic metals	-0.0049 (0.042)	-0.025 (0.041)	-0.15 (0.044)
28 Fabricated metal products	-0.18 (0.036)	-0.23 (0.035)	-0.15 (0.071)
29 Machineryand equipment	-0.068 (0.069)	-0.13 (0.071)	0.027 (0.076)
30 Office machinery and computers	-0.16 (0.032)	-0.11 (0.084)	-0.17 (0.11)
31 Electrical machinery and apparatus	-0.15 (0.037)	-0.16 (0.041)	-0.15 (0.050)
32 Radio, TV and comm. equipmment	0.25 (0.074)	0.27 (0.075)	0.095 (0.086)
33 Medical, precision etc. instruments	-0.20 (0.099)	-0.14 (0.15)	-0.22 (0.067)
34 Motor vehicles	0.020 (0.076)	-0.012 (0.079)	-0.017 (0.080)
35 Other transport equipment	0.13 (0.049)	0.091 (0.051)	0.11 (0.068)
36 Furniture manufacturing	-0.29 (0.034)	-0.32 (0.033)	-0.23 (0.047)
45 Construction	-0.057 (0.028)	-0.093 (0.029)	-0.033 (0.045)
50 Sale, maintenance and repair of motor vehicles	-0.16 (0.028)	-0.19 (0.032)	-0.19 (0.035)
51 Wholesale trade	-0.063 (0.018)	-0.07 (0.019)	-0.066 (0.021)
52 Retail trade	-0.27 (0.022)	-0.27 (0.025)	-0.22 (0.026)
55 Hotels and restaurants	-0.23 (0.023)	-0.19 (0.033)	-0.22 (0.022)
60 Land transport	0.13 (0.063)	0.096 (0.061)	0.0093 (0.074)
61 Water transport	0.23 (0.11)	0.18 (0.14)	0.29 (0.065)
62 Air transport	0.56 (0.082)	0.61 (0.12)	0.51 (0.087)
63 Transport activities	-0.045 (0.037)	-0.051 (0.046)	-0.026 (0.037)
64 Post and telecommunications	0.35 (0.10)	0.40 (0.10)	0.24 (0.092)

Table B1 (continued)

Sector	Raw differentials		
	All	Men	Women
65 Financial intermediation	0.33 (0.031)	0.35 (0.036)	0.34 (0.029)
66 Insurance and pension funding	0.49 (0.22)	0.53 (0.29)	0.53 (0.18)
67 Financial intermed.(ancillary)	0.14 (0.091)	0.24 (0.042)	-0.052 (0.096)
70 Real estate activities	-0.028 (0.11)	-0.062 (0.14)	0.033 (0.11)
71 Renting of machinery	0.055 (0.090)	-0.11 (0.10)	0.30 (0.15)
72 Computer and related activities	0.25 (0.052)	0.31 (0.054)	0.15 (0.069)
73 R&D	0.13 (0.085)	0.20 (0.086)	0.071 (0.075)
74 Other business activities	-0.087 (0.033)	-0.11 (0.039)	-0.028 (0.039)
St. dev.[2]	0.211	0.215	0.211

1 Coefficients on the industry dummies from the regression reported in Table 2 in the main text expressed with respect to an average wage (and not the excluded industry) Heteroscedastically consistent standard errors in parentheses.
2 Employment weighted standard deviation.

Table B2: Estimated wage differentials with controls (deviation from average employment weighted wage)[1]

Sector [2]	Conditional differentials		
	All	Men	Women
14	-0.024 (0.032)	0.0013 (0.033)	-0.15 (0.045)
15	-0.038 (0.018)	-0.04 (0.022)	-0.029 (0.017)
16	0.15 (0.073)	0.14 (0.060)	0.11 (0.015)
17	-0.043 (0.028)	-0.035 (0.038)	-0.043 (0.029)
18	-0.10 (0.023)	-0.076 (0.052)	-0.10 (0.024)
19	-0.12 (0.048)	-0.10 (0.062)	-0.12 (0.043)
20	-0.0009 (0.053)	0.011 (0.049)	-0.086 (0.055)
21	-0.0097 (0.032)	0.0032 (0.037)	-0.039 (0.037)
22	0.013 (0.030)	0.028 (0.032)	-0.0024 (0.039)
23	0.31 (0.036)	0.32 (0.038)	0.22 (0.053)
24	0.035 (0.027)	0.029 (0.032)	0.041 (0.032)
25	0.021 (0.025)	0.0089 (0.027)	0.048 (0.045)
26	0.048 (0.029)	0.053 (0.032)	-0.0072 (0.046)
27	0.043 (0.041)	0.047 (0.046)	-0.068 (0.045)
28	-0.069 (0.023)	-0.08 (0.022)	-0.037 (0.043)
29	-0.096 (0.026)	-0.11 (0.027)	-0.071 (0.035)
30	-0.064 (0.020)	-0.08 (0.086)	-0.067 (0.090)
31	-0.083 (0.036)	-0.046 (0.043)	-0.15 (0.029)
32	0.089 (0.020)	0.096 (0.032)	0.032 (0.038)
33	-0.12 (0.072)	-0.12 (0.091)	-0.13 (0.052)
34	0.0056 (0.053)	-0.0011 (0.049)	-0.028 (0.087)
35	0.13 (0.035)	0.13 (0.038)	0.088 (0.036)
36	-0.13 (0.027)	-0.15 (0.032)	-0.099 (0.031)
45	0.015 (0.021)	0.024 (0.023)	-0.034 (0.030)
50	-0.059 (0.023)	-0.048 (0.025)	-0.099 (0.026)
51	0.0038 (0.013)	0.0019 (0.013)	0.0082 (0.017)
52	-0.18 (0.021)	-0.21 (0.030)	-0.16 (0.018)
55	-0.055 (0.018)	-0.072 (0.025)	-0.037 (0.019)
60	0.070 (0.042)	0.072 (0.041)	-0.012 (0.037)
61	0.17 (0.10)	0.12 (0.13)	0.31 (0.060)
62	0.42 (0.093)	0.36 (0.11)	0.49 (0.082)
63	0.030 (0.028)	0.030 (0.034)	0.023 (0.025)
64	0.11 (0.067)	0.13 (0.066)	0.08 (0.067)

Table B2 (continued)

Sector[2]	Conditional differentials		
	All	Men	Women
65	0.059 (0.029)	0.014 (0.033)	0.12 (0.027)
66	0.27 (0.13)	0.26 (0.16)	0.29 (0.12)
67	-0.0036 (0.060)	0.0002 (0.072)	-0.055 (0.065)
70	-0.028 (0.067)	-0.042 (0.093)	-0.0037 (0.043)
71	0.10 (0.063)	0.023 (0.082)	0.22 (0.088)
72	0.13 (0.034)	0.17 (0.039)	0.06 (0.056)
73	-0.11 (0.051)	-0.13 (0.067)	-0.082 (0.043)
74	-0.011 (0.023)	-0.045 (0.025)	0.017 (0.030)
St.dev.[3]	0.095	0.093	0.109

1 Coefficients on the industry dummies from the regression reported in Table 2 in the main text expressed with respect to an average wage (and not the excluded industry). Heteroscedastically consistent standard errors in parentheses.
2 For description of each sector see Table B1 above.
3 Employment weighted standard deviation.

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Low Pay Dynamics in the Greek Labour Market

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Abstract

This paper investigates low pay dynamics among Greek men using data from the ECHP. A dynamic random effects probit framework is utilized allowing for endogeneity of the initial conditions. Analysis shows considerable state dependence, i.e. the experience of low pay increases, per se, the probability of future low pay. Evidence of a low pay-no pay cycle is also found, as the low paid are more likely to move out of paid employment and those entering paid employment are more likely to become low paid. However, low pay functions as a stepping stone to higher pay, as the low paid display greater likelihood of becoming higher paid compared to the unemployed. All estimated models reject exogeneity of the initial conditions.

1 Introduction

The analysis of low pay has been receiving increased attention in recent decades in many countries. Research has focused mainly on understanding which factors make it more likely for individuals to be located further away below the middle of the earnings distribution, as well as the chances of remaining in this lower part or moving into or out of it. While the interest in low

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pay has been reinforced by the sharp rise in wage inequalities since the 1980s in several industrial countries, the main issue actually concerns the determination of wages in the labour market without damaging productivity or employment, while simultaneously permitting workers at the low end of the earnings distribution to meet their basic needs. It is generally recognised that the existence of low pay may influence both efficiency in the labour market and social equity. Unfair pay differentials and/or cheap labour may affect negatively the evolution of productivity, cohesion and cooperation among workers, incentives for labour supply and human capital investment, as well as macroeconomic efficiency (Lucifora and Salverda, 2009). Furthermore, low pay may affect the ability of maintaining socially accepted living standards and result in increased fiscal cost through the funding of welfare programmes. Nevertheless, low pay employment might also positively affect total employment, providing opportunities for low productivity workers (Lucifora and Salverda, 1998).

Another aspect of low pay is its persistence, which can be associated with poverty or even unemployment (Stewart and Swaffield, 1999). At any point of his working life, an employee might experience low pay. This is neither unexpected, to the extent that it reflects lack of qualifications, nor does it have serious welfare implications if it is a transitory situation for new entrants in the labour market, who lack experience. However, if low pay is not a transitory event and signifies a situation in which workers are trapped and cannot escape, more serious problems might occur. For example, low pay can render difficult or even impossible the payment of contributions to pension schemes, getting a mortgage and in general making any kind of savings (Atkinson, 1973). Consequently, in policy terms it is important to identify whether previous low pay affects current low pay status i.e. whether there is persistence in low pay.

Greece is a country for which low pay has not been analyzed. Existing research on earnings in Greece has only examined earnings inequality utilizing cross-sectional and cohort datasets (Tsakloglou and Cholezas, 2005; Cholezas and Tsakloglou, 1999). Analysing the determinants and dynamics of low pay in Greece might be useful in many respects. The Greek economy was essentially stagnating from the late 1970s to the middle 1990s and, after a period of robust economic growth that followed, in 2009 it entered a deep recession. Macroeconomic imbalances, inflation and public debt, despite the various stabilization programmes, have long prevailed. The employment rate, even though on the rise since the early 1990s until 2008, remains remarkably lower than the average European Union rate, while the unemployment rate has been consistently high. The 1990s was characterized by successive stabilisation programmes applied by Greek governments to restore macroeconomic order and prepare the country for its entry to European Monetary Union, which took place in January 2002. During the 1980s Greece had maintained a wage indexation scheme (ATA), which systematically narrowed the pay dispersion, but it was eliminated in the early 1990s. Since then wages have been determined through collective national bargaining, which narrows wage dispersion. Such wage policy perhaps has enhanced labour market inflexibilities and contributed to the poor performance of the Greek economy in the sense that the labour force lacked the motivation and opportunity to seek greater responsibilities, acquire additional training or move to other posts. While in the 1990s financial markets were deregulated, labour market regulations and institutions in general remained unchanged. In this context the economy started improving and in the second half of the 1990s economic growth averaged 3.3 percent, which is slightly higher than the EU average.

This paper focuses on the bottom part of the pay distribution in Greece and analyses the persistence in low pay for the period 1994–2001. Its main purpose is to identify both the extent and profile of low pay and its determinants by estimating econometric models of pay probabilities at the bottom of the wage distribution. A sensible question is whether, among other factors, previous low pay affects current low pay status—i.e. whether there is persistence in low pay. If somebody who experiences low pay is prone to stay in low pay, or equivalently if those who are currently in low pay are there because they were low-paid before, there is low pay persistence. High degree of persistence signifies an immobile earnings distribution, where workers are trapped in the lower part for a substantial proportion of their career and labour market inequalities are created, even if cross-sectional distributions are stable over time. On the other hand, low levels of persistence imply high mobility, which means that the experience of low pay is a transitory phenomenon of the working career and it may serve as an entry point into the labour market through the acquisition of skills and experience. It is therefore important to identify how permanent the low pay state is through examination of its dynamics.

A number of problems emerge when analysing low pay dynamics, which are dealt within this paper. We must take into account not only movements into and out of low pay employment but also movements into and out of employment, otherwise neglecting exits of low paid workers to non-employment would overestimate upward mobility (Sloane and Theodossiou, 1998). The transitions between low and high pay are examined in this paper in conjunction with transitions into and out of paid employment. A vitally important issue in modelling low pay transition probabilities concerns the initial conditions problem (Stewart and Swaffieldm, 1999). This means that conditioning on being low paid at the starting period and then modelling the probability of moving out of low pay in the next period will lead to selection bias if being initially in low pay is not exogenous. In this paper the treatment of the initial conditions follows solutions suggested by Heckman (1981a), Orme (1996) and Wooldridge (2005) .

The profile and dynamics of low pay have not been analysed in Greece. To a large extent this is because of the lack of suitable statistical data. Low pay dynamics analysis presumably requires the examination of the same individuals over a long time period (longitudinal data), which allows compilation and modelling of transitions into and out of low pay. Only recently have such longitudinal data become available through the European Community Household Panel dataset (ECHP) covering the period 1994–2001.

The only empirical work on low pay in Greece is that of Clark and Kanellopoulos (2009), who examine low pay persistence in European countries including Greece. Using the Orme (1996) model, they focus on cross-country differences in low pay persistence and its connection to countries' labour market institutions. They find substantial levels of low pay persistence in all examined countries. These levels vary by country but their variation is not found to be systematically related to national labour market institutions. The present study is in many respects an extension of the paper by Clark and Kanellopoulos. While it examines low pay persistence, it utilizes a variety of estimators to check the robustness of the obtained results. As in their paper, it analyses transitions into low pay from high pay, but also examines flows between unemployment, inactivity, self-employment and low pay—i.e. it investigates the low pay-no pay cycle in Greece. Furthermore, higher order dynamic analysis is undertaken to explore thoroughly the path to low pay employment.

The rest of the paper is structured as follows. Section 2 presents the economics and measurement of low pay. Section 3 discusses the data used and provides preliminary empirical evidence on the dynamics of low pay. The econometric models applied are presented in section 4. The results from the estimated models are displayed in section 5 and finally section 6 concludes.

2 Economic Explanations and Definition of Low Pay

As low pay is located in the bottom part of wage distribution, explanation of wage distribution contributes heavily to its understanding. Figure 1 shows a typical wage distribution. All those workers on the left of the low pay threshold, regardless of how this is defined, are in low pay. The number of workers in the low pay area clearly depends on the shape of the wage distribution. Thus, anything that determines the shape of the wage distribution is likely to affect the incidence of low pay. In a competitive labour market, heterogeneous workers offer their labour services and are rewarded according to their qualifications, while employers post jobs with given productive capacity. In equilibrium, all workers will be matched to the existing jobs and a distribution of wages would emerge. In this frictionless framework low pay identifies those workers who, because of poor qualifications or low rewards to these qualifications, are likely to be found in the lower part of the wage distribution. Hence the extent of low pay employment is affected by both supply-side decisions and demand-side factors, since only successful matches between workers looking for a job and employers looking for workers would be observed. When labour market frictions and information limitations are recognised, there will be some workers who will not find a job and some firms will not fill their vacancies, which will coexist with the unemployed (Pissarides, 2000; Blanchard and Diamond, 1994). Institutions like minimum wage and unemployment benefit presumably would influence the lower segment of wage distribution and low pay.

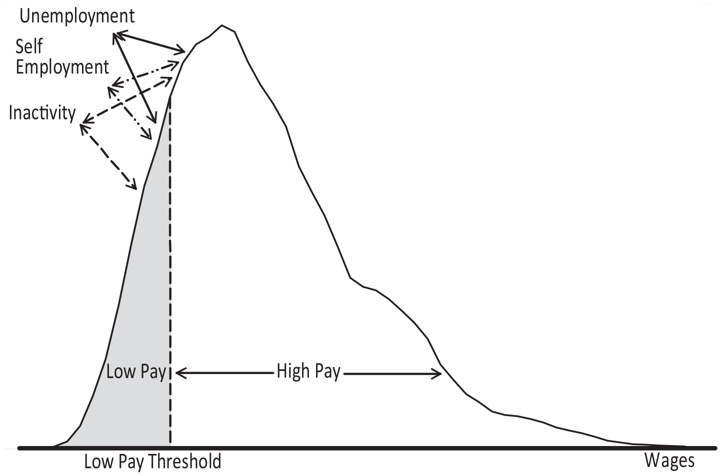
If workers face substantial costs when they change their jobs and firms display some power to reduce wages without its workers quitting immediately, the labour market is characterised as imperfectly competitive. The distinctive features of such a labour market, which seems more realistic than the competitive framework, are expected to be stronger in the lower part of wage distribution, where low skilled workers have low bargaining power and few outside opportunities. Thus monopsony power may increase the chances of low pay (Lucifora and Salverda, 2009).

As Figure 1 shows, it is likely to observe substantial change in both the low-pay/high-pay state of workers within a given distribution and the employment /non-employment position of individuals (dynamic perspective). Consequently, in addition to the static perspective of wage distribution and associated low pay, changes in the wage distribution as well as in the size of the flows among alternative labour market states are crucial for understanding low pay dynamics. Here the theory, which tries to explain changes in earnings inequality through forces that affect labour supply and demand in the wage determination, is invoked.

As was mentioned above, the incidence of low pay conditioning upon past low-pay experience (low-pay persistence) has been a central issue in low pay analysis. A potential source of low pay may be previous labour market status, which may arise from various models of the labour market. The human capital model of wage determination can predict persistence as a result of skill deterioration caused by previous experience of low pay. Low-paid jobs usually offer few opportunities for promotion and involve low-skilled jobs. Thus, a depreciation of human capital may occur, keeping an individual’s productivity low and reducing his chances of getting out of low pay in the future. Furthermore, the incidence of low pay, especially when it lasts long and continuously, may discourage the individual from applying for better jobs and change his preferences in a way that he feels reassured from his current job and does not take any action to move to a better one. In other words, low pay might work in a similar way as unemployment does—discouraging workers. Also, employees with poor human capital, low level of education and short experience would be the ones who are more prone to be low paid. At a further step, low pay can also represent differences in abilities (i.e. some individuals *ceteris paribus* are more productive than others). On the other hand, low pay persistence can be explained from a demand point of view. Employers may view previous low pay as an indicator of an individual’s low productivity and be discouraged from making a job offer. That can be even more severe if low pay is a continuous situation for a long time. “Employers offering good jobs may well use a person’s current position as a screening device. While unemployment is a bad signal, being in low-quality job may well be a worse one” (Layard et al. (1991): 249).

When judging whether an individual or group is low paid, the traditional

Figure 1: Wage distribution and labour market transitions

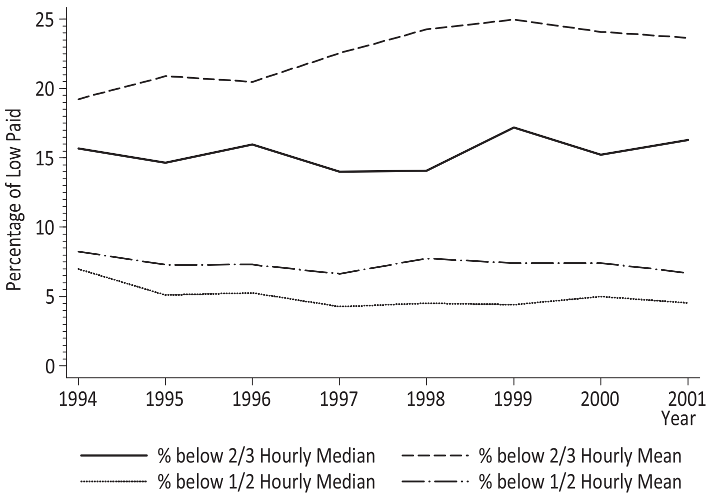


choice between a relative and an absolute measure of low pay is involved. In the former case, low pay is defined in relation to the mean or the median of pay distribution, while in the latter case it is defined at an absolute chosen level of pay given by a minimum acceptable standard of living or poverty level. A relative measure of low pay is more appropriate when international comparisons are undertaken, as it is free from the country-specific level of wages and it only reflects position in the wage distribution. However, upward or downward changes of the whole wage distribution would leave the low pay ratio unchanged, which does not happen with the absolute low pay level. Even within relative definitions there is disagreement about the cut-off point. Some researchers prefer to use definitions relative to the mean, others relative to the median.[1]

[1] Sloane and Theodossiou (1996) for the UK define as low paid those below the third decile of the earnings distribution. Stewart and Swaffield (1999) use three low pay thresholds (half the mean, half the median and two-thirds the median). A similar approach is also adopted by Cappellari (2000) for Italy who uses the first quantile and the third decile. Cappellari and Jenkins (2008a, 2008b) set the low pay threshold at 60% the median or two-thirds the median, respectively. In the latter case to check whether their results are sensitive to alternative definitions they also utilise a fixed threshold and four other relative thresholds. However, none of these made a substantial difference in their results.

In this paper, the low-paid are defined as those employees who earn less than two thirds of the hourly median earnings. This definition is less sensitive to pay outliers. It is also the most popular in the empirical literature and has been adopted by the OECD and the European Commission. Figure 2 depicts estimates of the percentages of low paid workers under four alternative cut-off points of relative pay using data from the ECHP. It is apparent that the extent of low pay depends heavily on the chosen low pay threshold. The adopted one (2/3 median) lies in between the lowest (1/2 median) and the highest (2/3 mean) thresholds, suggesting that it is a reasonable choice, which probably does not over- or under-estimate low pay.

Figure 2: Percentage of low paid using alternative low pay thresholds



Source: ECHP.

3 Data

The data used in this paper are from the Greek side of the European Community Household Panel (ECHP) dataset. ECHP is a harmonized cross-national longitudinal survey focusing on household income and living conditions for many European Union countries. ECHP was designed by Eurostat and implemented from 1994 to 2001 while the Greek data were collected by the National Statistical Service of Greece following a centrally designed questionnaire.[2] We restrict our analysis to (i) males,[3] (ii) aged 18 or over and under 65, (iii) full-time employees having left full-time education,[4] (iv) normally working more than 30 hours per week.[5] Following Arulampalam et al. (2000) and Stewart (2007), the potential endogenous selection into economic activity versus part-time work, self-employment and unemployment were ignored. Since in the analysis we use the lagged dependent variable as a regressor, the sample was further restricted to include only consecutive information.

The original sample contains 15,374 individuals resulting in 85,748 person-year observations. After the sample criteria are applied and observations with missing information are excluded, the final sample is comprised of 1,962 adults and 7,214 person-year observations. Of these individuals, 492 are observed in all 8 waves and thus our sample is an unbalanced panel.

The unit of analysis is the individual and the key variable used is the net hourly wage after deducting income taxes and social security contributions. The hourly wages are constructed dividing the previous month's net wages by the hours of work.

Table 1 provides some information regarding the distribution of low pay across waves. The average rate of low pay or synonymously the average low pay incidence over the eight year period is 15.36 per cent. This percentage does not change much over the years. Since it is not the same individuals who are low paid each year, it is useful to examine movements into and out of low pay in terms of conditional probabilities. Rows [2] to [4] of Table 1 report the

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[2] For more details on ECHP see EPUNet (2004), Eurostat (2003a), Eurostat (2003b), Eurostat (2004) and Peracchi (2002).

[3] While many researchers include in their samples both genders, in this paper we confine our analysis to males, following Cappellari and Jenkins (2008a, 2008b), to avoid the issues of endogenous female labour supply in a country with a relatively low female employment ratio.

[4] Part-time workers constitute 3.7 per cent of the sample. Alternative models including part-timers did not display advantages in terms of fit, while part-time employment came up negative and insignificant.

[5] Sample selection criteria (iii) and (iv) are relaxed when transitions outside paid employment are also included in the analysis.

conditional probabilities by low pay status at *t-1*. Row [2] of the Table reveals that there is considerable state dependence in low pay in the raw data, i.e. the probability of being low paid at *t* is much higher for those in low pay at *t-1*. During the examined period the raw conditional probability of remaining in low pay is on average 53.43 per cent. On the contrary the average raw low pay entry probability is only 5.36 per cent, suggesting that someone in low pay at *t-1* is almost ten times as likely to be low paid at *t* compared to someone not in low pay at *t-1*. Two measures of state dependence, the difference and the ratio between remaining [2] and entering low pay [3] are presented in rows [5] and [6] respectively. One can see that on the average the state dependence for the case of low-paid is 48 percentage points and that the probability of being low paid if one was in low pay the previous year is 10 times higher compared to someone without previous low pay.

Table 1: Low pay probabilities by wave

Year		1995	1996	1997	1998	1999	2000	2001	**All**
$Pr(LP_t=1)$	[1]	14.64	15.97	14.00	14.07	17.20	15.23	16.29	**15.36**
$Pr(LP_t=1 \mid LP_{t-1}=1)$	[2]	42.17	57.76	48.86	47.33	59.40	56.47	62.66	**53.43**
$Pr(LP_t=1 \mid LP_{t-1}=0)$	[3]	5.68	6.13	3.69	5.79	7.36	3.43	5.40	**5.36**
$Pr(LP_t=0 \mid LP_{t-1}=1)$	[4]	57.83	42.24	51.14	52.67	40.60	43.53	37.34	**46.58**
State Dependence									
Difference	[2] - [3]	36.49	51.63	45.18	41.54	52.04	53.04	57.26	**48.07**
Ratio	[2] / [3]	7.43	9.42	13.25	8.17	8.07	16.46	11.61	**9.97**

Note: $LP_t=1$ if the individual is low paid in time *t* and zero otherwise.
Source: ECHP, waves 1-8.

A remarkable fact emerging from Table 1 is that, although the probability of low pay remains stable over the examined period, the difference in the two conditional probabilities increased substantially. This reflects the consistent increase of low pay incidence among those previously low paid, while it has remained rather stable for those previously out of low pay.

These average raw low pay probabilities ignore observed characteristics of examined individuals. Table 2 presents low pay probabilities (unconditional and conditional) for various subgroups of the sample distinguished by age, level of education, marital status, job tenure, industry and sector of employment, work contract type, region and local unit size. Column 1 gives the probability of low pay and columns 2–3 give the probability of low pay conditional on low pay status a year ago. The difference between the unconditional and conditional probabilities turns out to be impressive within all subgroups, indicating that there is considerable low pay persistence.

Table 2 shows that there are considerable age effects on the likelihood of being low paid. The probability of low pay decreases by age. The same holds for entry into low pay according to age, while the opposite holds for exit from low pay. More educated workers are less likely to be low paid. In particular, the low pay probability is three times higher for secondary school graduates and four times higher for those who have finished primary school compared to that of university graduates. Table 2 also shows that never married employees are three times more likely to be low paid than those currently or previously married. Someone living in Attica has almost half the chance of being low paid compared to those residing elsewhere in Greece. He also has 20 percentage points higher probability of exiting low pay compared with the rest of examined regions, which are below the country average.

Low pay probabilities are lower for workers with longer tenure. In particular, workers having started in their current job before 1990 face half the chance of being low paid. One should however take into consideration that these are also older workers. Low pay is also more prevalent among workers in agriculture. A striking difference in low pay probability appears between workers in the public and in the private sector, with the latter facing five times higher low pay probability. It is worth noting that casual workers encounter double low pay probability compared to those with a fixed contract and quadruple compared to those with a permanent contract. Finally, working in a smaller workplace seems to slightly increase the likelihood of low pay.

The low pay entry and exit probabilities presented in Tables 1 and 2 provide a useful overview of the dynamics of low pay of employees. However, these probabilities ignore the fact that one can move not only between low and higher pay, but also among other labour market states. Table 3 presents the conditional probabilities of labour market status in period *t* given labour market status in period *t-1* among five mutually exclusive labour market states (low paid employee, higher paid employee, self-employed, unemployed or out of the labour force). Out of those low paid in *t-1*, 21.87% become either

Table 2: Unconditional and conditional low pay probabilities

	$Pr(LP_t=1)$ [1]	$Pr(LP_t=1\|LP_{t-1}=1)$ [2]	$Pr(LP_t=1\|LP_{t-1}=0)$ [3]	$Pr(LP_t=0\|LP_{t-1}=1)$ [4]
Age				
18-24	48.59	67.36	22.26	32.64
25-34	19.66	48.59	8.56	51.41
35-44	7.92	52.17	3.39	47.83
45 and over+	7.53	50.00	2.75	50.00
Highest level education completed				
University	5.43	38.64	1.20	61.36
Secondary education	15.99	53.37	5.60	46.63
Primary school	20.76	56.91	7.92	43.09
Marital status				
Married	8.44	47.32	3.43	52.68
Divorced/separate/widow	9.54	40.00	2.34	60.00
Never married	31.89	58.53	12.46	41.47
Region of residence				
Attica	10.15	38.46	4.18	61.54
Northern Greece	18.00	57.96	5.93	42.04
Central Greece	18.05	58.12	5.61	41.88
Islands & Crete	19.26	57.24	7.35	42.76
Year started current job				
1985 or before	6.35	56.25	2.03	43.75
1986-1990	10.11	52.58	4.53	47.42
1991-1996	22.13	52.1	8.54	47.90
1997	21.92	51.89	8.41	48.11
1998	26.20	66.04	10.81	33.96
1999	32.04	57.78	7.18	42.22
2000	33.43	54.76	13.98	45.24
Industry				
Agriculture	39.05	61.91	8.16	38.10
Industry	18.02	55.36	7.27	44.64
Services	12.98	52.82	3.85	47.18
Sector				
Public	4.05	34.62	1.28	65.39
Private	21.90	56.12	8.47	43.88

Table 2 (continued)

	$Pr(LP_t=1)$ [1]	$Pr(LP_t=1 \mid LP_{t-1}=1)$ [2]	$Pr(LP_t=1 \mid LP_{t-1}=0)$ [3]	$Pr(LP_t=0 \mid LP_{t-1}=1)$ [4]
Contract type				
Permanent/Unlimited time	10.10	51.98	3.22	48.02
Fixed time	22.19	61.54	6.99	38.46
Casual/other	39.26	66.67	15.33	33.33
Local unit size				
20 or more	7.85	47.83	2.59	52.17
50 or more	5.90	42.59	2.44	57.41
100 or more	4.40	40.00	2.50	60.00
ALL	**15.36**	**53.43**	**5.36**	**46.58**

Note: LP_t=1 if the individual is low paid in time *t* and zero otherwise.
Source: ECHP, waves 1-8.

self-employed, unemployed or out of the labour force in year *t*, 41.02% remain low paid, while only 37.10% move up the wage distribution. On the other hand of those employees in higher pay in *t-1* only 10.15% move to self-employment, unemployment or out of the labour force, while 4.83% move to low pay. This suggests that a considerable percentage (62.90%) of those in low pay do not move up in the pay distribution, while of those in higher pay 85% remain above the low pay threshold. Comparing Table 1 and Table 3 it turns out that the probability of not moving to higher pay for individuals who remain employees in both years is 53.43% while the corresponding probability when individuals out of paid employment are included increases to 62.90%. This suggests that the probability of escaping low pay is considerably undererestimated when transitions out of paid employment are ignored.

Moreover, those who enter paid employment from unemployment or out of the labour force are more likely to become low paid than average. In particular, of those men unemployed at *t-1* who become employees the following year, 33.67% enter low pay,[6] while the corresponding number for those

[6] For unemployed at *t-1* 33.67% = [12.40 / (12.40 + 24.42)] × 100%.

who were employees at *t-1* is 11.25%.[7] For those men out of the labour force at *t-1* who become employees at *t*, 33.92% enter low pay.[8] This indicates that the chance of being low paid at *t* for a man who was either unemployed or out of the labour force at *t-1* is roughly three times higher compared with one who was an employee at *t-1*.

Finally, those who are low paid at *t-1* are more likely not to work at *t* than those higher paid at *t-1*. In particular, 8.20% of those low paid at *t-1* move to unemployment next year and 7.85% move out of the labour force. For those who are higher paid at *t-1* the corresponding percentages are 2.43% and 3.23%. This suggests that the low paid are more likely to move out of employment. Taking into consideration the finding that those out of work are more likely to become low paid on re-entry, there is evidence of a low pay-no pay cycle.

The transition probabilities presented in Tables 1–3 suggest that there is strong state dependence in low pay, i.e. the probability of being low paid at *t* is higher for individuals who were low paid at *t-1*. Moreover, the average level of persistence is 53.43 per cent; for certain groups in Table 2 it is much

Table 3: Transition probabilities between labour market states, *t-1* to *t*

		Destination *(t)* state probabilities (%)				
Initial *(t-1)* state	Distribution *t-1*	(1)	(2)	(3)	(4)	(5)
1. Low paid	5.95	41.02	37.10	5.82	8.20	7.85
2. Higher paid	36.38	4.83	85.02	4.49	2.43	3.23
3. Self-employed	32.66	1.24	3.97	91.11	1.02	2.66
4. Unemployed	5.58	12.40	24.42	8.96	37.71	16.50
5. Out of labour force	19.43	2.49	4.85	2.00	5.90	84.76
All	**100.00**	**5.97**	**36.03**	**31.35**	**5.55**	**21.11**

Sample: t = 1994-2001; sample size: 23,979.
Source: ECHP, waves 1-8.

[7] For all employees at *t-1* col. (1) = [(41.02 × 5.95) + (4.83 × 36.38)]/(5.95 + 36.38) and col. (2) = [(37.10 × 5.95) + (85.02 × 36.38)]/(5.95 + 36.38). Then 11.25% = [col. (1)/(col. (1) + col. (2))] x 100%.

[8] For inactive at *t-1* 33.92% = [2.49 / (2.49 + 4.85)] × 100%.

higher or lower. This indicates that observed characteristics do influence low pay persistence.[9] Nevertheless, low pay persistence in Tables 1 to 3 can be a result of workers' unobserved heterogeneity (Heckman 1981b, 1981c). The question that arises is how much of the observed persistence in the raw data is due to observed characteristics, how much to unobserved characteristics (heterogeneity) and how much to genuine state dependence. Moreover, do initial conditions have a significant effect on low pay persistence? These questions are addressed in the next section using a dynamic random effects probit framework.

4 Econometric Models

This paper utilizes a dynamic random effects probit framework to analyze the dynamics of low pay in Greece. Such dynamic models include as an independent variable the previous low pay status in order to allow for state dependence. In these models, special attention should be paid to the treatment of unobserved heterogeneity, as well as the initial conditions problem, which arises when the beginning of the examined period does not coincide with the beginning of the stochastic low pay process. Unobserved heterogeneity is modelled following Mundlak (1978) and Chamberlain (1984), while the initial conditions solutions suggested by Heckman (1981a), Orme (1996) and Wooldridge (2005) are adopted. It is intentionally chosen to estimate a variety of alternative models and apply more than one solution to the initial conditions problem in order to examine whether the obtained results are robust. The main objective here is to properly measure true (structural) state dependence as it is expressed by the coefficient of the lagged dependent variable and not to model the mechanism causing this state dependence.

4.1 A Dynamic Random Effects Probit

The analysis begins with a basic dynamic random effects probit model[10]:

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[9] Certain variables in Table 2 are not used in the regression analysis presented later. The reason was data limitations, as some questions were not introduced in the survey from the beginning or have not been updated for a long time.

[10] The choice of random effects comes from the fact that in non-linear models fixed effects are problematic. Maximum likelihood estimator is inconsistent in probit models with fixed ef-

$$L_{it}^{*} = \gamma L_{it-1} + x_{it}'\beta + \varepsilon_i + u_{it} \quad (1)$$

where the subscript $i=1,2,...,N$ denotes individuals that are included in our sample and the subscript $t=2,3,...,T$ represents the time periods for which the model is estimated. L_{it} is the observed indicator of being low paid taking values one if low paid and zero otherwise, L_{it}^{*} is the underlying construct generating L_{it}, and x_{it} is a vector of strictly exogenous explanatory variables of low pay. Obviously L_{it-1} is the low pay status of individual i in the previous year t-1. Moreover, it is assumed that $u_{it} \sim iid\ N\left(0, \sigma_u^2\right)$. However, even if this is the case for the u_{it} the existence of the individual-specific error term (ε_i), which is time constant, causes the composite error term $v_{it} = \varepsilon_i + u_{it}$ to be serially correlated. Given the assumptions, this model implies equal correlation in v_{it} between any two different time periods: $\lambda = Corr\left(v_{it}, v_{is}\right) = \sigma_\varepsilon^2 / \left(\sigma_\varepsilon^2 + \sigma_u^2\right)$ for $t,s=2,3,...,T;\ t \neq s$.

The standard uncorrelated random effects model also assumes that ε_i is uncorrelated with x_{it} for all i and in every t period[11]. However, this can lead to omitted variable bias and thus it is necessary to allow for correlation between ε_i and x_{it}. Following Mundlak (1978) and Chamberlain (1984) a relationship between the unobserved heterogeneity ε_i and the time means of all time varying explanatory variables is assumed. Thus, $\varepsilon_i = \bar{x}_i'\delta + \alpha_i$ where $\alpha_i \sim iid\ N(0,1)$ and independent of x_{it} and u_{it} for all i and in all t periods. As a result, a corre-

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fects as it suffers from the incidental parameter problem (Neyman and Scott, 1948). Chamberlain (1980) proposed a conditional static logit model and later Chamberlain (1984) a dynamic one under the restriction that observable heterogeneity stays time-invariant. Honoré and Kyriazidou (2000) proposed a conditional dynamic logit model which requires very strong distributional assumptions about the observable heterogeneity over time and has a slower rate of convergence than $\sqrt{N}$.

[11] It is very restrictive to assume that is strictly exogenous i.e. $E\left(\varepsilon_i \mid x_i\right) = 0$. If it was chosen to ignore the fact that (1) is a non-linear equation, the moment conditions of the form $E\left(\Delta_{\varepsilon_{it}} \mid L_i^{t-1}\right) = 0$ and standard orthogonality conditions for x_{it} can be employed to estimate it with the GMM (Hyslop (1999), Stewart (2007)). In such a framework it is customary to use lags of previous low pay to instrument ΔL_{t-1} like Arellano and Bond (1991). The problem with this kind of estimator is that it bears all the "undesirable" properties of the linear probability models, especially when predictions are undertaken.

lated random effects probit model emerges, with extra regressors the means of all time varying variables. Substituting into (1) we obtain:

$$L_{it}^{*} = \gamma L_{it-1} + x_{it}^{'}\beta + \overline{x}_{i}^{'}\delta + \alpha_{i} + u_{it} \tag{2}$$

A crucial choice one needs to make in a dynamic model is whether the initial observation of the dependent variable L_{i1} and the unobserved heterogeneity a_i are correlated or not. If L_{i1} is taken as exogenous and thus uncorrelated with a_i then (2) is estimated by using the Gauss-Hermite quadrature because the likelihood can easily be decomposed into two independent factors and their joint probability for $t \geq 2$ can be maximized without referring to that of the initial period. However, this requires that the initial period is also the beginning of the stochastic process that generates low pay status. Nevertheless, this is not the case as a great number of individuals in the examined sample were employed well before they entered the survey and thus the initial conditions problem arises. In other words, L_{i1} is endogenous as it is correlated with a_i, and so the obtained estimator will be inconsistent and tend to overestimate the coefficient of the lagged dependent variable γ (Chay and Hyslop, 2000).

4.2 Heckman's Estimator

To deal with the initial condition problem, following Heckman (1981a), we indicate a reduced form equation for the initial observation:

$$L_{i1}^{*} = z_{i}^{'}\lambda + \eta_{i} \tag{3}$$

where L_{i1}^{*} is a binary variable taking the value of one if the individual is low paid in year 1 or zero otherwise. z_i is a vector of strictly exogenous instruments, which affect L_{i1}^{*}, $\mathrm{var}(\eta_i) = \sigma_\eta^2$ and $corr(a_i, \eta_i) = \rho$. Since we do not want ρ to be zero, a linear specification is introduced, in terms of orthogonal error components:

$$\eta_{i} = \theta\alpha_{i} + u_{i1} \tag{4}$$

By construction a_i and u_i are orthogonal to one another with $\theta = \rho\sigma_\eta/\sigma_a$ and $\mathrm{var}(u_{i1}) = \sigma_\eta^2\,(1-\rho^2)$. Furthermore, it is assumed that the initial observation of L is not correlated with u_{it}, i.e. $\mathrm{E}(u_{it}, L_{i1}) = 0$ and also it is not correlated with x_{it} for all i and in all $t=2,...,T$.

If equation (4) is now incorporated into equation (3), equation (5) emerges

$$L_{i1}^{*} = z_i^{'}\lambda + \theta\alpha_i + u_{i1} \tag{5}$$

which in combination with equation (2) constitute the following full specification of Heckman's model:

$$\begin{cases} L_{i1}^{*} = z_i^{'}\lambda + \theta\alpha_i + u_{i1} \\ L_{it}^{*} = \gamma L_{it-1} + x_{it}^{'}\beta + \overline{x}_i^{'}\delta + \alpha_i + u_{it}, \quad i=1,2,\dots,N \quad \text{and} \quad t=2,\dots,T \end{cases} \tag{6}$$

According to Heckman (1981a, 1981c), under the assumption that $\alpha_i \sim IN\left(0,\sigma_\alpha^2\right)$ is independent of u_{it} and that the distribution of L_{i1}^{*} conditional on a_i, x_{it} and L_{it-1} is independent normal, this model can be estimated by marginalizing with respect to a and we get the following likelihood function for each individual i:

$$\begin{aligned} logL_i = \int_{-\infty}^{\infty} \Bigg\{ \Bigg[\prod_{t=2}^{T} \Phi \Bigg[\left(x_{it}^{'}\beta + \gamma L_{it-1} + \overline{x}_i^{'}\delta + \sigma_\alpha \frac{\alpha_i}{\sigma_\alpha} \right) (2L_{it} - 1) \Bigg] \times \\ \times \Phi \Bigg[\left(z_i^{'}\lambda + \overline{x}_i^{'}\delta + \theta\sigma_\alpha \frac{\alpha_i}{\sigma_\alpha} \right) (2L_{i1} - 1) \Bigg] \Bigg] \Bigg\} \phi\left(\frac{\alpha_i}{\sigma_\alpha}\right) d\frac{\alpha_i}{\sigma_\alpha} \end{aligned} \tag{7}$$

where ϕ and Φ are the density and distribution function of the standard normal respectively. With a_i taken to be normally distributed, the integral over a_i / σ_α can be evaluated using Gaussian-Hermite quadrature (Butler and Moffit, 1982). To check the exogeneity of the initial conditions one can perform a t-test on θ.

4.3 Orme Model

Orme (1996) follows Heckman assuming that the model is fully specified by a system of a simple probit for the initial period, like the one in equation (3), and a dynamic random effects probit model for the remaining time periods, like the one described in equation (2). Orme then suggests a linear specification, in terms of orthogonal error components in such a way that again $\rho \neq 0$:

$$\alpha_i = \kappa\eta_i + w_i \tag{8}$$

By construction η_i and w_i are orthogonal to each other, $\varkappa = \rho\sigma_\alpha / \sigma_\eta$ and $\mathrm{var}(\varkappa) = \sigma_\alpha^2 (1-\rho^2)$. Substituting (8) into (2) we get:

$$L_{it}^* = x_{it}'\beta + \gamma L_{it-1} + \bar{x}_i'\delta + \kappa\eta_i + w_i + u_{it} \tag{9}$$

Orme points out that firstly, in this new random effects probit there are two individual specific random effects, η_i and w_i, and secondly the assumption of bivariate normality of (η_i, a_i) implies that $E(w_i \mid \eta_i) = 0$ and $E(\eta_i \mid L_{i1}) = e_i = (2L_{i1}-1)\phi(\lambda' z_i)/\Phi[(2L_{i1}-1)\lambda' z_i]$. Because u_{it} is assumed to be orthogonal to the regressors, w_i can be treated as the common error component in a random effects probit, as long as we take care of the unobservable η_i. Taking into consideration that e_i is derived from a probit model from equation (2), it is reasonable to substitute η_i by its conditional expectation. Thus, equation (9) becomes a random-effects probit with an extra regressor e_i, under normality assumptions. A test of the null hypothesis that $\rho = 0$ can be obtained by a simple *t*-test on the coefficient of e_i.

One must exercise caution as the assumption of bivariate normality of (η_i, a_i) makes w_i heteroskedastic[12] and might produce inconsistent results. Orme (1996) however, after performing Monte-Carlo simulations, shows that in the case of a small ρ, the heteroskedasticity is not a problem warranting particular concern.

4.4 Wooldridge Model

Wooldridge (2005) proposes a parametric method of estimation, which instead of modelling the density of (L_{i1},…,L_{iT}) with respect to x_i, models the density of (L_{i2},…,L_{iT}) conditional on (L_{i1}, x_i). In other words Wooldridge suggests modelling the unobserved effect conditional on the value of the initial period and other exogenous variables. ε_i is expressed in terms of L_{i1} and $\bar{x}_i$, following Mundlak (1978) and Chamberlain (1984) and get $\varepsilon_i = \alpha_0 + \alpha_1 L_{i1} + \bar{x}_i'\delta + \alpha_i$. Substituting in (1) the model is specified as:

$$L_{it}^* = x_{it}\beta + \gamma L_{i,t-1} + \alpha_0 + \alpha_1 L_{i1} + \bar{x}_i'\delta + \alpha_i + u_{it} \tag{10}$$

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[12] In particular $\mathrm{var}(w_i \mid L_{i1}) = \sigma_\alpha^2\left[1-\rho^2\left(\phi(\lambda' z_i)/\sqrt{\Phi(\lambda' z_i)\Phi(-\lambda' z_i)}\right)\right]$.

This estimator is a random effects probit following a different approximation for the unobservables. To test whether the initial conditions are exogenous one can perform a t-test on α_1.

4.5 Interpretation of Coefficients

It is essential to correctly interpret the estimated coefficients—especially that of γ as it measures the level of low pay persistence. Unlike linear models, the coefficients of all estimators presented in the previous section are not equal to the change in the conditional mean of the dependent variable when regressors change by one unit. This means that we need to estimate for example the partial effect of $L_{i,t-1}$ on $\Pr(L_{i,t}=1)$. There are several ways to estimate the marginal effects for this kind of model. Here the predicted probabilities, used to calculate the marginal effects, are estimated based on the coefficients from the estimated models and taking the lagged dependent variable fixed at 1 and 0 while the rest of the regressors are kept in their sample mean value:[13]

$$\begin{cases} \hat{\Pr}\left(L_{it}=1 \mid L_{it-1}=1, \overline{x}_{it}\right)=\Phi\left[\left(\gamma+\overline{x}'_{it}\hat{\beta}\right)\left(1-\hat{\rho}\right)^{0.5}\right] \\ \hat{\Pr}\left(L_{it}=1 \mid L_{it-1}=0, \overline{x}_{it}\right)=\Phi\left[\left(\overline{x}'_{it}\hat{\beta}\right)\left(1-\hat{\rho}\right)^{0.5}\right] \end{cases} \tag{11}$$

The difference between these two probabilities gives the marginal effect at the mean of L_{it-1} on $\Pr(L_{it}=1)$. In the same way marginal effects are estimated for all independent variables. Standard errors were estimated using the delta method.

5 Empirical Results

5.1 Low Pay Probabilities of Employees

Estimates of the models of the probability of being low paid for those in paid employment in *t* and *t-1* are presented in Table 4. In order to check whether the results are sensitive to the choice of estimator, five alternative

[13] For simplicity the vector $\overline{x}'_{it}$ contains the time means as well as the auxiliary terms used to model the initial conditions and $\hat{\beta}$ contains all the estimated coefficients.

estimators are presented: a dynamic pooled and a dynamic random effects probit model, which assume that initial conditions are exogenous, as well as the estimators of Heckman, Orme and Wooldridge, which assume endogenous initial conditions. All models contain as independent variables those listed in Table A.1 plus their time averages and year dummies. Moreover, pre-sample information is used to model the initial conditions in the Heckman and Orme model. In particular, a dummy variable of whether the individual was unemployed five years before the beginning of the survey, an indicator variable of having a job or not before joining the survey as well as a dummy variable of being unemployed one year before the survey are included in the initial conditions equation to ensure that identification of the model does not depend on non-linearities in the functional form.[14] A Wald test of the significance of the pre-sample information is also presented in the very bottom of Table 4, indicating that they are jointly highly significant in both models.

The results for the three estimators controlling for the initial conditions turn out to be very similar, especially regarding their marginal effects, indicating that our results are rather robust and free of any potential bias arising from the chosen model. In this context it should be noted that Arulampalam and Stewart (2009) argue that none of the three estimators displays an advantage over the others when the Mundlak–Chamberlain specification is included. Consequently, we focus on the Heckman model in order to shorten the presentation. Upon examination of Table 4, it appears that the marginal effect of the lagged dependent variable is smaller in the models controlling for the initial conditions, while those of the *X'*s in most cases are slightly higher (in absolute values) than those in the pooled probit.

The variable of analytical interest is that of previous low pay. In all models it came out positive and highly significant, suggesting that previous low pay status increases the probability of current low pay. It is worth mentioning that because random effects and pooled probit models involve a different normalization, their coefficients are not directly comparable (Arulampalam, 1999). For valid comparisons, one needs to multiply them by $\sigma_u/\sigma_v = (1-\lambda)^{0.5}$.

[14] Theoretically, we do not need such identifying variables, but without them we depend on functional form to identify the model. Some researchers do not use any instruments at all, e.g. Andrén (2007) and Hansen et al. (2006).

The scaled coefficients for the lagged dependent variable in models 2 to 5 are 0.963, 0.615, 0.598, and 0.553 respectively. This suggests that the coefficient of previous low pay status is further reduced when random effects are also taken into account. In models in columns 3 to 5, which also control for the initial conditions, the coefficient of the lagged dependent variable is almost half that of the pooled probit model. To quantify exactly the effect of previous low pay status upon current low pay, its marginal effect is also presented. It is worth mentioning two features of this marginal effect. First, it is defined in a "similar" way to the state dependence difference measure presented in Table 1 and thus shows the difference between the low pay probability for those previously low paid and those who were not low paid a year before. Secondly, it takes into account the above necessary scaling (see also equation (11)) making all the models directly comparable. While the raw state dependence measure is around 48%, it is reduced to 25.7% when observed characteristics are introduced in the estimation (pooled probit), to 16.3% when unobserved heterogeneity is also added (random effects probit) and is reduced further to 7.2% and 8.4% when the initial conditions are also taken into account (Heckman, Orme, and Wooldridge models). This result suggests that true state dependence is severely overestimated when observed and unobserved characteristics as well as initial conditions are ignored. However, it remains substantial, implying that there is a considerable *ceteris paribus* dependence between previous and current low pay.

Initial conditions are incorporated in models of columns 3 to 5. In all three specifications they appear highly significant and we cannot reject the hypothesis that initial conditions are endogenous and thus should be taken into consideration in the estimations. In the Orme and Wooldridge estimators the initial conditions are incorporated in the models as auxiliary regressors. In both cases they have a significant positive effect on the probability of being low paid. However, the size of the corresponding coefficient and marginal effect differ as a result of the different distributional assumptions each model makes. It is interesting that in the Wooldridge estimator, being low paid in the base year increases low pay probability by 7.2 percentage points, while the corresponding number for previous year low pay is 8.3, indicating that the experience of low pay has a longer effect.

Looking at the impact of the exogenous variables, education as expected has a significant negative effect on the probability of low pay. In particular being a secondary school graduate decreases the low pay probability by 1.5 percentage points, while having a university degree reduces the low pay probability by 3.6 percentage points. The effect of age in all models is negative, significant and increasing. Interestingly, marriage turns out to have the highest reduction of low pay likelihood, amounting specifically to 6 percentage points compared with the non-married. Low pay probabilities are lower for men living in Attica and for those holding a supervisory position in their job. Other job characteristics such as sector, type of work contract and level of skills came out as insignificant. However, their time averages, with the exception of high-skill, are highly significant and their sign as expected.

Table 4: Dynamic random effects probit models for low pay probability

	I. C. exogenous				I.C. endogenous					
	Probit		R.E. Probit		Orme's Estimator		Wooldridge's Estimator		Heckman's Estimator	
	(1)		(2)		(3)		(4)		(5)	
Low paid at *t-1*	1.303***	[0.257]	1.095***	[0.163]	0.763***	[0.084]	0.740***	[0.083]	0.728***	[0.072]
	(0.055)		(0.072)		(0.090)		(0.090)		(0.114)	
Generalised error					0.357***	[0.033]				
from *t=1* probit					(0.063)					
Low paid at *t=1*							0.671***	[0.072]		
							(0.114)			
University	-0.314***	[-0.026]	-0.345***	[-0.026]	-0.451***	[-0.029]	-0.380***	[-0.026]	-0.619***	[-0.036]
	(0.109)		(0.131)		(0.153)		(0.146)		(0.216)	
Secondary education	-0.152***	[-0.014]	-0.166**	[-0.014]	-0.221***	[-0.016]	-0.187**	[-0.014]	-0.224**	[-0.015]
	(0.056)		(0.069)		(0.079)		(0.078)		(0.106)	
Age 25-34	-0.420***	[-0.035]	-0.531***	[-0.038]	-0.634***	[-0.040]	-0.538***	[-0.036]	-0.379*	[-0.024]
	(0.084)		(0.100)		(0.117)		(0.109)		(0.206)	
Age 35-44	-0.520***	[-0.043]	-0.694***	[-0.050]	-0.836***	[-0.052]	-0.670***	[-0.045]	-0.534**	[-0.033]
	(0.100)		(0.124)		(0.145)		(0.137)		(0.233)	
Age 45+	-0.573***	[-0.048]	-0.752***	[-0.056]	-0.881***	[-0.058]	-0.735***	[-0.051]	-0.653***	[-0.040]
	(0.106)		(0.133)		(0.154)		(0.147)		(0.245)	
Attica	-0.171***	[-0.015]	-0.199***	[-0.016]	-0.218**	[-0.016]	-0.175**	[-0.013]	-0.344***	[-0.023]
	(0.058)		(0.073)		(0.085)		(0.083)		(0.116)	
Public sector	-0.064	[-0.006]	-0.068	[-0.006]	-0.124	[-0.009]	-0.083	[-0.006]	-0.177	[-0.012]
	(0.177)		(0.192)		(0.205)		(0.201)		(0.270)	
Permanent	-0.043	[-0.004]	-0.059	[-0.005]	-0.074	[-0.006]	-0.086	[-0.007]	-0.012	[-0.001]
contract	(0.082)		(0.088)		(0.093)		(0.092)		(0.122)	

Table 4 (continued)

	I. C. exogenous				I.C. endogenous					
	Probit		R.E. Probit		Orme's Estimator		Wooldridge's Estimator		Heckman's Estimator	
	(1)		(2)		(3)		(4)		(5)	
Supervisor	-0.452*	[-0.031]	-0.511*	[-0.032]	-0.685**	[-0.035]	-0.522*	[-0.031]	-1.155**	[-0.045]
	(0.272)		(0.298)		(0.343)		(0.312)		(0.554)	
Married	-0.401*	[-0.045]	-0.479**	[-0.048]	-0.595**	[-0.055]	-0.535**	[-0.050]	-0.715**	[-0.061]
	(0.205)		(0.225)		(0.238)		(0.237)		(0.311)	
High skilled	0.093	[0.009]	0.094	[0.008]	0.051	[0.004]	0.105	[0.009]	-0.204	[-0.013]
	(0.321)		(0.358)		(0.386)		(0.382)		(0.577)	
Time-averaged characteristics										
Public sector	-0.486**	[-0.046]	-0.581***	[-0.056]	-0.671***	[-0.062]	-0.633***	[-0.061]	-0.587*	[-0.038]
	(0.192)		(0.215)		(0.233)		(0.229)		(0.303)	
Permanent	-0.509***	[-0.048]	-0.675***	[-0.065]	-0.687***	[-0.064]	-0.667***	[-0.065]	-0.902***	[-0.090]
contract	(0.111)		(0.134)		(0.149)		(0.146)		(0.211)	
Supervisor	-0.831**	[-0.079]	-0.994**	[-0.095]	-1.027**	[-0.095]	-1.087**	[-0.105]	-1.087	[-0.043]
	(0.371)		(0.437)		(0.491)		(0.484)		(0.672)	
Married	0.049	[0.005]	0.036	[0.003]	0.069	[0.006]	0.084	[0.008]	0.009	[0.000]
	(0.219)		(0.243)		(0.259)		(0.259)		(0.339)	
High skilled	-0.611*	[-0.058]	-0.675*	[-0.065]	-0.664	[-0.062]	-0.703	[-0.068]	-0.842	[-0.041]
	(0.360)		(0.404)		(0.440)		(0.435)		(0.681)	
Constant	-0.047		0.232		0.424***		0.069		0.425*	
	(0.115)		(0.144)		(0.163)		(0.155)		(0.248)	
ϑ									0.566***	
									(0.134)	
σ_u			0.542***		0.733***		0.731***			
			(0.068)		(0.075)		(0.075)			
λ			0.227***		0.350***		0.348***		0.422***	
			(0.044)		(0.047)		(0.046)		(0.055)	
Log likelihood	-1656.896		-1639.734		-1572.573		-1617.617		.-1517.755	
Sample size	7214		7214		7093†		7214		10643	
PCP (%)	90		90		90		90		90	
x^2-statistic(df)	1856.70(23)		919.00(23)		680.57(24)		710.64(24)		341.42(23)	
[p-value]	0.000		0.000		0.000		0.000		0.000	
Wald test for IC instrument validity			$x^2(3)$		36.18				28.49	
			[p-value]		0.000				0.000	

Notes: (i) Standard errors shown in parentheses. (ii) Marginal effects shown in square brackets. (iii) All models contain year dummies. (iv) Models (1) - (4) estimated using observations for t>1 only. (v) PCP: Percentage of Correct Predictions. (vi) df: Degrees of freedom. (vii) * p<0.10, ** p<0.05, *** p<0.01.

† Different sample size due to missing values in instruments used for initial conditions.

5.2 Low Pay-No Pay Probabilities

The analysis so far has been confined to those in paid employment in both *t* and *t-1* years, ignoring transitions out of paid employment. However, as the raw data of Table 3 illustrated, about 22% of those in low pay at *t-1* move in the following year to self-employment, unemployment or inactivity. Consequently it would be interesting to analyze the probability of low pay for those out of paid employment at *t-1* as well. Likewise, it would also be interesting to model the transitions from low pay at *t-1* to higher pay or out of paid employment. The latter is reasonable on the assumption that for those in low pay a transition to unemployment, to inactivity or even to self-employment is probably indifferent in terms of well-being, especially if their reservation wage is close to the low pay threshold. A framework similar to that used by Stewart (2007) for unemployment is adopted, to model such probabilities. In particular, a dynamic random effects probit framework is utilised, where the five mutually exclusive labour market states of previous year, as presented in Table 3, are used as independent regressors. In the estimated models four dummy variables are included treating self-employed as the reference group. Since all estimators controlling for the initial conditions problem in section 5.1 provided similar results, only the Wooldridge estimator is presented.

Results of the Wooldridge estimator are presented in Table 5. Model (1) estimates the probability of low pay in a similar way as the models in Table 4. The difference is that here the sample is extended to include those not in paid employment in *t-1* and thus we examine the effect of previous unemployment or inactivity on the probability of current low pay.[15] The lagged dependent variable emerges as positive and highly significant. The same holds for the previous higher pay and unemployment variables. This implies that employees as well as the unemployed have a higher probability of ending up in low pay the next year compared with the self-employed, our reference group. Thus, the low paid are 19 per cent more likely to remain in low pay, while the corresponding numbers for the higher paid and the unemployed are 4.3 and 9.0 per cent respectively. The coefficient of previously being in-

[15] Obviously the analysis here, like that of Cappellari and Jenkins (2008a), does not include the same variables as in Table 4, because there is no information on job related variables for those out of paid employment.

Table 5: Dynamic random effects probit models for low pay, higher pay, out of labour market probability

	Prob.(low paid in *t*) (1)		Prob.(higher paid in *t*) (2)		Prob.(unemployed or inactive in *t*) (3)	
Low paid at *t-1*	1.380***	[0.189]	1.699***	[0.529]	0.892***	[0.240]
	(0.078)		(0.062)		(0.066)	
Higher paid at *t-1*	0.649***	[0.043]	2.342***	[0.646]	0.304***	[0.064]
	(0.063)		(0.057)		(0.049)	
Unemployed at *t-1*	0.881***	[0.090]	1.229***	[0.390]		
	(0.081)		(0.065)			
Inactive at *t-1*	-0.041	[-0.002]	0.102	[0.028]		
	(0.083)		(0.064)			
Unemployed or inactive at *t-1*					2.203***	[0.589]
					(0.062)	
Initial status	0.464***	[0.035]	1.056***	[0.304]	0.992***	[0.243]
	(0.073)		(0.075)		(0.087)	
University	-0.556***	[-0.023]	0.475***	[0.139]	-0.426***	[-0.076]
	(0.073)		(0.051)		(0.058)	
Secondary education	-0.228***	[-0.012]	0.234***	[0.065]	-0.115***	[-0.023]
	(0.047)		(0.040)		(0.041)	
Age 25-34	-0.238***	[-0.012]	0.295***	[0.084]	-0.436***	[-0.079]
	(0.063)		(0.061)		(0.060)	
Age 35-44	-0.575***	[-0.025]	0.386***	[0.110]	-0.508***	[-0.091]
	(0.082)		(0.073)		(0.080)	
Age 45+	-0.843***	[-0.045]	0.009	[0.002]	0.396***	[0.082]
	(0.085)		(0.072)		(0.072)	
Attica	-0.159***	[-0.008]	0.115***	[0.032]	0.096**	[0.020]
	(0.051)		(0.041)		(0.041)	
Married	-0.301***	[-0.018]	0.157***	[0.042]	-0.247***	[-0.052]
	(0.060)		(0.050)		(0.057)	
Constant	-1.616***		-2.641***		-0.102*	
	(0.092)		(0.083)		(0.059)	
σ_u	0.586***		0.623***		0.5768***	
	(0.045)		(0.041)		(0.050)	
λ	0.256***		0.280***		0.2496***	
	(0.029)		(0.026)		(0.033)	
Log likelihood	-3398.671		-5644.646		-5131.018	
Sample size†	21255		21255		21255	
PCP (%)	94		89		92	

Table 5 (continued)

	Prob.(low paid in *t*)	Prob.(higher paid in *t*)	Prob.(unemployed or inactive in *t*)
	(1)	(2)	(3)
x^2-statistic(df)	1338.72(18)	6221.34(18)	5840.91(17)
[p-value]	0.000	0.000	0.000
$\hat{p}_{lp}$	0.236	0.606	0.376
$\hat{p}_{hp}$	0.094	0.695	0.279
$\hat{p}_{un}$	0.147	0.524	0.634
$\hat{p}_{in}$	0.051	0.362	
$\hat{p}$	0.053	0.349	0.250

Notes: (i) Standard errors shown in parentheses. (ii) Marginal effects shown in square brackets. (iii) All models contain year dummies (iv) PCP: Percentage of Correct Predictions. (v) df: Degrees of freedom. (vi) $\hat{p}_{lp}$, $\hat{p}_{hp}$, $\hat{p}_{un}$, $\hat{p}_{in}$ = average predicted probabilities of dependent variable =1 given low paid, higher paid, unemployed, inactive at *t-1*, respectively. (vii) $\hat{p}$ = average predicted probability of dependent variable =1. (viii) * p<0.10, ** p<0.05, *** p<0.01.
† These models include those in and out of paid employment at *t-1*.

active is insignificant. This means that the low pay probability for those inactive at *t-1* does not differ from that of those self-employed at *t-1*. A possible explanation might be that the majority of the inactive do not move out of this state for a long time or even at all, which is difficult to capture in an eight year survey. Since these marginal effects are estimated with respect to a reference group, at the bottom of Table 5 predicted probabilities are also reported. It is clear that those previously on low pay display the highest probability of being low paid the following year. Another interesting result is that the probability of low pay for those in unemployment at *t-1* is rather high, almost 15 per cent. An individual is about 1.5 times more likely to be low paid at *t*, if he was unemployed at *t-1* than if he was employed and higher paid at *t-1 ceteris paribus*. The low pay probability ratio for those previously unemployed to those previously inactive is around 3. This reaffirms in a more formal way what the raw probabilities in Table 3 suggest. Finally, initial low pay has a positive and highly significant effect on current low pay.

Model 2 of Table 5 estimates the probability of being highly paid in *t*. The coefficients for all previous labour market status dummy variables, except inactivity, are positive and statistically significant. This implies that compared to the reference group, employees and the unemployed are more likely to end up in higher pay the following year. The predicted probabilities at the bottom of Table 5 suggest that the probability of being higher paid is 60 per cent for those previously low paid and 69.5 per cent for those previously higher paid. The corresponding probabilities for the unemployed and inactive are 39 and 2.8 respectively. These probabilities show that low pay can be considered as a stepping stone to higher pay. Compared to unemployed men, low paid men have a higher probability of ending up in higher pay next year, i.e. the probability of being highly paid is larger for previously low paid workers than for the unemployed or inactive. Again, initial conditions have a positive effect on current higher pay and their exogeneity is strongly rejected.

Model 3, presented in the last two columns of Table 5, shows the incidence of unemployment or inactivity in period *t*. As expected, the lagged dependent variable has a positive and highly significant effect. Its marginal effect is 60 per cent and the corresponding probability 63.4 per cent. An interesting result here is that the low paid have four times higher marginal effect than those highly paid. In terms of predicted probabilities, the probability of being out of employment at *t* condition on low pay at *t-1* is 37.6 per cent, while for those previously highly paid it is 28 per cent. This finding, combined with the results of model 1, shows that there is a low pay-no pay cycle in the Greek labour market—i.e. the low paid compared with higher paid are more likely to move out of employment. It should be pointed out that for those previously in low pay, the probability of moving to higher pay is almost double (60.6 per cent) the probability of exiting employment (37.6 per cent), while their probability of staying low paid is remarkably lower (23.6 per cent). A low pay-no pay cycle is also found by Stewart and Swaffield (1999) for the UK. It is worth mentioning that in all models of Table 5 the coefficients and the marginal effects of the lagged labour market status are significantly different from each other, suggesting that when the sample is restricted only to those in paid employment in both *t-1* and *t* and does not include transitions in and out of paid employment, a considerable amount of information is lost.

The rest of the exogenous variables used in the analysis display the expected sign. In particular, education has a negative effect on the probability of low pay and unemployment-inactivity and a positive effect on the likelihood of higher pay. The negative/positive effect of education is stronger for higher levels of education. The age effect is consistent with the human capital model. Younger men face higher probability of being low paid or not working, as well as lower probability of being highly paid. A noteworthy result is that the negative impact of age on the likelihood of low pay almost doubles between age categories, which is not the case in models 2 and 3; nevertheless, the absolute difference in the marginal effects remains notable. Moreover, living in the area of Attica decreases the incidence of low pay but increases the incidence of higher pay and being out of paid employment. Finally, married individuals have higher chances of being better paid and lower chances of being low paid or not employees.

5.3 Second-Order Low Pay Dynamics

The results from the previous sections suggest that the labour market status in year *t-1* has a significant impact on the likelihood of low pay in year *t*. A reasonable question is whether the effect of previous labour market status extends further back in time than *t-1*. Moreover, it is interesting to examine how different combinations of previous labour market statuses affect the probability of future low pay. For instance, of the men who were low paid at *t-2*, are those who became highly paid at *t-1* more or less likely to be low paid again at *t* compared with those who entered unemployment at *t-1*? One way to address this issue is to use a second-order dynamic model which allows low pay at *t* to depend on labour market status at *t-1* and at *t-2*. Combinations of previous labour market statuses enter the equation as independent variables. For the five different states at *t-2* and *t-1* there are twenty-five such combinations.[16] Indicator variables for twenty-three of them are used in our estimations, with those self-employed at *t-2* and inactive or self-employed at *t-1* as the reference group.[17] Initial conditions are modelled using labour market status indicators for the first two periods, following Wooldridge (2005).

Results of the second order model are presented in Table 6. A notable finding is that the coefficients of repeated low pay and low pay after higher pay, unemployment, inactivity or self-employment are rather similar in terms of significance and size. A test of coefficient equality suggests that they are in-

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[16] If the lags were increased to three, the additional variables would be 125 with many of them having no observations, while there would be a great loss of degrees of freedom.
[17] Because of the very small number of observations the two categories had to be merged.

Table 6: Second-order dynamic random effects probit for low pay probability

Prob.(low paid in *t*)					
LL	1.567*** (0.165)	[0.245]	SL	1.574*** (0.203)	[0.256]
LH	0.948*** (0.150)	[0.100]	SH	1.147*** (0.169)	[0.141]
LU	1.042*** (0.214)	[0.120]	SU	1.028*** (0.260)	[0.118]
LI	0.109 (0.267)	[0.006]	Low paid at t=1	0.367*** (0.122)	[0.024]
LS	0.321 (0.295)	[0.021]	Higher paid at t=1	0.110 (0.110)	[0.005]
HL	1.510*** (0.155)	[0.232]	Unemployed at t=1	0.100 (0.126)	[0.005]
HH	0.431*** (0.130)	[0.024]	Inactive at t=1	0.094 (0.135)	[0.005]
HU	0.923*** (0.207)	[0.097]	Low paid at t=2	0.394*** (0.147)	[0.026]
HI	0.534** (0.239)	[0.041]	Higher paid at t=2	0.091 (0.122)	[0.004]
HS	0.504** (0.214)	[0.038]	Unemployed at t=2	0.152 (0.143)	[0.008]
UL	1.577*** (0.184)	[0.255]	Inactive at t=2	0.276* (0.143)	[0.016]
UH	0.761*** (0.189)	[0.070]	University	-0.558*** (0.085)	[-0.020]
UU	0.819*** (0.164)	[0.078]	Secondary education	-0.228*** (0.053)	[-0.010]
UI	0.408* (0.211)	[0.028]	Age 25-34	-0.306*** (0.077)	[-0.013]
US	0.044 (0.367)	[0.002]	Age 35-44	-0.529*** (0.098)	[-0.020]
IL	1.270*** (0.217)	[0.172]	Age 45+	-0.816*** (0.101)	[-0.040]
IH	0.830*** (0.210)	[0.082]	Attica	-0.197*** (0.058)	[-0.009]
IU	0.639*** (0.185)	[0.054]	Married	-0.273*** (0.067)	[-0.015]
II	-0.261 (0.160)	[-0.011]	Constant	-1.688*** (0.120)	[-0.090]

Table 6 (continued)

Prob.(low paid in *t*)		
IS	0.698** (0.300)	[0.062]
σ_u	0.476***	(0.067)
λ	0.184***	(0.042)
Log likelihood	-2457.645	
Sample size†	16397	
PCP (%)	94	
x^2-statistic(df)	1310.86(43)	
[p-value]	0.000	

Notes: (i) Lagged status variables: L, H, U, I denote low paid, higher paid, unemployed, inactive, respectively. (ii) First letter in lagged status variables is status at *t-2*, second is status at *t-1*. (iii) Standard errors shown in parentheses. (iv) Marginal effects shown in square brackets. (v) All models contain year dummies. (vi) PCP: Percentage of Correct Predictions. (vii) df: Degrees of freedom. (viii) * p<0.10, ** p<0.05, *** p<0.01.
† These models also include individuals not employed at *t-1* & *t-2*.

significantly different from each other, implying that the probability of low pay is higher for those low paid at *t-1* regardless of their status at *t-2.*[18] In other words, the effect of previous year low pay is not mitigated by labour market status at *t-2*. This finding is important as it suggests that low pay itself creates a kind of trap with long-term effects.

Low pay predicted probabilities from the second order model are presented in Table 7. Obviously they follow the same pattern as the estimated coefficients. Thus, the predicted probability of low pay for those low paid at *t-1* is almost double the corresponding probability of any other state at *t-1*. It also emerges that unemployment at *t-1*, following a spell of paid employment or unemployment, has a relatively high impact on the likelihood of low pay. This result implies that certain individuals either cannot keep a higher paid job, or cannot remain in paid employment and become low paid. On the other hand, higher pay after inactivity or self-employment has the highest impact on the probability of low pay at *t*, which suggests that a considerable

[18] The Wald test of coefficient equity is $x^2(4)$=2.89 (*p*-value: 0.58).

proportion of the self-employed or inactive do not remain higher paid and become low paid.

Table 7: Probability of low pay from second-order random effect probit model

	Status at *t-1*				
Status at *t-2*	(1)	(2)	(3)	(4)	(5)
1. Low paid	0.217	0.099	0.113	0.025	0.037
2. Higher paid	0.204	0.044	0.096	0.053	0.050
3. Unemployed	0.220	0.075	0.082	0.043	0.022
4. Inactive	0.153	0.084	0.062	0.012	0.068
5. Self-employed	0.219	0.131	0.111	*Reference:* 0.020	

6 Summary and Conclusions

This paper has used data from the European Community Household Panel to analyse low pay dynamics in Greece, paying attention to the existence and measurement of individual state dependence in low pay. The raw data indicate that there is extensive persistence of low pay. The probability of being low paid is considerably higher for those who were low paid a year ago. Moreover, low paid employees are more likely to exit paid employment than higher paid employees, while those entering paid employment are more likely to end up in low pay, suggesting that there is a low pay-no pay cycle in Greece.

This aggregate state dependence can be a result of either (un)observed heterogeneity or of the experience of previous low pay. To correctly quantify the latter, various dynamic random effects probit models that control for observed and unobserved heterogeneity have been used. It is analytically necessary to take into consideration unobserved heterogeneity, as well as the initial conditions. All estimated models indicate that initial conditions are endogenous and ignoring them tends to considerably overestimate the effect of previous low pay incidence. In general, the risk of low pay in year *t* is evidently higher if one was low paid the previous year, even after controlling for observed and unobserved characteristics. The extent of low pay persistence varies between 7.2 to 8.4 percentage points, suggesting that there is a scarring effect of low pay and that for some workers low pay is not a transitory situation but a lasting "curse". Moreover, it seems that certain characteristics, such as old age, higher level of education, living in Attica and being married reduce the risk of being low paid. These results also indicate that the probability of being low paid is lower for those working in the public sector, under a permanent contract or holding a supervisory position.

When transitions into other labour market states are also included in the analysis, the probability of moving up the wage distribution is higher for those previously low paid than for the unemployed or inactive. This supports the hypothesis that low paid jobs act as stepping stones to higher paid jobs, suggesting that low pay employment is better than no employment at all. On the other hand the analysis has also shown strong evidence of a cycle of low pay-no pay in the Greek labour market. Low paid men are more likely to be out of work in the future compared with higher paid employees, while those unemployed are more likely to be low paid on re-entry.

Second order dynamic models were used to examine the paths into low pay as well as how the dynamics of low pay extend further back than a year. A main finding is that the probability of low pay is very high for those low paid at *t-1* regardless of their status the previous year, that is at *t-2*. Moreover, unemployment leads to low pay after paid employment or unemployment. A substantial proportion of those entering higher pay from inactivity or self employment do not keep their highly paid job and move to low pay employment.

The documented impact of previous low pay on current labour market status (low/higher pay, out of paid employment) bears important policy implications. Since previous low pay is the major determinant of current low pay, policies tending to reduce short-term low pay would have a longer lasting negative effect on the level of low pay and unemployment in the economy. Moreover, understanding of the causes of low pay, the main conduits into low pay and the ensuing trajectories of the low paid is very important.

While the impact of labour market institutions, such as minimum wage or trade unions, upon the profile and dynamics of low pay remains internationally an open issue, it is beyond the scope of this paper. The binding minimum wage in Greece, substantially lower than the low pay threshold adopted here, seems to keep some low paid men at its level rather than moving further to the left of the wage distribution.

APPENDIX A

Table A.1: Variable definitions, means and standard deviations

Variable	Description	Mean	(SD)	Mean	(SD) †
University	Holds a degree from university	0.242	(0.428)	0.229	(0.420)
Secondary education	Higher level of education is high school	0.389	(0.488)	0.397	(0.489)
Age 25-34	Aged between 25-34	0.296	(0.457)	0.294	(0.456)
Age 35-44	Aged between 35-44	0.287	(0.452)	0.293	(0.455)
Age 45+	Aged more than 45	0.319	(0.466)	0.327	(0.469)
Attica	Lives in Attica	0.344	(0.475)	0.324	(0.468)
Public	Works in the public sector	0.381	(0.486)	0.363	(0.481)
Permanent contract	Permanent contract in work	0.797	(0.402)	0.803	(0.398)
Supervisor	Supervisory position in work	0.086	(0.280)	0.076	(0.265)
Married	Married	0.694	(0.461)	0.703	(0.457)
High skilled	High skilled	0.150	(0.357)	0.148	(0.355)

Notes:

1. Pooled data for the ECHP waves 1-8 (1994-2001).
2. Sample size unrestricted (minimum number of observations: 8859, maximum: 10643).

† Sample size= 8270 (non-missing in all variables).

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Decomposition of Gender Wage Differentials in Greece Using Quantile Regression Analysis: The Impact of Education

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Abstract

The paper studies the gender earnings differential by education in Greece employing quantile regression analysis and applying a variant of the selection adjusted Oaxaca and Ransom (1994) decomposition method to explain the components of the wage differentials. The results suggest that, in Greece, substantial differences in wages between men and women can be identified among workers with different educational levels. The average wage is higher for men than women for low and high educated workers. Examining the differences in the wage distributions the evidence shows that this differential is sensitive to the choice of the quantile. Gender wage differentials for high educated employees increase towards the upper part of the wage distribution. At all levels of the wage distribution the female disadvantage seems to be the strongest component of the unexplained part of the wage distribution. As regards the employees with a low education level, the unexplained part of the wage differential explains a significant portion of the wage differential at the mean and across the wage distribution.

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1 Introduction

Macroeconomic theory places emphasis on the importance of human capital and its contribution to the theory of economic growth. Economists such as Adam Smith and David Ricardo attempted to study economic growth and to determine its causes. In the 1950s and 1960s, the first theories on economic growth were formulated. In these initial attempts to interpret economic growth, changes in technology – and, therefore, the increase in productivity – were regarded as exogenous factors. The Solow model (1956), sometimes referred to as the Solow - Swan model, has been the cornerstone in the theory of economic growth. It was based on a well-behaved neoclassical production function and it relied on the simplifying assumption that technological progress, the main driver of economic growth in the long-run, is exogenous and to a large extent unexplained (Solow's residual). In the early 1980s, a new approach to economic growth theory underlined the role of human capital as an important factor of economic growth.[1] Lucas (1988) stressed the importance of human capital, as opposed to physical capital. The reinstatement of the concept of human capital is of particular significance for economic growth and social welfare.

Apart from contributing to the economic growth of a country, another aspect of the significance of education is associated with the productive characteristics of a person and is identified by Becker and Mincer's human capital theory. According to the human capital theory, education increases a person's skills, while, at the same time, helps to develop and cultivate existing abilities, thus making an employee more productive and efficient, as well as better paid. Theory, as well as most empirical studies, supports the view that higher education levels are associated with higher remuneration and better opportunities for career advancement.

However, both theoretically and empirically, it seems that remuneration is different between employees with the same productive characteristics. In particular, studies probing the existence of wage differences between men and women indicate that men are better paid than women. Moreover, further

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[1] For an extensive review of literature on the effects of education on economic growth and empirical evidence in developed economies see, *inter alia*, Aghion and Howitt (1988) and Temple (2001).

studies attempt to establish whether these differences are explained by the productive characteristics of employees (education among other things) or constitute the unexplained part of the wage differences. The standard approach to these studies is to estimate separate earnings functions for men and women and to decompose the wage gap into two parts: one part due to differences in the means of variables used in the earnings functions and a second part due to differences in the estimated coefficients on those factors. According to Oaxaca (1973) and Blinder (1973) the first part is explained by differences in observable human capital endowments and other job-related variables between sexes (endowment effect or characteristics differential) and reflects differences in labour productivity between men and women. The second part reflects differences in the coefficients that are assigned to women's and men's characteristics (price effect). This second part is often treated as reflecting discrimination against women (discrimination effect) and in other cases as reflecting unobserved heterogeneity (unexplained residual).[2] A shortcoming of the standard decomposition approach is that it focuses on the mean wage difference. What it really overlooks is the variations of the wage difference across the entire wage distribution. Recent developments in the semiparametric technique of quantile regression analysis allowed combining the decomposition technique with quantile regression analysis to determine the rent components at various points of the wage distribution (Albrecht, Bjorklund and Vroman, 2003; Papapetrou, 2007; de la Rica, Dolado and Llorens, 2008; and Arulampalam, Booth and Bryan, 2007).

The purpose of this study is to expand the examination of wage differentials between men and women and to examine the effect of education levels on those differentials for Greece. The Greek labour market has similar characteristics to the labour markets of some European Union countries, such as Spain and Italy, but is quite different from the labour markets in other EU countries. Moreover, there are major differences and similarities concerning genders, which depend on the education level of employees. Therefore, the

[2] Various researchers have adopted a different terminology to label the second part of the wage gap. Some researchers call the second part 'discrimination effect' and others use the term 'unexplained residual'. For a discussion on the issue see, among others, Weichselbaumer and Winter-Ebmer (2003).

conclusions drawn could be instructive to other countries facing similar economic realities.

For this purpose, men and women employees are distinguished according to their education into low education level employees (primary and secondary education) and high education level employees (post-secondary non-tertiary education, tertiary education and post-graduate studies). As a next step, the existence of wage differentials between men and women depending on the education level is analysed, at the mean and across the entire wage distribution, employing the quantile regression analysis technique. Finally, the study makes use of a variation of the Oaxaca and Blinder decomposition technique in order to explain components of gender wage differentials by education level, on average and in various deciles of the wage distribution. Thus, it is possible to analyse the degree to which this differential is due to differences in the productive characteristics of employees or cannot be explained by them. In addition, the present study aims to bring evidence of the evolution of these differentials in two subsequent years and examine whether these differentials have changed over this two-year period.

The paper proceeds as follows: The second section briefly describes the relation between certain measures of the Greek labour market and the educational characteristics of the population. The third section presents the theoretical approaches used in the analysis of wage differentials between men and women, taking into consideration the role of education, while the fourth section presents the methodological framework of the empirical analysis. The fifth section presents the statistical data used in the analysis and reports the empirical results. In the last section, the conclusions of the analysis are summarised.

2 Some Features of the Greek Labour Market

2.1 Education and Skill Level of the Population

The education level of the Greek population is an indication for the development potential of the country. Younger persons record higher education levels (tertiary education) compared with those already in the labour market (OECD, 2004). This change in education characteristics, over time, possibly reflects the change in the education preferences of the population, which is attributed to higher demand for a highly skilled workforce, the rise in unemployment, which affects the rate of young people wishing to get tertiary education, as well as the general increase in demand for education.

In 2008, the percentage of highly skilled persons (high education level) in Greece was at about 20% of the working age population (15-64 years), 40% of this group was low skilled (lower education level) and 40.2% was medium skilled (medium education level – see Table 1). The percentage of the highly skilled working age population is lower than the corresponding percentage for the EU-25 as a whole (around 22%). The same applies to both male and female highly skilled employees.

Table 1: Working population structure by educational level in Greece and the European Union, 2008[1]

(Classification by educational level and gender, percentages)

	Total Education			Men Education			Women Education		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Greece	40.0	40.2	19.8	41.3	38.8	19.8	38.6	41.6	19.9
EU-25	32.2	45.9	21.8	31.9	47.0	21.1	32.6	44.9	22.5

[1] 15-64 years of age

Notes: Skills correspond to the UNESCO International Standard Classification of Education (ISCED) levels (1997) as follows:

Low skills: ISCED levels 0-2 (pre-primary, primary and lower secondary education).

Medium skills: ISCED levels 3-4 (upper secondary, post-secondary non-tertiary education).

High skills: ISCED levels 5-6 (first stage of tertiary education, second stage of tertiary education).

Source: Authors' own calculations based on the Eurostat Labour Force Survey (original source: European Commission, DG- Employment and Social Affairs, Employment in Europe 2006, Recent Trends and Prospects, on the basis of the Eurostat Labour Force Survey, Spring Results).

2.2 Education and Labour Market Participation

Labour force participation increases with the education level (see Table 2). According to Table 2, which presents the participation rates of the population aged 15-64 in the labour force by education level in Greece and in the EU, it seems that persons with a high level of education are more likely to participate in the labour market. In 2008, the participation rate of the population aged 15-64 in the labour force was around 88% for high educated persons and smaller for the others: around 67% for medium education level employees and almost 57% for lower education level employees. Moreover, in Greece the participation rate of the tertiary education graduates in the labour force is a little higher than the Community average (EU-15: 87.3%), while the participation rate of the population with medium education level in the labour force is smaller than the corresponding Community average (EU-15: 77.5%). Obviously, there is a positive correlation between education levels and participation rates in the labour force.[3]

Table 2: Labour force participation by educational level in Greece and the European Union, 2008[1]

Total education			Low education			Medium education			High education		
Greece	EU-15	EU-25	Greece	EU-15	EU-25	Greece	EU-15	EU-25	Greece	EU-15	EU-25
67.1	72.5	71.4	56.8	57.7	55.0	67.1	77.5	76.0	87.7	87.3	87.2

[1] 15-64 years of age.
Notes: Low education: ISCED levels 0-2 (pre-primary, primary and lower secondary education).
Medium education: ISCED levels 3-4 (upper secondary, post-secondary non-tertiary education).
High education: ISCED levels 5-6 (First stage of tertiary education, second stage of tertiary education).
Source: Eurostat, Labour Force Survey.

2.3 Education and Employment Rate[4]

There are significant differences between the employment rate in the Greek market and the corresponding rate in other European countries, which varies according to education levels (see Table 3).

The employment rate in Greece (around 62% of total population in 2008) is lower than the EU average (67.3% in 2008 for EU-15 and 66.3% for EU-25), while it also falls short of the target-rate (70%) set for 2010 on the basis of the "Lisbon Strategy" (see Table 3). However, in the last few years, the employ-

[3] The Greek educational system consists of three levels: primary, secondary and tertiary education level. Primary education is divided into pre-school education, i.e. kindergartens, and compulsory primary education, i.e. primary schools. Secondary education includes two cycles, compulsory lower secondary education, i.e. gymnasium, and post-compulsory higher secondary education, offered by Unified Senior High Schools and Technical Vocational Educational Institutions (TEE). Tertiary education is divided into university education and non-university education. Post-graduate courses are also available at tertiary education level.
[4] The employment rate is defined as the ratio of the employed persons aged 15-64 to the total number of persons aged 15-64.

Table 3: Employment Indicators in Greece and the European Union, 2008[1]

	Total education			Low education			Medium education			High education		
	Greece	EU-15	EU-25	Greece	EU-15	EU-25	Greece	EU-15	EU-25	Greece	EU-15	EU-25
Total												
Employment rate[2]	61.9	67.3	66.3	52.4	51.2	48.6	61.2	72.4	71.1	82.1	83.8	83.8
Part-time employment rate[3]	5.4	20.4	18.3	6.5	21.2	20.7	5.3	22.2	18.7	4	16.9	15.3
Unemployment rate[4]	7.8	7.2	7.1	7.6	11.4	11.6	8.8	6.5	6.6	6.3	4.0	3.9
Employment gap (2008)[5,7]	26.3 *(-3.1)*	13.8 *(-3.5)*	13.8 *(-2.5)*	35.9 *(1.5)*	20.6 *(-2.5)*	19.6 *(-1.8)*	25.5 *(-3.5)*	11.9 *(-1.4)*	13.0 *(-0.3)*	9.8 *(-3.0)*	7.0 *(-0.6)*	7.2 *(-0.4)*
Unemployment gap (2008)[6,7]	6.4 *(-2.4)*	1.0 *(-0.7)*	1.0 *(-0.7)*	7.3 *(0.0)*	1.9 *(-0.8)*	1.8 *(-0.7)*	7.8 *(-4.0)*	1.2 *(-0.6)*	1.3 *(-0.6)*	3.8 *(-2.4)*	1.0 *(-0.3)*	1.0 *(-0.4)*
Men												
Employment rate[2]	75.0	74.2	73.2	69.8	61.6	58.5	74.4	78.3	77.4	87.0	87.4	87.5
Part-time employment rate[3]	2.5	7.6	7.1	2.9	8.2	8.3	2.4	7.7	6.8	2.0	6.8	6.4
Unemployment rate[4]	5.1	6.7	6.7	5.2	10.6	10.9	5.4	6.0	6.0	4.5	3.5	3.4
Women												
Employment rate[2]	48.7	60.4	59.4	33.9	41.0	38.9	48.9	66.4	64.4	77.2	80.4	80.3
Part-time employment rate[3]	9.8	36.1	32.0	14.5	40.3	39.0	9.3	39.8	33.6	6.3	27.5	24.5
Unemployment rate[4]	11.5	7.7	7.7	12.5	12.5	12.7	13.2	7.2	7.3	8.3	4.5	4.4

[1] 15-64 years of age. As regards education levels, see note in Table 2.
[2] Employed persons aged 15-64 as a percentage of the population aged 15-64.
[3] As a percentage of total employment.
[4] Unemployed persons aged 15-64 as a percentage of the labour force.
[5] Employment rate differentials between males and females.
[6] Differences in the rates of unemployment between males and females.
[7] Numbers in brackets correspond to percentage changes in employment and unemployment gaps respectively in the period 2002-2008 (negative signs indicate decrease in the relative gap, while positive signs indicate increase in the relative gap).
Source: Authors' own calculations based on the Eurostat Labour Force Survey.

ment rate in Greece has risen gradually (56.6% in 2000, 57.7% in 2002, 58.9% in 2003, 59.6% in 2004, 61% in 2006 and 61.9% in 2008), while the corresponding employment rate for the EU-25 increased from 62.2% in 2000 to 66.3% in 2008. The employment gap in Greece (the employment rate differentials between male and female employees) narrowed from 29.4% in 2002 to 26.3% in 2008 reflecting, primarily, the increased participation of women in the labour market and the corresponding increase in the female employment rate. Despite its decrease over time the employment gap in Greece remains higher than the respective gap in the EU-15 (13.8%) and the EU-25 (13.8%) in 2008. Furthermore, the gap seems to have widened since 2002 between low education level male and female employees (35.9% in 2008 from 34.4% in 2002).

The employment rate for men in Greece rose (from around 72% in 2000 to 75% in 2008), while the corresponding rate in the EU-15 increased to 74.2%. The employment rate for women in Greece is significantly lower than that of men (75% for men and 48.7% for women in 2008). Female employment rate in Greece has risen in the last few years (from around 42% in 2000 to 48.7% in 2008), though it falls considerably short of the corresponding EU-15 rate (around 60% in 2008). According to a recent study (Nikolitsas, 2006), certain institutional, social and economic factors caused the increase in female participation in the Greek labour market during the post-1980 period.

Employment rates differ significantly depending on education levels and it seems that the employment rate increases with the rise in education level. The employment rate in Greece for those with a high education level was around 82% in 2008 (close to the EU average in this category, which is around 84%), while the corresponding rates for medium and low education level employees were about 61% and 52%, respectively.

The employment rate for men with high education level (87%) is close to the EU average (87.4%). As regards women, the employment rate in Greece in 2008 is lower than the EU-15 employment rate (around 60%), while it also falls short of the target-rate (60%) set for 2010 on the basis of the "Lisbon Strategy". The employment rate for women with a high education level (77.2%) is relatively close to the EU-15 average (around 80%), and more than double the employment rate for women with lower education (around 34%). The employment rates for women with low and medium education levels are significantly smaller than those for men, and are lower than the corresponding employment rates for women in the EU. Women with a lower education level in Greece are in the least favourable position relative both to men of the same education level and to women in the EU as a whole. It also seems that there is a positive association between education level and employment, as high education levels increase a person's productivity, thus also enhancing the possibility to enter the labour market and to find a job.

Part-time employment, i.e. the number of those employed part-time as a percentage of the total number of employed people in Greece (5.4%) is considerably lower than the EU-15 average (approximately 20%). The part-time employment rate for women in Greece (9.8%) is more than three times higher than for men (2.5%) but lower than the average female part-time employment rate for EU-25 (32%) in 2008. Part-time employment offers employees, particularly women, the opportunity to reconcile work with attending to the needs of their family, especially when the available child-care solutions are insufficient or in cases where the family cannot afford the cost. On the other hand, part-time jobs are typically associated with limited opportunities for career advancement and with lower remuneration (OECD, 1999). This is also indirectly supported by data in Table 3, which show that the part-time employment rate falls with high education levels. Note that women of a lower education level show a higher part-time employment rate (14.5%), which is more than four times higher than the corresponding rate for male employees of a lower education level (2.9%), and more than double that of women with a high education level (6.3%).

2.4 Education and Unemployment

Economic theory suggests that there is a negative relationship between education and unemployment, as the unemployment rate is an indicator for the capacity of the economy to offer suitable employment to any person wishing to work. The unemployment rate in Greece (7.8% of the total labour force in 2008) is higher than the EU average (EU-15: 7.2% and EU-25: 7.1%). However, there is a differentiation of the rate of unemployment based on the education level of employees. High education levels increase skills, productivity and employment opportunities of a person participating in the labour force, while, at the same time, diminish the possibility for a person to remain unemployed. As seen in Table 3, the unemployment rate of the labour force with a high education level (6.3%) in 2008 is significantly smaller than that of the labour force with a medium (8.8%) and a lower (7.6%) education level, although it exceeds the EU-15 average (4%). Women record higher unemployment rates, compared with men of the same education level. In Greece the unemployment gap between male and female employees in 2008 is 6.4% from 8.8% in 2002 (while in the EU-15 the respective gap is 1% from 1.7% in 2002). For high education level employees the unemployment gap has narrowed to 3.8% in 2008 from 6.2% in

2002, but it remains higher in comparison to the respective gap in both the EU-15 and the EU-25 (1.0% in 2008). It is interesting to note that while the unemployment rate of men with a high education level (4.5%) is relatively close to the average EU-15 rate (3.5%), the unemployment rate for women with a high (8.3%) or medium education level (13.2%) is almost double the corresponding rate for the EU-15 (high education level: 4.5%, medium education level: 7.2%). These figures demonstrate that there is a poor match between education in Greece and the needs of the Greek labour market.

3. Theoretical Evidence and Empirical Approaches to Gender Wage Differentials

Studies explaining the existence of wage differentials between the two genders follow one of two different approaches. The first approach, which is the most widely used, is based on quantitative methods in order to determine the relative strength of the various factors affecting the earnings differentials between men and women. One such method is the Oaxaca-Blinder decomposition, which examines whether earnings differentials are due to differences in the productive skills of those employed or they form the unexplained part of the wage differentials. Proponents of this method argue that it identifies those factors that explain the wage differences among the two genders, and so the appropriate policies may be applied in order to address the issue. On the other hand, critics of this method remain sceptical and underline the simplicity of its assumptions.

The second approach on the gender earnings differentials is the comparative institutional approach. In this case, wage differences between men and women reflect both historical and contemporary effects of social and institutional processes, and the functioning of the markets in general and, in particular, the labour markets. Labour market features, such as separation of occupations according to gender, provide a feasible explanation for the earnings differentials between men and women employees. Furthermore, this approach posits that differences in wage structures can largely explain the earnings differentials between genders. These differentials are not explained by differences in abilities and productivity, but reflect contemporary and historical effects of social and institutional processes (Grimshaw and Rubery, 2002). Critics of this theory argue that, according to the human capital theory, women rationally choose certain occupations over others as these occupations require abilities that need not be renewed often.

Empirical studies tend to confirm that male employees receive higher wages than their female counterparts, a fact which is not solely attributed to different productive characteristics of employees. Recent studies examine the wage differentials between men and women across the entire spectrum of the wage distribution in order to establish whether there are wage differentials among the two genders (de la Rica, Dolado and Llorens, 2005; Albrecht, Bjorklund and Vroman, 2003; and Arulampalam, Booth and Bryan, 2007).

Using relevant statistical methodology, de la Rica, Dolado and Llorens (2005) examine wage differentials for Spain for 1999. Their findings are twofold. First, for employees with high education, the wage differentials increase towards the upper levels of the wage distribution. In contrast, as regards low education employees, wage differentials decline towards higher levels of the wage distribution. On the other hand, for workers with high education, a higher unexplained wage differential is revealed at the top rather than the bottom of the wage distribution. For workers with low education, this pattern is reversed as the gap is much higher at the bottom rather than at the top of the distribution. The authors claim that this is the result of statistical discrimination exercised by employers in view of the lower participation rate of women in this group.

Albrecht, Bjorklund and Vroman (2003), using 1998 data for Sweden, estimate that wage differentials increase along the wage distribution, with a sharp acceleration in the upper end of the wage distribution.

Arulampalam, Booth and Bryan (2007), using data for 11 countries (Austria, Belgium, United Kingdom, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands and Spain), show that the wage gap between men and women employees increases significantly towards the upper end of the wage distribution. The authors present various possible explanations for gender wage differentials in the EU. According to this analysis, male-female wage differentials are due to institutional, economic and structural factors. For instance, certain institutional factors, such as legislation against gender discrimination, improvement in childcare infrastructure, as well as parental leave provisions, affect gender wage differentials (Jaumotte, 2003).

Finally, Arulampalam, Booth and Bryan (2007) claim that the institutional framework for wage formation may have a direct effect on the gender wage gap. In countries with higher levels of unionisation and more centralised or coordinated bargaining, which raise the minimum level of pay, the wage distribution spectrum is more compressed and, therefore, the gender wage gap is smaller, particularly towards the lower end of the wages distribution (Blau and Kahn, 1996, 2003).[5]

There is a limited number of studies trying to measure the gender wage gap and evaluate the causes of the existing gap in Greece. Psacharopoulos (1983) estimates wage differentials between males and females and shows that they do not reflect differences in the productive characteristics of the workers. Patrinos and Lambropoulos (1993) show that, despite an increase in women's earnings in relation to men's overtime, earnings differentials attributable to productivity differences account for little, if any, of the gross earnings gap. Kanellopoulos and Mavromaras (2002) study the link between labour market participation and wages in paid employment in Greece. They show that the observed lower female relative pay can be attributed primarily to the factors that determine paid employment participation. The process of labour participation was shown to be highly discriminatory in favour of males. Recently Papapetrou (2007, 2008) reports that in Greece, substantial differences in wages between men and women can be identified, and male and female wage differentials increase towards the upper end of the wage distribution spectrum. Karamessini and Ioakimoglou (2007) develop a heterodox analytical framework of wage determination and a new method of decomposition of the gender pay gap based on Marxian and feminist theories. The authors claim that the proposed method allows for separate estimates of the impact of social and individual gender wage discrimination on the gender pay gap in Greece. Equally limited is the number of studies exploring the earnings differentials between men and women in Greece in comparison with other European countries (Rice, 1999, using data for eight European countries -Denmark, Greece, France, Germany, Italy, Portugal, Spain and the United Kingdom- looks into the case of Greece compared to the other European countries). However, these studies have not looked at the earnings differentials between men and women across the entire range of the wage

[5] For further reference on the effect of the institutional framework on male-female wage differentials see, *inter alia*, Grimshaw and Rubery (2002).

distribution and have not investigated the extent to which the observed wage differentials reflect differences in productive characteristics or constitute the unexplained part of the earnings differentials.

The objective of this study is to examine wage differentials between men and women, according to level of education, on the basis of both average wage and across the wage distribution and to analyse these differentials in order to show whether they reflect differences in the productive characteristics of employees, or constitute a part that cannot be explained on the basis of employees' productive abilities. In addition, the present study aims to bring evidence of the evolution of these differentials in two subsequent years and examine whether these differentials have changed over this two-year period.

4 Methodological Issues and Data

4.1 Methodology

The empirical approach and analysis method of gender wage differentials applied in this study is in accordance with the decomposition technique developed by Oaxaca (1973) and Blinder (1973). According to this method, two equations of wages are estimated. Specifically, one wage equation is estimated for working men:

$$W_{male} = \beta_{male} X_{male} + \varepsilon_{male} \tag{1}$$

and another for working women:

$$W_{female} = \beta_{female} X_{female} + \varepsilon_{female} \tag{2}$$

where W_{male} and W_{female} are the logarithms of men's and women's wages respectively, X_{male} and X_{female} are vectors of variables that describe the characteristics of employed men and women (such as demographic, human capital, or labour characteristics), β_{male} and β_{female} are the coefficients of the variables vector X_{male} and X_{female} and ε_{male} and ε_{female} are the error terms for employed men and women respectively. Equations (1) and (2) were estimated at both low and high education levels.

Following Oaxaca (1973) and Blinder (1973) the total difference in mean wages of men and women can be decomposed into two parts:

$$\overline{W}_{male} - \overline{W}_{female} = (\overline{X}_{male} - \overline{X}_{female})\hat{\beta}_{male} + \overline{X}_{female}(\hat{\beta}_{male} - \hat{\beta}_{female}) \quad (3)$$

where $\overline{W}_{male}$ and $\overline{W}_{female}$ denote the mean log wages and $\overline{X}_{male}$ and $\overline{X}_{female}$ the mean productivity characteristics of male and female employees. $\hat{\beta}_{male}$ and $\hat{\beta}_{female}$ represent the estimated parameters from equations (1) and (2). The first term on the right-hand side of equation (3) represents the part of the logarithm of the earnings differential between genders attributable to the observed differences in human capital or productive characteristics of the employed and is referred to as the "characteristics differential" or "justifiable earnings". The second term represents the part of the earnings differential that is attributable to labour market discrimination and would be equal to zero if male and female employees had the same returns. All estimates are based on the wage distribution mean.

In our analysis the earnings differential is obtained by employing the non-discriminatory structure proposed by Neumark (1988) and Oaxaca and Ransom (1994). The non-discriminatory wage is a vector of rates of return obtained by estimating earnings functions based on the pooled sample of the two demographic groups. This method allows the discrimination component to be further disagreggated into overpayment of male workers (male advantage) and underpayment of female workers (female disadvantage). This decomposition is estimated employing the following equation:

$$\overline{W}_{male} - \overline{W}_{female} = (\overline{X}_{male} - \overline{X}_{female})\hat{\beta}_{pooled} + \overline{X}_{male}(\hat{\beta}_{male} - \hat{\beta}_{pooled}) + \overline{X}_{female}(\hat{\beta}_{pooled} - \hat{\beta}_{female}) \quad (4)$$

where the estimated $\hat{\beta}_{pooled}$ coefficients are obtained employing the non-discriminatory wage structure, when both male and female employees are pooled together. That is, a regression equation is estimated including all the employees without discrimination as to the gender of the employees. The hat over parameters denotes estimated values. The left part of equation (4) is the average wage between genders. The first term on the right side of the equation measures the total difference between genders in the means of the independent variables weighted by the estimated regression coefficient of the estimated non-discriminatory wage structure. This term is the component of the log wage differential due to differences in the productive characteristics between male and female employees and is referred to as "characteristics differential" or "endowment difference". The second term in equation (4) measures the total difference between male workers and the pooled regression for both genders in the coefficients of the estimated wage equations weighted by the means of the regressors in the equation for male employees. The term represents the amount by which men's productivity characteristics are overvalued and it shows the component due to the advantage of the male workers. The third term in equation (4) measures the total difference between the pooled regression for male and female employees in the coefficients of the estimated wage equations weighted by the means of the regressors in the equation for female employees. The last term represents the amount by which women's productivity characteristics are undervalued and it shows the component due to the disadvantage of female employees.

Buchinsky (1994) combined decomposition techniques with quantile regressions to determine the rent component enjoyed by male workers at various points of the wage distribution. In our analysis the decomposition technique suggested by Neumark (1988) and Oaxaca and Ransom (1994) is employed in the case of quantile regression analysis to determine the endowment difference, the advantage of male workers and the disadvantage of female workers. In the quantile regression analysis the Least Absolute Error estimation technique is employed. The objective of this estimation technique is for a given value of θ such that 0<θ<1 the θ^{th} sample regression quantile to be found minimising the function:

$$\sum_{(t|Y_t \geq X_t'\beta)} \theta |Y_t - X_t'\beta| + \sum_{(t|Y_t \leq X_t'\beta)} (1-\theta)|Y_t - X_t'\beta|$$

The solution to the minimisation is the estimator:

$$\hat{\beta} \times (\theta)$$

The quantile regressions have the advantage of being more robust than the more familiar mean regression equations. The observed differences in the estimated coefficients across different quantiles are interpreted as differences in the response of the dependent variable to changes in the independent variables at different points in the conditional distribution. These types of effects are not captured by employing the mean regression equations.

Thus, equation (3) is reformulated as follows:

$$Quant_{\theta}(W_{male} \mid \overline{X}_{male}) - Quant_{\theta}(W_{female} \mid \overline{X}_{female}) = (\overline{X}_{male} - \overline{X}_{female})\hat{\beta}_{pooled} + \\ + \overline{X}_{male}(\hat{\beta}_{male} - \hat{\beta}_{pooled}) + \overline{X}_{female}(\hat{\beta}_{pooled} - \hat{\beta}_{female}) \quad (5)$$

where $Quant_{\theta}$ represents quantiles 0.10, 0.25, 0.50, 0.75, and 0.90 respectively.

5 Data and Empirical Results

5.1 Data

The empirical analysis uses statistical data for Greece, derived from the EL.STAT. survey on Income and Living Conditions (EU-SILC). The survey was carried out in 2003, 2004 and 2005 (covering 2002, 2003 and 2004 income data respectively) and the results for Greece were released by the EL.STAT. The survey includes questions referring both to a household as a whole and to each separate member and derives information regarding demographic characteristics, income, economic conditions, housing conditions etc. The questions on each separate household member present information about age, the family status of each member, education, income, type of work, type of employment, health etc. The EU-SILC survey replaced the European Community Household Panel (ECHP) sampling survey, conducted by Eurostat from 1994 to 2001 and covering all EU countries.

The following statistical analysis uses data from the 2005 survey, referring to 2004 income data. Wage earners were taken into account, while students were excluded. The sample narrowed down to 3,276 (women: 1,345, men: 1,931). Finally, respondents not answering to all the questions used in the empirical examination were not taken into account.

Employees are distinguished at two levels: low education level employees and high education level employees. Low education level employees also include secondary education graduates, while high education level employees also include post-secondary education level employees (post-secondary non-tertiary education, tertiary education, and post-graduate education).

Sample Characteristics

Table 4 presents the average levels of the major variables used in the empirical analysis, both by education level and by gender. The wage is a logarithm of the respondent's monthly income from wages.[6] The difference between the respondent's current age and the age at which he or she started working is used as an indicator of the person's experience.

Table 4 shows that the average income of high education level employees is larger than that of low education level employees. The average gross monthly income is higher for men, compared to women, irrespective of education level. Women with a high education level earn, on average, 77% of the remuneration of male employees, while women with a low education level earn 71% of the remuneration of male employees.

Table 4: Sample means of the variables by gender and educational level

	Educational level			
	Low		High	
Variables	Women	Men	Women	Men
Number of observations	751	1378	594	553
Lnwage	6.66	7	7.03	7.29
Age (years)	40.04	40.72	37.78	41.65
Experience (years)	14.84	18.99	12.82	16.32
Marital status (single)	0.21	0.31	0.32	0.26
Employment hours per week	35.41	40.8	33.15	37.58
Permanent employment	0.71	0.8	0.84	0.92
Primary education	0.23	0.3		
Lower secondary education	0.16	0.18		
Upper secondary education	0.61	0.52		
Post-secondary non-tertiary education			0.2	0.16
Tertiary education			0.8	0.84

Source: SILC 2005.

[6] The gross monthly earnings for employees is the selected wage variable. Income does not include overtime payments. Table 4 shows that the average gross monthly income of women with a low education level is around €780, while that of men is €1,096. The average monthly income of women with a high education level is around €1,130, while that of men is €1,465.

Moreover, Table 4 shows that the average age of male employees with a high education level is almost 3.9 years above that of female employees, while the average age of male employees with a low education level is 0.68 years above that of female employees. On the other hand, male employees seem to have higher levels of experience than female employees (around 3.5 extra years of experience, on average, for high educated workers and 4.15 for less educated workers). High educated employees have less years of experience, as higher education attainment forces them to enter the labour market at a later stage. Male and female employees with a high education level are mostly employed in permanent positions, compared with low educated employees. Low educated employees work more hours per week than high educated employees. In particular, low educated female employees work almost 2 hours more than high educated female employees.

Initially, a wage equation for the total sample (men and women) was estimated, in order to determine statistically significant socio-economic variables that affect the workers' wages.[7,8] Next, wage equations were calculated, first on the basis of employees' education level (low and high education level) for the sample as a whole (both men and women) and then separately for men and women.[9] The results show that, irrespective of gender, monthly wage earnings are influenced by employees' personal characteristics, human capital (education), working hours, experience, type of work, type of employment, responsibility, occupation and the size of the company. Moreover, quantile regression estimations at various points of the wage distribution were performed and it was tested whether the estimated coefficients are statistically different. A Wald test showed that at the 1% significance level, the null hypothesis that the estimated coefficients are equal can be rejected. Then, by applying the quantile regression analysis, the wage equations were estimated separately for men and women employees at each decile of the wage distribution.

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[7] As independent variables, the wage estimation model uses variables concerning the family status of the employee, experience, education, the size of the employer-company, the type of work, the type of employment, the job description and the place of work.

[8] The standard deviations, and thus the *t*-statistics calculated for the estimated coefficients, have been corrected for heteroskedasticity following White's method.

[9] The results of the wage equations estimation carried out according to the ordinary least squares method are presented in the Appendix.

5.2 Wage Decomposition

By employing a variant of the Oaxaca and Ransom (1994) decomposition technique, it is possible to decompose the differences in wages between genders: (i) to observed differences in the human capital and productivity characteristics and (ii) to the part that remains unexplained. This second unexplained part is separated into two components: the first is titled 'male advantage' and the second 'female disadvantage'. The 'male advantage' refers to the extent that the coefficients for males exceed the non-discriminatory wage structure and the 'female disadvantage' refers to the extent that the coefficients for females fall below the pooled wage structure. Therefore, initially, we estimate a pooled regression equation including all the employees. This is the non-discriminatory equation, which is the benchmark in the estimation of the Oaxaca and Ransom decomposition.

Equation (4) was estimated to determine the percentage of the wage differential that cannot be explained on the basis of different characteristics between men and women with the same education level. Tables 5 and 6 present the results of the Oaxaca and Ransom decomposition for the total sample (at the mean) and for selected percentiles (10th, 25th, 50th, 75th and 90th).

Table 5 shows wage differentials for high educated employees. As presented in Table 5 gender wage differentials increase at the higher deciles of the wage distribution. The female wage disadvantage seems to increase towards the higher levels of the wage distribution. Moreover, a significant portion of the wage differential can be explained by changes in the productive characteristics of the workers.

Table 5: Oaxaca-Ransom decomposition of wages between male and female employees with high educational level

	Total	10%	25%	50%	75%	90%
Wage gap	0.269	0.241	0.248	0.239	0.262	0.278
Endowment difference	0.178	0.174	0.149	0.14	0.155	0.183
'Male advantage'	0.047	0.029	0.062	0.038	0.051	0.028
'Female disadvantage'	0.043	0.038	0.036	0.06	0.054	0.065

Notes: The natural logarithm of the monthly earnings of the individual from wages.
10%=1st percentile, 25%=1 st quartile, 50%=2 nd quartile, 75%=3rd quartile, 90%=9 th percentile.
Source: SILC, 2005.

By contrast, as presented in Table 6, the unexplained part of the wage differential of the sample that includes low education level employees as a whole is relatively high, while it is also higher than that of employees with a high education level. In this employee category, the wage differential is relatively high in the low deciles of the distribution and rebounds in the middle of the wage distribution. In addition, the 'female disadvantage' is consistently higher than the 'male advantage' throughout the wage distribution implying inefficiencies in the labour market, as discrimination components are present. Especially the 'female disadvantage' seems to increase at the higher levels of the wage distribution.

Table 6: Oaxaca-Ransom decomposition of wages between male and female employees with low educational level

	Total	10%	25%	50%	75%	90%
Wage gap	0.356	0.363	0.333	0.353	0.355	0.353
Endowment difference	0.213	0.238	0.213	0.216	0.2	0.183
'Male advantage'	0.051	0.063	0.045	0.051	0.034	0.046
'Female disadvantage'	0.091	0.061	0.074	0.085	0.12	0.123

Note: The natural logarithm of the monthly earnings of the individual from wages.
10%=1st percentile, 25%=1st quartile, 50%=2nd quartile, 75%=3rd quartile, 90%=9th percentile.
Source: SILC, 2005.

The foregoing analysis indicates that: (i) women with high and low education levels are underpaid for the entire sample and at all quantiles of the earnings distribution, (ii) for lower educated workers the unexplained part of the wage differential seems to be higher than that of the higher educated workers; (iii) the component due to differences in returns (discrimination) is explained mainly by the 'female disadvantage' and to a lesser extent by the 'male advantage' both for the low and high education level employees.

Papapetrou (2007) reports qualitatively similar results although the magnitude of the estimated differences diverges among these studies. The wage differentials among the low and high education level workers may be attributed to the different selection of the two samples and the estimation period.

5.3 Relative Changes Among Subsequent Years - An Oaxaca-Blinder Decomposition Analysis

The Oaxaca-Blinder wage decomposition as described by equation (3) is estimated for two consecutive years, 2004 and 2005. The estimates indicate that the average wage gap using unbalanced pooled sample for the years 2004 and 2005 for the group of high educated employees is equal to 0.260. A proportion of 58% of this gap is explained by the individual characteristics and the remaining 42% is unexplained. The wage gap for the low educated group of employees is 0.349. The differences in the individual characteristics explained 44% percent of the wage gap and the remaining 56% is unexplained. The estimated statistics indicate that both wage gaps and the estimated coefficients for the explained and unexplained components of the wage gap are statistically significant and different from zero.

Table 7: Oaxaca-Blinder wage decomposition, 2004 - 2005

	High education	Low education
Wage gap	0.260*** (0.021)	0.349*** (0.022)
Explained component	0.151*** (0.016)	0.154*** (0.019)
Unexplained component	0.109*** (0.017)	0.195*** (0.017)

Notes: The numbers in parenthesis are the robust standard errors. *** indicates rejection of the null hypothesis that the estimated coefficient is equal to zero at 1% level of significance.

6 Conclusions

The paper examines the male and female wage structures for low and high education level employees and the factors which explain the wage differential between genders in Greece using micro data. To this end, employees were divided according to their education level into low educated employees and high educated employees. Then, the existence of wage differentials between men and women based on their education level was examined both in relation to average wages and across the wage distribution spectrum, using the quantile regression analysis technique. Then, a variant of the Oaxaca and Blinder decomposition technique was used in order to explain the components of wage differentials between men and women by education level, on average, and at various deciles of the wage distribution of employees.

The results suggest that, in Greece, substantial differences in wages between men and women can be identified among workers with different educational levels. The average wage is higher for men than women for low and high educated workers. Examining the differences in the wage distributions the evidence shows that this differential is sensitive to the choice of the quantile.

As regards high educated employees, wage differentials between men and women increase towards the upper part of the wage distribution. Thus, it seems that as female employees with a high education level climb towards the upper parts of the wage distribution, the wage differential with their male colleagues increases. At all levels of the wage distribution the female disadvantage seems to be the strongest component of the unexplained part of the wage distribution indicating the presence of inefficiencies in the labour market for educated female workers. Finally, a higher portion of the estimated wage differential is explained by the differences in the productive characteristics of the employees. As regards the employees with low education level, the unexplained part of the wage differential explains a significant portion of the wage differential at the mean and across the wage distribution.

Finally, using the Oaxaca-Blinder wage decomposition technique for the two subsequent years, the results show that for employees with low education, the wage differential is higher compared to workers with high education. Furthermore, for employees with high education, the largest part of the between years wage differential is explained by differences in the productive characteristics (58%) and to a lesser extent to the unexplained component (around 40%). In contrast, for low education workers, decomposing this difference between genders, may be mainly attributed to the unexplained part of the difference (about 55%) and to a lesser extent to the employee's endowment.

These results have significant implications for growth, employment and public debt dynamics in Greece. As female participation and employment ratios are among the lowest in the European Union, discriminatory pay inequalities do not contribute, along with other factors, to the rise of these two ratios to levels closer to the EU average. In a country like Greece, which is expected to develop one of the most acute dependency ratios in the future with adverse effects on social security and public debt dynamics, the very low female participation and employment ratios and the socio-economic factors, which are responsible for this phenomenon, need to be analysed, understood and remedied as soon as possible.

Discriminatory pay differentials (as well as persistent high unemployment rates) can also be considered as a negative incentive for women's human capital formation through education and training and an obstacle to higher growth per capita. In this sense, discriminatory pay differentials can be considered as part of the negative social infrastructure (see, among others, Romer, 2000), which needs to be addressed through socio-economic institutional reform. Policies for encouraging women's participation in the labour market may include strategies for eliminating gender stereotypes and measures for reconciling work and family life of both men and women. This issue provides a classical example of unused opportunities in the Greek labour market for increasing both the participation and the employment ratios. The implications will be important: potential output will increase and social security imbalances will ease.

Appendix

Table A1: Wage equations by level of education

Variable	Low educational level			High educational level		
	Total	Male	Female	Total	Male	Female
Constant	5.51*** (22.07)	4.12*** (7.7)	2.75*** (9.21)	6.83*** (24.09)	5.57*** (16.54)	3.77*** (10.35)
Sex	0.234*** -9.83			0.135*** (5.3)		
Single	-0.131*** (-4.86)	-0.172*** (-5.03)	-0.066 (-1.42)	-0.103*** (-2.86)	-0.236*** (-5.77)	0.008 (0.14)
Firm size (less than 10 persons)	-0.176*** (-5.94)	-0.179*** (-5.13)	-0.154*** -2.88	-0.183*** (-5.10)	-0.210*** (-4.57)	-0.157*** (-2.83)
Firm size (11-19 persons)	-0.076** (-2.56)	-0.079** (-2.22)	-0.062 (-1.18)	-0.090** (-2.34)	-0.058 (-1.23)	-0.114* (-1.88)
Firm size (20-49 persons)	-0.075** (-2.05)	-0.081* (-1.87)	-0.046 (-0.71)	-0.025 (-0.64)	-0.014 (-1.24)	-0.035 (-0.58)
Hours of employment	0.767*** -12.14	0.572*** (4.2)	0.822*** (11.22)	0.411*** (5.66)	0.249*** (2.76)	0.484*** (5.15)
Permanent job	0.309*** (10.03)	0.294*** (7.37)	0.313*** (6.48)	0.460*** (8.27)	0.344*** (4.7)	0.475*** (6.41)
Managerial position	0.203*** (6.85)	0.196*** (6.06)	0.207*** (3.34)	0.212*** (6.72)	0.196*** (5.11)	0.229*** (4.22)
Urban	-0.073*** (-3.66)	-0.091*** (-3.80)	-0.052 (-1.44)	0.008 (0.28)	0.018 (0.52)	0.011 (0.25)
Agriculture. hunting, forestry and fishing	-0.388*** (-3.81)	-0.584*** (-4.27)	-0.179 (-1.47)	-0.039 (-0.30)	-0.171 (-1.35)	0.052 (0.43)
Mining and quarrying	0.087 (1.6)	-0.054 (-0.66)	0.168** (2.21)	0.078 (1.02)	0.022 (0.26)	0.104 (0.82)
Construction	0.076 (1.33)	-0.082 (-0.99)	0.374*** (3.13)	-0.099 (-0.87)	-0.306** (-2.58)	0.338 (1.38)
Wholesale and retail trade	0.035 (0.65)	-0.097 (-1.17)	0.081 (1.16)	0.106 (1.4)	0.102 (1.14)	0.12 (1.05)
Hotels and restaurants	-0.075 (-1.30)	-0.220** (-2.38)	-0.006 (-0.09)	-0.141 (-1.27)	-0.048 (-0.39)	-0.175 (-1.07)
Transport, storage and communication	0.209*** (3.42)	0.066 (0.73)	0.272*** (3.2)	0.225*** (2.58)	0.144 (1.46)	0.318** (2.14)
Financial intermediation	0.457*** (7.18)	0.228** (2.42)	0.574*** (7.09)	0.307*** (3.4)	0.153 (1.25)	0.471*** (3.81)

Table A1 (continued)

Variable	Low educational level			High educational level		
	Total	Male	Female	Total	Male	Female
Real estate, business activities	0.126* (1.8)	0.017 (0.17)	0.162* (1.71)	0.197*** (2.29)	0.151 (1.52)	0.274** (2.07)
Public administration and defence, compulsory social securities	0.312*** (5.59)	0.122 (1.47)	0.511*** (6.76)	0.210*** (2.83)	0.140* (1.78)	0.289** (2.44)
Education	0.291*** (2.84)	0.488*** (2.9)	0.193 (1.64)	0.387*** (5.19)	0.167** (2.02)	0.557*** (4.95)
Health and social work	0.275*** (4.37)	0.085 (0.93)	0.372*** (4.48)	0.272*** (3.72)	0.077 (0.77)	0.400*** (3.75)
Experience	0.368*** (6.35)	0.422*** (5.08)	0.366*** (4.18)	0.320*** (4.16)	0.101 (1.19)	0.470*** (4.18)
Experience squared	-0.057*** (-4.47)	-0.068*** (-3.95)	-0.061*** (-2.94)	-0.26 (-1.47)	0.016 (0.77)	-0.055** (-2.13)
R^2-adjusted	0.526	0.442	0.55	0.522	0.466	0.516
F-statistic	107.279	52.143	44.593	58.032	23.732	31.539

Note: The values in the parenthesis are the *t*-statistics.
*Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. **Statistically significant at the 1 percent level.

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Analyzing and Comparing the Impact of Alternative Concepts of Resources in Distributional Studies: Greece, 2004/5

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Abstract

The usual practice in empirical distributional studies is to use either disposable income or consumption expenditure as a proxy for welfare. Essentially, both variables are used as approximations of the unobserved "permanent income" of the population members. The paper exploits the information of the Greek Household Budget Survey of 2004/5 and constructs an indicator of "permanent income" using a latent variable approach. The distributions of disposable income, consumption expenditure and permanent income are compared regarding their level and structure of inequality and poverty. Both inequality and poverty appear to be substantially lower using the distribution of permanent income instead of either the distribution of disposable income or the distribution of consumption expenditure, while differences are also evident when decomposition analysis of inequality and poverty is employed using appropriate indices.

1 Introduction

A common problem encountered in many empirical distributional studies is that of the selection of an appropriate distribution. Usually, when economists and other social scientists analyse inequality and poverty, they are ultimately interested in inequality in the distribution of welfare. However,

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welfare is not directly observable and hence, for the purposes of empirical studies, a reasonably close approximation to it has to be used instead. Standard microeconomic theory suggests that, other things being equal, an individual's welfare level is determined in the short-run by his/her levels of consumption and leisure and in the long-run by his/her level of "life-cycle" or "permanent" income. These notions of welfare are closely related to the concepts of "full income" and "earnings capacity" developed by Becker (1965) and Garfinkel and Haveman (1977). Reliable estimates of permanent income at the individual level can be obtained from long series of panel data. Hardly any such datasets exist—and those that do, in a small number of countries.

Regarding short-term concepts of welfare, since there are enormous difficulties in evaluating leisure in monetary terms, most empirical studies use current consumption or current income as welfare indicators. Each variable has its merits from a theoretical point of view. Current consumption is usually considered as a better approximation to life-cycle income than current income, because individuals and households tend to save and dissave in different periods of their life-cycles in an attempt to smooth their consumption and, thus, maximise their utility (assuming that utility is a positive but diminishing function of consumption). On the other hand, the use of current income has some advantages, since it can be considered as a better indicator of the ability of an individual or a household to achieve a particular welfare level (Sen 1992, Chaudhuri and Ravallion 1994). In practice, the data on consumption and income that are available for empirical studies in most countries usually come from Household Budget and Income Surveys and are far from ideal.[1] Apart from being influenced by life-cycle factors, in most such surveys the relevant data are generally collected using recall questions and are subject to large margins of error. As a result, in many instances the recorded level of correlation between income and consumption is relatively low and a considerable proportion of the population who are classified as poor according to one welfare indicator appear close to the top of the distribution according to the other indicator. This finding may have disturbing implications for the design of policies aimed to alleviate poverty and/or reduce

[1] Note also that the data collected in such surveys concern consumption expenditures, not consumption. Although the two variables are closely related, they are not identical— the former being a “noisy” approximation of the latter (from a statistical point of view).

inequality, if the recorded levels of inequality and poverty as well as the composition of the poor or the structure of inequality are influenced by the welfare indicator used. Therefore, it is interesting to explore the possibility of constructing a composite welfare indicator of the members of the population using the existing information about their current incomes and consumption expenditures. This is the aim of the present paper and examples are provided using the data of the most recent Greek Household Budget Survey of 2004/05.

The remainder of the paper is organised as follows. The next section discusses briefly the data used, while the third section presents a methodology for the construction of an approximation of the "composite welfare indicator" of the members of the population. The fourth section is devoted to the analysis of inequality and poverty in Greece using alternative concepts of resources, while the final section concludes the paper and provides a discussion of its main findings.

2 The Data

The paper uses the microdata of the 2004/04 Greek Household Budget Survey that was carried out by the National Statistical Service of Greece. The survey covers all the non-institutional households of the country and its sampling fraction is about 2/1000 (around 6,600 households or 17,900 individuals). It contains detailed information about consumption expenditures (actual and imputed), incomes after taxes, social security contributions and transfer payments, socio-economic characteristics of the households and their members as well as information on a number of housing amenities and consumer durables owned by the household. In order to approximate welfare as closely as possible, the concepts of both current consumption expenditure and current income include, apart from actual consumption expenditures and net incomes, the consumption of income-in-kind evaluated at market prices. A number of adjustments were made to the data before they were used for the purposes of the paper. A few households were removed from the sample because the information they provided was considered to be extremely unreliable and the sample was re-weighted in order to reflect more accurately the entire population using weights derived from the 2001 population census. Further, all consumption expenditure and income figures were expressed in constant mid-2004 prices in order to remove the impact of inflation (4.0% from the beginning to the end of the survey). Finally, the value of cars purchased during the period of the survey was subtracted from the concept of consumption expenditure and replaced by the value of imputed car services, estimated using hedonic regression techniques, for all the households which owned cars. The latter estimates were also added to the concept of income as an imputed item.

The unit of analysis is the household member and the corresponding distributions were normalised using the so called “modified OECD scales” (Hagenaars et al. 1994) which assign a weight of one to the household head, a weight of 0.5 to each of the remaining adults in the household and a weight of 0.3 to each child (person aged up to 13) in the household. Nevertheless, since the unit of information collection in the Household Budget Survey was the household, for the purposes of the derivation of the composite welfare indicator in the next section the unit of analysis is the household.[2]

3 Alternative Concepts of Resources: A Descriptive Comparison

In this study we use the three alternative concepts of resources that usually are used in distributional studies. These are: disposable income (no imputed items, DI), consumption expenditure (with imputed items, CE) and full income from private sources (DI with imputed items, FI). Using the previous welfare indicators, we propose and construct a fourth composite one named permanent income (PI) which is described in the next section.

A casual first inspection of the distributions of equivalent consumption expenditure and equivalent full income per capita reveals that they are relatively similar in terms of decile shares and inequality indices although—as anticipated in a country with widespread self-employment such as Greece—the former distribution is less unequal than the latter. For example, the share of the bottom (top) decile of the distribution of consumption expenditure is 3.8% (22.2%) while that of the bottom (top) decile of the full income distri-

[2] The empirical results of the next section are almost identical if the unit of analysis is the household member rather than the household (results available from the authors on request).

bution is 3.5% (23.2%), the corresponding Gini indices being 0.278 and 0.293, respectively. Final, the exclusion of income in kind and other imputed items from the definition of income makes the distribution DI more unequal (Gini: 0.319) comparing CE and FI distributions.

However, a closer inspection of the data reveals that the two variables are not as closely related as one could anticipate. The Spearman rank (Pearson) correlation coefficient for CE and FI is 0.687 (0.617).[3] This is evident in Table 1 where the members of the population are ranked from the least well-off to the most well-off, in quintiles according to their equivalent consumption expenditure and equivalent full income and then cross-tabulated. Only 41.9% of them remain in the same quintile when moving from one distribution to the other, while almost a fifth of the sample (19.1%) moves by three or more quintiles.[4] There are even population members who belong to the top quintile of one distribution and the bottom quintile of the other (Table 3). Hence, at least one of the two distributions cannot be considered as a good approximation of the unobservable distribution of "welfare". Smaller correlation and greater differences we could find comparing CE and DI distributions.

Part of the previous discrepancies should be attributed to genuine life-cycle factors, while another part should be attributed to the short interview period of the survey and the extensive use of recall questions, or even deliberate under-reporting. The latter factors are likely to add a lot of "artificial" variation to the estimates of both consumption expenditure and income. Under these circumstances it is worth trying to construct a less "noisy" welfare indicator.

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[3] The corresponding coefficient between actual consumption expenditure (excluding in-kind expenditures) and net monetary income— that is, the variables most frequently used in similar studies — is substantially lower, at 0.627 (0.621).

[4] The relatively low degree of correlation between the ranks of the members of the population in the distributions of consumption expenditure and income is not a peculiarly Greek phenomenon. See, for example, similar evidence for the UK and Spain cited in McGregor and Borooah (1992) and Mercader-Prats (1998), respectively. Similar evidence but in a slightly different framework can be found in Anand and Harris (1994) for Sri Lanka and Hagenaars et al. (1994) for twelve member-states of the European Union, Krueger and Perri (2006) and Meyer and Sullivan (2003) for the U.S.

Table 1: Cross-tabulation of population members ranked according to alternative concepts of resources (% of the total population)

CE x FI		Quintile of the distribution of FI				
		1	2	3	4	5
Quintile of the distribution of CE	1	11.0	5.3	2.7	0.8	0.2
	2	5.0	6.6	4.8	2.6	0.9
	3	2.6	4.5	5.7	5.1	2.2
	4	1.2	2.6	4.6	6.7	4.8
	5	0.2	1.0	2.2	4.8	11.9

CE x DI		Quintile of the distribution of DI				
		1	2	3	4	5
Quintile of the distribution of CE	1	9.5	6.1	2.9	1.3	0.2
	2	5.1	5.7	5.0	3.2	1.0
	3	3.2	4.1	5.4	4.7	2.6
	4	1.7	2.8	4.4	6.1	5.0
	5	0.5	1.3	2.3	4.7	11.3

4 The Composite Welfare Indicator

Following Abul Naga (1994), Abul Naga and Burgess (1997) and Mercader-Prats (1998), let X be the vector of available welfare indicators $(x_1, x_2, ..., x_k)$,' such as current income, consumption expenditure, etc. Further, assume that these indicators are related to the "true" composite welfare indicator, y_p, ("permanent income" in their terminology), in the following way

$$X = by_p + U \tag{1}$$

where $b=[b_1, b_2, ..., b_k]'$, and $U=[u_1, u_2, ..., u_k]'$, is the vector of residual error terms. (1) is a factor analysis model where y_p is not observable. A number of techniques can be used for the estimation of such models (method of moments, factor analysis, principal component analysis, etc). The choice of estimation technique depends on the number of welfare indicators available (k), as well as the number of additional assumptions that the researcher is willing to make.[5] Once the structural parameters of the system have been estimated and in order to extract information about y_p, additional assumptions have to be made about the joint distribution of X and y_p.

In this paper we assume that $y_p \sim N(\mu_p, \sigma_p^2)$ and $U \sim N(0, \Omega)$. In this case,

[5] As Greene (1993) points out, if $k>3$, the model is over-identified and its estimation using the method of moments requires the imposition of additional assumptions (structure). Nevertheless, the advantage of the method of moments is that the estimated parameters are consistent and independent of the type of distribution of the welfare indicators X.

from the properties of the normal distribution (1) implies that $X \sim N(b\mu_p, bb'\sigma_p^2 + \Omega)$. Following Greene (1993, p. 76), the conditional distribution of y_p given the vector X, $f(y_p|X)$, will be

$$y_p|X \sim N[\mu_p + \Sigma_{y_pX}\Sigma_{XX}^{-1}(X - b\mu_p),\ \ \Sigma_{y_py_p} - \Sigma_{y_pX}\Sigma_{XX}^{-1}\Sigma_{Xy_p}] \tag{2}$$

where Σ is the $[(k+1)\times(k+1)]$ covariance matrix of $y_p, x_1, x_2, \ldots, x_k$, which can be broken down into the sub-matrices: $\Sigma_{y_py_p} = \mathrm{cov}(y_p, y_p) = \sigma_p^2$, Σ_{y_pX}, Σ_{Xy_p} which are the $(1 \times k)$ and $(k \times 1)$ covariance matrices of y_p with $x_1, x_2, \ldots, x_k$, and Σ_{XX} which is the $(k \times k)$ matrix of covariances of $x_1, x_2, \ldots, x_k$.

Then, the best (minimum mean square error) predictor of the composite welfare indicator is defined as

$$E(y_p|X) = \mu_p + \Sigma_{y_pX}\Sigma_{XX}^{-1}(X - b\mu_p) \tag{3}$$

that is, the composite welfare indicator of each household is a linear function of all the available welfare indicators X of the household in question.[6] The weights assigned to the various welfare indicators are determined by the degree of covariance of these indicators both with y_p and between themselves.

In order to derive the composite welfare indicator from our data, we assume that for every household in the sample the logarithms of the two welfare indicators most commonly used in the literature, disposable income, Y, and consumption expenditure on non-durable goods, C, are related with the logarithm of their Y_p in the following way

$$Y = Y_p + Y_t \tag{4}$$

$$C = B + Y_p + C_t \tag{5}$$

[6] Bartholomew (1984) demonstrates that such an index can be constructed if the distribution of at least $k-1$ of the X indicators belongs to the family of exponential distributions (normal, gamma, Poisson, etc.).

where Y_t and C_t are, respectively, the residual income and the error term of the consumption function. Both variables are used in logarithmic form since, using appropriate tests (x^2 , Kolmogorov-Smirnov) it was found that consumption expenditure on non-durable goods is approximately lognormally distributed, whereas in the case of disposable income the assumption of log-normality was only marginally rejected at the 1% level of significance. For Y_t and C_t it is assumed that they have zero means and, further, that they are uncorrelated both with each other and with Y_p.

$$\text{cov}(Y_p,Y_t)=\text{cov}(Y_p,C_t)=\text{cov}(Y_t,C_t)=0 \tag{6}$$

The first two assumptions are pretty innocuous, but this is not necessarily the case regarding the third assumption, $\text{cov}(Y_t,C_t)=0$, although this assumption is frequently made in macroeconomic studies. It implies that unanticipated changes in the current disposable income of a household affect its current non-durable consumption only through their effect on the composite welfare indicator ("permanent income" in macroeconomics).

Taking (6) into account, the sample moments of (4) and (5) are

$$\text{var}(Y)=\sigma_p^2+u_Y \tag{7}$$

$$\text{var}(C)=\sigma_p^2+u_C \tag{8}$$

$$\text{var}(Y,C)=\sigma_p^2 \qquad (9).$$

The system of these three equations can be identified and, hence, we can estimate the three unknown variances of the composite welfare indicator, σ_p^2, residual income, u_Y, and residual consumption, u_C. Estimates of the corresponding parameters are provided in Table 2. As anticipated, the proportional contribution of residual income to the variance of disposable income (50.3%) is higher than the proportional contribution of residual non-durable consumption to the variance of consumption expenditure on non-durable goods (22.7%).

In our case, the general model (1) as specified in equations (4) and (5), gives the following expression for (3)

$$E(y_P \mid X) = \mu_Y + \frac{\sigma_P^2}{(\sigma_P^2+u_Y)(\sigma_P^2+u_C)-(\sigma_P^2)^2}[u_C(Y-\mu_Y)+u_Y(C-\mu_C)] \tag{10}$$

that is, the composite welfare indicator of a particular household is equal to the mean of the disposable income of the entire population plus the weighted sum of the deviations of disposable income and consumption expenditure on non-durables of the household from the corresponding sample means. The weights depend positively on the variance of the residual terms of the opposite variable; in other words, the "noisier" that one variable is, the greater the weight assigned to the other variable. Finally, substituting the estimated values of the parameters σ_p^2, u_Y, and u_C from Table 2 in equation (10) we obtain the following

$$E(Y_p | Y,C)=1.075 + 0.183Y + 0.632C \quad (11).$$

Table 2: Permanent and transitory components of the variances of the logarithms of disposable income and consumption (on non-durables)

WELFARE INDICATOR	VARIANCE		
	Total	Permanent component	Transitory component
Disposable income	0.384	0.191	0.193
Contribution (%)	100.0	49.7	50.3
Consumption expenditure	0.247	0.191	0.056
Contribution (%)	100.0	77.3	22.7

As anticipated, the composite welfare indicator is found to be more closely related with the less "noisy" consumption expenditure and, therefore, its estimate is determined to a larger extent by this variable than by disposable income.[7]

How does the new distribution compare with the distributions of income (DI, FI) and consumption expenditure (CE)? An answer to this question is provided in Table 3 and Graph 1. Table 3 provides decile shares and estimates of

[7] Dimelis et al. (1997) derive transitory components of disposable income and consumption expenditure on non-durable goods by applying the Hodrick and Prescott (1997) filter on National Accounts data for the period 1960-94. If this macroeconomic estimate of $\mathrm{cov}(Y_t,C_t)$, 0.000809, is used instead of $\mathrm{cov}(Y_t,C_t)=0$ and (10) is modified accordingly (see Mercader-Prats 1998), (11) changes very marginally and the value of the Gini index declines from 0.234 to 0.233. Even assuming that the value of $\mathrm{cov}(Y_t,C_t)$ is twelve times higher than the above macroeconomic estimate, measured inequality is affected very modestly (the Gini index changes by less than 5%).

Table 3: Deciles' shares, inequality and poverty indices for alternative concepts of resources

	Distribution of			
	DI	CE	FI	PI
Decile				
1 (bottom)	2.9	3.8	3.5	4.5
2	4.6	5.2	5.1	6.2
3	5.8	6.3	6.1	7.1
4	7.0	7.3	7.1	7.9
5	8.0	8.2	8.1	8.8
6	9.1	9.3	9.3	9.7
7	10.6	10.6	10.6	10.7
8	12.3	12.3	12.2	12.0
9	15.1	14.8	14.7	13.9
10(top)	24.6	22.2	23.2	19.3
Inequality and poverty indices				
Gini	0.319	0.278	0.293	0.168
Atkinson (e=0.5)	0.083	0.062	0.069	0.038
2^{nd} Theil (Mean Logarithmic Deviation)	0.175	0.125	0.142	0.076
Poverty rate (FGT0)	19.6	15.1	15.6	9.0
Normalised Pov. Gap (FGT1)	5.2	2.9	3.6	1.3
FGT2	2.2	0.9	1.3	0.3

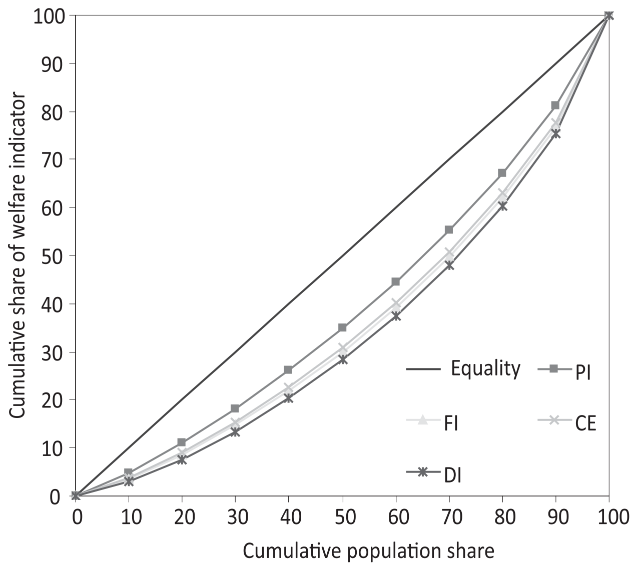
six widely used inequality and poverty indices for the distributions of equivalent disposable income, equivalent consumption expenditure, equivalent full income and the composite welfare indicator per capita (permanent income, PI). Graph 1 reports the corresponding Lorenz curves. The new distribution appears to be far more equal than the other distributions and the Lorenz curve of the distribution of the composite welfare indicator clearly dominates the Lorenz curves of the other distributions. Depending on the index and the distribution, the estimates of the inequality indices decline between 20% and 45% when moving to the last column of Table 3. Since the most important differences between the distribution of the composite welfare indicator and the other distributions concern the shares of the top and bottom deciles, the largest proportional declines in inequality are recorded by those indices which are relatively more sensitive to changes in the tails of the distribution rather than the Gini index which is relatively more sensitive to changes around the median (Cowell 1995).

Further, these indices suggest that inequality and poverty is lower in the distribution of consumption than in the distribution of full income, while the inclusion of imputed items in these two distributions makes them more equal compared to the distribution of disposable income. In fact, the Lorenz curves reported in Graph 1 do not intersect and, thus, provide a complete ranking of the distributions under examination.

Finally, the composite welfare indicator appears to be more correlated with consumption expenditure (Spearman rank correlation coefficient: 0.962) than the other two distributions of disposable (0.773) and full income (0.821, see Table 4).

Is the new variable able to predict the relative welfare position of the population members better than the existing variables? An attempt to provide an answer to these questions is provided in Table 4. As noted in section 2, the Household Budget Survey contains information about a number of housing amenities and consumer durable goods of each household. For the purposes

Graph 1: Lorenz curves for alternative concepts of resources



of Table 4, three new indices are constructed. The first index (INDEX1) exploits the information on housing amenities available in the Household Budget Survey. For each population member the value of the index is the average score on seven items, the weights of the items being the proportion of the population living in households with such amenities. These amenities and the corresponding proportion of the population living in households with such items (in parentheses) are: dwelling with bath or shower (98.8%), dwelling with running water (99.5%), separate kitchen inside the dwelling (99.3%), dwelling with telephone (96.1%), WC inside the dwelling (95.5%), at least 40 square metres available per equivalent adult in the household (59.8%) and second (holiday) home (20.7%). The second index (INDEX2) is the counterpart of INDEX1 for consumer durable goods. The following nine items were selected: refrigerator (99.4%), electric cooker (88.0%), vacuum cleaner (82.5%), colour TV (99.3%), video (51.4%), hi-fi (69.2%), washing machine (93.8%), dishwasher (33.0%) and car (78.4%). Since the cost of obtaining these items varies considerably across items and information on the average cost per item exists in the Household Budget Survey, it was decided to construct a third index (INDEX3) reflecting the average monetary value of the corresponding stock of durable goods for each household.[8]

Once the scores for every member according to each of the three indices were calculated, the population was ordered from the member with the lowest to the member with the highest score according to each index and the corresponding ranks were estimated. The Spearman rank correlation coefficients of each of these indices and the three monetary indicators are reported in Table 6. In all cases the correlation of the ranks of the population mem-

[8] It should be stressed that, for a number of reasons, these indices should not be considered as better indicators of the standard of living than the monetary indicators and they are used here for illustrative purposes only. The fact that in the Household Budget Survey there is no information about tastes, poses limitations in the examination of the role of tastes versus resource constraints as determinants of the availability of various housing amenities and consumer durables—for example, a household may have the ability to buy a car but decide not to do so. Further, there is no information about the quality of the stock of durable goods available to each household, thus, possibly blurring the differences in the living standards of various members of the population. For example, better-off households are likely to have more expensive cars than less well-off households· For an extensive discussion of the construction of non-monetary welfare indicators, see Callan et al. (1996, ch. 6).

bers according to their composite welfare indicator with the ranks according to any of the three indices are substantially higher than the corresponding correlation coefficients of the ranks of the other monetary indicators (DI, FI, CE) with the ranks of these indices. The estimate of the Spearman rank correlation coefficient between the composite welfare indicator PI and INDEX1 is 0.464 against estimates of 0.343–0.440 in the case of the other monetary welfare indicators, while the corresponding estimates are 0.559 against 0.443–0.538 in the case of INDEX2 and 0.580 against 0.458–0.560 in the case of INDEX3. Given the non-monetary welfare indicator (INDEX1, INDEX2 or INDEX3), the differences between the rank correlation coefficient of the composite welfare indicator and the rank correlation coefficient of disposable income or consumption expenditure are statistically significant at any conventional level of significance.

Finally, the results of Table 4 seem to suggest that the composite welfare indicator is able to depict better the relative welfare position of the members of the population than the other monetary indicators of welfare employed in the paper. It is likely that the differences between the three monetary welfare indicators reported in Table 4 would have been substan-

Table 4: Spearman rank (Pearson simple, in parenthesis) correlation coefficients of alternative welfare indicators

	DI	CE	FI	PI	INDEX1	INDEX2	INDEX3
DI	1						
CE	0.618 (0.617)	1					
FI	0.959 (0.973)	0.687 (0.686)	1				
PI	0.773 (0.767)	0.962 (0.960)	0.821 (0.817)	1			
INDEX1	0.343 (0.278)	0.440 (0.352)	0.430 (0.334)	0.464 (0.383)	1		
INDEX2	0.443 (0.345)	0.538 (0.430)	0.456 (0.358)	0.559 (0.467)	0.256 (0.343)	1	
INDEX3	0.458 (0.315)	0.560 (0.394)	0.473 (0.329)	0.580 (0.427)	0.257 (0.211)	0.969 (0.779)	1

All values are significant at the 0.01 level (2-tailed).

tially larger if we were using the "noisier" disposable income and consumption expenditure data of the Household Budget Survey without the adjustments reported in section 2.[9]

5 Structure of Inequality and Poverty

As noted earlier, the level of inequality recorded by the distribution of the composite welfare indicator is substantially lower than the levels recorded by the distributions of disposable income and consumption expenditure. The next question to be investigated is whether the structures of inequality and poverty as accounted using the distribution of the composite welfare indicator differ in significant ways from the corresponding structures as accounted by the other monetary welfare indicators available in the Household Budget Survey. In order to examine the structure of inequality we rely on the mean logarithmic deviation, N

$$N = \frac{1}{n}\sum_{i=1}^{n} \ln\left(\frac{\mu}{y_i}\right) \tag{12}$$

where n is the size of the population, y_t the welfare indicator of person i (income, consumption expenditure or the composite indicator) and μ the mean of the distribution of this indicator. N is strictly additively decomposable. Thus, if the population is grouped into J mutually exclusive and exhaustive groups, N can be written in the following way that allows the quantification of the contributions of disparities "within" and "between" population groups to aggregate inequality (Anand (1983, Appendix C))

$$N = \sum_{j=1}^{J}\left(\frac{n_j}{n}\right)N_j + \sum_{j=1}^{J}\left(\frac{n_j}{n}\right)\ln\left(\frac{\mu}{\mu_j}\right) \tag{13}$$

where the subscripts j denote the values of the corresponding variables in group j. The first component in the right hand side of (13) is the contribution of disparities "within groups" to aggregate inequality—that is, the level of in-

[9] It should be noted that the practice of using the original (unadjusted) data of Income from Budget Surveys is very common in empirical distributional studies.

equality that would have been recorded if the mean of each group's welfare indicator became equal to the aggregate mean by equi-proportionate changes in the welfare indicators of the members of the group. The second term is the "between groups" component of inequality—that is, the level of inequality that would have been recorded if the welfare indicators of the members of each group became equal to the group mean but differences between group means remained intact.

For the purposes of our analysis, the population is grouped into mutually exclusive and exhaustive groups using four alternative criteria: region of residence, locality, household type, socio-economic group and educational level of the household head. Further, multivariate decomposition of inequality by population sub-groups is attempted by combining these factors. The proportionate contributions of "between groups" disparities to aggregate inequality according to each of the four welfare indicators for each grouping of the population are presented in Table 5.[10]

The results of Table 5 suggest that the structure of inequality is not affected dramatically by the distribution used. In most population groupings, the "between groups" component of inequality is higher when the distribu-

Table 5: Inequality decomposition using alternative concepts of resources

Grouping factor	Number of groups	% of aggregate inequality attributable to differences "between groups"			
		DI	CE	FI	PI
Region	13	4.3	6.2	5.0	6.6
Size of Locality	3	5.1	6.8	5.2	7.3
Household Type	9	6.1	7.0	4.7	6.8
Socio-economic group of household head	11	11.8	15.8	12.7	16.6
Educational level of household head	5	17.2	21.1	18.1	23.3
Multivariate decomposition	420	27.2	29.4	27.6	32.5

[10] *Ceteris paribus*, the larger the number of groups and the more homogeneous the groups, the higher the proportion of aggregate inequality that is attributed to "between-groups" disparities.

tion of the composite welfare indicator is used. This is most profound in the case of the contribution of the "between-educational-groups" component. As the evidence of Table 5 partly shows, the increase in the proportional contribution of "between-groups" disparities when the distribution of the composite welfare indicator is used instead of the other distributions occurs despite the fact that in the distribution of the composite welfare indicator the differences in the group means are not as large as in the distributions of either disposable income or consumption expenditure. The increase in the relative importance of the "between groups" component should be attributed to the fact that our formulation of the composite welfare indicator mitigates extreme values of disposable income or consumption expenditure and, thus, influences the level of inequality within particular groups substantially more than it affects the relationship between the group means and, hence, the "between groups" component of inequality. In other words, even though both "between groups" and "within groups" inequalities decline in absolute terms when we move from the distribution of full income, disposable income or consumption expenditure to the distribution of the composite welfare indicator, the disparities "within groups" decline more significantly.[11]

From a substantive point of view, the estimates of Table 5 confirm earlier results that inequality in Greece emanates primarily from disparities "within" rather than "between" population groups (Tsakloglou 1993, 1997; Tsakloglou and Mitrakos 2006; Mitrakos and Tsakloglou 1997, 2000). Only when the population is grouped—into just five groups—according to the educational level of the household head, can a substantial proportion of aggregate inequality (almost 1/4) be attributed to disparities "between groups".

For the purposes of the examination of the structure of poverty under alternative concepts of resources, we employ the additively decomposable index of Foster, Greer and Thorbecke (1984), F

[11] Using bootstrap techniques it can be shown that, although relatively small, the proportional contributions of "between groups" disparities to aggregate inequality are statistically significantly higher when the distribution of the composite welfare indicator is used instead of the distribution of disposable income, full income or consumption expenditure, when the population is grouped according to region, locality, socio-economic group of household head, educational level of household head and, particularly, in the multivariate decomposition of inequality.

$$F = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{z - x_i}{z}\right)^{a} \tag{14}$$

where z is the poverty line, while x_i represents the "truncated distribution" of the corresponding variable; x_i is equal to y_i when the population member falls below the poverty line and equal to z when the population member lies above it. a is a "poverty aversion" parameter whose value, in line with most empirical studies in the field, is set at a =2, at which the index has a number of desirable properties (focus, monotonicity, transfer sensitivity). When the population is grouped into J mutually exclusive and exhaustive groups, F can be written in the following way that allows the quantification of the contribution of particular population groups to aggregate poverty

$$F = \sum_{j=1}^{J}\frac{n_j}{n}F_j \tag{15}$$

In line with Eurostat practice and several studies of poverty in the European Union, we set the poverty line at 60% of the median of the corresponding distribution. Since the composite welfare indicator is far more equally distributed than either income (full or disposable) or consumption expenditure, the resulting poverty rates using this type of poverty line differ considerably across distributions: 9.0% in the case of the composite welfare indicator against 19.6% in the case of disposable income, 15.1% in the case of consumption expenditure, and 15.6% in the case of full income (Table 3).

Table 6 reports the population shares, the mean equivalent disposable income, consumption expenditure, full income and composite indicator, as well as the relative poverty risk of different population groups. Some of these groups were found to be high-poverty-risk in earlier studies (Tsakloglou 1990, Tsakloglou and Panopoulou 1998, Tsakloglou and Mitrakos 2006)—namely, members of rural households, persons aged over 64 living alone, childless couples with at least one member aged over 64, members of households headed by farmers, members of households headed by unemployed persons, members of households headed by pensioners and members of households headed by persons who did not complete primary education.

As noted above, on almost all occasions the mean composite welfare indicators of the high-poverty-risk groups (see the rows in italic and bold format

Table 6: Relative poverty risk according to alternative concepts of resources

Characteristic of household or household head	Population share	Mean equivalent (Greece: 100.0)				Relative poverty risk. Foster, Greer and Thorbecke index (α=2, Greece: 100.0)			
		DI	CE	FI	PI	DI	CE	FI	PI
Household type									
One person aged below 65	3.4	107.3	119.2	109.4	111.9	95.6	64.1	101.8	67.9
One person aged 65 or more	***4.2***	***69.9***	***77.2***	***81.4***	***83.0***	***195.5***	***210.9***	***162.7***	***179.6***
Childless couple (both below 65)	5.8	127.4	118.6	127.5	117.2	69.3	55.1	52.0	52.7
Childless couple (at least one person above 65)	***10.5***	***76.5***	***79.8***	***83.1***	***84.5***	***177.4***	***188.4***	***148.8***	***177.8***
Couple with one child below 18	8.6	120.3	123.1	116.6	116.5	60.5	40.4	71.5	45.3
Couple with two children below 18	15.6	101.3	111.1	101.0	106.1	88.5	49.4	90.7	52.4
Couple with three or more children below 18	5.9	86.0	96.4	85.5	93.7	134.5	82.1	151.3	118.1
Mono-parental household	1.2	74.3	107.4	78.2	97.1	176.2	71.8	178.5	132.1
Other household types	44.7	102.5	95.0	100.5	97.7	82.1	109.6	88.4	106.6
Locality									
Cities with population over 10.000	66.8	108.5	108.4	107.9	106.9	73.6	73.8	76.1	69.1
Semi-urban areas (population 2.000 - 10.000)	12.8	91.2	91.3	90.7	92.5	114.6	96.3	108.6	88.3
Rural areas (population below 2.000)	***20.4***	***77.6***	***78.0***	***79.8***	***82.1***	***177.4***	***188.3***	***173.0***	***208.5***
Socio-economic group of household head									
Employer in non-agriculture	5.8	142.3	140.3	137.7	130.4	55.4	6.9	57.4	11.8
Professional self-employed in non- agriculture	1.2	184.5	176.2	178.8	160.5	9.9	5.5	14.5	0.0
Non-professional self-employed in non-agriculture	10.0	92.5	98.8	93.3	97.2	135.0	62.3	117.9	85.3
Farmer or agricultural worker	***6.9***	***84.4***	***79.4***	***84.5***	***83.4***	***182.8***	***179.1***	***177.4***	***230.8***
Manual employee in non-agriculture (private sector)	14.1	83.0	84.2	79.3	85.6	97.8	133.8	135.1	132.9

Non-manual employee in non- agriculture (private sector)	9.1	122.6	125.7	120.7	119.4	50.9	33.6	48.9	35.2
Manual employee in non-agriculture (public sector)	4.1	99.7	96.3	96.3	97.3	45.0	87.1	56.5	41.7
Non-manual employee in non- agriculture (public sector)	11.5	129.0	127.7	126.1	123.1	7.7	20.7	11.1	10.0
Unemployed	***2.3***	***69.9***	***79.2***	***70.6***	***81.2***	***170.3***	***120.0***	***201.8***	***143.3***
Pensioner	***27.9***	***90.4***	***87.6***	***94.2***	***92.2***	***125.9***	***150.2***	***112.4***	***141.2***
Other	7.1	82.0	86.8	86.5	89.2	145.6	119.1	132.0	104.3
Educational level of household head									
Tertiary education completed	16.9	151.1	145.2	147.9	137.5	17.3	22.7	19.4	12.0
Upper secondary education completed	30.5	103.7	106.2	103.4	104.5	73.0	54.7	77.6	51.9
Lower secondary education completed	13.0	89.0	90.9	88.4	92.0	107.0	103.4	119.7	118.5
Primary education completed	***29.9***	***83.2***	***82.8***	***84.3***	***86.3***	***136.4***	***138.5***	***129.5***	***144.4***
Primary education not completed	***9.6***	***65.2***	***66.6***	***69.6***	***73.0***	***208.8***	***255.8***	***194.7***	***244.5***
GREECE	100	100	100	100	100	100	100	100	100

of Table 6) are closer to the national average than their mean disposable incomes, consumption expenditures or full incomes. Nevertheless, in all but two cases, the contributions of these groups to aggregate poverty are considerably higher when we use as a welfare indicator the composite welfare indicator instead of disposable income, consumption expenditure or full income. Moreover, further analysis indicates that residence in rural areas, working in agriculture and having low educational qualifications significantly increase the probability of falling below the poverty line. The poverty risk for these population groups is higher according to the new composite indicator of permanent income. At the other end, irrespective of the distribution used, the probability of poverty declines significantly as a result of high educational qualifications—particularly occupational characteristics of the household head (employer, non-manual employee or professional self-employed) and, to a lesser extent, residence in big cities.

6 Conclusions

The great majority of empirical distributional studies utilise cross-sectional data on disposable income or, to a lesser extent, consumption expenditure from Household Income and Budget Surveys. For a number of reasons, in many cases these variables exhibit a lot of artificially high variation. In addition, due to life-cycle factors, in many surveys containing information on both variables, they do not exhibit a particularly high degree of correlation. As a result, at least one, and possibly both, might not be considered as very reliable indicators of the welfare of the members of the population and their use for the design of policies aimed to alleviate poverty, or reduce inequality, could be problematic. The problem is likely to be particularly serious in many developing countries with high levels of poverty where such surveys are conducted at irregular intervals, usually many years apart from one another. In these cases, errors in the identification of the truly high-poverty risk groups may have serious consequences in terms of human suffering.

This paper has presented a simple methodology that can be easily replicated in other data sets, for extracting information about a more stable welfare indicator of the population members under assumptions that cannot be considered as particularly restrictive. The resulting indicator utilises the information of all the available monetary welfare indicators, with the corresponding weights determined endogenously and being inversely related to the degree of "noisiness" of each monetary welfare indicator.

Then, an application is provided using the data of a Greek Household Budget Survey for 2004/05. The distribution of the composite welfare indicator is found to exhibit substantially lower inequality than the distributions of disposable income, full income or consumption expenditure. Moreover, the composite welfare indicator is found to be more closely correlated than the other three monetary welfare indicators to a number of non-monetary welfare indicators constructed using the information available in the Household Budget Survey. The structure of inequality, as accounted by all welfare indicators, does not differ substantially across distributions, although in the distribution of the composite welfare indicator differences "between groups" are found to account for a higher proportion of aggregate inequality than in the distributions of disposable income, full income and consumption expenditure. Moreover, the contributions of a number of high-poverty-risk groups to aggregate poverty are found to be larger using the distribution of the composite welfare indicator than either of the other distributions. Naturally, these findings are likely to have implications for the design of policies aimed to reduce aggregate inequality and, particularly, for the purposes of targeting efficiently the limited resources available for poverty alleviation.[12]

[12] From a different point of view, these findings provide some support for the argument that anti-poverty policies should be targeted towards people that experience deprivation in terms of both income and consumption (see, for example, Nolan and Whelan 1996). About three-quarters of those who fall below the poverty line, according to both current income and consumption expenditure, are classified as poor by the composite welfare indicator, although the remaining one quarter are not.

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The Balance of Demand and Supply of Professions: A Labour Market Information System for Greece

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Abstract

This study utilizes various data sources and methods in order to develop a system of employment and occupational forecasting in Greece and on an international level. A holistic approach, which uses both quantitative and qualitative techniques, is introduced in order to "balance" the demand for and supply of specific occupations. In general, our findings show a growing need for highly skilled mainly technical occupations, while the future of occupations related to theoretical studies is degraded.

1 Introduction

The growing interest for reliable labour market information, able to provide the input for decision making, both collective and individual, has led many developed countries to create Labour Market Information (LMI) systems aiming to conduct employment forecasts for various occupations. Official forecasting activities have been limited in Greece, mainly because of data constraints (Karadinos 2001) and only by individual researchers has this field of study attracted some attention (Katsanevas 1998). Such information is of crucial importance especially since this is a country where most recent educational reforms have been made irrespective of the needs of the labour market while graduates of specific fields experience adverse labour market prospects. Thus information on the prospects of specific occupations can be

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used effectively by both policy makers and individuals. This article aims to cover the gap by examining various methodologies and datasets for producing labour market information that can be used effectively by both policy makers and individuals while helping in policy decision making for the educational system, the labour market career guidance.

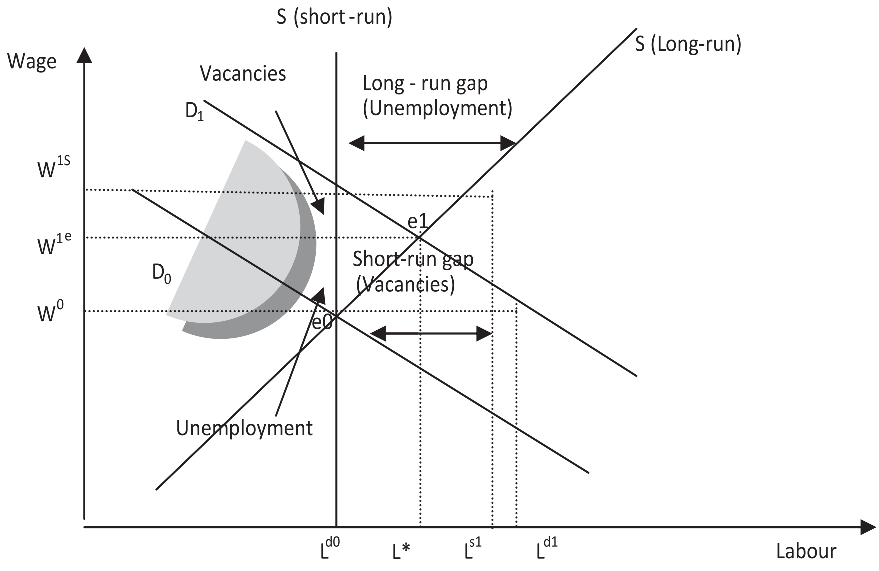
2 Theoretical Considerations: Disequilibrium in the Labour Market

The mismatches between demand and supply for specific types of education/ occupation, create various disequilibrium situations in the labour market. In cases where a shortage exists, caused when demand for a specific type of education/ occupational category is higher than the supply, then labour market mechanisms will initiate a rise in the level of wages offered to these workers, which will lead to a positive supply response. The neo-classical theory of economics suggests that this will lead eventually to a new equilibrium situation. However, the labour market does not always clear and thus certain disequilibrium situations may persist. In particular, workers with lower qualifications or less appropriate for the particular position may be employed in order to fill in the gaps. This is a substitution process that leads to the situation of under-qualification of employees for the particular occupation. Where the shortage cannot be covered with less qualified workers, then the shortage may manifest itself in difficulties in filling vacancies (i.e. hard -to-fill vacancies). On the other hand, a labour surplus may be expressed by a decline in the wage level, a move towards occupations that require fewer skills (over-qualification), and/or a rise in unemployment. The rise in unemployment often happens for lower levels of education as usually highly skilled workers will tend to be employed in jobs with less appropriate education.

Figure 1 depicts some of these imbalances focusing on vacancies and unemployment. In the short-term the supply of skilled labour might be rather inelastic as it takes some time to educate new entrants. The short-term supply is depicted by the vertical curve S in Figure 1. e0 shows the equilibrium situation in the labour market, where the demand curve (D_0) crosses the long-run supply curve. An external shock might shift the demand curve to the right (D_1) and the equilibrium situation will cease to exist. Now there will be a gap between demand at L^{d1} and the short-term supply, at level L^{do}. This gap will be reflected in unfilled vacancies. If wages adjust upwards, the long-term supply will expand until it reaches e1. However, it might be possible that wages increase more than required for the equilibrium level. In such case, a wage W^{1s} is required in the short run, which will encourage a long-run supply of L^{s1}. This would create an excess supply over demand, resulting in unemployment until wages adjust to level W^{1e}, where short-run supply is adjusted to its long run.

While wages and employment are moving towards an equilibrium situation in the labour market there will always be some temporary vacancies unfilled and some people temporarily unemployed. This is depicted by the shaded semicircle in Figure 1. This gap between the shaded area and the supply curve is a measure of frictional unemployment and the gap between the shaded area and the demand curve is a measure of frictional vacancies.

Figure 1: Imbalances in the labour market



3 Tools for Producing Labour Market Information

Measuring skill shortages is not easy. In fact, it is a 'notoriously difficult' task (Bosworth 1993:242) for which there is no one "best way" to do it. In theory, most of the econometric literature measuring skill shortages has focused on disequilibrium or equilibrium models in which the primary source of adjustment is relative wages (see for example Bosworth and Warren 1992). These models have made a significant contribution to the methodology of analysing skill shortages, but owing to data constraints, they have not been very successful in presenting generalisable results (Bosworth 1993). Thus, such models have not been very successful for producing consistent occupational projections.

Another well-known practice for scanning the needs of the labour market is that of quantitative projections. The first employment forecasting activities, then ‘manpower planning’, date back to the post World War II era which was characterised by rather intense planning activities. Since then, the methodologies have improved significantly and most of the criticisms have been overcome and quantitative projections are carried out regularly in various countries (see, for example, Lindley 2002, HRDC 2003, Fullerton 2003, Sexton et al. 2004, Mane and Alonso 2002, Dixon and Rimmer 1998, Corvers et al. 2002). Most recently, CEDEFOP (2008) carried out a large project aiming to develop medium-term forecasts at a pan-European level, which mainly focus on projections of occupations and qualifications employment. This project discussed various methodological issues as well as data concerns regarding the development of robust estimates at a pan-European level. Similar studies are carried out in many other parts of the world.

Nevertheless, even though significant methodological improvements have been made, such studies do focus solely on quantitative methods, thus overlooking the qualitative side of the results. Moreover, they mainly focus on ISCO[1] occupational categories, which might be difficult to interpret and use for guidance. However, the usefulness of such classifications is debatable as it refers to broad occupational groups rather than specific occupations. We argue that, the use of specific occupations is of more practical importance and can provide better input especially for the purposes of career guidance. Moreover, the focus of employment projections is mostly on the demand side without taking into consideration the supply side, which might be moving towards the same or the opposite directions. Thus, the identification of poten-

[1] That is the International Standard Classification of Occupations.

tial skill imbalances in the labour market is not possible and conflicting messages may be given.

4 Data and Methods

In order to estimate the prospects of the various occupations, this study has made use of both primary and secondary data. These are described as follows.

4.1 Collection of Primary Data

Primary data are collected by 3rd year students of the department of Economics of the University of Piraeus as part of their course in labour economics. In particular, each year approximately 200 students conduct 5 to 7 semi-structured interviews each, with actors within the labour market such as public sector administrators, professionals, business owners, human resource managers of companies, trade unionists, etc. Each student focuses on a specific sector of the economy and the various occupations comprising it. During the interview, the interviewee is asked about the prospects of the professions of that sector. In particular the interviewees are asked to reply to the questions taking into consideration their own experience and knowledge of the labour market. The interview is facilitated with the use of a specific questionnaire which lists all the occupations of the relevant category. The interviewer, in accordance with the responses of the interviewee, marks the prospects of each profession as 'very positive', 'positive', 'neutral', 'negative' and 'very negative'. In addition, the interviewees are asked to provide their opinions about the causes of existing shortages or surpluses. Each student is asked to provide a full report presenting the findings of his/her fieldwork research. This report is assessed while combining all the data in order to construct the qualitative indices. The results presented in this paper have utilized 1,200 reports that were produced during the period 2002–2008.

4.2 Secondary Data

Aggregate time series data for the period 1993–2006 were taken from the Greek Labour Force Survey. These data refer to employment, unemployment and wages broken down by industry and occupational group, and were obtained from the National Statistical Service of Greece (ESYE). Moreover, data on flows of the educational system by course attended were collected in order to assess the trends of the supply of qualifications.

After all the analyses are conducted, the results are assessed and qualitative indices are produced rating the prospects of specific occupations. Since the main purpose of this research is to create the input for career guidance a classification of professions (rather than occupational categories as in ISCO) has been developed, which is most appropriate for such purposes and has practical applicability especially for vocational guidance. In particular, the factors that are taken into consideration are:

- The job description of each occupation concerning the context of each profession. Therefore, professions with similar context have been put together.
- The features of the labour market as well as the structure of the economy. The existed classifications (e.g. STAKOD 91 used by the ESYE, ISCO-88, ISCO-88 COM, NACE etc.)
- The nature of the Greek higher educational system and the onomatology of several courses.

The sectoral classification,[2] along with some selected occupations, are presented later in this paper along with the results.

After the primary and secondary data have been collected, these are assessed in order to derive the projections. The assessment involves three stages. These are described as follows.

First stage: The first stage involves the processing of the data collected. The above data are combined and a first set of projections regarding the prospects of the professions is made. In particular, qualitative indices are constructed ranking the prospects of the professions as ‘positive’, ‘neutral’ and ‘fair’. A first report is written, which apart from the prospects of the occupations, includes an analysis of the labour market, as well as a discussion about causes of skills shortages and surpluses in the Greek labour market.

Second stage: The second stage entails expert assessment of the first set of projections. In particular, experts of the labour market such as University professors, researchers, directors of organisations, managers/owners of com-

[2] The full classification is available from the authors upon request.

panies and chairmen of chambers are asked to comment on these projections and provide their own estimations.

Third stage: In the third final stage of the research, the work of the second stage is edited and the final round of projections is produced. Finally the predictions are presented using qualitative indices. These are described as follows.

• Professions with positive employment prospects……………………•••
• Professions with neutral employment prospects……………………..••
• Professions with fair employment prospects…………………………•

The advantage of this approach is that utilizes both qualitative and quantitative methods in order to create a holistic approach able to look in depth at the issue of employment prospects of occupations. For that purpose, both the demand for and the supply of professions in the Greek labour market is considered by taking into consideration both the trends of the labour market and the flows from the educational system.

5 Empirical Results

5.1 Analysis of Skill Shortages

Historical Labour Force Survey figures, such as employment, unemployment and wages, are able to provide a picture of skill imbalances (Veneri 1999, Cohen and Zaidi 2002, Manacorda and Petrongolo 1999). For instance, a potential shortage might be indicated by the growing level of employment, the declining rate of unemployment, the increase in the relative earnings, and/or combinations of the above. The examination of these trends, even though they cannot provide robust measurements of skill imbalances, can paint a useful picture as long as the caveats are acknowledged (Veneri 1999).

This section examines trends in these figures using information from the 1999–2004 LFS of the National Statistical Service of Greece. The reason that this period has been chosen is that wages in the Greek LFS are only available from 1998 onwards. Table 1 presents changes in employment, unemployment and wages for two-digit ISCO 88-COM occupational groups. Various implications can be made by observing these figures. For instance, the parallel opposite changes in employment and unemployment are likely to suggest an imbalance. Thus, a potential shortage is likely to exist for: teaching professionals, accountants, customer service clerks, and protective services workers. Nevertheless, these trends described above are constrained by the limited period of data availability since the examined period was highlighted by intensive construction activities and thus occupations related to construction were in high demand.

On the other hand, for groups whose unemployment rose considerably more than employment, a surplus might exist. Such was the case for: professionals, clerks and elementary occupations. These trends follow the general trends discussed in the previous sections, reflecting the problems that professionals as well as clerks and elementary workers face in the labour market.

Turning to changes in the average relative wage level a potential imbalance may be indicated by a higher change than the average wage level. Nevertheless, this is not without caveats since an increase in the wage level of a group might also be due to other factors, such as the rise in the levels of productivity within that particular group. Table 2 presents the relative wages[3] of the various occupational categories for the years 2000 and 2004, as well as the percentage change over this period. Thus, the picture we get from this analysis of the data is not clear enough to make safe conclusions and therefore the results should be regarded as indicative of general trends rather than definitive.

Finally, in order to assess whether there is a correlation between these indicators, the percentage changes in employment were regressed against the changes in unemployment and relative wages. Only a small positive relationship was found to exist between the changes in employment and unemployment (correlation coefficient = 0.24, standard error = 0.04). Moreover, a non-statistically significant relationship was found to exist between the change in employment and wages (correlation coefficient = 0.33, standard error = 0.62). Also, a non-significant relationship was found between changes in unemployment and wages (coefficient = 0.0004, standard error = .040). The lack of correlation between the changes in these figures is another indication that no safe conclusions can be made about the existence of skill imbalances utilizing information on indicators such as employment, unemployment, and wages.

[3] The relative wages were calculated by dividing the wage level for each occupation with the average wage level across all occupations.

5.2 The Macroeconomic Model and Occupational Projections

An analysis of the behaviour of the markets for goods and services is essential to understand the labour market (Wilson 2001). The prospects for skills need to be assessed based on a sound understanding of the economic factors that are influencing the economy and its structure. That can be done with the use of a multi-sectoral macroeconomic model, which has two main advantages (Wilson 1994). The first is that a comprehensive set of projections is ensured for individual sectors, occupations or regions that are mutually consistent and fit into a common scenario. The second main advantage is that the methods and assumptions used are all explicit and quantified. This study rather than building a new macro-economic model utilizes an existing one. In particular, the study adopts the macro-economic model E3ME[4] (Energy-Environment-Economy) as developed by Cambridge Econometrics (CE).

The E3ME sectoral classification identifies 40 sectors of economic activity. These sectors are based on the 2-digit 1990 NACE (Statistical Classification of Economic Activities in the European Union) Rev. 1. ESYE's classification, STAKOD 91, is also based on NACE 1.1. Thus, it is possible to make ESYE's sectoral classification compatible to the one used by E3ME. Doing so, the E3ME sectoral projections of employment growth can be applied to ESYE's levels of historical employment in order to derive the sectoral projections. As for occupational classifications**,** ESYE uses STEP which is based on ISCO (International Standard Classification of Occupations) COM-88. ISCO COM-88 is also used by Eurostat. Thus, ESYE's occupational classification is consistent with the one used by Eurostat.

The sectoral projections are then used to produce occupational projections using a changing shares approach. This process is described as follows.

The occupational shares (S_{ijt}) were obtained using a mixed methods approach based on simple specifications that take the general form:

$$S_{ijt} = F(time) \tag{1}$$

The models estimated include a number of variations including linear, and a logistic forms. Such equations can be regarded as versions of equation (1),

[4] See www.cameron.com

where time is used as a proxy for technological change. A number of variants are possible. These range from simple extrapolation between fixed points, to various methods based on 'line fitting'. The latter includes fitting:

- a linear trend [$S = a + b \times Time$], (2)

- or a logistic equation [$Ln(S/(1-S)) = a + b \times Time$]. (3)

The shares derived from the above models are then constrained in order to match up to 100%. Then the shares are applied to the sectoral forecasts of E3ME. The set of shares that is used as default is the one based on the logistic equation (3). The occupational projections obtained are assessed and in cases where unrealistic patterns are observed (e.g. very sharp increases over 100%), then the shares based on the linear trend approach are adopted. Finally, in cases that the trends based on the linear trends still do not look convincing enough, then the average LFS shares are utilized.

The results are presented in Table 3. The years that have been chosen as reference points include 2006, 2009 and 2015. The results suggest a marginal increase for highly skilled occupations, such as managers and professionals (2% and 6% respectively). On the other hand, a more significant projection (34%) is made for the increase in associate professionals. Low skilled occupations, such as agricultural and craft workers, are projected to experience a decline in employment (-18% and -3% respectively). There is, however, a significant increase projected for service workers (24%). The overall findings suggest that even though much importance has been laid on highly skilled occupations, and policies have been targeted towards the increase of the supply of such workers, the developments on the demand side do not seem able to absorb such a workforce (with the exception of associate professionals) but are more oriented towards service workers.

5.3 Employment Prospects for Selected Occupations

This section presents the employment prospects for a number of selected professions (Table 4) as estimated by the "balance of demand and supply of professions". These predictions are the outcome of our latest research. One of the most interesting findings of our research is that professions that are traditionally considered to be prestigious–such as doctors, dentists and lawyers–

show high saturation and thus the prospects of such occupations in the labour market are relatively poor. In addition to the above, there is a wide range of professions that even though they require a university degree have very poor prospects in the Greek labour market. Amongst these are biologists, pharmacists and chemists. Similar is the case for teachers in the area of philology, history, and theology, for which there is poor demand in the labour market while the supply is rather high.

On the other hand, professions related to computing, modern technologies, construction, tourism, ecological agriculture etc. appear to be considerably better. Similarly, very positive are the prospects for technical and auxiliary occupations, such as the plumber, the electrician, the refrigerating technician, the carpenter, the blacksmith-aluminous technician, the telecommunications technician, the medical laboratories technician, but also the nurse, the hairdresser, the domestic assistant and the gardener, etc. Specifically, the auxiliary occupations and some of which are related with the technical-professional education, are filled by immigrants.

The predictions presented in Table 4 refer to the whole of Greece. However, various regional differentiations might exist across sectors, such as tourism and agriculture. In regions with immense tourist growth, such as the Ionian and Aegean Islands, tourism-related occupations are expected to be smiling in the future. Regions where the agricultural production is dominant, e.g. Crete, or people that practice relevant occupations and possess knowledge of modern efficient or even alternative cultures, have better chances of absorption in the labour market. In most regions, such as the regions of Northern Greece, the industrial occupations have a declining path, because of technological progress and the transfer of many industries to countries with low working costs, such as Bulgaria and Albania. On the contrary, the occupations within the transport sector have good prospects. Regarding occupations related to arts and media, these are particularly competitive and saturated, since a lot of young people aspire to a career in these shining fields. Occupations related to theoretical studies and teaching appear to be rather saturated, since the number of graduates is larger than the number of the job positions available in the same fields.

6 Conclusion

In this paper, various possibilities for developing a Labour Market Information System for Greece have been explored and a methodology, namely the '*balance of demand and supply of projections*' has been developed. This model takes into account all reliable data available in Greece and generates a more holistic approach. It is the purpose of our methodology to scan the labour market and make predictions about future employment prospects of about 700 individual professions of various levels of education. In general, our results suggest a growing demand for highly skilled, mainly technical occupations, while the demand for low skilled ones, with the exception of those related to trade and commerce, is declining. The outcome of this research can be used by both policy makers as well as by individuals making career choices.

Table 1: Changes in Employment-Unemployment-Wages 1998-2004 (LFS published data 2nd quarter)

	(A)	(B)	(C)
	% change in the level of employment	% change in the rate of unemployment	% change of the median nominal wage level
Legislators and officials			
Legislators and senior officials	0	20	5
Corporate managers	18	20	31
General managers	11	20	39
Professionals			
Physical, mathematical and engineering science professionals	100		35
Architects, engineers and related professionals	16	98	28
Life science and health professionals	30	22	25
Teaching professionals	31	-56	34
Accountants	27	-33	25
Legal professionals	11	180	35
Scientific, artistic and other related professions	6	53	44
Associate professionals			
Physical and engineering science associate professionals	22	26	27
Life science and health associate professionals	36	24	37
Teaching associate professionals	-16	-60	43
Office and service workers		-	
Salesmen	30	-	31
Office clerks	11	20	32
Customer service clerks	36	-21	31
Personal services workers	2	-7	27
Protective services workers	43	-8	33
Models, salespersons and demonstrators	12	24	35
Total	**10.8**	**8.6**	**32.4**
Agricultural workers			
Agricultural workers oriented in annual production	1	-0.2	39
Agricultural workers specialised in tree cultivation	-4	-0.5	35
Multi-cultivators	-41	-	16
Animal producers	2	-0.4	11

Table 1 (continued)

	% change in the level of employment	% change in the rate of unemployment	% change of the median nominal wage level
Agricultural workers (continued)			
Forestry and related workers	-49	-0.4	38
Fishery workers	-4	-0.3	69
Craft and related trades workers			
Miners, shot-firers, stonecutters and carvers	-41	–	37
Building frame, finishers and related	17	–	38
Metal moulders, welders, sheet-metalworkers, etc.	1	–	36
Electrical and electronic equipment mechanics and fitters	0	-0.3	38
Precision, handicraft, printing and related trades workers	-12	-0.4	32
Food processing and related trades workers	-21	-0.1	30
Wood treaters, cabinet-makers and related trades workers	-9	0.2	35
Textile, garment and related trades workers	-31	-0.0	32
Total	**10.8**	**8.6**	**32.4**
Operators and other workers			
Stationary plant and related operators	-12	-0.3	31
Metal and mineral products machine operators	32	1.0	31
Chemical processing plant operators	13	-0.6	43
Wood processing and papermaking plant operators	18	-0.5	43
Textile, fur and leather products machine operators	-20	-0.1	38
Food and related products machine operators	33	-0.1	26
Other machine operators and assemblers	23	-0.1	25
Drivers and mobile plant operators	8	-0.1	36
Elementary occupations			
Sales and services elementary occupations	25	0.1	30
Agricultural, fishery and related labourers	104	0.1	36
Labourers in mining	20	0.1	5
Total	**10.8**	**8.6**	**32.4**

Notes: 1. A shows the % change of the share of each occupational group. B shows the % change in the rates of occupational unemployment during 1998-2004. C shows the % change of the median nominal wage level for each occupational group.
2. Unemployment refers only to those with an occupation; new unemployed are excluded. Wages refer to employees only, i.e. self-employed are excluded.
Source: LFS data.

Table 2: Relative wages by occupational category 2000-2004

	2000	2004	Change %
Legislators and officials			
Legislators and senior officials	1.9	1.4	-24
Corporate managers	1.5	1.5	-3
General managers	1.0	1.1	10
Professionals			
Physical, mathermatical and engineering science professionals	1.3	1.3	2
Architects, engineers and related professionals	1.4	1.3	-4
Life science and health professionals	1.5	1.4	-5
Teaching professionals	1.2	1.2	2
Accountants	1.2	1.2	-5
Legal professionals	1.3	1.3	2
Scientific, artistic and other related professions	1.2	1.2	-1
Associate professionals			
Physical and engineering science associate professionals	1.2	1.2	-4
Life science and health associate professionals	1.0	1.1	6
Teaching associate professionals	0.9	1.0	12
Clerks			
Salesmen	1.0	1.0	0
Office clerks	1.0	1.0	1
Service workers			
Customer service clerks	0.9	0.9	0
Personal services workers	0.8	0.8	-4
Protective services workers	1.1	1.2	2
Models, salespersons and demonstrators	0.7	0.7	0
Skilled agricultural and fishery workers			
Agricultural workers oriented in annual production	0.7	0.8	5
Agricultural workers specialised in tree cultivation	0.6	0.6	-2
Multicultivators	0.6	0.5	-11
Animal producers	0.8	0.7	-9
Forestry and related workers	0.7	0.7	6
Fishery workers	0.7	0.9	25
Craft and related trades workers			
Miners, shot-firers, stonecutters and carvers	0.9	0.9	2
Building frame, finishers and related	0.8	0.9	4
Metal moulders, welders, sheet-metalworkers, Structural-metal preparers and related trades	0.8	0.9	4
Electrical and electronic equipment mechanics and fitters	1.1	1.1	6
Precision, handicraft, printing and related trades workers	0.9	0.9	-1
Food processing and related trades workers	0.8	0.8	-1
Wood treaters, cabinet-makers and related trades workers	0.8	0.8	2
Textile, garment and related trades workers	0.7	0.7	-1

Table 2 (continued)

	2000	2004	Change %
Machine operators			
Stationary plant and related operators	1.0	1.0	0
Metal and mineral products machine operators	1.0	1.0	0
Chemical processing plant operators	0.8	0.9	5
Wood processing and papermaking plant operators	0.8	0.8	6
Textile, fur and leather products machine operators	0.8	0.8	5
Food and related products machine operators	0.8	0.8	-7
Other machine operators and assemblers	0.8	0.8	-6
Drivers and mobile plant operators	1.0	1.0	3
Elementary occupations			
Sales and services elementary occupations	0.7	0.7	-1
Agricultural, fishery and related labourers	0.6	0.6	5
Labourers in mining	0.8	0.8	5

Note: Relative wages have been calculated by dividing the nominal wage with the average wage level across all occupational categories. The data refer to the 2nd quarter (LFS data).

Source: LFS data.

Table 3: Occupational groups

				2006-2015 change	
	2006	2009	2015	Change in 000s	Change in %
Legislators, senior officials and managers	430	415	437	7	2
Professionals*	475	541	504	29	6
Technicians and associate professionals	313	368	420	107	34
Clerks	455	480	477	22	5
Service workers and shop and market sales workers	594	632	737	143	24
Skilled agricultural and fishery workers	529	499	433	-96	-18
Craft and related trades workers	634	668	618	-16	-3
Plant and machine operators and assemblers	351	366	388	37	11
Elementary occupations*	380	335	462	82	22
Total	**4,159**	**4,307**	**4,475**	**316**	**8**

Note: various methods are used to estimate the occupational shares.

*For these particular groups there is discontinuity in the data for 2006.

Source: LFS data and authors' estimates.

Table 4: Prospects of selected occupations

Profession	Prospects
1. Agriculture	
Higher Education	
Agriculturalist	**
Geologist	*
Greenhouse - Floriculture technologist	***
Professional Education	
Biological - ecological agriculture technician	***
Gardener	***
Fish farm technician	***
2. Constructions	
Higher Education	
Mechanic engineer	**
Civil engineer	**
Architect engineer	**
Technologist - electrician	***
Textile industry technologist	*
First Levels of Education	
Electrician	***
Plumber	***
Machinery and tools techician	***
Painter	**
Tailor	*
3. Chemistry	
Higher Education	
Pharmacist	*
Biologist	*
Total quality controller	*
Quality control technologist	**
Chemical Engineer	*
Food Mechanic	**
First Levels of Education	
Industrial automation equipment technician	**
Dairy farm worker	**
Wine technologist	**
4. Computers	
4.1 Software	
Higher Education	
Informatics programmer	***
Economy and administration informatics	***
Telecommunication & networks Informatics	***
Information systems informatics scientist	***
Internet informatics scientist	***
First Levels of Education	
Application informatics scienitist	***
Data base and network technician	***
Website technician	***
4.2 Hardware	
Higher Education	
Informatics- Electronics	***
Mechanic	***
Radio - television	***
First Levels of Education	
Mobile telephony	***
PC and network technician	***
Electronic micro device	***
5. Business	
Higher Education	
Economist	**
Manager	**
Tax consultant - accountant	***
Economist in informatics	***
Economist - mechanical	***
First Levels of Education	
Executive secretary	**
Logistics manager	**
Courier	**

Table 4 (continued)

Profession	Prospects	Profession	Prospects
6. Trade, Public Relations, Insurance, Commerce		**10. Sports**	
Higher Education		**Higher Education**	
Insurer	**	Physical education instructor	**
Sales executive	**	Sport coach	**
Public relations specialist	**	**First Levels of Education**	
Stockbroker	*	Security manager	*
First Levels of Education		Physical trainer assistant	
Salesman	**	**11. Information and Mass Media**	
Public relations expert	**	**Higher Education**	
7. Law occupations		Journalist	*
Lawyer	*	Creative advertiser	**
Judge	***	Radio Producer	*
8. Trasport, Shipping		Publications editor	**
Higher Education		TV and cinema producer	*
Pilot	*	**First Levels of Education**	
Captain	***	Sound engineering technician	*
Merchant navy officer	***	Camera man	*
First Levels of Education		Editor	*
Air hostess - flight	*	Makeup artist	*
Driver	***	**12. Fine, Applied and Graphic Arts**	
9. Tourism		**Higher Education**	
Higher Education		Actor	*
Tourist enterprises executive	**	Director	*
Tourist guide	**	Graphic arts technologist	**
Receptionist	**	Musician	*
First Levels of Education		Fashion designer - Stylist	**
Hotel employee	***		
Executive chef	**		
Restaurant manager	**		

Source: Authors’ estimates.

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The Educational Outcomes of Youth of Migrant Origin in Greece

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Abstract

This paper investigates educational outcomes of youth of migrant origin in Greece aged 15-29, and compares them with outcomes of native youth. To this purpose, we pool data from the Greek Labour Force Surveys for the years 2004-2008 in order to achieve a satisfactory number of migrant-origin youth for our analysis. Then, we divide our data into two samples: those who have completed their education and those still attending formal education. Our results show that in accordance with the experience of other countries, there is an educational gap between youth of migrant and native origin, evident in both samples. Even after controlling for various characteristics, which seem to have a variant effect both as regards to gender and ethnic group, estimated probabilities indicate that native youth have double the chances of having completed or attending higher education compared to youth of migrant origin. It is also observed that women fare better than men in all ethnic groups. Although there is significant variation in educational status among youth of various migrant origins, it is particularly alarming that the largest group, Albanian citizens, are characterised by the greatest educational deficit. Policy efforts must be intensified if youth of migrant origin are to be successfully and smoothly integrated into the Greek economy and society.

1 Introduction

Nearly twenty years after the onset of massive migration flows into Greece at the beginning of the 1990's, a second generation of migrants is

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coming of age and embarking on the transition from the educational system to the labour market. In many countries of the European Union, examination of the experience of the second generation and of the problems they encounter in the educational system and labour market has created great concern and led to the formulation of policy measures to facilitate their integration. In Greece, research of the experience of youth of migrant origin is in an embryonic stage. Knowledge of their experiences is crucial in order to identify the difficulties they face and prevent their marginalisation as well as to assess the implications of their presence for the Greek economy.

In this paper, data from the Labour Force Survey of Greece are utilized to investigate the educational status of youth 15-29 years of age who are of migrant origin, and compare it with that of their native peers. We focus on participation in formal educational programmes and the type of programme attended, as well as on educational attainment, first using descriptive analysis and then examining factors associated with specific outcomes, by means of econometric estimation techniques.

The international literature on the integration of migrant youth has expanded greatly over the last decade.[1] A recent study in OECD countries (OECD 2007) compared the educational attainment of three groups of youth aged 20-29 years: migrants, children born in the host country to parents who had migrated ("second generation"), and children of parents who were born in the host country ("natives"). It was ascertained that young migrants are characterised by lower educational levels than are children of natives in all the countries of the comparison except for Australia and Canada. Likewise, the educational levels of the second generation were higher than those of the migrants of the same age group, again with the exception of Australia and Canada. It was considered that the experience of these two countries diverged because of their migration policies, which attempted to attract migrants with high educational levels. Important differences were also observed by gender. Specifically, young women who were born in the host country to migrant parents exhibited higher attainment levels than their male peers, with the exception of the United States. On the contrary, young women who

[1] For an overview of some of the competing theoretical frameworks that have been developed see Thomson and Crul (2007) and Portes et al. (2009).

were migrants themselves exhibited low attainment levels which in many countries were below those of their male peers. In other words, in the second generation, improvement in educational attainment appeared to be much greater for women.

In a comparative study of the integration of migrant youth in eight countries of the EU (Crul and Vermeulen 2003, Thomson and Crul 2007), the main reference group was youth of Turkish origin, since migrants of Turkish origin constituted the largest migrant community in Europe and had a significant presence in multiple countries. In each country, youth of Turkish origin were compared with native youth as well as with youth of other migrant origins. Compared to native youth and to youth of Moroccan origin, also a major ethnic group in many of the countries studied, youth of Turkish origin were characterised by shorter educational "careers" and greater concentration in technical and vocational streams. Differences were observed not only by migrant origin but also by gender. Second generation Turkish women fared well in school but compared to their Moroccan peers, more often left school to work or to marry. This tendency was attributed to the greater cohesion that characterised the Turkish immigrant community, which allowed for more effective enforcement of gender roles.

In separate research on educational attainment in Germany (Riphahn 2001, Riphahn 2004), increasing divergence was observed between successive cohorts of the children of nationals and of immigrants, casting doubt on optimistic assumptions concerning the assimilation of the second generation of migrants. However, it was noted that increasing divergence over time could be the result of changes in the country composition of successive waves of migrants.

In Greece, most of the existing research on the experience of a "second generation of migrants" or of youth of migrant origin focuses on the educational system, as could be expected given the relative recentness of flows. According to the Institute for the Greek Diaspora Education and Intercultural Studies (IPODE), in the school year 2008-9, 10.3% of the students in public elementary schools were "foreign" students (not Greek citizens nor of Greek descent) while 0.9% were "repatriated co-ethnics" ("palinnostountes"). The corresponding figures for the gymnasium (lower secondary education) were 9.2% and 1.3%, for the lyceum (upper secondary education) 4.4% and 1.1%, and for TEE-EPAL (technical and vocationally oriented upper secondary schools) 10.1% and 2.2% (http://www. ipode.gr/). While comparable official figures for the tertiary level do not appear to be available, it is generally believed that both these groups of migrant origin are under-represented compared to their shares in the age-relevant population. The above figures indicate a sharp decrease in the share of foreign non-co-ethnic students at the lyceum level compared to the gymnasium, but noteworthy presence of both groups of migrant origin youth in vocationally-oriented schools of the upper secondary level compared to the lyceum. The same two trends were exhibited in the data collected by the Hellenic Migration Policy Institute (IMEPO) from school districts in 2005 and 2006 (Giannitsas, Mavrommatis and Avramidi 2008).

A significant proportion of youth of both co-ethnic and non-co-ethnic origin experience serious difficulties in school due to their insufficient command of the Greek language (Evangelou and Palaiologou 2007). According to the data collected by IMEPO (Giannitsas, Mavrommatis and Avramidi 2008), large proportions of students of non-co-ethnic origin had lived in Greece for only a few years. Specifically, 14% of gymnasium students in the Attica region had been in Greece for 0-4 years and another 29% had been in Greece for 5-7 years, while the respective percentages for Lyceum students were 9% and 19% and for TEE students 12% and 27%. The Greek Ministry of Education has provided for the operation of reception and support classes within the public schools, which focus on the teaching of Greek as a foreign language and on tackling academic problems related to insufficient command of the Greek language. However, they do not cover existing needs (Kasimi 2006, Evangelou and Palaiologou 2007, Triandafyllidou and Gropas 2007, Therianos 2008). The language difficulties confronting students of migrant origin undoubtedly constitute an important factor shaping their educational strategies and choices with respect to continuation from the lower secondary to the upper secondary level and beyond.

2 Data

In order to assess and compare the factors associated with educational outcomes of youth aged 15-29 of native and migrant origin, we use micro-data from the Labour Force Survey of Greece. In this section we briefly outline our mode of utilisation of the Labour Force Survey, our dependent and independent variables, the general characteristics of our sample, and main descriptive patterns, before moving on in the next section to the empirical procedures employed and in the subsequent section to the results of our analysis.

Due to the relatively small numbers of youth of migrant origin included in the sample of the Labour Force Survey, data for all twenty quarters from 2004 through 2008 were merged, and multiple observations of the same individual were deleted from the dataset (households remain in the sample for eighteen months or six consecutive quarters, in other words, this is a rotating panel dataset). Therefore, our sample includes data from the last interview of individuals, regardless of the total number of times they were interviewed.

Taking into consideration the educational status of individuals, we divided our data into two distinct samples: those who have completed their education and those who are still attending formal education. For each of the two groups we have detailed information regarding their educational status, but, in order to provide reliable estimates, we have decided to treat that information differently. Thus, for those having completed their education the dependent variable takes on three values: 1 if a person has completed a low level of education (compulsory schooling, including primary education and lower secondary education), 2 if a person has completed an intermediate level of education (upper secondary or post-upper secondary) and 3 if a person has completed a high level of education (tertiary or post-tertiary). On the other hand, for the sample of those still attending formal education, the dependent variable takes on two values: 1 if the person currently attends higher education and 0 if a person currently attends intermediate education. The observations for those attending lower education were excluded from the sample, since no credible analysis could be undertaken due to their very small number in the age groups under consideration.

Independent variables include various individual, background and demographic characteristics suggested by economic theory. First, the model of child quantity vs. child quality proposed by Becker (1981) indicates that parents are more likely to invest in a child's education rather than in a higher number of offspring, the higher parental wages and human capital are, among other things. Therefore, we included separate dummies for father and mother with low, intermediate or high educational attainment, in order to capture the effect of parents' characteristics. Since information on parental education is available only for those individuals still living with their parents, many missing values appear, which we model with an additional dummy variable.

Ethnicity and country of origin are another group of dummy variables employed based on the ethnic capital model developed by Borjas (1992, 1994) and the investible funds schooling model conceptualized by Chiswick (1988). According to the first model, skills of young immigrants depend not only on the skills and labour market experience of their parents, but also on those same characteristics in parents' generation. Thus, belonging to a given ethnic group might explain part of a child's educational attainment. According to the second model, the amount of education chosen by individuals and their parents is determined by the intersection of schooling demand and supply schedules. Supply schedules could differ due to different tastes for schooling and discount rates of future consumption. Demand schedules could also differ substantially between ethnic groups due to varying productivities and returns to education. Therefore, the optimal amount of schooling is directly related to ethnicity and country of origin.

Furthermore, Gang and Zimmermann (2000) argue that demand for education is determined by assimilation to the host country's culture, differences in social capital and the amount of social support received from an ethnic group. Accordingly, we included a number of dummies for residence, both region (five dummies) and degree of urbanisation (five dummies), in order to capture the varying effect of immigrants' concentration throughout the country. In order to examine the extent of the assimilation process we aimed to include a dummy for first generation immigrants and a dummy for second generation immigrants (i.e. those born in Greece, but who do not have Greek citizenship). According to Chiswick and DebBurman (2004) there should be differences between these two groups if second generation immigrants possess more destination specific skills, in other words, if they are better assimilated to the host country's culture through their participation in the educational system and their better command of the language. Unfortunately, the number of second generation immigrants in our sample who were born in Greece is too small to calculate reliable econometric results and so the distinction was not used in the analysis.

Finally, additional controls include the year the interview took place, family status, age and age squared. Year of survey (five dummies) might explain part of the educational attainment of both natives and immigrants, if it is considered as a proxy for general economic conditions. In periods of economic growth the decision to seek further education might prove a difficult puzzle, since both opportunity cost (foregone earnings) and returns to education are expected to be greater. Family status (two dummies) could affect the decision to continue schooling if not being single introduces constraints, especially for those still attending school. Alternatively, family status could be used as a proxy for other unobservable characteristics that are relevant to the decision to acquire more education (presently or in the past). Age and its square are included as proxies for cohort effects, since younger individuals are expected to possess more schooling in an environment of continuous educational advancement. On the other hand, for those still attending education, we would expect older individuals to possess more schooling.

In order to capture differences among ethnic groups and assess the role of specific migrant origins for educational outcomes, youth were divided into categories according to their citizenship and migration status. In Greece, much of the research and discussion concerning migrants is bifurcated, focusing either on so-called “migrants,” who are usually conceptualized as not including migrants of Greek origin, or on migrants of Greek origin, who are usually referred to as “palinnostountes” or “omogeneis.” This bifurcation parallels the sharp distinction between the two groups in the legal and institutional framework governing their migration and stay. In this research project, it was deemed important to include migrants of Greek origin, in order to compare their educational trajectories both with those of native Greeks and with those of youth of other migrant origins. While it could be hypothesised that access to Greek citizenship and the existence of special programmes designed for the integration of “palinnostountes” might shape opportunity structures for young “palinnostountes” that resemble those of native Greek youth, resulting in similarity of the educational strategies pursued by native youth and migrant youth of Greek origin, it could also be hypothesised that migrant youth of Greek origin confront many of the same problems and obstacles as migrant youth of non-Greek origin, particularly with respect to Greek language skills, resulting in similar educational outcomes for migrant youth of Greek and non-Greek origin.

More specifically, the groups formed for purposes of comparison are the following: 1. “Greek natives - GN,” containing youth with Greek citizenship born in Greece as well as youth of Cypriot citizenship, whether born in Cyprus or Greece, 2. “Greek palinnostountes from countries of Central and Eastern Europe- GPCEE,” containing youth with Greek citizenship born in countries such as Russia, Georgia, Armenia and Albania, 3. “Greek palinnostountes from other countries - GPOC,” containing youth with Greek citizenship born in other countries than the above, mainly Germany, 4. “Citizens of Albania - CA,” regardless of country of birth, 5. “Citizens of other Central and Eastern European countries - COCEE,” containing citizens of countries such as Romania, Bulgaria, Georgia, Russia, Poland, Armenia and the Ukraine, regardless of country of birth and finally 6. “Citizens of Asia and Africa - CAA,” containing citizens of Asian and African countries, regardless of country of birth.

It should be stressed with respect to the definition adopted for “palinnostountes” that it constitutes a “proxy” for this group[2] and may result in the inclusion of individuals who were born outside Greece and obtained Greek citizenship for reasons other than status as “palinnostountes”. For example, some migrants included in this group may have been naturalized due to marriage to a Greek citizen, or may have been born abroad to Greek citizens, acquiring Greek citizenship as a “birthright”.[3] It should also be emphasized that “omogeneis” from Albania did not enjoy the same ease of access to Greek citizenship as “palinnostountes” who migrated to Greece from countries of the former Soviet Union, and therefore many youth of Greek descent from Albania are included in the group “citizens of Albania”.

Before presenting descriptive patterns, an examination of sample characteristics is in order. As seen in Table 1, youth of migrant origin constituted 8.9% of the population aged 15-29 that resulted from the merger of the LFS data for the years 2004-2008, as described above. Their actual population share was probably higher, since it is considered that migrants are under-rep-

[2] Unfortunately, Labour Force Surveys do not allow for a more accurate definition of “palinnostountes”.

[3] It should be noted that on the contrary, “second-generation migrants” born in Greece to parents without Greek citizenship, appear as citizens of other countries since, until March 2010, they did not have a right to Greek citizenship as a result of birth on Greek territory. On the other hand, “second-generation palinnostountes” born in Greece whose parents migrated to Greece and were naturalised due to their status as “palinnostountes” cannot be identified as “second-generation palinnostountes” and appear as native Greeks, since they were born in Greece and have Greek citizenship.

Table 1: Sample decomposition by citizenship-country of birth, age group and gender

Groups[1]	Men and Women				Men				Women			
	15-19	20-24	25-29	15-29	15-19	20-24	25-29	15-29	15-19	20-24	25-29	15-29
GN	17,913	18,498	19,686	56,097	8,965	9,409	10,127	28,501	8,948	9,089	9,559	27,596
	92.3	*91.3*	*89.7*	*91.1*	*91.7*	*90.9*	*89.9*	*90.8*	*93*	*91.7*	*89.6*	*91.4*
GPCEE	281	278	250	809	144	136	105	385	137	142	145	424
	1.4	*1.4*	*1.1*	*1.3*	*1.5*	*1.3*	*0.9*	*1.2*	*1.4*	*1.4*	*1.4*	*1.4*
GPOC	91	99	137	327	48	40	71	159	43	59	66	168
	0.5	*0.5*	*0.6*	*0.5*	*0.5*	*0.4*	*0.6*	*0.5*	*0.4*	*0.6*	*0.6*	*0.6*
CA	835	968	1188	2,991	469	524	609	1,602	366	444	579	1,389
	4.3	*4.8*	*5.4*	*4.9*	*4.8*	*5.1*	*5.4*	*5.1*	*3.8*	*4.5*	*5.4*	*4.6*
COCEE	232	274	453	959	109	128	182	419	123	146	271	540
	1.2	*1.4*	*2.1*	*1.6*	*1.1*	*1.2*	*1.6*	*1.3*	*1.3*	*1.5*	*2.5*	*1.8*
CAA	46	138	223	407	37	110	173	320	9	28	50	87
	0.2	*0.7*	*1*	*0.7*	*0.4*	*1.1*	*1.5*	*1.0*	*0.1*	*0.3*	*0.5*	*0.3*
Immigrants[2]	1,485	1,757	2,251	5,493	807	938	1,140	2,885	678	819	1,111	2,608
	7.7	*8.7*	*10.3*	*8.9*	*8.3*	*9.1*	*10.1*	*9.2*	*7.0*	*8.3*	*10.4*	*8.6*
Total	19,398	20,255	21,937	61,590	9,772	10,347	11,267	31,386	9,626	9,908	10,670	30,204
	31.5	*32.9*	*35.6*	*100.0*	*31.1*	*33*	*35.9*	*100.0*	*31.9*	*32.8*	*35.3*	*100.0*

Percentages in Italics.

[1] Citizenship-Country of birth groups are as follows:

GN: Greek natives, containing youth with Greek citizenship born in Greece, as well as youth of Cypriot citizenship, whether born on Cyprus or Greece.

GPCEE: Greek “palinnostountes” from countries of Central and Eastern Europe, containing youth with Greek citizenship born in countries such as Russia, Georgia, Armenia and Albania.

GPOC: Greek “palinnostountes” from other countries.

CA: Citizens of Albania, regardless of country of birth.

COCEE: Citizens of other Central and Eastern European countries, regardless of country of birth.

CAA: Citizens of Asian and African countries.

[2] Total of GPCEE, GPOC, CA, COCEE and CAA.

resented in the sample of the LFS, despite improvements in their coverage in recent years. The largest group of non-native youth is composed of Albanian citizens, who account for 4.9% of youth, followed by citizens of other Central and Eastern European countries, who account for 1.6%, and then by "palinnostountes" from countries of Central and Eastern Europe, who account for 1.3%. While for all three groups of foreign citizens, population share increases in ascending age groups, this is not the case for the group of "palinnostountes". Skewed distributions of non-native youth are observed not only with respect to age group, but also with respect to gender.

Turning to descriptive patterns, the decomposition of our sample with respect to educational status in Table 2 shows first that young men and women of migrant origin exhibit lower attendance rates in formal educational programmes than young men and women of native origin. Greater differences in attendance rates are found between natives and immigrants in the case of men, due to lower rates among men of migrant origin and not higher rates among native men, who exhibit lower rates than native women. At the same time, marked variation is observed by ethnic origin. More specifically, attendance rates of migrant youth of Greek origin ("palinnostountes") exhibit the smallest gap compared to natives, while youth of other migrant origins lag further behind. As for gender, women exhibit higher attendance rates: in 9 of the 15 groups created when non-native ethnic groups are stratified by age group, women's rates exceed men's. It should be noted that the most numerous non-native group, Albanian citizens, is characterized by a particularly wide gender gap, with much higher attendance rates for women.

Differences between youth of native and migrant origin are also ascertained with regard to type of program attended (Table 3). In the first age group (15-19), for natives and all ethnic groups, the majority of both men and women are found in intermediate education. It should be stressed that the shares attending intermediate education are higher for immigrants, but this is easily explained by the larger share of natives in higher education. Important differences are also observed by gender. For instance, greater shares of women attend higher education irrespective of the age group examined. For older individuals (20-24 and 25-29), differences among ethnic groups are more pronounced. Thus, while noteworthy shares of natives, "palinnostountes" from central and eastern Europe as well as "palinnostountes" from other countries attend higher education, the same is true for only a small

Table 2: Sample decomposition by citizenship-country of birth, age group, gender and status of education

	Education attending						Education completed					
	Men			Women			Men			Women		
Groups[1]	15-19	20-24	25-29	15-19	20-24	25-29	15-19	20-24	25-29	15-19	20-24	25-29
GN	7,111	4,134	924	7,334	4,361	730	1,854	5,275	9,203	1,614	4,728	8,829
	79.3	*43.9*	*9.1*	*82.0*	*48.0*	*7.6*	*20.7*	*56.1*	*90.9*	*18.0*	*52.0*	*92.4*
GPCEE	98	29	3	111	27	5	46	107	102	26	115	140
	68.1	*21.3*	*2.9*	*81.0*	*19.0*	*3.4*	*31.9*	*78.7*	*97.1*	*19.0*	*81.0*	*96.6*
GPOC	34	16	4	30	19	2	14	24	67	13	40	64
	70.8	*40*	*5.6*	*69.8*	*32.2*	*3*	*29.2*	*60*	*94.4*	*30.2*	*67.8*	*97*
CA	310	70	7	289	79	10	159	454	602	77	365	569
	66.1	*13.4*	*1.1*	*79.0*	*17.8*	*1.7*	*33.9*	*86.6*	*98.9*	*21.0*	*82.2*	*98.3*
COCEE	64	13	3	91	11	4	45	115	179	32	135	267
	58.7	*10.2*	*1.6*	*74.0*	*7.5*	*1.5*	*41.3*	*89.8*	*98.4*	*26.0*	*92.5*	*98.5*
CAA	22	5	2	9	4	3	15	105	171	0	24	47
	59.5	*4.5*	*1.2*	*100*	*14.3*	*6*	*40.5*	*95.5*	*98.8*	*0.0*	*85.7*	*94*
Total	7,639	4,267	943	7,864	4,501	754	2,133	6,080	10,324	1,762	5,407	9,916
	78.2	*41.2*	*8.4*	*81.7*	*45.4*	*7.1*	*21.8*	*58.8*	*91.6*	*18.3*	*54.6*	*92.9*

Percentages in Italics.

[1] See endnote Table 1.

Table 3: Type of education attending (%)

Groups[1]	Men			Women		
	Low	Intermediate	High	Low	Intermediate	High
15-19						
GN	*6.4*	*80.6*	*13.0*	*5.9*	*77.0*	*17.1*
GPCEE	*12.2*	*81.6*	*6.2*	*9.0*	*81.1*	*9.9*
GPOC	*11.8*	*85.3*	*2.9*	*10*	*83.3*	*6.6*
CA	*13.5*	*83.3*	*3.2*	*11.8*	*83.0*	*5.2*
COCEE	*9.4*	*90.7*	*0.0*	*14.3*	*81.3*	*4.4*
CAA	*22.7*	*72.7*	*4.5*	*0.0*	*88.9*	*11.1*
Total	*6.9*	*80.8*	*12.3*	*6.3*	*77.4*	*16.3*
20-24						
GN	*0.2*	*11.6*	*88.2*	*0.2*	*10.4*	*89.4*
GPCEE	*0.0*	*20.7*	*79.3*	*0.0*	*37.0*	*62.9*
GPOC	*0.0*	*6.3*	*93.8*	*0.0*	*10.6*	*89.5*
CA	*4.3*	*58.6*	*37.2*	*2.5*	*43.1*	*54.4*
COCEE	*0.0*	*61.6*	*38.5*	*0.0*	*54.6*	*45.5*
CAA	*0.0*	*0.0*	*100.0*	*0.0*	*25.0*	*75.0*
Total	*0.3*	*12.5*	*87.3*	*0.2*	*11.3*	*88.5*
25-29						
GN	*1.0*	*10.4*	*88.6*	*0.8*	*9.7*	*89.5*
GPCEE	*0.0*	*0.0*	*100.0*	*0.0*	*20.0*	*80.0*
GPOC	*0.0*	*0.0*	*100.0*	*0.0*	*0.0*	*100.0*
CA	*0.0*	*71.5*	*28.6*	*0.0*	*50.0*	*50.0*
COCEE	*0.0*	*0.0*	*100.0*	*0.0*	*0.0*	*100.0*
CAA	*0.0*	*50.0*	*50.0*	*0.0*	*0.0*	*100.0*
Total	*1.0*	*10.8*	*88.3*	*0.8*	*10.2*	*88.9*

Low: primary education and lower secondary, Intermediate: upper secondary technical, upper secondary general and post upper secondary, High: technological and vocational institution (TEI), university (AEI) and masters or PhD.

[1] See endnote Table 1.

fraction of citizens of Albania and of other central and eastern European countries. Especially within "palinnostountes" from other countries, older individuals still attending education almost all attend higher education.

Important differences between youth of native and migrant origin are also ascertained for those who have completed their education (Table 4), with na-

Table 4: Type of education completed (%)

Groups[1]	Men			Women		
	Low	Intermediate	High	Low	Intermediate	High
GN	*26.0*	*58.6*	*15.4*	*16.9*	*58.1*	*25.0*
GPCEE	*52.2*	*42.7*	*5.1*	*36.3*	*52.3*	*11.4*
GPOC	*21.9*	*53.3*	*24.8*	*6.8*	*70.9*	*22.2*
CA	*72.8*	*26.5*	*0.7*	*62.4*	*34.1*	*3.5*
COCEE	*51.0*	*43.1*	*5.9*	*40.1*	*47.5*	*12.4*
CAA	*81.8*	*15.8*	*2.4*	*60.6*	*35.2*	*4.2*
Total	*30.7*	*55.3*	*14.0*	*20.6*	*56.3*	*23.1*

Low: primary education and lower secondary, Intermediate: upper secondary technical, upper secondary general and post upper secondary, High: technological and vocational institution (TEI), university (AEI) and masters or PhD.
[1] See endnote Table 1.

tive men and women greatly surpassing the attainment levels of men and women of migrant origin, with the exception of "palinnostountes" from other countries, in which men surpass their native peers and women approach the level of their native peers. For instance, among men of the largest non-native group, that of Albanian citizens, seven out of ten (72.8%) had an attainment level of lower secondary or less, while less than 1% had completed tertiary education or higher, with the corresponding proportion for native men being about one-fourth (26.0%) and one-seventh (15.4%). In the case of women, about three-fifths of Albanian citizens (62.4%) exhibited an attainment level of lower secondary or less, while just 3.5% had tertiary education or higher, compared to 25% for native women. Therefore, "palinnostountes" from other countries seem to be the group closest to natives, with citizens from central and eastern European countries somewhere in the middle and citizens of Albania lagging behind.

It must be emphasised that the observed educational differences between youth of native and migrant origin cannot be attributed solely to their different experiences while living in Greece. For many migrant youth who did not migrate to Greece at an early age, the low level of attainment exhibited in the data can be considered to reflect their experiences in the country of origin, before migration. For other migrant youth, on the other hand, low level of achievement must be interpreted in terms of their experiences in Greece. Unfortunately, the data do not allow determination of the country where schooling was obtained, while prior to 2008, the coding scheme used in the LFS regarding years of stay in Greece was problematic and hinders utilization of such a variable in the analysis.

3 Methodology

Considering the nature of our data and the restrictions imposed by the number of observations available, we have decided to use two distinct methods of estimation; an ordered probit and a bivariate probit, both fitted using maximum-likelihood.

Starting with individuals who have completed their education, the ordinal nature of the dependent variable (three outcomes: low education, intermediate education and high education) leads us to choose an ordered-probit, in which the actual values of the dependent variable are irrelevant, except that larger values correspond to higher educational level. In an ordered-probit an underlying score is estimated as a linear function of the independent variables and a set of cut-points. The probability of observing a particular outcome (*i*) corresponds to the probability that the estimated linear function, plus random error, is within the range of the cut-points estimated for the outcome:

$$\Pr(outcome_j = i) = \Pr(\kappa_{i-1} < \beta_1 x_{1j} + \beta_2 x_{2j} + \ldots + \beta_k x_{kj} + u_j \leq \kappa_i, \qquad (1)$$

u_j is assumed to be normally distributed. In either case, we estimate the coefficients $\beta_1, \beta_2, .., \beta_\kappa$ together with the cut-points $\kappa_1, \kappa_2, \ldots, \kappa_{I-1}$, where I is the number of possible outcomes (three in our case). κ_0 is taken as -∞ and κ_I is taken as +∞. In essence, the ordered-probit predictions are the probability that $\beta_1 x_{1j} + \beta_2 x_{2j} + \ldots + \beta_k x_{kj} + u_j$ lies between a pair of cut-points κ_{i-1} and κ_i. In other words, setting $S_j = \beta_1 x_{1j} + \beta_2 x_{2j} + \ldots + \beta_k x_{kj}$ we get:

$$\Pr(S_j + u_j < \kappa = \Phi(\kappa - S_j) \qquad (2)$$

$$\Pr(S_j + u_j > \kappa = 1 - \Phi(\kappa - S_j) = \Phi(S_j - \kappa) \qquad (3)$$

$$\Pr(\kappa_1 < S_j + u < \kappa_2) = \Phi(\kappa_2 - S_j) - \Phi(\kappa_1 - S_j) \qquad (4)$$

$\Phi()$ is the standard normal cumulative distribution function.

Turning next to individuals who are still attending formal education, we observe that there are very few observations in lower education. Therefore, a bivariate probit seems more appropriate with the dependent variable taking the value of 1 if the individual attends higher education and 0 if the individual attends intermediate education; individuals at lower education are excluded from the sample. A probit model is defined as:

$$\Pr(y_i \neq 0 \mid x_j) = \Phi(x_j b) \qquad (5)$$

where $\Phi()$ is the standard cumulative normal distribution and $x_j b$ is known as the probit score or index.

It should be stressed that separate regressions were fitted for four ethnic groups, namely Greek natives (Greeks), Greek "pallinostountes" from central and eastern European countries – GPCEE), citizens of Albania (CA) as well as citizens from other central and eastern European countries (COCEE) for the sample of individuals who have completed their education. Alternatively, for the sample of those still attending we have fitted two regressions; one for Greek natives and one for immigrants overall. In order to capture the effect of ethnic group, dummies were employed.

4 Results

Our analysis begins with the sample of those who have completed their education, grouped in the following sub-samples according to their country of birth and their citizenship: Greek natives (Greek citizens born in Greece), Greek «palinnostountes» from central and eastern European countries (Greek citizens born in one of these countries), Albanian citizens, and citizens of other central and eastern European countries. Since regression coefficients have no direct interpretation, except for their signs, the results are reported in the Appendix (Table A1).

Instead, we focus on the estimated probabilities related to a series of outcomes, which we present in Table 5. Sharp differences are observed across ethnic groups. Greek natives have the lowest probability of having completed only lower education (21.6%), while citizens of Albania have three times the respective probability (68%) of natives. On the other hand, natives have twice the probability of having completed a high educational level compared to im-

Table 5: Probabilities by level of education completed

	GN[1]		GPCEE[1]		CA[1]		COCEE[1]	
	p	*s.e.*	p	*s.e.*	p	*s.e.*	p	*s.e.*
Men and Women								
Low education	0.216	*0.160*	0.437	*0.175*	0.680	*0.150*	0.448	*0.171*
High education	0.200	*0.127*	0.083	*0.071*	0.019	*0.023*	0.095	*0.062*
Men								
Low education	0.260	*0.167*	0.519	*0.159*	0.733	*0.136*	0.516	*0.169*
High education	0.154	*0.093*	0.052	*0.042*	0.012	*0.014*	0.069	*0.046*
Women								
Low education	0.169	*0.139*	0.362	*0.154*	0.617	*0.141*	0.395	*0.153*
High education	0.250	*0.140*	0.112	*0.079*	0.027	*0.029*	0.116	*0.065*

[1] See endnote Table 1.

migrants (20% vs. less than 10%). Again, Albanians stand out as the group with the lowest probability of higher education, close to 2%. As far as gender is concerned, there seems to be a common pattern across ethnic groups: men have a greater probability of possessing a low level of education, while women have a greater probability of possessing a high level of education.[4] Nevertheless, these gender differences are more pronounced among immigrants when low educational attainment is taken into consideration (the smallest difference, 9.1 percentage points(pp), is observed between native men and women) and more pronounced among natives when high educational attainment is considered (the largest difference, 9.6 pp, is observed between native men and women). In sum, ceteris paribus, Albanians and men, in general, fare poorly with respect to educational attainment and, therefore, their prospects in the labour market do not appear optimistic.

The probabilities of having completed a particular level of education are, of course, very interesting themselves, but some would argue that what matters most is the effect each characteristic has on that probability. For instance,

[4] At this stage the reader should be reminded that there is a third outcome, namely intermediate education. Therefore, increased probability of having completed lower education does not necessarily mean decreased probability of having completed higher education.

how much does the probability of having completed higher education change, if a person is female? An estimate is given by marginal effects presented in Tables 6a and 6b for lower and higher education respectively. According to the first table, it seems that characteristics have generally similar effects (signs) irrespective of ethnic group, but their size varies. For instance, being female decreases the probability of having a lower education degree for everyone, but much more so in the case of non-natives (11.7 pp vs. 19.9 pp for GPCEE, 20.7 pp for CA and 14 pp for COCEE). On the other hand, having a mother with intermediate education increases the probability of lower education by 2.9 pp, only when native. In addition, the positive impact on the probability of lower education degree of not residing in Attica ranges from around 11 pp (Albanians) to almost 33 pp (GPCEE) in rural areas. Last but not least, marriage increases the respective probability by around 24 pp at most for natives (just 7% for COCEE), although being widowed/divorced/separated is even more important for natives. Interestingly though, living in northern or central Greece has a small negative impact for natives and somewhat stronger for GPCEE, while, at the same time, it has a positive impact for CA.

Turning to higher education and Table 6b, females have an advantage ranging from less than 2 pp (CA) to more than 10 pp (GN). Ageing also ensures improved chances of having a higher education degree by as much as 17 pp (natives). Marginal effects for regions, when statistically significant, never exceed 4.2 pp. and have a positive impact, except for CA. On the other hand, the degree of urbanisation is more important than region for all ethnic groups, since living in rural areas entails a decrease in the probability of having a higher education by as much as 14.5 pp (natives). It is interesting to note that Albanians seem to be the least affected ethnic group regarding both region and urbanity. Finally, marriage has an effect that fluctuates greatly in size, ranging from less than 1 pp (Albanians) to a little higher than 14 pp (natives).

The course of those who have completed their education is, to a large extent, set, with the exception of possible further education acquired later in their working life. The focus now turns to those who are still in the formal educational system, for whom future prospects with respect to educational attainment and successful incorporation in the labour market remain open. Due to restrictions imposed by our data, we have chosen to estimate the regressions separately for only two groups: Greek natives and immigrants in-

Table 6a: Marginal effects in the probability of having completed lower education

	GN[1]		GPCEE[1]		CA[1]		COCEE[1]	
	coef.	*s.e.*	coef.	*s.e.*	coef.	*s.e.*	coef.	*s.e.*
Female	-0.117***	*0.004*	-0.199***	*0.043*	-0.207***	*0.024*	-0.140***	*0.036*
Father's education (intermediate)	0.011	*0.007*	0.078	*0.086*	0.033	*0.051*	-0.097	*0.099*
Father's education (high)	-0.001	*0.010*	0.030	*0.129*	0.010	*0.076*	-0.189	*0.124*
Mother's education (intermediate)	0.029***	*0.009*	0.183	*0.114*	0.025	*0.057*	0.142	*0.126*
Mother's education (high)	0.006	*0.007*	-0.016	*0.098*	0.042	*0.057*	0.085	*0.103*
Parents' education missing	-0.021***	*0.007*	0.080	*0.091*	0.246***	*0.051*	0.002	*0.089*
Age	-0.186***	*0.007*	-0.162**	*0.080*	-0.214***	*0.041*	-0.331***	*0.076*
$Age^2/100$	0.339***	*0.015*	0.274	*0.170*	0.379***	*0.085*	0.608***	*0.157*
North Greece	-0.029***	*0.007*	-0.149**	*0.067*	0.085**	*0.035*	-0.019	*0.087*
Central Greece	-0.023***	*0.007*	-0.102	*0.139*	0.021	*0.033*	-0.159**	*0.075*
South Greece	-0.004	*0.007*	-0.095	*0.114*	0.001	*0.036*	-0.043	*0.073*
Islands	-0.009	*0.009*	0.023	*0.203*	0.010	*0.049*	0.059	*0.166*
Thessaloniki prefecture	0.024**	*0.011*	0.176*	*0.099*	-0.057	*0.055*	-0.047	*0.101*
Urban areas	0.040***	*0.008*	0.074	*0.082*	0.046	*0.032*	0.094	*0.071*
Suburban areas	0.127***	*0.010*	0.275***	*0.101*	0.113***	*0.032*	0.101	*0.090*
Rural areas	0.211***	*0.011*	0.328***	*0.104*	0.113***	*0.036*	0.291***	*0.084*
Married	0.237***	*0.009*	0.216***	*0.062*	0.103***	*0.029*	0.071*	*0.039*
Widowed/Divorced/Separated	0.295***	*0.034*	0.090	*0.183*	0.032	*0.115*	0.185	*0.160*
Interviewed: 2004	0.045***	*0.006*	0.027	*0.063*	0.002	*0.030*	-0.054	*0.048*
Interviewed: 2005	0.059***	*0.006*	0.015	*0.060*	0.004	*0.029*	-0.026	*0.052*
Interviewed: 2006	0.028***	*0.007*	0.101	*0.075*	-0.025	*0.033*	0.019	*0.054*
Interviewed: 2007	0.023***	*0.007*	0.078	*0.079*	0.022	*0.032*	-0.056	*0.058*

s.e. =standard errors, *=significant at 10% level, **=significant at 5% level, ***=significant at 1% level, [1] See endnote Table 1.

Table 6b: Marginal effects in the probability of having completed higher education

	GN[1]		GPCEE[1]		CA[1]		COCEE[1]	
	coef.	*s.e.*	coef.	*s.e.*	coef.	*s.e.*	coef.	*s.e.*
Female	0.111***	*0.004*	0.062***	*0.015*	0.019***	*0.004*	0.049***	*0.013*
Father's education (intermediate)	-0.010	*0.006*	-0.023	*0.023*	-0.003	*0.004*	0.040	*0.047*
Father's education (high)	0.001	*0.009*	-0.009	*0.037*	-0.001	*0.006*	0.094	*0.084*
Mother's education (intermediate)	-0.025***	*0.007*	-0.042**	*0.020*	-0.002	*0.004*	-0.040	*0.027*
Mother's education (high)	-0.006	*0.007*	0.005	*0.032*	-0.003	*0.004*	-0.027	*0.029*
Parents' education missing	0.020***	*0.007*	-0.024	*0.026*	-0.027***	*0.008*	-0.001	*0.032*
Age	0.174***	*0.006*	0.050**	*0.025*	0.018***	*0.004*	0.118***	*0.028*
$Age^2/100$	-0.317***	*0.014*	-0.085	*0.054*	-0.032***	*0.008*	-0.217***	*0.057*
North Greece	0.028***	*0.007*	0.042**	*0.018*	-0.006**	*0.003*	0.007	*0.032*
Central Greece	0.022***	*0.007*	0.040	*0.067*	-0.002	*0.003*	0.074	*0.046*
South Greece	0.004	*0.007*	0.036	*0.053*	0.000	*0.003*	0.016	*0.029*
Islands	0.008	*0.009*	-0.007	*0.057*	-0.001	*0.004*	-0.019	*0.047*
Thessaloniki prefecture	-0.021**	*0.009*	-0.048*	*0.025*	0.005	*0.006*	0.018	*0.041*
Urban areas	-0.036***	*0.007*	-0.022	*0.024*	-0.004	*0.003*	-0.032	*0.023*
Suburban areas	-0.091***	*0.006*	-0.059***	*0.017*	-0.008***	*0.002*	-0.031	*0.024*
Rural areas	-0.145***	*0.006*	-0.059***	*0.013*	-0.008***	*0.002*	-0.068***	*0.014*
Married	-0.143***	*0.004*	-0.061***	*0.017*	-0.009***	*0.003*	-0.025*	*0.014*
Widowed/Divorced/Separated	-0.133***	*0.007*	-0.023	*0.039*	-0.002	*0.008*	-0.047*	*0.028*
Interviewed: 2004	-0.039***	*0.004*	-0.008	*0.018*	0.000	*0.002*	0.021	*0.020*
Interviewed: 2005	-0.049***	*0.004*	-0.005	*0.018*	0.000	*0.002*	0.010	*0.020*
Interviewed: 2006	-0.025***	*0.005*	-0.027	*0.017*	0.002	*0.003*	-0.007	*0.018*
Interviewed: 2007	-0.020***	*0.006*	-0.021	*0.019*	-0.002	*0.002*	0.022	*0.025*

s.e. = standard errors, *= significant at 10% level, **=significant at 5% level, ***=significant at 1% level, [1] See endnote Table 1.

cluding dummies for four ethnic groups (men Albanian citizens are the reference group). As previously mentioned, we report the regression results in the Appendix (Table A2).

Therefore, Table 7 presents calculated probabilities based on probit estimates. According to our calculations natives are much more likely to receive higher education, irrespective of gender, while Greek palinnostountes from other countries (mainly Germany) have the second highest probability, followed by Asians and Africans[5] (AA). On the other hand, receiving higher education is the least probable scenario for citizens of other central and eastern European countries and citizens of Albania. Regarding gender differences, once again the pattern is similar for Greeks and immigrants. Thus, men have lower probability of attending higher education than women. Overall though, the gender gap is greater among youth of migrant origin than among native youth (4.1 pp vs. 2.3 pp disadvantage). The largest disadvantage in the comparison between men and women is found among Asians and Africans, followed by Albanians.

Finally, we calculate the marginal effects of attending higher education for each separate variable. According to the results reported in Table 8, females have increased probabilities of attending higher education, slightly

Table 7: Probabilities of attending high education

Groups[1]	Men and women		Men		Women	
	p	*s.e.*	p	*s.e.*	p	*s.e.*
GN	0.468	*0.414*	0.456	*0.411*	0.479	*0.415*
Immigrants	0.193	*0.286*	0.172	*0.272*	0.213	*0.297*
GPCEE	0.252	*0.304*	0.268	*0.314*	0.237	*0.295*
GPOC	0.418	*0.407*	0.397	*0.404*	0.438	*0.413*
CA	0.148	*0.240*	0.112	*0.199*	0.184	*0.270*
COCEE	0.122	*0.205*	0.104	*0.198*	0.136	*0.211*
CAA	0.338	*0.411*	0.289	*0.389*	0.412	*0.445*

[1] See endnote Table 1.
s.e. = standard errors

[5] This could be due to migrant inflows from these countries, particularly Africa, specifically for studies.

Table 8: Marginal effects in the probability of attending higher education

	GN[1]		Immigrants	
	coef.	*s.e.*	coef.	*s.e.*
Female	0.047***	*0.010*	0.039***	*0.014*
GPCEE[1]	-	-	0.078***	*0.031*
GPOC[1]	-	-	0.252***	*0.086*
COCEE[1]	-	-	-0.008	*0.017*
CAA[1]	-	-	0.066	*0.070*
GPCEE*Female	-	-	-0.024*	*0.010*
GPOC*Female	-	-	-0.029**	*0.007*
COCEE*Female	-	-	-0.010	*0.020*
CAA*Female	-	-	-0.017	*0.031*
Father's education (intermediate)	-0.007	*0.018*	0.013	*0.017*
Father's education (high)	0.040	*0.026*	0.009	*0.023*
Mother's education (intermediate)	-0.036*	*0.020*	-0.015	*0.012*
Mother's education (high)	0.019	*0.019*	0.011	*0.017*
Parents' education missing	0.372***	*0.019*	0.086***	*0.050*
Age	1.115***	*0.017*	0.187***	*0.027*
$Age^2/100$	-2.331***	*0.040*	-0.389***	*0.057*
North Greece	-0.034*	*0.019*	-0.029**	*0.013*
Central Greece	-0.036*	*0.020*	-0.008	*0.014*
South Greece	-0.069***	*0.020*	-0.025*	*0.010*
Islands	-0.126***	*0.024*	-0.026	*0.010*
Thessaloniki prefecture	0.099***	*0.027*	0.049*	*0.035*
Urban areas	-0.018	*0.020*	0.011	*0.015*
Suburban areas	-0.100***	*0.019*	-0.024	*0.011*
Rural areas	-0.159***	*0.020*	-0.029**	*0.008*
Married	-0.177***	*0.034*	-0.015	*0.018*
Interviewed: 2004	0.075***	*0.016*	0.026	*0.020*
Interviewed: 2005	-0.025*	*0.014*	-0.017	*0.010*
Interviewed: 2006	0.019	*0.017*	-0.002	*0.013*
Interviewed: 2007	-0.018	*0.018*	-0.006	*0.013*

s.e. = standard errors, *= significant at 10% level, **=significant at 5% level, ***=significant at 1% level
[1] See endnote Table 1.

more when they are natives compared with an Albanian woman (4.7 pp vs. 3.9 pp), while mother's possession of an intermediate level of education has a small negative impact for natives only (3.6 pp). The variables region of residence and degree of urbanity have a more important role in determining the probability of attending higher education in the case of natives, since they are more frequently statistically significant and have a stronger effect, but the direction of that effect is similar across ethnic groups. Lastly, marriage seems to worsen the probability of higher education attendance for natives by a noteworthy 17.7 pp, but it has no statistically significant effect for immigrants. Focusing exclusively on the latter, both groups of "palinnostountes" (GPCEE and GPOC) have 7.8 pp and 25.2 pp, respectively, higher probability of attending higher education compared to Albanian men. Finally, being a female GPCEE or GPOC decreases the probability of attending higher education compared to their male co-ethnics[6], although these marginal effects never exceed 3 pp, while it makes no difference in the case of COCEE and CAA.

5 Conclusions

Our results are in accordance with findings in other migrant-destination countries which ascertain divergence between youth of native and migrant origin in educational outcomes, with youth of migrant origin lagging behind natives. In the Greek case, noteworthy differences among youth of migrant origin were observed both by specific ethnic origin and by gender. What is particularly alarming in the Greek data is that youth of the largest ethnic group present in Greece, Albanian citizens, seem to have the greatest deficit in educational attainment compared to both native youth and youth of other ethnic groups. The social and economic consequences of this divergence may prove dire, as many youth of migrant origin will no doubt face problems either upon entering the labour market or staying employed, since there is evidence that higher education is associated with higher wages and lower unemployment rates (Tsakloglou, Mitrakos and Cholezas 2010a and 2010b).

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[6] The overall effect compared to Albanian men remains positive regarding GPCEE and GPOC, since one should take into consideration both the effects of belonging to the specific ethnic group and being a female.

The expansion of tertiary education (new institutions or new departments in existing institutions) -especially over the last decade- was not accompanied by the closing of the gap of the educational attainment of youth of immigrant origin with that of native youth. This is an issue that needs to be further explored.

Two findings are particularly important. First, even after controlling for various characteristics, the educational deficit presented by youth of migrant origin persists. Second, the effects of personal characteristics is similar across ethnic groups as far as their direction is concerned, but there are noteworthy differences regarding the size of those effects, both across ethnic groups and between men and women. For instance, ceteris paribus, the probability of having completed higher education is twice as large for youth of native compared to migrant origin, while women seem to have better chances of having completed higher education compared to men, especially in the case of natives. Similarly, the probability of attending higher education is also more than double for youth of native compared to migrant origin. On both counts, youth of Albanian origin seriously lag behind; among those who have completed their education, those of Albanian origin exhibit the largest educational deficit while among those who are attending, they bring up the rear along with citizens of other central and eastern European countries. Further, based on marginal effects estimates, being female increases the probabilities both of having completed and of attending higher education, while living in rural areas decreases both probabilities for all groups, although the effect is stronger for natives. Finally, married individuals, irrespective of ethnic group, have fewer probabilities of either having completed or currently attending higher education, probably due to different ordering of their priorities or increased obligations associated with marriage, and once again the effect is stronger for natives.

Of course, the poor educational outcomes characteristic of many youth of migrant origin cannot be attributed solely to failures of the Greek educational system and other Greek social policies but also to circumstances in the countries from which some youth migrated as teenagers or young adults. Nonetheless, Greek public policies can obviously play an important role in addressing the educational deficit exhibited in the data. In order to limit the potential negative effects of low educational attainment, efforts should be made to assist immigrants, especially Albanians, to acquire more education, either by staying in school longer, returning to school, or participating in lifelong learning.

It is clear that existing programmes such as reception classes and support classes, which target the language difficulties faced by migrant children and the academic problems stemming from their insufficient command of the Greek language, constitute important steps in the right direction but in their present form and extent are inadequate to the task of successfully incorporating youth of migrant origin into the Greek educational system. Such programmes must be revised and expanded while new policy measures should be explored. In Greece, as elsewhere, the successful integration of youth of migrant origin should be considered a public good that will benefit not only this specific population group, but society as a whole (Portes et al. 2009).

Appendix

Table A1: Ordered probit estimation results (education completed)

	GN[1]		GPCEE[1]		CA[1]		COCEE[1]	
	coef.	*s.e.*	coef.	*s.e.*	coef.	*s.e.*	coef.	*s.e.*
Female	0.441***	*0.014*	0.512***	*0.112*	0.591***	*0.069*	0.356***	*0.092*
Father's education (intermediate)	-0.040	*0.026*	-0.198	*0.216*	-0.096	*0.152*	0.248	*0.261*
Father's education (high)	0.004	*0.037*	-0.077	*0.327*	-0.030	*0.220*	0.504	*0.360*
Mother's education (intermediate)	-0.106***	*0.030*	-0.462	*0.295*	-0.074	*0.169*	-0.359	*0.324*
Mother's education (high)	-0.023	*0.027*	0.040	*0.250*	-0.125	*0.173*	-0.213	*0.260*
Parents' education missing	0.078***	*0.028*	-0.204	*0.230*	-0.679***	*0.139*	-0.005	*0.225*
Age	0.695***	*0.026*	0.413**	*0.203*	0.615***	*0.118*	0.837***	*0.192*
$Age^2/100$	-1.265***	*0.054*	-0.698	*0.433*	-1.087***	*0.246*	-1.536***	*0.397*
North Greece	0.110***	*0.027*	0.377**	*0.172*	-0.254**	*0.108*	0.049	*0.220*
Central Greece	0.086***	*0.027*	0.270	*0.382*	-0.061	*0.097*	0.417**	*0.211*
South Greece	0.015	*0.028*	0.249	*0.312*	-0.003	*0.102*	0.109	*0.187*
Islands	0.033	*0.034*	-0.059	*0.511*	-0.030	*0.143*	-0.147	*0.415*
Thessaloniki prefecture	-0.087**	*0.038*	-0.446*	*0.255*	0.157	*0.150*	0.119	*0.259*
Urban areas	-0.146***	*0.028*	-0.189	*0.208*	-0.133	*0.093*	-0.237	*0.178*
Suburban areas	-0.423***	*0.031*	-0.706**	*0.276*	-0.346***	*0.107*	-0.255	*0.227*
Rural areas	-0.691***	*0.032*	-0.865***	*0.315*	-0.350***	*0.121*	-0.762***	*0.246*
Married	-0.739***	*0.025*	-0.550***	*0.160*	-0.298***	*0.085*	-0.180*	*0.100*
Widowed/Divorced/Separated	-0.848***	*0.086*	-0.226	*0.459*	-0.094	*0.347*	-0.471	*0.425*
Interviewed: 2004	-0.162***	*0.019*	-0.069	*0.159*	-0.006	*0.085*	0.138	*0.124*
Interviewed: 2005	-0.210***	*0.020*	-0.038	*0.151*	-0.012	*0.083*	0.065	*0.131*
Interviewed: 2006	-0.102***	*0.023*	-0.256	*0.188*	0.070	*0.091*	-0.048	*0.136*
Interviewed: 2007	-0.084***	*0.025*	-0.196	*0.199*	-0.063	*0.093*	0.141	*0.150*
κ1	8.142	*0.299*	5.326	*2.358*	8.330	*1.397*	11.132	*2.292*
κ2	9.999	*0.300*	7.040	*2.363*	10.098	*1.402*	12.699	*2.298*
Number of observations	31503		536		2226		773	
Log likelihood	-27256.0		-451.9		-1428.5		-673.4	
Pseudo R^2	0.106		0.086		0.082		0.076	

s.e. = standard errors, *= significant at 10% level, **=significant at 5% level, ***=significant at 1% level, [1] See endnote Table 1.

Table A2: Probit estimation results (education attending)

	GN[1]		Immigrants[2]	
	coef.	*s.e.*	coef.	*s.e.*
Female	0.128***	*0.026*	0.553***	*0.179*
GPCEE[1]	-	-	0.740***	*0.211*
GPOC[1]	-	-	1.391***	*0.284*
COCEE[1]	-	-	-0.124	*0.300*
CAA[1]	-	-	0.585	*0.421*
GPCEE*Female	-	-	-0.506*	*0.282*
GPOC*Female	-	-	-0.845**	*0.389*
COCEE*Female	-	-	-0.164	*0.374*
CAA*Female	-	-	-0.325	*0.852*
Father's education (intermediate)	-0.019	*0.049*	0.186	*0.230*
Father's education (high)	0.107	*0.070*	0.125	*0.317*
Mother's education (intermediate)	-0.099*	*0.056*	-0.251	*0.232*
Mother's education (high)	0.052	*0.052*	0.147	*0.227*
Parents' education missing	0.975***	*0.053*	0.725***	*0.269*
Age	2.999***	*0.049*	2.736***	*0.258*
$Age^2/100$	-6.270***	*0.115*	-5.691***	*0.601*
North Greece	-0.091*	*0.052*	-0.473**	*0.215*
Central Greece	-0.097*	*0.054*	-0.135	*0.250*
South Greece	-0.190***	*0.057*	-0.541*	*0.288*
Islands	-0.366***	*0.077*	-0.630	*0.433*
Thessaloniki prefecture	0.258***	*0.069*	0.519*	*0.269*
Urban areas	-0.049	*0.053*	0.152	*0.197*
Suburban areas	-0.284***	*0.056*	-0.479	*0.299*
Rural areas	-0.464***	*0.064*	-0.766**	*0.341*
Married	-0.552***	*0.129*	-0.298	*0.477*
Interviewed: 2004	0.197***	*0.040*	0.309	*0.192*
Interviewed: 2005	-0.067*	*0.039*	-0.309	*0.202*
Interviewed: 2006	0.051	*0.044*	-0.030	*0.202*
Interviewed: 2007	-0.050	*0.049*	-0.098	*0.216*
Constant	-34.324***	*0.523*	-32.677***	*2.764*
Number of observations	23673		1240	
Pseudo Log likelihood	-6030.2		-291.8	
Pseudo R^2	0.632		0.522	

s.e. = standard errors, *= significant at 10% level, **=significant at 5% level, ***=significant at 1% level

[1] See endnote Table 1.

[2] Reference group for immigrants: male citizens from Albania.

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Part III
Sectoral Studies

Sectoral Capital-Output Ratios and Capital Intensity in the Greek Economy

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Abstract

Direct and total (direct plus indirect) fixed capital-output ratios and capital intensity coefficients (e.g. capital-labour ratios) are estimated for 16 production sectors of the Greek economy, so as to make sectoral comparisons of these coefficients and comparisons with the corresponding coefficients of the whole economy. For the estimation of the total coefficients the open input-output model is applied, on the basis of the most recent (2005) input-output Table of the Greek economy. Also a comparison of the intertemporal changes of the direct coefficients is performed.

1 Introduction

The objectives of this article are the following:

- The estimation of capital-output ratios at a sectoral level. The reason for this sectoral analysis is that the capital requirements per unit of production show large differences between the various sectors of the economy. As a result of these differences the required investment and saving at the national level will be affected by the structure of production which is scheduled.
- The estimation of the indirect capital requirements for the sectoral final products. Depending on the density of the sectoral interconnection, the total capital required per unit of final output of a sector may differ greatly from the capital which is used directly per unit of production of the sector.

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In section A of the article we describe the way in which the open input-output model can be used for the estimation of the direct and indirect capital coefficients of 16 sectors of the Greek economy. Section B deals with the analysis of the empirical results as well as the changes of the direct capital coefficients overtime.

A. Theoretical Framework

When capital is combined with the other factors of production an output is produced. The relationship between capital and the produced output is often used for estimating the magnitude of the investment required for achieving a postulated rate of growth of production.

With the term capital coefficient (or capital-output ratio) we mean the fixed capital units required in order to produce one unit of output. The reverse of the capital-output ratio gives the productivity coefficient of capital, which shows the units of output produced by one unit of capital.

When a development plan is set up and in order to estimate the required investments for achieving a fixed rate of growth of GDP, a general capital-output ratio is used for the national economy. However, this general capital coefficient depends on a number of factors some of which lead to greater and some others to smaller increases in GDP when capital increases. More specifically, the general capital coefficient will tend to be higher when:

– Most of the investments in fixed capital are concentrated on sectors that use relatively greater quantities of capital, as happens with the sectors of public utilities, public capital infrastructure, housing, heavy industries, etc.
– There is idle productive capacity when capital is used.
– Capital is used as a substitute when there is a shortage of other factors of production.
– The rate of technical progress is low.
– The life of capital is long.

On the other hand, the general capital coefficient will tend to be smaller when the structure of production is dominated by labour intensive products, the average life duration of capital is shorter, the rate of technical progress is high etc.

In view of the above reasons, it is necessary that the capital-output relations are analysed on a sectoral rather than a national economy level.

Given the fact that in modern economies most of the technological progress is incorporated in capital, the application of production methods according to the latest technological developments can be put forward through the substitution of the traditional factors of production, especially labour, by capital.

The use of computers, automatic textile machinery, modern construction equipment, modern agricultural machines and many other modern tools and equipment can be considered as the application of labour saving techniques in the production process. To the extent to which the capital used per unit of labour is increased, this can be viewed as an indication of introduction of technological progress in the production process, under certain circumstances. From now on, we define the capital-labour ratio as 'capital intensity'. Capital intensity provides us with an indication about the quantity of capital required per unit of labour in the production process and this is a very important element in planning.

A.1. Direct and Total Capital Coefficients

The direct capital coefficient for a production sector is estimated by dividing the value of fixed capital directly used in the sector by the value of its gross production. In this way the capital-output ratio shows the quantity of capital directly used per unit of gross production of the sector. The value of gross production of a sector consists of the value of the intermediate inputs purchased by the sector from other sectors of the economy plus the value added—that is, the remuneration of the classical factors of production (labour, capital, etc.).

The direct capital coefficient of a sector, however, does not include the quantities of capital that were used in the production of the intermediate inputs purchased by the sector in question. If we add the capital used in the production of the intermediate inputs to the capital directly used per unit of output of a sector, we get the total capital which was used (directly and indirectly) in the production of a unit of final product (i.e. consumption, investment, exports).

The total capital coefficient, also called the capital multiplier, shows the value of capital that directly and indirectly is used per unit of the final product of a sector. If from the total capital coefficient we substract the direct capital coefficient we get the indirect capital coefficient (or the indirect capital multiplier). For the estimation of the total capital coefficients we use the classical input-output model.[1]

Let the following symbols:

n = number of production sectors of the economy.

$\mathbf{X}$ = column vector (nx1) with elements the levels of gross production of the n production sectors of the economy.

$$\mathbf{A} = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \cdots & \alpha_{1n} \\ \vdots & \vdots & & \vdots \\ \vdots & \vdots & & \vdots \\ \alpha_{n1} & \alpha_{n2} & \cdots & \alpha_{nn} \end{bmatrix} \tag{1}$$

is a square matrix (nxn), called matrix of technological coefficients or Leontief matrix or matrix of the direct input-output coefficients, with elements the direct input-output coefficients α_{ij}.

$\mathbf{F}$ = column vector (nx1) with elements the final product of each sector.

Given the vector $\mathbf{F}$ the general solution to the input-output model is

$$\mathbf{X} = (\mathbf{I}-\mathbf{A})^{-1}\mathbf{F} \tag{2}$$

Where

$$(\mathbf{I}-\mathbf{A})^{-1} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ \vdots & \vdots & & \vdots \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nn} \end{bmatrix} \tag{3}$$

is the inverse matrix of $(\mathbf{I}-\mathbf{A})$, also called matrix of interdependencies, and the coefficient r_{ij} are called total coefficients of interdependence. The coefficients r_{ij} show the direct and indirect effects on the production of the sectors which are caused by the unit changes in the final demands of the sectors.

[1] For a detailed analysis of the input-output model see T. Skountzos et al., 'Intersectoral relations of the Greek economy at the national and regional levels'. Academy of Athens, No 7, Athens 2007.

c_j = direct capital coefficient of sector j.

C_j = capital stock of sector j.

X_j = gross production of sector j.

The direct capital coefficient of sector j is given by the relation

$$c_j = \frac{C_j}{X_j} \tag{4}$$

For the n production sectors the direct capital coefficients are given in the row vector

$$c = \left[\frac{C_1}{X_1}\,\frac{C_2}{X_2} .. \frac{C_n}{X_n}\right] = (c_1\, c_2 \ldots c_n) \tag{5}$$

The total capital coefficient of a sector shows the effect on the total capital of the economy caused by a unit change in the final product of the sector in question and is estimated as follows:

$$C\Pi_j = \sum_{i=1}^{n} k_{ij} \tag{6}$$

where:

$C\Pi_j$ = total capital coefficient of sector j.

k_{ij} = typical element of matrix $\mathbf{K}$.

Matrix $\mathbf{K}$ is estimated as follows:

$$\mathbf{K} = \hat{c} \times (\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} k_{11} & k_{12} & .. & k_{nn} \\ k_{21} & k_{22} & .. & k_{nn} \\ : & : & & : \\ k_{n1} & k_{n2} & .. & k_{nn} \end{bmatrix} \tag{7}$$

where

$$\hat{c} = \begin{bmatrix} c_1 & 0 & .. & 0 \\ 0 & c_2 & .. & 0 \\ : & : & & : \\ : & : & .. & c_n \end{bmatrix} \tag{9}$$

is a diagonal matrix with diagonal elements the direct capital coefficients.

Let us now examine the meaning of the elements of matrix **K.** The elements of a column of matrix **K** show the direct and indirect effects on the capital of the sectors of the economy caused by a unit change of the final product of the sector corresponding to the column in question. For example, k_{11} shows the direct and indirect effects on the capital of sector 1 caused by a unit change in the final product of sector 1; k_{21} shows the direct and indirect effects on the capital of sector 2 caused also by the unit change in the final product of sector 1, and so on for the other sectors.

In order to make comparisons among sectors, however, a procedure of standardization or adjustment of the total capital coefficients is followed: in making the adjustment a comparison is performed between the average total capital coefficient of the sector and the general average total capital coefficient of all the sectors of the economy. The standardized total capital coefficient of a sector is estimated according to the following formula:

$$UC\Pi_j = \frac{\dfrac{\sum_{i=1}^{n} k_{ij}}{n}}{\dfrac{\sum_{i=1}^{n}\sum_{j=1}^{n} k_{ij}}{n^2}} \tag{10}$$

where

$UC\Pi_j$ = the standardized total fixed capital coefficient of sector j.

k_{ij}= typical element of matrix **K**.

In this way, the standardized total capital coefficient measures the average effect on the fixed capital of a sector of the economy caused by a unit change in the final product of the sector, in comparison with the general average effect on the capital of any sector due to a unit change in the final product of all sectors of the economy. When $UC\Pi_j >1$ this implies that a unit change in the final product of sector j will cause average effects on the fixed capital of the economy greater than the average effects of all the sectors. The opposite is true when $UC\Pi_j <1$.

A.2. Direct and Total Capital Intensity

The direct capital intensity (or capital-labour ratio) of a sector is estimated by dividing the total employed fixed capital stock of a sector by the total employed labour. In this way the direct capital intensity coefficient of a sector shows the units of capital stock combined with a unit of labour. In order to estimate the total capital intensity of a sector the capital intensities of the intermediate inputs into the sector must also be taken into account.

Let

cl_j = the direct capital intensity coefficient of sector *j*.

L_j = total employment of the sector.

The direct capital intensity coefficient is given by the relation

$$cl_j = \frac{C_j}{L_j} \tag{11}$$

For the n production sectors the direct capital intensity coefficients are given by the row vector

$$cl = \left(\frac{C_1}{L_1} \; \frac{C_2}{L_2} \; .. \; \frac{C_n}{L_n} \right) = (cl_1 \; cl_2 \; ... \; cl_n) \tag{12}$$

The total capital intensity coefficients are estimated in a way analogous to that of the total capital coefficients.

Specifically:

$$KL\Pi_j = \sum_{i=1}^{n} kl_{ij} \tag{13}$$

where $KL\Pi_j$ = total capital intensity coefficient.

kl_{ij} = typical element of matrix $\mathbf{KL}$ which is estimated as follows:

$$\mathbf{KL} = \hat{cl}\,(\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} kl_{11} & kl_{12} & .. & kl_{1n} \\ kl_{21} & kl_{22} & .. & kl_{2n} \\ : & : & & : \\ kl_{n1} & kl_{n2} & .. & kl_{nn} \end{bmatrix} \tag{14}$$

where

$$\hat{cl} = \begin{bmatrix} cl_1 & 0 & .. & 0 \\ 0 & cl_2 & .. & 0 \\ : & : & & : \\ : & : & .. & cl_n \end{bmatrix} \tag{15}$$

is a diagonal matrix with diagonal elements the direct capital intensity coefficients and off-diagonal elements zero.

Let us now examine the meaning of the elements of matrix **KL.** The elements of a column of matrix **KL** show the direct and indirect effects on the capital intensity of the sectors providing intermediate inputs to the sector corresponding to the column and are caused by a unit change of the final product of the sector. In this way the sum of the elements of a column of matrix **KL** shows the total capital intensity of the sector corresponding to the column.

The standardization of the total capital intensity coefficients is realized in a way analogous to that used in the case of standardization of the total capital-output ratios. Specifically:

$$UKL_j = \frac{\dfrac{\sum_{i=1}^{n} kl_{ij}}{n}}{\dfrac{\sum_{i=1}^{n}\sum_{j=1}^{n} kl_{ij}}{n^2}} \tag{16}$$

where

UKL_j = the standardized total capital intensity coefficient of sector j.

kl_{ij} = typical element of matrix **KL**.

B Empirical Analysis

On the basis of the previous theoretical analysis we proceed to the empirical investigation of the sectoral capital coefficients and the capital intensity coefficients of the Greek economy. The statistical data used are the official data of the National Statistical Service of Greece and refer to:

– Two input-output tables of the economy for the years 2000 and 2005 (see Annex).
– Time series data of fixed capital stock by sectors. More specifically, the calculation of capital by industry complies with the European System of Accounts ESA 95 and the OECD Manual for Measuring Capital Stocks[2] using the Perpetual Inventory Method. The data used for the foresaid calculations are the official data deriving from the National Accounts Division of ELSTA, in order to guarantee exhaustiveness and consistency of the time series (in level and percentage change) with the basic macroeconomic data that compose the National Accounts of Greece.
– Number of employed persons by sectors(www.statistics.gr)

B.1. Sectoral Capital Coefficients

In Table 1 are shown the following sectoral capital coefficients:
Column 1: Direct capital coefficients [see equation (4)]
Column 2: Total capital coefficients [see equation (6)]
Column 3: Percentages of the indirect on the total capital coefficients
Column 4: Standardized total capital coefficients [see equation (10)]
Column 5: Ranking numbers of the capital coefficients.

1. Direct Capital Coefficients

The direct capital coefficient shows, as it was said earlier, the monetary value of the fixed capital stock which is used for the production of a unit of gross output. On the basis of column 1 the following observations are appropriate:

On a national economy level, the direct general capital coefficient for 2005 was 3.55, which means that in order to produce a €1 of gross output the fixed capital stock used was €3.55.

The direct capital coefficients for the various sectors of the national economy show on the one hand significant divergences from this general coefficient and on the other hand important differences between each other. Specifically:

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[2] Measuring Capital, OECD Manual. Measurement of capital stocks, consumption of fixed capital and capital services, 2001.

Table 1: Fixed capital-output ratios of the Greek economy, 2005

Sector number	NACE code	Name of sectors	Direct capital coefficient (1)	Total capital coefficient (2)	Percentages of indirect on total capital coefficients (3) = {(2)-(1)}/(2)	Standardized total capital coefficients	
						Coefficients (4)	Ranking number (5)
1	A	Agriculture, hunting, forestry	3.02	4.65	34.98	0.95	5
2	B	Fishing	2.14	2.48	13.82	0.51	13
3	C	Mining and quarrying	2.26	4.98	54.49	1.02	4
4	D	Manufacturing	0.76	4.50	83.16	0.92	6
5	E	Electricity, gas, water	5.64	7.65	26.36	1.56	3
6	F	Construction	0.26	3.45	92.57	0.70	10
7	G	Wholesale and retail trade, repair of vehicles and household appliances	0.77	3.22	76.13	0.66	11
8	H	Hotels and restaurants	1.40	3.63	61.48	0.74	9
9	I	Transportation, warehouses, communications	1.77	3.98	55.66	0.81	8
10	J	Intermediate financial institutions	0.50	3.15	84.21	0.64	12
11	K	Real estate, rents, business activities	17.82	19.92	10.52	4.07	1
12	L	Public administration and compulsory social insurance	6.49	8.24	21.33	1.68	2
13	M	Education	1.52	1.99	23.61	0.41	15
14	N	Health and social affairs	0.78	2.09	62.64	0.43	14
15	O	Other social services	1.69	4.43	61.79	0.90	7
16	P	Private households	0.00	0.00	.....	.....	.....
1 to 16		National Economy	3.55	3.55	-	-	-

The highest direct capital coefficient is noticed in 'Real estate, rents and business activities' (sector 11) and is 17.82 units of capital per unit of gross production.

In two sectors, 5 and 12, the direct capital coefficients are 1.6 and 1.8 times higher than the general capital coefficient of the national economy, while at the same time the capital coefficients for 12 sectors are lower than the general capital coefficient of the economy. Sector 16, which is private households, neither purchases intermediate inputs from other sectors nor does it use fixed capital. As was noted earlier, the inverse of the capital coefficient measures the productivity of capital. As a consequence of this fact, the sectors with relatively higher direct capital coefficients have respectively lower productivity of the capital they use.

2. Total Capital Coefficients

The total capital coefficient for a sector shows the value of capital used not only directly by the sector but also the values of capital of all the sectors providing intermediate inputs to the sector, as a result of a unit change in the final product of the sector, under examination. On the basis of column 2 of Table 1 the following comments may be made:

For the national economy as a whole, the total capital coefficient is identical with the direct capital coefficient, while the sectoral total capital coefficients are higher than the corresponding direct capital coefficients. The difference between the total and the direct capital coefficient of a sector constitutes the indirect use of capital due to a unit change in the final product of the sector in question. In column 3 of Table 1 is presented for each sector the percentage of the indirect on the total capital coefficient. On the basis of column 3 we notice the following:

– There are significant differences between the percentages of indirect on the total capital coefficients. These percentages range from 10–93% of the corresponding total capital coefficients. Specifically, the construction sector (6), which has the lowest direct capital coefficient, is the sector with the highest indirect capital coefficient, being 93% of the total coefficient. At the other end, the sector 'Real estate, rents, business activities' (11) shows the lowest indirect capital coefficient which is 10.5% of the respective total coefficient. Of the above two sectors, the construction sector is interconnected heavily with a large number of sectors through its intermediate inputs while the interconnections of sector 11 are much smaller.

– The manufacturing sector (4) and the sector of intermediate financial institutions (10), with also large intersectoral connections through their intermediate inputs, present high percentages of indirect on their total capital coefficients, 83% and 84% respectively.

3. Standardized Total Capital Coefficients

In column 4 of Table 1 are presented the standardized total capital coefficients and in column 5 the ranking numbers of these coefficients. As noted earlier, when the standardized coefficient for a sector is greater than unity the implication is that a unit change in the final product of the sector will cause an average effect on the fixed capital of the economy higher than the average effect of a unit change of the final product of all the sectors of the economy. The opposite is true when the standardized coefficient is smaller than unity.

B2. Sectoral Coefficients of Capital Intensity

Table 2 presents the following capital intensity coefficients:

Column 1: Direct capital intensity coefficients [see equation (11)]

Column 2: Total capital intensity coefficients [see equation (13)]

Column 3: Percentages of indirect on the total capital intensity coefficients

Column 4: Standardized total capital intensity coefficients

Column 5: Ranking numbers of the standardized capital intensity coefficients[see equation (16)].

1. Direct Fixed Capital Intensity Coefficients

The direct capital intensity coefficient of a sector shows the value of capital used per unit of labour employed during the production process. On the basis of column 1 of Table 2 (below) the following comments may be made:

For the national economy as a whole the value of capital per employed person in 2005 was €240 thousand. However, the sectoral coefficients of capital intensity diverge significantly from this national average.

– The sectors of 'electricity, gas and water' (5) and of 'real estate, rents and business activities' (11) show direct capital intensity 6.2 and 9.3 times higher than the national average, respectively.

– Regarding the other sectors, their direct capital intensity is lower than the

Table 2: Fixed capital intensity coefficients of the Greek economy, 2005

Sector number	NACE code	Name of sectors	Direct capital intensity (1) € mil.	Total capital intensity (2) € mil.	Percentages of indirect on total capital intensity coefficients (3) = {(2)-(1)}/ (2)	Standardized total capital intensity coefficients	
						Coefficients (4)	Ranking number (5)
1	A	Agriculture, hunting, forestry	0.07	0.23	70.01	0.40	12
2	B	Fishing	0.09	0.12	24.56	0.21	14
3	C	Mining and quarrying	0.24	0.66	62.98	0.63	10
4	D	Manufacturing	0.08	0.54	84.78	0.94	4
5	E	Electricity, gas, water	1.49	1.81	17.62	3.14	2
6	F	Construction	0.02	0.41	95.01	0.71	7
7	G	Wholesale and retail trade, repair of vehicles and household appliances	0.04	0.35	89.79	0.61	11
8	H	Hotels and restaurants	0.10	0.39	74.91	0.68	8
9	I	Transportation, warehouses, communications	0.21	0.49	57.43	0.85	5
10	J	Intermediate financial institutions	0.06	0.39	85.44	0.68	9
11	K	Real estate, rents, business activities	2.23	2.49	10.53	4.33	1
12	L	Public administration and compulsory social insurance	0.34	0.58	40.36	1.01	3
13	M	Education	0.05	0.10	48.94	0.17	15
14	N	Health and social affairs	0.04	0.20	80.41	0.35	13
15	O	Other social services	0.11	0.45	76.62	0.78	6
16	P	Private households	0.00	0.00	.....	.....	.....
1 to 16		National Economy	0.24	0.24	-	-	-

national average, with the exception of the ‘public administration’ sector (12), for which the respective coefficient is 1.4 times higher than the national average.

2. Total Fixed Capital Intensity Coefficients

The total capital intensity coefficient for a sector includes not only the direct capital intensity we referred to above but the capital intensities of the sectors providing intermediate inputs as well. The difference between the total and the direct capital intensity coefficient constitutes the indirect capital intensity coefficient.

From column 2 of Table 2 we see that the total capital intensity coefficients are higher than the direct coefficients for all the sectors of the economy. For the economy as a whole the direct and the total capital coefficients are identical at the level of €240 thousand. For four sectors (1, 2, 13, 14) the total coefficients are lower and for the remaining sectors, except private households, are higher than the national coefficient. The highest total capital intensity coefficients are noticed in ‘real estate, rents and business activities’ with coefficient €2,490 thousand of capital per employed person and ‘electricity, gas and water’ with €1,810 thousand of capital per employed person.

In column 3 of Table 2 are presented the percentages of indirect capital intensities on the total capital intensities. The main comments that can be made for these percentages are the following:

– The indirect capital intensity as a percentage of the total ranges from 10–93% in the sectors of the economy.
– Sectors 5 and 11 with the higher direct coefficients show the lowest percentages which are 17.6% and 10.5% respectively. On the other hand, sectors 6 and 7 with the lowest direct coefficients have the highest percentages of indirect capital intensities, 95% and 90% respectively.
– High percentages (above 80%) of indirect intensities on total intensities are also observed in sectors 4, 10 and 14.

3. Standardized Capital Intensity Coefficients

In column 4 of Table 2 are presented the standardized total capital intensity coefficients and in column 5 the ranking numbers of these coefficients. When the standardized coefficient for a sector is greater than unity the unit change in the final product of the sector will cause an average effect on the capital intensity of the economy greater than the average effects of all the sectors. The opposite is the case when the standardized coefficient is smaller than unity.

From column 4 of Table 2 we can see that for the sectors 'real estate, rents and business activities' (11) and 'electricity, gas and water' (5) the standardized coefficients are 4,3 and 3,1 times higher than unity, respectively. For the sector of education the coefficient is practically unity, while for the remaining sectors the coefficient is below unity, ranging from 0.17 (sector 14) to 0.94 (sector 4).

B3. Intertemporal Changes of the Direct Coefficients

a. Changes of the Direct Capital Coefficients

For the national economy as a whole the capital coefficient between 2000 and 2005 shows a decrease of more than 10%. Specifically, the coefficient declined from €3.90 in 2000 to € 3.55 in 2005. This reduction means that for a unit of gross production in 2005 smaller quantities of capital were required in comparison with 2000. Alternatively, it can be said that the productivity of capital in the economy increased between 2000 and 2005.

With regard to the changes of the direct sectoral coefficients we notice significant divergences, both positive and negative, from the change in the national economy. Specifically, we may underline the following sectoral changes in the direct coefficients:

– In five sectors (1, 2, 10, 13, 15) the direct capital coefficients increased between 2000 and 2005 with the highest increase in the agricultural sector (1), at 18%.
– In sector 14 there was no change and in the remaining sectors there were negative changes. The greatest negative change took place in mining and quarrying and was 60.4%. Considerable negative changes, around 28%, were observed in the sectors of electricity etc. (5) and in construction (6).

Generally, it can be said that the productivity of capital declined in the subsectors of the primary sector (1 and 2), increased in all the subsectors of the secondary sector (3, 4, 5, 6), while the subsectors of the tertiary sector show both positive and negative changes.

b. Changes in the Direct Capital Intensity Coefficients

From Table 3 we can observe that for the national economy the capital-labour ratio increased by 7.5% between 2000 and 2005. From this national av-

Table 3: Intertemporal comparisons of direct capital coefficients and direct capital intensity coefficients

Sector number	NACE code	Name of sectors	Direct capital coefficients		Percentage change of direct capital coefficients 2000–2005	Direct capital intensity coefficients, € mil. 2005 prices		Percentage change of the direct capital intensity coefficients 2000–2005
			2000	2005		2000	2005	
1	A	Agriculture, hunting, forestry	2.56	3.02	18.04	0.0477	0.0690	44.6
2	B	Fishing	2.03	2.14	5.4	0.0599	0.0930	55.2
3	C	Mining and quarrying	5.71	2.26	-60.4	0.2420	0.2440	0.8
4	D	Manufacturing	0.81	0.76	-6.2	0.0752	0.0830	10.4
5	E	Electricity, gas, water	7.97	5.64	-29.2	1.1167	1.4930	33.7
6	F	Construction	0.36	0.26	-27.8	0.0182	0.0200	9.9
7	G	Wholesale and retail trade, repair of vehicles and household appliances	0.93	0.77	-17.2	0.0336	0.0350	4.2
8	H	Hotels and restaurants	1.50	1.40	-6.7	0.1011	0.0970	-4.0
9	I	Transportation, warehouses, communications	2.04	1.77	-13.2	0.1377	0.2100	57.1
10	J	Intermediate financial institutions	0.48	0.50	4.2	0.0444	0.0570	28.4
11	K	Real estate, rents, business activities	19.48	17.82	-8.5	2.9050	2.2270	-23.3
12	L	Public administration and compulsory social insurance	5.98	6.49	8.5	0.3117	0.3430	10.0
13	M	Education	1.81	1.52	-16.0	0.0541	0.0530	-2.0
14	N	Health and social affairs	0.78	0.78	0	0.0292	0.0400	37.00
15	O	Other social services	1.61	1.69	5.0	0.0650	0.1050	61.5
16	P	Private households	0.00	0.00	0	0	0	0
1 to 16		National Economy	3.90	3.55	-10.4	0.2200	0.2364	7.5

erage, both negative and positive divergences are noticed for the capital-output ratios of the various sectors. Among the 15 sectors for which the direct capital intensity coefficients were estimated, 12 sectors show an increase and three a decrease.

The increase in capital intensity implies the substitution of labour by capital and the decrease the opposite. The greatest percentage decrease of capital intensity between 2000 and 2005 occurred in the sector of 'real estate etc.' (11) and was 23.3%.

There were 12 sectors with an increase in their capital intensity coefficients. In three sectors (15, 10, 2) the increase is more than 50%; in four (1, 14, 5, 10) the increase ranged from 28% to 45%; in three (4, 6, 13) the increase is around 10% and in two others (3 and 7) the increases are 0.8% and 4.2% respectively.

3 Conclusions

The main conclusions that can be drawn from the sectoral analysis of capital coefficients and capital intensity coefficients are summarized as follows:

- The sectoral direct capital coefficients show significant variation between themselves as well as divergence from the national capital coefficient. The longer the life of fixed capital, the higher the capital-output ratio. In some sectors of the economy the proportion of long duration capital goods of their total fixed capital stock is larger relative to the short duration ones. Such 'long-duration' sectors in the Greek economy are electricity, gas, water, public administration etc. (roads, ports, public buildings etc.) and real estate etc. (mainly houses). The output produced by these sectors is spread over a long period of time and the result is a relatively high capital-output ratio at a given time. A part of the high capital-output ratios in these sectors may also be attributed to the lack of modern technology in production, inadequate maintenance service of the capital equipment and other factors.
- The total capital coefficients (or capital multipliers)—which include not only the direct use of capital but also indirect use through the intersectoral transactions for intermediated inputs—are greater than the direct coefficients. The indirect use of capital as percentage of the total use ranges from 10–90% in the various sectors for the production of their final products.

- The direct capital intensity of the sectors of the economy shows significant variation among them. Great differences among the various sectors are also noticed for indirect capital intensity as a percentage of the total capital intensity, in the production of the final products.
- Over the period 2000–05, the capital coefficient for the national economy fell as a result of negative and positive changes in the sectoral coefficients while the capital intensity increased as a result of the positive changes, for the great majority of sectors. In a number of sectors such as Agriculture (1), Fishing (2), Electricity etc. (5), Transportation etc. (9), Health and Social Services (14), other Social Services (15) the substitution of labour for capital was remarkable between 2000 and 2005 since the percentage increase in fixed capital per unit of labour ranged from over 30% (sector 5) to 61% (sector 15). In other words the production of these sectors became more capital-intensive relative to the other sectors. The only sector with a significant reduction in capital per unit of labour (23%) was real estate etc. (11).

ANNEX

Statistical Data

NACE Code	Gross value of production € mil.		Employed persons		Fixed capital stock € mil.		Deflators of gross production and of fixed capital
	2000	2005	2000	2005	2000	2005	2005=1,00
A	11349	12260	693748	539081	29052	37068	1.14
B	840	1047	28692	24028	1703	2237	1.01
C	1107	1437	14100	13353	6318	3255	0.54
D	43371	55074	492098	504651	35233	41722	1.05
E	4204	7125	34187	26889	33488	40149	1.14
F	21403	28946	300095	361679	7710	7410	0.71
G	26642	43677	805522	947756	24848	33571	1.09
H	15945	20273	265272	290264	23957	28289	1.12
I	17463	29735	289646	250130	35624	52495	1.12
J	9410	11918	107661	103489	4508	5930	1.06
K	26305	36031	201051	288283	512332	642063	1.14
L	16609	21037	363060	397427	99274	136428	1.14
M	6694	10659	248951	303690	12139	16186	1.11
N	6328	10896	177432	213167	4932	8499	1.05
O	7641	11378	156940	182826	12296	19240	0.83
P	751	1316	766560	99318	0	0	–
A to P	216062	302810	4255114	4546031	843415	1074542	1.12

Source: National Statistical Service of Greece.

Table A1: Symmetric input-output table (product × product) at basic prices (industry technology assumption) € mil., Year 2000

	Intermediate consumption																Total interm. outputs
NACE CODE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	
A	2137	2	1	4675	0	0	78	296	14	0	29	3	0	6	9	0	**7251**
B	0	39	0	27	0	0	1	102	1	0	1	0	0	0	1	0	**172**
C	4	0	30	4501	632	826	234	12	6	0	22	1	0	0	0	0	**6269**
D	1110	91	125	12098	340	6298	2066	3685	1799	145	689	3698	86	908	406	0	**33542**
E	194	0	50	700	195	80	131	357	109	60	89	237	82	62	124	0	**2469**
F	5	0	32	574	30	3	104	121	33	65	1902	60	47	44	90	0	**3110**
G	634	39	40	3798	104	1660	846	1024	547	51	333	904	34	360	139	0	**10511**
H	0	0	0	24	1	1	8	0	202	31	105	50	9	15	227	0	**674**
I	30	27	20	240	45	282	1775	230	3875	225	605	229	32	31	152	0	**7798**
J	176	19	14	594	52	355	683	155	272	811	401	154	22	46	143	0	**3898**
K	30	3	54	1851	87	1956	2164	535	792	1016	2079	483	137	145	891	0	**12224**
L	0	0	0	1	0	0	0	0	1	0	3	329	0	0	0	0	**334**
M	0	0	0	0	0	0	0	0	1	19	25	79	19	19	2	0	**165**
N	5	0	0	0	0	0	0	0	3	15	7	92	1	74	7	0	**204**
O	0	0	1	42	8	0	194	115	28	27	339	3	14	24	328	0	**1125**
P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total interm. inputs at basic prices	**4326**	**220**	**368**	**29125**	**1496**	**11462**	**8283**	**6632**	**7682**	**2466**	**6629**	**6321**	**484**	**1734**	**2518**	**0**	**89746**
Taxes less subsidies on products	-64	30	43	971	140	1152	567	339	953	338	554	459	31	130	292	0	**5934**

	Intermediate consumption																Total
NACE CODE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	
Total interm. inputs at purchasers' price	**4261**	**250**	**411**	**30096**	**1635**	**12614**	**8850**	**6971**	**8635**	**2804**	**7184**	**6780**	**515**	**1864**	**2810**	**0**	**95680**
Compensation of employees	610	82	333	6526	817	2472	6265	1443	4185	3211	2316	7514	4274	2421	2093	751	**45313**
Wages and salaries	573	65	253	5359	665	1957	4391	1234	3490	2449	1882	5511	3132	2242	1843	595	**35642**
Other net taxes on production	-264	1	2	16	6	21	238	22	71	159	53	0	13	10	43	0	**391**
Consumption of fixed capital	849	69	181	1689	626	533	1074	824	501	185	5414	2315	480	257	544	0	**15540**
Operating surplus, net	5893	436	181	5045	1120	5763	10215	6685	4071	3050	11338	0	1413	1776	2150	0	**59138**
Operating surplus, gross	6742	506	362	6733	1746	6297	11289	7509	4573	3236	16752	2315	1893	2033	2695	0	**74678**
Mixed income, gross	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Value added at basic prices	7088	589	697	13275	2569	8789	17791	8974	8828	6606	19121	9829	6179	4464	4831	751	**120382**
Output at basic prices	**11349**	**840**	**1107**	**43371**	**4204**	**21403**	**26642**	**15945**	**17463**	**9410**	**26305**	**16609**	**6694**	**6328**	**7641**	**751**	**216062**
Imports, cif	1384	77	4529	34190	9	448	0	0	4001	1057	689	398	56	54	247	0	**47140**
Domestic production value	**12734**	**917**	**5636**	**77561**	**4213**	**21851**	**26642**	**15945**	**21464**	**10467**	**26994**	**17007**	**6750**	**6382**	**7887**	**751**	**263202**

Table A1 (continued)

	Final uses							
Final users NACE CODE	**Households final consumption**	**Final consumption of non profits institutions**	**Final consumption of general government**	**Gross fixed capital formation**	**Changes in inventories**	**Exports**	**Total**	**Total uses**
A	4306	0	0	71	78	1028	**5483**	**12734**
B	539	0	0	0	13	193	**745**	**917**
C	0	0	0	8	-928	287	**-633**	**5636**
D	25643	0	0	7180	2116	9079	**44019**	**77561**
E	1744	0	0	0	0	0	**1744**	**4213**
F	506	0	0	17708	274	253	**18740**	**21851**
G	10942	0	0	2422	427	2341	**16131**	**26642**
H	15271	0	0	0	0	0	**15271**	**15945**
I	5045	0	0	0	0	8621	**13666**	**21464**
J	6286	0	0	0	0	283	**6569**	**10467**
K	13375	0	134	743	0	518	**14770**	**26994**
L	298	0	16311	0	0	64	**16673**	**17007**
M	1988	0	4504	0	0	94	**6586**	**6750**
N	2935	0	3152	0	0	91	**6178**	**6382**
O	5058	1274	170	114	0	146	**6762**	**7887**
P	751	0	0	0	0	0	**751**	**751**
Total inputs at basic prices	**94688**	**1274**	**24271**	**28246**	**1979**	**22998**	**173456**	**263202**
Taxes less subsidies on products	8412	0	0	1204	349	0	9965	15899
Total inputs at purchasers' price	**103100**	**1274**	**24271**	**29450**	**2328**	**22998**	**183421**	**279101**

Table A2: Symmetric input-output table (product × product) at basic prices (industry technology assumption) € mil., year 2005

	Intermediate consumption																Total interm. outputs
NACE CODE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	
A	1807	0	2	4190	0	0	85	415	17	0	37	0	188	0	5	0	**6745**
B	0	59	0	13	0	0	0	59	1	0	0	0	0	0	0	0	**133**
C	4	0	20	6446	778	76	128	14	6	0	36	0	0	0	0	0	**7508**
D	1240	6	201	13763	471	8994	2443	4162	1808	132	908	2192	213	1651	435	0	**38620**
E	218	0	138	1679	551	92	477	670	373	88	194	444	16	101	154	0	**5193**
F	11	0	67	284	23	3	157	108	77	102	1720	105	28	70	129	0	**2884**
G	913	34	74	5425	168	2738	1330	1720	759	46	453	920	130	711	173	0	**15595**
H	0	0	0	49	1	56	15	0	190	13	160	36	0	6	277	0	**803**
I	33	11	35	475	64	293	3248	257	7098	369	861	851	7	23	216	0	**13841**
J	153	7	12	227	132	661	4246	425	223	1067	858	477	3	62	332	0	**8885**
K	34	0	59	2917	142	1935	2975	533	1113	1231	2666	753	92	145	1089	0	**15682**
L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
M	0	0	0	0	0	0	1	0	2	7	27	30	4	32	2	0	**106**
N	5	0	0	1	0	0	0	0	6	52	10	140	0	56	6	0	**276**
O	0	0	1	77	9	0	217	116	58	79	528	9	150	32	529	0	**1806**
P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Total inputs at basic prices	**4418**	**118**	**609**	**35545**	**2339**	**14848**	**15322**	**8479**	**11730**	**3186**	**8458**	**5957**	**831**	**2889**	**3347**	**0**	**118077**
Taxes less subsidies on products	14	7	55	1288	171	1583	772	487	995	271	645	420	51	192	284	0	**7236**

Table A2 (continued)

	Intermediate consumption																Total
NACE CODE	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	
Total inputs at purchasers' price	**4432**	**124**	**665**	**36833**	**2510**	**16432**	**16094**	**8966**	**12726**	**3457**	**9103**	**6377**	**882**	**3081**	**3631**	**0**	**125313**
Compensation of employees	1054	94	435	7517	1209	3742	9380	2357	5699	3884	5317	11533	7147	4042	3544	1316	**68270**
Wages and salaries	991	75	380	5958	965	2831	7340	1953	4530	2726	4120	8398	5323	3837	3175	1063	**53663**
Other net taxes on production	-593	2	2	20	8	25	61	25	39	164	57	0	19	15	18	0	**-138**
Consumption of fixed capital	986	83	182	2389	883	963	1672	1231	1234	314	6461	3126	753	422	929	0	**21628**
Operating surplus, net	6382	744	153	8315	2515	7784	16471	7694	10037	4099	15092	0	1859	3336	3256	0	**87737**
Operating surplus, gross	7368	827	336	10704	3397	8747	18143	8925	11271	4413	21554	3126	2612	3757	4185	0	**109365**
Mixed income, gross	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Value added at basic prices	7829	922	772	18241	4615	12514	27584	11307	17009	8461	26927	14660	9778	7815	7747	1316	**177497**
Output at basic prices	**12260**	**1047**	**1437**	**55074**	**7125**	**28946**	**43677**	**20273**	**29735**	**11918**	**36031**	**21037**	**10659**	**10896**	**11378**	**1316**	**302810**
Imports, cif	1412	87	6418	42608	149	80	0	0	5124	1214	932	87	32	53	456	0	**58653**
Domestic production value	**13672**	**1134**	**7856**	**97682**	**7274**	**29027**	**43677**	**20273**	**34859**	**13132**	**36962**	**21124**	**10691**	**10949**	**11834**	**1316**	**361462**

	Final uses							Total uses
Final users NACE CODE	**Households final consumption**	**Final consumption of non profits institutions**	**Final consumption of general government**	**Gross fixed capital formation**	**Changes in inventories**	**Exports**	**Total**	
A	5902	0	0	79	-52	998	**6928**	**13672**
B	885	0	0	0	-111	227	**1001**	**1134**
C	0	0	0	0	213	135	**348**	**7856**
D	38915	0	0	9769	-1106	11485	**59062**	**97682**
E	2067	0	0	0	0	15	**2081**	**7274**
F	775	0	0	25136	0	232	**26143**	**29027**
G	19990	0	0	4364	126	3602	**28082**	**43677**
H	19470	0	0	0	0	0	**19470**	**20273**
I	6828	0	0	0	0	14190	**21018**	**34859**
J	3949	0	0	0	0	298	**4247**	**13132**
K	18745	0	254	1358	0	923	**21280**	**36962**
L	723	0	20313	0	0	87	**21124**	**21124**
M	3432	0	7125	0	0	28	**10585**	**10691**
N	5488	0	5137	0	0	48	**10673**	**10949**
O	7601	1921	194	161	0	150	**10027**	**11834**
P	1316	0	0	0	0	0	**1316**	**1316**
Total inputs at basic prices	**136086**	**1921**	**33024**	**40867**	**-929**	**32417**	**243386**	**361463**
Taxes less subsidies on products	11453	0	0	1815	-356	0	**12912**	**20148**
Total inputs at purchasers' price	**147539**	**1921**	**33024**	**42682**	**-1285**	**32417**	**256298**	**381611**

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An Empirical Investigation of Direct and Spillover Effects from Information and Communication Technology in Greek Industries

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Abstract

This paper examines the impact of ICT, as well as the presence of ICT spillovers, on productivity growth of Greek industries. An extended Cobb Douglas production function is estimated using industrial data from two-digit industries. We examine two different time periods: the period of the late 1990s and the period 2001-2008. There has been a significant increase in the productivity impact of ICT, which was highly positive during the period 2001-2008, as opposed to an insignificant impact during the 1990s. The effect of lagged ICT is also significantly positive and larger in size than the impact of current ICT investment. When focusing on the service sector, the results indicate an even stronger effect of ICT on productivity growth. With respect to ICT spillover effects, we found a negative, though small in size, impact on productivity growth, probably due to high adoption costs.

1 Introduction

The modern economic literature has placed technological progress at the heart of the growth process (Grossman and Helpman 1991). Historical and theoretical evidence suggest that general purpose technologies (GPTs), like the steam engine, electricity and Information and Communication Technology (ICT), play a catalytic role in the process of economic growth (David 1990).

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ICT is a core element of the knowledge based society. The GPT nature of ICT (Bresnahan and Trajtenberg 1995) stresses its importance for productivity, both within the same industry or firm and across different industries or firms.

The wide diffusion of ICT investment has triggered discussions about its potential effects on output and productivity growth.[1] It seems that differences in the speed of ICT adoption have played a critical role in the productivity gap in favour of the US, as opposed to the EU (Jorgenson and Stiroh 2000, Van Ark et al. 2003). Although the existing literature has shown that the direct productivity impact of ICT has been sizeable during the second half of the 1990s in several developed countries (Daveri 2002), the existing literature has neglected the indirect impact arising from ICT spillovers. The main focus of this paper is to assess the direct, as well as the indirect, impact of ICT on labour productivity growth across Greek industries. We will also examine for possible differences in ICT effects between ICT intensive industries (which make heavy use of ICT) and the remaining ones.

The present study contributes to the relevant literature by focusing on the existence of ICT spillover effects in a small peripheral economy like Greece. Although theoretically recognized, the issue of ICT spillovers has not been adequately investigated in the empirical literature (Stiroh 2002). Studying the above effects for Greece makes it an interesting application for policy purposes as well, since the Greek economy experiences severe failures in adopting in a consistent and timely manner EU policy related to the Information Society. This study differentiates itself from other relevant studies on the Greek economy by adopting an econometric framework to explore the impact of ICT, instead of the most often used methodology of growth accounting (e.g. Antonopoulos and Sakellaris 2009). The findings of this study could be useful, given the fact that Greece has been credited with about €20 billion additional EU funds to implement the National Strategic Reference Framework for 2007–2013. That includes the strengthening of the telecommunications infrastructure, promoting entrepreneurship, investing in human capital, improving the efficiency of public administration and promoting digital convergence.

[1] In Greece and according to published OECD figures, investment in ICT, as a percentage of gross fixed capital formation, increased significantly from 4.5%, in the late 1980s, to more than 10% during the 2000s.

Our results, based on data from two-digit industries, indicate that there has been a significant increase in the productivity impact of ICT which was highly positive and significant during the period 2001–2008, as opposed to an insignificant impact during the 1990s. We have also found significant effects of lagged ICT for the period 2001–2008. A particular emphasis is placed on the industries of the service sector, for which an even stronger effect of ICT is estimated. With respect to ICT spillover effects, we have found a negative, though small, impact on productivity growth, probably due to high adoption costs.

The paper proceeds as follows. In section 2, the theoretical role and empirical impact of ICT on economic growth is discussed; section 3 provides the econometric model, while section 4 describes the data and variables used in the empirical analysis. Section 5 presents the regression results, while section 6 concludes.

2 Theoretical and Empirical Literature

The idea that technology acquired by a firm or an industry can spill over and affect the productivity of another firm or industry was first introduced by Arrow (1962). The recently developed endogenous growth models have stressed the importance of technology spillovers in generating growth (Romer 1986, Grossman and Helpman 1991). Regarding the case of ICT investment, the improved communications among firms and the network nature of ICT (increasing value as the number of users grows) imply that ICT investment might improve the productivity of the others and lead to increased growth.

ICT seems to have changed the methods of production, with a considerable decrease in communication and transaction costs and a wide applicability in several sectors of the economy. It has been characterized as a GPT (Bresnahan and Trajtenberg 1995) which presents characteristics like technological dynamism and innovational complementarities that lead to further investment in new products and methods of production and new ways of producing and organizing work. ICT investments are also expected to lead to lower costs and productivity gains. However, such effects are likely to be delayed until the economies have implemented the necessary complementary investments and have reorganized the production activity (Brynjolfsson and Hitt 2000). At the initial stage of implementing ICT, productivity and GDP growth are likely to present negative growth rates (Bresnahan and Trajtenberg 1995). This is consistent with the empirical evidence of Basu et al. (2003) which showed that, initially, ICT investments were negatively correlated with output and that they were significantly associated with TFP growth only after a lag period of 5 to 15 years. For ICT spillover effects, the lag period may be longer (Rincon and Vecchi 2004).

As already noted above, a spillover effect occurs when a technology acquired by a firm or industry is able to affect the productivity growth of another firm or industry. From this definition of spillovers, one can assume that this is a kind of social return, without paying for the initial cost. Such spillover effects are related to the efficiency of transactions among firms, the transfer of knowledge between firms and industries and reduction of administrative and production costs. Common examples include the electronic transfer of payments, internet based markets, automated inventory management and increased product quality.

Earlier studies estimated econometrically the impact of ICT investments on TFP growth. The results of these studies were significant in the case of four-digit U.S. manufacturing industries (Griliches and Siegel 1991) but not significant for the whole sample of U.S. industries (Stiroh 2002), nor in the G7 group (Schreyer 2000).

In studies employing spillover variables, Madden and Savage (2000) examined the role that R&D spillovers can play in the productivity of OECD and Asian economies, showing that the benefits of R&D spillovers arise through trade and, in particular, through trade in information technology equipment.

Mun and Nadiri (2002) used inter industry data from input-output tables to examine the impact of ICT externalities on the performance of U.S. private sector industries over the period 1984–2000. Their results suggest considerable effects of ICT externalities on TFP growth. Van Leeuwen and van der Wiel (2003), using firm level data, analyzed the impact of ICT spillovers on TFP of the service sector in the Netherlands. Their results show that when accounting for ICT spillovers, the estimated elasticity of own ICT capital is reduced. This evidence suggests that ICT spillovers can be an important source of productivity growth in ICT using industries.

Rincon and Vecchi (2004) used firm level data for the US and for several European countries in order to analyze the impact of ICT spillovers on productivity. After having used different versions of inter and intra industry spillovers, they showed that the ICT spillover effects are present in the US in both the short as well as the long run—however, the impact is larger when long-run effects are considered. In the EU, on the other hand, short-run effects do not exist; however, in the long run, ICT spillovers significantly affected productivity growth.

Regarding the Greek economy, Terrovitis (2005), as well as Antonopoulos and Sakellaris (2009), used a neoclassical growth accounting framework to analyze the contribution of ICT on the productivity growth of Greece. They found that the contribution of ICT increased over the period 1996–2003. Furthermore, Arvanitis and Loukis (2009) used an econometric framework to assess the productivity impact of ICT at the firm level. They ured a sample of 300 Greek firms and demonstrated a positive and significant effect of ICT for the period 2003–2005.

3 Econometric Framework

Following common practice in the empirical ICT literature (Berndt and Morisson 1995; Gera et al. 1999), we will assume the following augmented Cobb Douglas production function, in order to capture the direct ICT or spillover ICT effects on labour productivity growth among industries:

$$Y_{it} = AL_{it}^{a_1} K_{it}^{a_2} ICT_{it}^{a_3} SICT_{it}^{a_4} e^{\lambda t} \tag{1}$$

The above equation relates value added of each industry i at time t (Y_{it}) to its labour input (L_{it}), non-ICT capital (K_{it}), ICT capital (ICT_{it}) and ICT spillover effects ($SICT_{it}$). Furthermore, A is the level of technological progress, t is a time trend and λ is a parameter which indicates the rate of technical change. The coefficients of α_1 to α_3 denote the value added elasticities with respect to labour, non-ICT capital and ICT capital.

As mentioned above, ICT is considered as a special type of knowledge and technology capital, and, thus, its impact cannot be bounded within countries, industries or firms. To test for the existence of spillover effects, arising from technological progress existing in other industries, an additional variable is considered in equation (1) which proxies for ICT (*SICT*) spillovers among industries.

We approximate the ICT spillover variable for industry *i* as the weighted sum of ICT investment across all industries, with the weights being the percentage share of goods and services (*inp*) that industry *i* purchases from other industries:

$$SICT_i = \sum_{j \neq i} ICT_j \times \left(\frac{inp_j}{\sum_{j \neq i} inp_j}\right) \tag{2}$$

Consequently, the coefficient α_4 in equation (1) represents the value added elasticity with respect to ICT capital embodied in imported goods and services. In this way, a channel through which an industry might grow is the use of equipment, services or intermediate goods being manufactured in other industries with a high ICT intensity. After taking logarithms of equation (1), the following log linear relationship arises between value added per worker and the various types of inputs described above:

$$lnY_{it} = lnA + \lambda t + a_1(lnL_{it}) + a_2(lnK_{it}) + a_3(lnICT_{it}) + a_4(lnSICT_{it}) \tag{3}$$

By taking the first order derivatives with respect to time, we obtain the following growth equation:

$$\frac{\dot{Y}_{it}}{Y_{it}} = \lambda + a_1 \frac{\dot{L}_{it}}{L_{it}} + a_2 \frac{\dot{K}_{it}}{K_{it}} + a_3 \frac{I\dot{C}T_{it}}{ICT_{it}} + a_4 \frac{S\dot{I}CT_{it}}{SICT_{it}} \tag{4}$$

After subtracting the growth rate of labour from both sides of equation (4), using the definition for the value-added elasticity[2] and adding an error term, the following regression equation is obtained:

$$\frac{\dot{y}_{it}}{y_{it}} = \lambda + \beta_1 \frac{\dot{L}_{it}}{L_{it}} + \beta_2 \frac{\dot{K}_{it}}{Y_{it}} + \beta_3 \frac{I\dot{C}T_{it}}{Y_{it}} + \beta_4 \frac{S\dot{I}CT_{it}}{Y_{it}} + \varepsilon_{it} \tag{5}$$

where $\frac{\dot{y}_{it}}{y_{it}}$ is output per worker growth, a measure of labour productivity growth of industry *i* at time *t*. The variables $\frac{\dot{K}_{it}}{Y_{it}}$, $\frac{I\dot{C}T_{it}}{Y_{it}}$ are investments in non-ICT capital and ICT capital, respectively, as a share of value added, while $\frac{S\dot{I}CT_{it}}{Y_{it}}$

[2] The output elasticity of non-ICT capital (α_2), for example, is equal to $\frac{dY}{dK} \times \frac{K}{Y}$.

represents ICT spillovers as a share of value added. The coefficient β_1 is the value added elasticity of labour (a_1) minus 1, while the parameters β_2 to β_4 are the rates of return to the various types of investments and the spillover variable.

4 Data

4.1 Variables

The empirical analysis is based on data from thirty industries (for the years 1995 and 1999) and from forty industries for the period 2001–2008, all at the two-digit level. The sample of our observations does not include non-market industries, since problems in the measurement of output still constitute an issue of major concern (Van Ark et al. 2003).

Table 1: List of Variables

Variable name	Definition	Source
Y	Value Added per Worker Growth	OECD STAN Industrial Database
L	Employment Growth (in persons employed)	OECD STAN Industrial Database
K	Gross Fixed Capital Formation (as a share of Value Added)	OECD STAN Industrial Database
ICT	ICT Input (as a share of Value Added)	Eurostat Use Matrixes
SICT	Spillovers of ICT (as a share of Value Added)	Eurostat Use Matrixes

The data for value added, labour (expressed as full time equivalent employees) and gross investment are obtained from the OECD STAN Industrial Database (2006a)[3] and are expressed in constant 2000 prices.[4] Since ICT investment data are not available from OECD databases, we will follow the paradigm of Gera et al. (1999) and proxy ICT investment for each industry as the sum of inflows coming from the following industries:

- Office, Accounting and Computing Machinery,

[3] See Table 1 for a definition and sources of variables.

[4] Since the use of investment in a particular year does not reflect accurately the change in capital, we preferred to use instead the moving average of investment for the last three years.

• Radio, Television and Communication Equipment
• Computer and Related Activities

The data for inflows in each industry are provided: a) from OECD Input-Output Tables (2006b) for the years 1995 and 1999, and b) from Eurostat Use Matrices for the period 2001–2008. We should note at this point that the obtained series for ICT investment is subtracted from the series of total investment in order to obtain two different forms of ICT and non-ICT investment.

4.2 Trends

Table 2 presents labour productivity growth in each industry for 1995 as well as the periods 2001–2004 and 2005–2008. A quite heterogeneous pattern prevails among Greek industries. In the period 2005–2008, the industries with the highest productivity growth were 'Coke, refined petroleum products and nuclear fuel', 'Air transport' and 'Financial intermediation', while the lowest productivity industries were 'Recycling' and 'Manufacturing'. Furthermore, we can see that the three ICT industries, as defined above (Office, Accounting and Computing Machinery, Radio, Television and Communication Equipment and Computer and Related Activities), did not witness any important increase in their labour productivity.

It is worth mentioning that the high productivity growth witnessed in the U.S. during the 1990s was heavily based on the rapid increase of productivity growth in ICT producing industries (Jorgenson and Stiroh 2000). However, the ICT sector in Greece is characterised by a very small number of large firms and a vast majority of small and very small enterprises. In addition, the Greek ICT sector is not competitive enough, as it suffers from complex relationships with other productive entities and the public sector and follows the delays and anomalies of the Greek economy and public sector.

Table 2: Labour Productivity Growth % (in value added terms)

Industry	1995	Average 2001-2004	Average 2005-2008
Mining of metal ores		-6.46	-4.19
Other mining and quarrying		-1.77	1.33
Food products and beverages	3.60	1.94	2.76
Tobacco products	-10.90	20.91	4.62
Textiles	3.22	3.55	-5.43

Table 2 (continued)

Industry	1995	Average 2001-2004	Average 2005-2008
Wearing apparel, dressing and dyeing of fur	4.21	-16.15	-3.31
Leather, leather products and footwear	0.23	2.30	7.02
Wood and products of wood and cork	-6.98	-12.75	-5.08
Pulp, paper and paper products	-8.52	-10.83	-0.01
Printing and publishing	6.73	4.39	6.56
Coke, refined petroleum products and nuclear fuel	8.83	10.61	17.07
Rubber and plastics products	7.59	5.63	2.55
Other non-metallic mineral products	9.48	-3.56	-4.77
Fabricated metal products, except machinery and equipment	9.81	7.56	2.88
Machinery and equipment, n.e.c.	9.88	2.47	2.79
Office, accounting and computing machinery	-16.65	-15.74	-16.21
Electrical machinery and apparatus, n.e.c.	-4.56	7.21	-14.36
Radio, television and communication equipment	-3.22	-29.16	-0.86
Medical, precision and optical instruments	8.03	26.00	8.84
Motor vehicles, trailers and semi-trailers	13.86	15.16	-13.23
Manufacturing n.e.c.	2.85	-18.96	-33.61
Recycling	11.26	15.10	-77.96
Electricity, gas, steam and hot water supply	-2.96	0.99	-4.59
Collection, purification and distribution of water	-18.13	13.06	-0.72
Construction	1.02	2.67	-9.66
Retail trade excl. motor vehicles - repair of household goods	7.53	12.80	-2.66
Hotels and restaurants	3.41	8.68	2.63
Land transport - transport via pipelines	-2.99	-3.39	2.22
Water transport	0.95	49.01	6.14
Air transport	8.51	-1.76	10.86
Supporting and auxiliary transport activities	8.93	0.39	8.48
Post and telecommunications	-19.67	7.94	0.52
Financial intermediation, except insurance and pension funding	14.96	-4.18	10.48
Activities auxiliary to financial intermediation	14.69	-23.63	-5.79
Real estate activities	-8.14	-4.10	-1.30
Renting of machinery and equipment	25.83	-16.36	1.74
Computer and related activities	44.67	48.85	-5.79
Research and development	0.28	14.09	2.29
Other business activities	3.25	-3.72	-2.50

Regarding ICT investment (Table 3) in each industry, we can see that the level of ICT investment (approximated by inflows from the three ICT industries

Table 3: ICT Investment (as a % share of Value Added)

Industry	1995	Average 2000-2004	Average 2005-2008
Food products, beverages and tobacco	0.01	0.38	0.20
Textiles, textile products, leather and footwear	0.01	0.45	0.41
Wood and products of wood and cork	0.00	0.40	0.49
Pulp, paper, paper products, printing and publishing	0.01	0.71	0.56
Coke, refined petroleum products and nuclear fuel	0.10	0.65	0.11
Rubber & plastics products	0.08	0.37	0.30
Other non-metallic mineral products	0.01	0.88	1.10
Fabricated metal products, except machinery & equipment	0.06	0.83	0.90
Machinery & equipment, nec	0.23	2.01	1.28
Office, accounting & computing machinery	1.65	45.18	16.10
Electrical machinery & apparatus, nec	0.17	6.96	2.04
Radio, television & communication equipment	45.75	40.52	44.82
Medical, precision & optical instruments	1.41	12.38	0.31
Motor vehicles, trailers & semi-trailers	0.06	0.20	0.14
Manufacturing nec; recycling (include Furniture)	0.02	0.46	0.44
Construction	0.01	1.45	1.22
Wholesale & retail trade; Repairs	0.68	2.36	1.53
Hotels & restaurants	0.00	0.44	0.13
Land transport; transport via pipelines	0.00	1.44	1.18
Water transport	0.03	0.78	0.69
Air transport	0.70	0.53	0.24
Supporting and auxiliary transport activities; activities of travel agencies	0.07	0.30	0.46
Post & telecommunications	0.22	4.35	4.02
Finance & insurance	0.37	1.72	1.14
Real estate activities	0.00	1.57	0.00
Renting of machinery & equipment	0.00	2.90	2.74
Computer & related activities	0.01	29.43	19.26
Research & development	0.01	6.80	1.99
Other Business Activities	0.86	3.49	5.18

* The data for 1995 are taken from OECD Input Output tables, while the data for the periods 2000-2004 and 2005-2008 were taken from the Eurostat Use Matrixes.

that were defined above) was very low in 1995. Nevertheless, a sharp increase in ICT investment was observed in the majority of industries after 2000. The most intensive users of ICT are those that produce ICT (Office, Accounting and Computing Machinery, Radio, Television and Communication Equipment and Computer and Related Activities). From the remaining industries, the service industries of ‘Post and telecommunications’, ‘Renting of machinery and equipment’ and ‘Other business activities’ display the highest shares of ICT investment as a share of value added. Table 4 presents a correlation matrix to reassure that no serious multicollinearity problem exists between explanatory variables.

Table 4: Correlation Table

	Y	L	K	ICT	SICT
Y	1.00				
L	-0.58	1.00			
K	-0.01	-0.08	1.00		
ICT	-0.06	0.12	-0.05	1.00	
SICT	-0.15	-0.05	0.60	0.33	1.00

5 Econometric Results

Equation (5) was estimated first with OLS using two-digit industry data for the years 1995 and 1999[5]. Then, it was re-estimated for the period 2001–2008 by applying panel data econometric techniques.

The results of Table 5 (for the years 1995 and 1999) indicate that labour productivity growth is negatively and significantly correlated with employment growth (L). There have been several recent productivity studies which show that during the last 25 years of the twentieth century, most industrialized countries have either achieved increased employment at the expense of productivity or have improved productivity against the goal of increasing employment (see, for example, Beaudry and Collard 2002). This empirical regu-

[5] We should note at this point that owing to data discontinuities (OECD input-output tables are available only for 1995 and 1999), we could not apply panel data econometric methods.

Table 5: OLS Regression Estimates for 1995 and 1999

Dependent Variable: Value Added per Worker Growth				
Independent Variables†	(1)	(2)	(3)	(4)
C	-0.080 (-1.34) ††	-0.1062 (-1.55)	-0.181 (-1.52)	-0.077 (-1.19)
L	-1.342 (-3.77)*	-1.564 (-3.50)*	-2.212 (-2.52)*	-1.444 (-4.19)*
K	0.609 (4.09)*	0.640 (4.16)*	0.881 (3.62)*	0.408 (2.49)*
ICT	0.109 (0.15)	0.097 (0.14)		-0.088 (-0.16)
SICT		0.086 (0.83)		0.089 (1.10)
ICT (L)			0.003 (0.00)	
SICT(L)			0.064 (0.43)	
Dummy (Service Sector)				-0.060 (-0.70)
Dummy (Service Sector) × ICT				45.777 (5.19)*
Dummy (Service Sector) × SICT				-0.175 (-0.21)
Obs.	55	55	31	55
R^2	0.30	0.30	0.27	0.59
F stat.	8.90	6.81	3.85	12.31

† See Table 1 for the definitions of variables.
†† t-statistics are reported in parentheses.
* Significant at the 5% level.

larity can be justified by the fact that as employment increases, the capital input attributable to each worker is reduced and so is labour productivity growth. Therefore, economies with high employment growth should experience a temporary decrease of labour productivity growth as the result of lower capital deepening ratios. Regarding non-ICT investment (K), the results are positive and significant as expected, showing that labour productivity growth is highly affected by an increase in the ratio of non ICT investment to total value added.

The insignificant impact of ICT investment on labour productivity growth is in line with estimates obtained in numerous studies on the U.S. and other European economies, for the periods of the early adoption of ICT (Oliner and Sichel 1994, Daveri 2002). With respect to ICT spillovers (SICT), the results of column 2 in Table 5 indicate that no significant impact is exerted from ICT capital embodied in imports from other industries.

An implicit assumption of the literature is that ICT direct and spillover effects are a static phenomenon, so that only contemporaneous effects are allowed. As Sena (2004) argues, there might be a more dynamic process through which they are diffused in the long run. The general purpose technology nature of ICT assumes that any benefits cannot be realised in the short run since they are likely to require a substantial period of time before their full potential can be realised (David 1990). Thus, returns to new ICT investment, as well as the generation of spillover effects, are likely to be delayed until complementary investments, organisational changes and skills training have been made in order to maximise the potential benefits of ICT (Brynjolfsson and Hitt 2000). Equation (5) was re-estimated, replacing the ICT and the spillover variable with their lagged values (Table 5, column 3 with variables ICT(L) and SICT(L)). However, the results still indicate that the impact of lagged ICT and its spillover variable are not statistically significant.

At this point, it would be useful to account for heterogeneity among industries, especially when assessing ICT and productivity linkages. Van Ark et al. (2003) have shown that most of the productivity benefits of ICT in the USA and European countries have been realized inside the service sector. In the fourth column of Table 5, a dummy (Dummy-Service Sector) was included indicating whether an industry belongs to the service sector. An interaction term was also introduced, defined as the product of the industry dummy with the ICT (Dummy $\times$ ICT) or ICT spillover variable (Dummy $\times$ SICT), to account for heterogeneity in ICT and ICT spillover effects between service and remaining industries. The results of the fourth column indicate that the ICT effect on labour productivity growth is significantly higher in the service industries, as compared to the remaining ones. No significant difference was observed in spillover effects between service and remaining industries.

The results in Table 6 come from estimating equation (5) for the period 2001-2008, applying the fixed effect panel data estimator. As we can see, the

Table 6: Fixed Effect Regression Estimates for 2001-2008

Dependent Variable: Value Added per Worker Growth			
Independent Variables†	(1)	(2)	(3)
C	1.672 (1.00) ††	-1.383 (-0.53)	2.204 (1.15)
L	-1.093 (-13.35)*	-1.106 (-7.02)*	-1.059 (-12.81)*
K	0.069 (2.23)*	0.042 (1.44)	0.058 (1.66)**
ICT	0.316 (2.41)*		0.153 (1.00)
SICT	-0.033 (-4.92)*		-0.030 (-3.89)*
ICT (L)		0.712 (4.63)*	
SICT(L)		-0.106 (-6.95)*	
Dummy (Service Sector)			-1.578 (-0.45)
Dummy (Service Sector) × ICT			0.818 (2.44)*
Dummy (Service Sector) × SICT			-0.113 (-0.69)
Obs.	316	117	276
R^2	0.38	0.45	0.39
Wald stat.	196.52	92.48	204.38

† See Table 1 for the definitions of variables.
†† t-statistics are reported in parentheses.
* Significant at the 5% level.
** Significant at the 10% level.

ICT effects on labour productivity growth are highly positive and quite sizeable—indicating that a one percentage point increase in the share of ICT investment is expected to raise productivity growth by more than 30% per cent. This result differs from the estimates obtained for the years 1995 and 1999. We attribute this new finding to the fact that ICT investment rose sharply in the period 2001–2008, as compared to the level of ICT investment (which was very low) during the 1990s (see Table 3). As stressed by Oliner and Sichel

(1994), a sufficient stock of ICT capital equipment is required in order for ICT to exert a measurable contribution to labour productivity growth. Other reasons for the rise of the ICT impact might be the increase in complementary infrastructure investments as well as the availability of highly skilled labour, the existence of which is considered as a necessary precondition for the realization of positive and significant ICT returns (Bresnahan et al. 2002).

With respect to ICT spillovers, the estimates in column 1 demonstrate a significantly negative, though small in size, effect on labour productivity growth. These results are in contrast to several recent studies (Mun and Nadiri 2002, Van Leeuwen and van der Wiel 2003, Rincon and Vecchi 2004) which have shown that ICT spillovers are a significant source of productivity for the U.S. and several European industries. However, these results should not come as a surprise given the late adoption of ICT in the Greek economy. The negative results with respect to ICT spillovers might, also, reflect large adjustment costs (Kiley 2000). Basu et al. (2003) have shown that productivity growth is negatively correlated with contemporaneous ICT investments, but is positively linked with past investments.

The lack of positive impact does not eliminate the possibility that ICT spillover effects will arise in the long run. Furthermore, its is possible that ICT spillover effects are not a static but rather a dynamic phenomenon, so that any benefits will be realised in the future, after advancements in technological capabilities and skills training have been made. Therefore, the current widespread payoffs to ICT investments in several ‘information based’ economies, such as the USA, reflect their early start in engaging with ICT, as opposed to slow adopters, such as Greece.

In column 2 of Table 6, equation (5) was re-estimated, replacing the ICT and the spillover variable with their lagged values (variables ICT(L) and SICT(L)). The effect of lagged ICT indicates a significantly higher contribution on labour productivity growth, as compared to its contemporaneous effect. The impact of the lagged ICT spillover variable remains significantly negative. Furthermore, the regression results of column 3 confirm the results of Table 5 that the ICT effect on labour productivity growth is significantly higher in the service industries, as compared to the remaining ones.

In Table 7, equation (5) was re-estimated only for industries belonging to the service sector. The ICT effect on labour productivity growth is positive, statistically significant and larger in size than in the entire sample of industries.

Table 7: Fixed Effect Regression Estimates – Service Sector

Dependent Variable: Value Added per Worker Growth		
Independent Variables†	(1)	(2)
C	1.668 (0.60)††	1.972 (0.79)
L	-1.367 (-9.29)*	-1.347 (-10.43)*
K	0.036 (0.92)	0.002 (0.06)
ICT	0.862 (3.30)*	
SICT	-0.080 (-0.55)	
ICT (L)		0.818 (3.61)*
SICT(L)		0.056 (0.42)
Obs.	120	105
R^2	0.49	0.55
Wald stat.	112.03	126.84

† See table 1 for the definitions of variables.
†† t-statistics are reported in parentheses.
* Significant at the 5% level.

This is consistent with the fact that the service industries are more intensive ICT users than the remaining industries. In particular, if we exclude the two manufacturing industries that produce ICT (‘Office, Accounting and Computing Machinery’ and ‘Radio, Television and Communication Equipment’), the average share of ICT investment is 2.67% of total value added in service industries, as compared to 0.64% in the remaining industries. Our results are also in line with the estimates of Stiroh (2002) and Van Ark et al. (2003), who estimated that productivity growth has grown faster in service industries that make intensive use of ICT.

Overall, the results with respect to the impact of ICT on productivity growth are indicative of its potential benefits for the Greek economy. The estimates of this paper confirmed the results of previous studies (Terrovitis

2005, Antonopoulos and Sakellaris 2009, Arvanitis and Loukis 2009), having demonstrated a significant growth contribution of ICT in the Greek economy. However, our study adds to the relevant literature for the Greek economy in two ways. First, we have found a significant impact of lagged ICT, which is higher when compared to its contemporaneous effect: this evidence indicates the dynamic nature of ICT effects on productivity growth. Secondly, we have examined separately the role of ICT across the service industries and the results indicate that its impact on productivity growth is significantly higher when compared to the remaining industries.

6 Conclusion

This paper examined the productivity impact of ICT in Greek industries, while emphasis was laid on the possible presence of ICT spillovers. An extended Cobb Douglas production function was estimated using two-digit industry data for the late 1990s, and for the period 2001–2008. The results indicate that there has been a significant increase in the productivity impact of ICT which was highly positive during the period 2001–2008, as opposed to an insignificant impact during the 1990s. With respect to ICT spillover effects, we found a negative, though small in size, impact on productivity growth, probably caused by high adoption costs. We also found a significant impact of lagged ICT, which is larger in size than the contemporaneous one. Furthermore, the results indicate that the impact of ICT is much stronger in the service industries, as compared to its impact in the remaining ones.

The results of this study are in agreement with the evidence of the international empirical literature which indicates that after a long period of adoption, investments in ICT have started to show their potential benefits for productivity growth (Jorgenson and Stiroh 2000, Van Ark et al. 2003). This suggests that policies towards the expansion of ICT investment are of essential importance in order to boost economic growth. The Greek economy should respond to a number of challenges in order to maximise all the potential benefits from ICT. A high priority issue is the modernisation of the economy, which is largely focused on traditional manufacturing and services. Furthermore, greater emphasis should be placed on research and investment in innovation, as well as on entrepreneurship and the strengthening of the ICT sector.

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The Impact of CAP Reforms on the Distribution of Farm Income

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Abstract

This paper empirically examines the distributional implications of the continuous CAP reforms on farm income in Greece, presenting the most effective instruments in favoring income distribution equity and evaluating them with regard to the operational criteria of targeting. The results reveal that income inequality has increased, farms' degree of dependency on support is decreasing, and agricultural income presents a rather stable share in total farm income over time. Disparities are linked to structural factors such as size, specialisation, and region, owing mainly to subsidies tied to output.

1 Introduction

Policy-makers intervene in agriculture aiming to achieve a wide range of socioeconomic objectives including the improvement of farm income. The dispersion of government support benefits across farmers essentially affects distributional goals of maintaining an adequate standard of living for farmers and minimising income disparities. Despite continuous reforms in agricultural policies, concern about inequality remains very strong given both the highly skewed income distribution and the heterogeneity among farms.[1]

[1] A brief overview of the CAP reforms is provided in Table A1 in the Annex.

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The early stages of the Common Agricultural Policy (CAP) in the European Union, which intended to establish high price levels in domestic markets with trade measures, have been criticised due to the regressive distributional effects of such policies on farm income. Market price support payments are considered relatively ineffective in income transfer efficiency terms, allowing a large share of government support to be directed to unintended recipients (OECD, 1996). Transitional direct payments were proposed as a viable alternative to mitigate these shortcomings, whereas the range of concern has been expanded to new issues such as the environment, sustainability and rural development. However, government support in its various forms continued to leave agricultural income distributions within Europe more or less unchanged. Recently, fully decoupled payments were introduced, as they are expected to correct market outcomes according to politically determined objectives through more effective income transfers to farmers. This type of support is anticipated to minimise economic distortions and distributive leakages, since the effects on production decisions are minimal (OECD, 2003).

Overall, changes in agricultural policy instruments from market price support to (fully) decoupled payments have undoubtedly affected farm income and the related increase in transparency, with respect to the distribution of government support have gradually increased the awareness of the distributional problem. This paper, therefore, aims to empirically examine the distributional implications of the continuous CAP reforms on farm income in Greece, presenting the most effective instruments in favouring income distribution equity and evaluating them with regard to the operational criteria of targeting.

In particular, Gini coefficients and Generalized Entropy measures of inequality are computed to explain inequality through decomposition of the levels of farm income inequality and changes in its components. The decomposition will be both vertical and horizontal. Vertical decomposition into the contributions of the various sources of farm income and subpopulations will determine the distributional implications of government support and examine whether their magnitude depends on farm location, specialisation, and economic size. Horizontal decomposition into inequality within and between subpopulations will determine farm income inequality within group and between groups. The linked Lorenz curves are also presented, whereas alternative classes of Atkinson inequality measures are employed, each of which includes a set of alternative indices reflecting different assumptions about the degree of inequality aversion. Finally, bootstrapping techniques are used to examine the robustness of the results. Farm income is disaggregated by income source into income from government support and net income from market sources. The government support component relates to payments received under various instruments of CAP schemes. The analysis covers three sequent CAP regimes, based on the (1992) MacSharry CAP reform, the Agenda 2000 CAP reform, and the (2003) Fischler CAP reform. Grouped, as well as individual farm data is used in analysing farm income inequality, whereas data is retrieved by the FADN (Farm Accountancy Data Network) database for the years 1998, 2002, and 2006.

The paper is organised as follows. Section 2 provides a brief literature review on the impact of agricultural policies on the distribution of farm income. Section 3 describes the methodology used to measure and decompose income inequality. The following section reviews the level, sources and distribution of farm income in recent years, providing details of the data used. Section 5 presents and discusses the empirical results, whereas conclusions and policy implications are included in the final section.

2 Literature Review

Many empirical studies of economic inequality have been conducted at the level of various groups of population. The comparability or parity of income between the farm sector and the non-farm sectors has been common, indicating that farm inequalities differ structurally from those of the rest of society (Commins, 2004; Frawley *et al*., 2000; Pauw, 2007). Low income is higher among farms than among non-farms and income distribution shows a higher degree of inequality in farms than in non-farms, even though farms benefit from government support (Kurashige and Hwan Cho, 2001). Farm income lags persistently behind the income generated by the other sectors of the economy and it is characterised by its remarkable temporal and spatial variation (Baldwin, 2005; Gardner, 1992; Hill, 1999).[2]

Despite the profound CAP reforms and the renewed interest in the welfare

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[2] Income inequality as a problem of agriculture is primarily discussed with respect to developing countries (e.g. Kuznets, 1955; Adler, 1972; Anand, 1983; Amiel *et al.*, 1996; Martens, 2005 and World Bank, 2005).

aspect of the CAP, the unequal distribution of income and government support is continuously considered an essential reason for CAP's reduced effectiveness (Fennel, 1997). Government support is unequally distributed among farms and often concentrated on a small number of commodities in certain regions and on larger farms, thereby alleviating income disparities (OECD, 2003). While improvements in the standard of living for farms must mainly derive from increasing farm income, the income to farms from non-farming activities and the increasing importance of part-time farming are also significant factors (Mishra and Sandretto, 2002). Indeed, farms derive a significant share of income from off-farm sources, mainly, from other gainful activities but also from social transfers and property income. In this case, farms enjoy on average income levels that are close to those of the rest of society (OECD, 1996).

In Ireland, the distribution of farm income appears to have altered substantially over the MacSharry CAP reform period, owing to the partial substitution of market price support by direct payments. The distribution of direct payments has actually become more unequally distributed since then (Keeney, 2000). In Scotland, the same effect is observed introducing direct payments, and the Fischler CAP reform seems to have no effect on the given redistribution of farm income (Allanson, 2003). Moreover, Mediterranean farming is differentiated compared to continental farming, due to the fact that smaller and more labour intensive farms are disadvantaged in the CAP framework (Mora and San Juan, 2004). Overall, inequality within the agricultural sector is very strong given both the high income dispersion and the heterogeneity between farms (Barkaoui *et al*., 1991; Brangeon and Jegouzo, 1992). Most studies looking at the distributional effects of the CAP conclude that, in the EU, poorer farms benefit more from government support than richer ones, but larger (and high income) farms get more direct payments than smaller ones. As a result, direct payments, which are linked to the acreage of farms, cannot be considered an effective instrument to ensure a fair standard of living for farms, since such instruments do not prevent a substantial part of farmers from being among the poorest citizens of the EU member states (Schmid *et al.,* 2006).

In terms of the farm income in Greece, Sarris and Zografakis (1996) show that income distribution within farms is much more skewed compared with income distribution of non-farms and this pattern remains the same over time. Mitrakos and Sarris (2003) further conclude that the bulk of inequality in the Greek farm sector is due to disparities within, rather than between groups, even when the farms are grouped according to various criteria, such as place of residence, age, education, etc. Finally, Karanikolas and Zografakis (2009) show that farm and non-farm income generate a combined stabilization effect, mitigating the overall inequality within Greek farm households.

3 Methodology

The impact of CAP reforms on the distribution of farm income in Greece is measured using as inequality measure, the *Gini coefficient*, and its decomposition by source of income and subpopulations. The *Lorenz curves* based on the estimations of the inequality measures are also presented, as well as a family of inequality indices originating from quite different considerations.

Starting with the Lorenz curves (Lorenz, 1907), they illustrate the percentage of the population arranged from the poorest to the richest on the horizontal axis and the percentage of total income (or one of its components) earned by the population on the vertical axis. If all individuals (farms) earn the same income, then the Lorenz curve runs diagonal, i.e. absolute equality. The distance between the Lorenz curve and the equality line indicates the degree of inequality of income distribution. The further the distance, the more concentrated the income and the more unequal the distribution.

The Gini coefficients (Gini, 1921) are a relative inequality measure. A Gini coefficient is the ratio of the difference between the diagonal line of absolute equality and a bended Lorenz curve to the triangular region underneath the diagonal. This coefficient is bounded between 0 (absolute equality) and a theoretical maximum of 1 (absolute inequality). To highlight the role of government support to total farm income inequality, results will be derived from a decomposition of the Gini coefficient of farm income into three components; namely agricultural income, non-agricultural income and government support. Apart from the two components of the market based income, government support will relate to payments received under various CAP instruments of direct payments (i.e. area payments); as well as rural-development payments (i.e. environmental premiums); and LFA subsidies.[3]

[3] The decomposition of farm income into agricultural and non-agricultural income, as well as the decomposition of government support is applicable in the grouped data due to data availability.

Following Lerman and Yitzhaki (1985), the Gini coefficient for total income inequality, *G*, can be represented by:

$$G = \sum_{k=1}^{K} S_k G_k R_k \tag{1}$$

where S_k denotes the share of component k in total income, G_k is the source Gini corresponding to the distribution of income from source k, and R_k is the Gini correlation of income from source k with the distribution of total income. If an income source represents a large share of total income, it may potentially have a large impact on inequality. However, if it is equally distributed (G_k= *0*), it cannot influence inequality, even if its magnitude is large. On the other hand, if this income source is large and unequally distributed (S_k and G_k are large), it may either increase or decrease inequality, depending on which individuals earn it at which points in the income distribution. Moreover, if this income source is unequally distributed and flows disproportionately toward individuals at the top of the income distribution (R_k is positive and large), its contribution to inequality will be positive. However, if it is unequally distributed but targets poor individuals, it may have an equalising effect on the income distribution, and the Gini coefficient may be lower with this income source than without it.

Moreover, using the Gini decomposition by income source, the effect of changes in a particular component (e.g. government support) on inequality can be estimated, holding income from all other sources constant. Assuming an income change from source k to be equal to ey_k, where *e* is close to 1, then it can be shown that the partial derivative of the Gini coefficient with respect to a percentage change *e* in source k is equal to:

$$\partial G / \partial e = S_k \left(G_k R_k - G \right) \tag{2}$$

The percentage change in inequality resulting from a small percentage change in income from source *k* is, therefore, equal to its initial share in inequality minus its share in total income. Consequently, if the Gini correlation between an income source and total income, R_k, is negative or zero, an increase of this source necessarily decreases inequality. If the Gini correlation is positive, then the impact on inequality depends upon the sign of ($G_k R_k - G$). A necessary condition for inequality to increase is that the inequality of this source must exceed the inequality of total income; i.e. $G_k > G$ (since $R_k \leq 1$).

In summary, the influence of various income components upon total income inequality depends on (i) how important the income source is with respect to total income, S_k; (ii) how (un)equally distributed the income source is, G_k; (iii) how the income source and the distribution of total income are correlated, R_k; and (iv) how an increase in a particular income source will affect income inequality.

A number of additional inequality measures are also computed in this paper following Cowell (1995). These are the *Generalized entropy class*, E_θ, and its prominent members; i.e. the *Theil index*, T, the *Mean logarithmic deviation*, L, and *half the squared coefficient of variation*, c. The general formula for the Generalized entropy indices is:

$$E_\theta = \frac{1}{\theta^2-\theta}\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)^{\theta}-1\right] \tag{3}$$

where y_i is the income of individual i, and $\bar{y}$ is the mean income for n individuals in the population and for $\theta \neq 0{,}1$. Different values of θ correspond to differences in the sensitivity of the inequality index to differences in income shares in different parts of the income distribution. The more negative θ is, the more sensitive the index is to differences in income shares among the poor. The more positive θ is, the more sensitive the index is to differences in income shares among the rich.

For $\theta = 0$, the so-called Mean log deviation can be derived, which is the average deviation between the log income shares and the log shares that would represent perfect equality. The Theil index is given by E_θ, for $\theta = 1$. This index is always positive and if it is equal to zero, perfect equality prevails. Moreover, half the square of the coefficient of variation is denoted by E_θ, for $\theta = 2$, assuming that the coefficient of variance is the standard deviation divided by the mean.

An additional inequality measure that is often used is the *Atkinson index* given by:

$$A_\varepsilon = 1-\left[\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\bar{y}}\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}} \tag{4}$$

where $\varepsilon > 0$ is an inequality aversion parameter; that is, the higher ε, the higher the weight given to poor. The Atkinson and Generalized entropy measures are closely related. For each value of ε, there is an E_θ index with $\theta = 1- \varepsilon$

that ranks a pair of distribution in the same way as A_ε, even though they do not have a cardinal equivalence, since the relationship between them is non-linear:

$$A_\varepsilon = 1 - \left[\left(\theta^2 - \theta\right) E_\theta + 1\right]^{1/\theta} \tag{5}$$

Apart from decomposing inequality by income source, these measures can be used to decompose inequality by subpopulations, based on farms economic size, regions and specialisation. To analyse inequality *within* and *between groups* in the population, let there be l such groups so that every individual belongs to one and only one group, while the proportion of the population falling in group *j* be f_j. Assuming that the mean income in group *j* is given by $\bar{y}_j$, and that the share of group j in total income is g_j, E_θ can be measured as follows:[4]

$$I_{total} = I_{between} + I_{within} = \left[\frac{1}{\theta^2-\theta}\left(\sum_{j=1}^{l} f_j \left(\frac{\bar{y}_j}{\bar{y}}\right)^{\theta} - 1\right)\right] + \left[\sum_{j=1}^{l} w_j I_j\right] \tag{6}$$

where $w_j = g_j^{\theta} f_j^{1-\theta}$. The between group component of inequality is found by assuming that everyone within a group receives that group's mean income; whereas the within group inequality is a weighted average of inequality in each subpopulation, although the weights, w_j, do not necessarily sum to one.[5] Using equation (5), the decomposition formula for the Atkinson index, A_ε, can be also derived.

Finally, the *Sen index* is used, which, unlike the previous measures, is a measure of poverty that incorporates the Gini coefficient and a headcount poverty ratio, *H*. If no one lives below the threshold poverty line, the headcount ratio is zero, as well as the Sen index. As the number of people living below the threshold increases, the Sen index also increases, and it can be calculated as:

$$S = H\left(1 + G\right)\bar{y} \tag{7}$$

---

[4] The following stand: $g_j = f_j \bar{y}_j / \bar{y}$, $\sum_{j=1}^{l} f_j \bar{y}_j = \bar{y}$, $\sum_{j=1}^{l} g_j = 1$, and $\sum_{j=1}^{l} f_j = 1$.

[5] The within group component weights will only sum to one if θ=0 (the case of *L*) or if θ=1 (the case of *T*).

This is an index of the income dispersion (the Gini coefficient) among the low income individuals. The smaller the Sen index, the better the income situation of the population.

Analysis based on these inequality measures is conducted using grouped and individual farm data.[6] In both cases, data are from the FADN database, which is an instrument for evaluating farm income and can be used to study the impact of CAP reforms on income distribution. It provides detailed data on assets, socio-demographic characteristics, production and income sources, while a nationally representative sample of farms is surveyed every year. In this paper, the sample of individual farm data includes 4,000 farms in 1998 and 4,054 farms in 2002, while the grouped-data reflects farms for 1998, 2002 and 2006.[7] Farm income is measured by the total of market revenues from agricultural plus farm policy transfers and non-agricultural incomes (e.g. receipts of tourism, hiring out of equipment).

4 Farm Income and Government Support

Factors such as farm location, economic size and specialisation affect total farm income. Differences in average farm income by these structural characteristics are presented in Table 1. In 1998, farms located in Thessaly appear to have the highest average income. In 2002, mean farm income in the remaining regions increased by more than 15%, whereas the average income in Thessaly remained the highest for this year as well, and it is more than €32,000. Owing to differences in farm size (stremmas of land) and in levels of government support between commodities, there are also income disparities between farm types, although they are not as large as between farms classified by their economic size. Farmers producing livestock have experienced a large increase in their income over the examined period. Similarly, the average income of crop producers increased by 30%. Very small farms (less than 4 ESU) were negatively affected by the Agenda 2000, as their income decreased slightly. The average income of larger farms though increased, and

[6] For the grouped data analysis, the average value of each population group (economic size and region) is used.

[7] The year 2006 is not included for the individual farm data analysis due to data availability.

it appears that the higher the economic size of the farm, the larger the change in total income. The largest farms and often the wealthiest are therefore the main beneficiaries of the CAP reform, indicating that government support is inequitable.

In 1998, the share of government support in total farm income was 39.4% in Thessaly, 30% in Macedonia-Thrace and about 20% in the other regions. In 2002, this share decreased only in Macedonia-Thrace and Thessaly. In the latter, the reduction was more than 20%, although farms in this region have the highest average income. When farms are differentiated by their economic size, the share of government support in total farm income varies in 1998 from 20% to 37%. As expected, the highest share is found for the largest farms (more than 40 ESU), while small farms are less dependent on support than large ones. However, these figures are lower for the year 2002. It is only the small and medium farms (4 to 16 ESU) that experienced a reduction in the share of government support in their income. The highest reduction is observed for the largest farms, as their share was reduced to 22%. In terms of farms specialisation, government support was reduced for the crop producers, while the opposite effect is observed for livestock producers. As a result, crop producers that received 2.1% higher subsidies than the average support in 1998 ended up receiving 3.4% lower subsidies than the average in 2002. On the other hand, livestock producers moved from -11.5% to 18.4% in the same years. These figures indicate that a significant part of total farm income is derived from the market and not from the CAP schemes.

The results from the calculation of the Sen index show that in 1998 the incidence of low income is higher in Thessaly. In 2002, this phenomenon remains higher in this region, despite the significant increase of farm income that was observed. Changes in the Sen index under the two different CAP regimes suggest that the low income situation of farms did not improve. Similar arguments can be derived when differentiating farms according to their economic size or specialisation. Poverty appears to have declined only among small and very small farms. Finally, it should be noted that the Sen index increased for all regions when including only government support, except for the case of Thessaly.

Using box-plot charts, Figure 1 illustrates the median of total farm income for the three different CAP regimes at the grouped data level. Fifty percent of the farms receive at least the median income. The lower edge of the box cor-

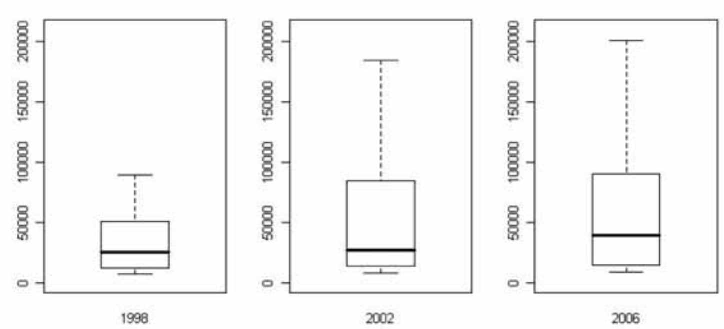
Table 1: Farm income, government support and poverty

	Income				*Subsidies*			
	Mean		*Sen's index*		*Mean*		*Sen's index*	
	1998	2002	1998	2002	1998	2002	1998	2002
Region								
Macedonia-Thrace	22,394	30,054	15,476	19,276	6,828	7,262	4,032	4,175
Epirus-Peloponnese-Ionian islands	21,867	31,128	15,181	18,523	3,731	6,245	2,293	3,005
Thessaly	26,328	32,502	17,178	20,743	10,382	5,135	5,100	2,705
Central Greece-Aegean islands-Crete	24,312	28,161	16,345	17,188	4,833	6,053	2,579	3,451
ESU								
0-<4	10,542	10,402	7,714	7,401	2,156	1,824	1,374	1,196
4-<8	14,665	15,258	11,521	11,490	3,432	3,313	2,239	2,122
8-<16	21,073	24,891	16,610	19,094	5,283	5,837	3,356	3,832
16-<40	33,509	44,775	25,467	33,767	9,495	8,917	5,767	5,413
>40	62,023	92,814	45,022	62,121	23,161	20,730	13,461	8,050
Specialization								
Crop	22,952	29,871	15,421	18,529	6,380	6,267	3,327	3,282
Livestock	24,591	32,144	17,814	20,389	5,529	7,679	3,525	4,811
Total	23,209	30,221	15,773	18,803	6,247	6,485	3,339	3,510

Source: Farm Accountancy Data Network (FADN).

responds to the 25th percentile and the upper edge to the 75th percentile. Fifty percent of the population has income between these two values. In 1998, total farm income appears to have the lowest median, with 50% of farms having an income higher than €25,077 and 25% receiving more than €50,040. Total farm income is higher in 2002, as half of the farms obtained at least €26,946. Relatively significant income scatter is observed under the last CAP regime, since 50% of the farms received €39,479, but 25% of farms had income lower than €14,670 and 25% at least €88,582. This means that, excluding extreme values, farms can have an income difference of more than €88,455 in 2006.

Figure 1: Total farm income

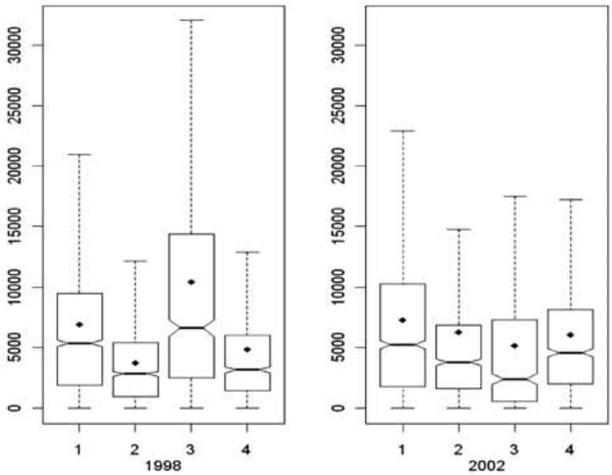


Source: Farm Accountancy Data Network (FADN).

In a similar manner, Figure 2 illustrates the median of government support for the different CAP regimes at a regional-level. The mean is also marked by a dot for reasons of comparison. It appears that the highest scatter of government support is found in the most privileged region, Thessaly, in 1998. The average support given to the farms of this region was €10,382, with 50% reporting incomes lower than €6,618 and the lower quartile at most €2,471. However, there was a significant gap between the median and the higher quartile, as the upper 25% of farms generated at least €14,324. This scatter of subsidies was reduced in 2002, where half of the farms received less than €2,391 even though the average support was €5,135. The difference between the 75th and 25th percentiles is now about €11,525. These results are consistent with those obtained examining Sen's index. It can be concluded that the implementation of Agenda 2000 had a negative impact on the average farm located in Thessaly, although the skewness of the distribution of income inequality was reduced.

For the remaining regions, the highest median government support is observed in Macedonia-Thrace under both CAP regimes (i.e. €5,337 and €5,237, respectively). The median in Epirus-Peloponnese-Ionian Islands is closely followed by the figure for Central Greece-Aegean Islands-Crete in 1998 (about €3,000), while the average of subsidies was €3,731 in region 2 and €4,833 in region 4. For the year 2002, the median of the former region increased by 34%, whereas for the latter by 46%. Overall, the difference between the support for the 25% of farms with the highest support and the 25% with the low-

Figure 2: Government support



Note: 1: Macedonia-Thrace, 2: Epirus-Peloponnese-Ionian Islands, 3: Thessaly, 4: Central Greece-Aegean Islands-Crete.
Source: Farm Accountancy Data Network (FADN).

est increased in these regions as well, because of the CAP reforms. The larger gap is observed in Central Greece-Aegean Islands-Crete, and amounts to €1,517.

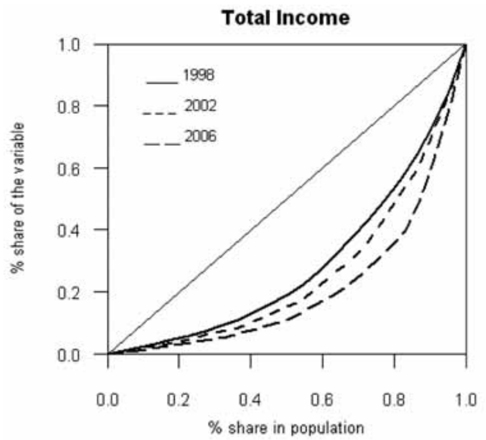
5 Empirical Results

5.1 Grouped Data Analysis

Starting with the grouped data analysis, the Lorenz curve in Figure 3 plots the cumulated share of total farm income received by the cumulated share of farms under the three sequent CAP regimes. It is obvious that income inequality increases owing at least partially to continuous CAP reforms. In 2006, approximately the higher 10% of the farm population earned about 40% of farm income. This share reduces in 2002 and 1998, indicating that the decoupling method resulted in income inequality disparities.

The concentration of the different income sources are compared using separate Lorenz curves (Figure 4). Area payments are distributed more un-

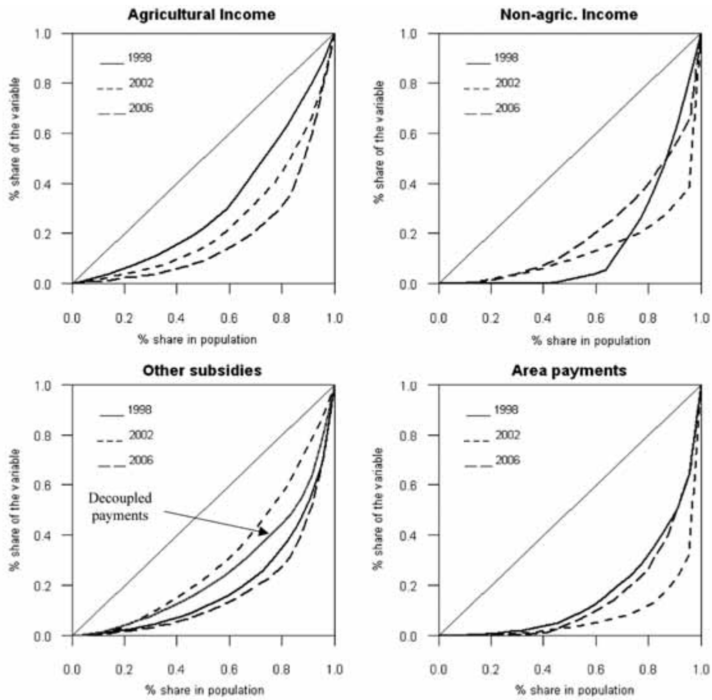
Figure 3: Lorenz curve



equally within farms than any other income source independently of the CAP regime. Moreover, this income source is distributed more unequally comparing the sequent reforms. The same trend is observed for both farms' agricultural income and the other subsidies, though at a lower level. Nonetheless, total farm income is distributed less unequally than government support as evident from above. This might be due to the fact that there are farms with either low agricultural income coupled with high government support or vice versa. Thus, adding agricultural income to non-agricultural income and government support reduces inequality, as they complement each other generating a combined stabilisation effect at the level of the total farm income. With regard to decoupled payments, it appears that this instrument brings a slight improvement in income distribution, as all other subsidies increased inequality under the Fischler CAP. Finally, the distribution of non-agricultural income is less equal than that of other income sources and, therefore, has a negative effect on total income distribution, although the crossing Lorenz curves do not allow the assessment of inequality changes in different regimes.

Using the linked Gini coefficients, the impact of government support on the distribution of farm income is analysed as follows. The Gini coefficient is calculated with and without government support, decomposing inequality by income sources to obtain the percentage changes in inequality due to a percentage change in each source of income. A decomposition of inequality by income source is provided in Table 2. The first column, S_k, presents the share of each income source in total farm income for three sequent CAP

Figure 4: Lorenz curve by income source



regimes. Government support represents 35.5% of total farm income in 1998. The vast majority of government support comes from other subsidies (31.2%); however, this share is considerably reduced in the most recent CAP regimes. The contribution of area payments goes from 4% in 1998, to 9.4% in 2002 and finally to 0.2% in 2006. It is worth mentioning that decoupled payments that count 11.4% of total farm income in 2006 have replaced other subsidies. Agricultural income is the largest income source, accounting for more than 60% in all cases. Non-agricultural income accounts for just 0.3% of total farm income in 1998, and it represents 0.6% of total farm income in 2006. Its share is much higher under the Agenda 2000 (2%), though remaining relatively low.

The second column, G_k, presents the Gini coefficient for each income source. Inequality in the distribution of government support is relatively high; as G_k for area payments is 0.66, 0.83 and 0.70 for the three sequent CAP regimes. These high values for the source specific Gini coefficients can be partially explained by the fact that the amount of area payments depends on the acreage of farms, implying that larger (and high income) farms get more direct payments than smaller ones. Agricultural income is unequally distributed through time. The Gini coefficient for agricultural income is rather low in 1998, and it increases under the following two CAP regimes. Surprisingly, agricultural income is less unequally distributed than total farm income in 1998. The same applies to the decoupled payments in 2006.

A high income source Gini does not necessarily imply that an income source has an unequalizing effect on total income inequality. An income source may be unequally distributed yet favour the poor (small). This is the case with the environmental subsidies. The Gini coefficient for this income source appears to be the highest in 2006 (0.81), however, the Gini correlation between environmental subsidies and the distribution of total farm income (R_k) is lower than that of the other income sources (0.46). Consequently, the percentage contribution of this income source to inequality is smaller than the percentage contribution to income. Environmental subsidies have, therefore, an equalizing effect on the distribution of total farm income.

The Gini correlation between agricultural income and total farm income rankings is the highest in all CAP regimes. The same applies to the other subsidies, which include other than area payments crop subsidies, livestock subsidies and subsidies on non-agricultural activities (e.g. tourism). As a result, these agricultural instruments have an unequalising effect on farm income. The impact that a marginal change in a particular income source has on equality is also evaluated with bootstrap estimation techniques to obtain standard errors and confidence intervals of all estimators. For instance, a 1% increase in government support for other subsidies, other things being equal, increases the Gini coefficient by 0.11% in 1998. The opposite effect is observed for the following regimes. On the other hand, a 1% increase in decoupled payments, other things being equal, reduces the Gini coefficient of total income by 0.04%, and this change is statistically significant. Finally, LFA payments appear to have almost the same distributional effect in 2002 and 2006.[8]

Overall, the distribution of area payments and other subsidies is considerably more skewed than the distribution of agricultural income in the first and third CAP regimes. The distribution of other subsidies is less skewed

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[8] About 17% of farms in Greece are located in LFAs.

Table 2: Gini decomposition by income source using grouped data

Income source	Share in total income (S_k)			Income source Gini (G_k)			Gini correlation with total income rankings (R_k)			Share in total income inequality			% Change in Gini from a 1% change in income source*		
	1998	*2002*	*2006*	*1998*	*2002*	*2006*	*1998*	*2002*	*2006*	*1998*	*2002*	*2006*	*1998*	*2002*	*2006*
Agricultural income	0.645	0.783	0.806	0.363	0.513	0.623	0.982	0.959	0.994	0.539	0.789	0.855	-0.106 (-.172, -.003)	0.006 (-.136, .080)	0.049 (.012, .098)
Non-agric. income	0.003	0.020	0.006	0.682	0.721	0.578	-0.005	0.792	0.457	0.000	0.023	0.003	-0.003 (-.006, -.001)	0.003 (-.007, .023)	-0.003 (-.005, -.001)
Area payments	0.040	0.094	0.002	0.661	0.831	0.704	0.589	0.805	0.656	0.037	0.129	0.001	-0.004 (-.023, .035)	0.035 (-.021, .145)	-0.000 (-.001, -.0005)
Other subsidies	0.312	0.098	0.060	0.608	0.394	0.661	0.955	0.706	0.844	0.425	0.056	0.058	0.113 (-.006, .166)	-0.042 (-.06, -.018)	-0.003 (-.020, .010)
LFA		0.006	0.008		0.544	0.535		0.492	0.639		0.003	0.004		-0.003 (-.006, -.000)	-0.003 (-.005, -.001)
Decoupled payments			0.114			0.494			0.787			0.076			-0.038 (-.066, -.012)
Environmental subsidies			0.004			0.808			0.463			0.003			-0.002 (-.005, .000)
Total income				0.427	0.488	0.583							(.359, .503)	(.418, .590)	(.517, .644)

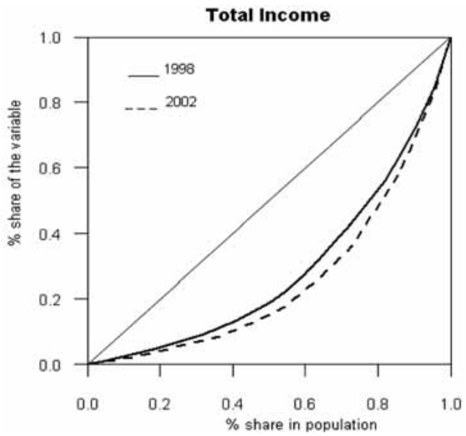
*: 95% bias-corrected bootstrapped percentile confidence intervals in parentheses.

under the Agenda 2000. The trend in the total Gini coefficient under the different CAP regimes shows an increase in inequality of 36.5%. This means that a smaller number of farms earn higher income.

5.2 Individual Farm Data Analysis

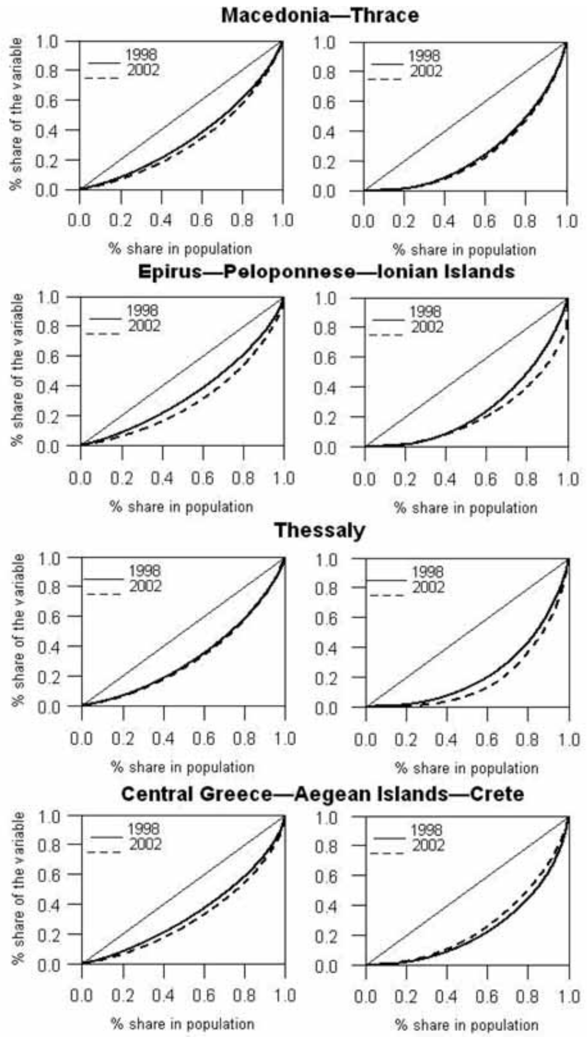
Using the individual farm data, the Lorenz curves for two CAP regimes are estimated. Figure 5 shows that the dispersion of total farm income increased between 1998 and 2002; a conclusion similar to that of the previous subsection. As a result, it is fairly acceptable to expect that a similar trend to that presented in Figure 3 will be observed for the year 2006.

Figure 5: Evolution of the concentration of total farm income



Owing to differences in levels of commodity support and location, there are also disparities between farms in terms of the distribution of government support. This is examined in relation to the four large regions defined by FADN, for 1998 and 2002 (Figure 6). It is obvious that total income and support are distributed more equally in Epirus-Peloponnese-Ionian Islands than in the other regions under both CAP regimes. In Central Greece-Aegean Islands-Crete government distribution is more equal after the implementation of the Agenda 2000. However, government support is markedly more concentrated than total farm income. In the other two regions, changes in the dis-

Figure 6: Evolution of the concentration of total farm income and government support per region



tribution of total income and support were smaller and almost identical, although income inequality is higher in Thessaly.[9]

[9] See the Annex for an analysis in detail.

Table 3 presents the Gini coefficients resulting from different income sources at the individual farm level. Based on the first column, agricultural income comprises the majority of total farm income. It is obvious again that, for instance, the contribution of government support to farm income ranges from 39.4% of total farm income in Thessaly to 17.1% in Epirus-Peloponnese-Ionian Islands, for 1998. The results included in the second column point out the importance of government support in reducing farm income disparities. In all regions, income inequality decreases when government support is considered. In Macedonia-Thrace, for example, Gini drops by 6.2 and 4.1 percentage points when subsidies are included for the two CAP regimes, respectively. However, the Gini coefficients for the subsidies appear to increase through time at the national, as well as the regional level, owing, at least, partially to CAP reforms. The only exception is the region Central Greece-Aegean Islands-Crete, whereas the highest increase is observed in Thessaly.

In terms of the Gini correlations, the variation observed in the different regions under the two different CAP regimes is striking. An income source may be unequally distributed yet favour the poor, as is the case for subsidies. Subsidies that have an unequalising effect on total income inequality are highly correlated with total income in Thessaly in 1998 (0.80), while in 2002 the correlation appears to be much lower (0.46), indicating that the McSarry reform favours the rich more than Agenda 2000. The importance of the Gini correlation is also evident when the percentage contribution of each income source is compared to total farm income inequality. Although a 1% increase in government support, other things being equal, reduces the Gini coefficient of total income by 0.030% in 2002, the opposite effect is observed in 1998.

Moreover, the difference between the impacts of small changes in both income sources upon inequality in the different regions is large. A 1% increase in subsidies reduces inequality in Macedonia-Thrace, but increases inequality in Thessaly. Thus, the impact of marginal changes in government support upon inequality as captured by the Gini coefficient is ambiguous. It depends essentially upon where farmers are situated in the overall farm income distribution, the share of government support in farm income, the distribution of the support itself, and the location of the farm.

Table 3: Gini decomposition by income source using individual farm data

Income source	Share in total income (S_k)		Income source Gini (G_k)		Gini correlation with total income rankings (R_k)		Share in total income inequality		% Change in Gini from a 1% change in income source*	
	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002
Greece										
Agricultural income	0.731	0.785	0.352	0.417	0.895	0.953	0.719	0.827	-0.012 (-.025, .001)	0.041 (.010, .058)
Subsidies	0.269	0.215	0.545	0.547	0.615	0.558	0.281	0.174	0.012 (-.001, .025)	-0.041 (-.058, -.010)
Total income		0.320	0.378					(.312,	.329)	(.366, .394)
Macedonia-Thrace										
Agricultural income	0.695	0.758	0.371	0.400	0.876	0.937	0.732	0.792	0.037 (.018, .056)	0.033 (.020, .048)
Subsidies	0.305	0.242	0.502	0.522	0.541	0.592	0.268	0.208	-0.037 (-.056, -.018)	-0.033 (-.048, -.020)
Total income			0.309	0.359					(.298, .320)	(.347, .370)
Epirus-Peloponnese-Ionian Islands										
Agricultural income	0.823	0.799	0.318	0.425	0.961	0.972	0.829	0.815	-0.001 (-.018, .017)	0.016 (-.075, .071)
Subsidies	0.171	0.201	0.504	0.587	0.609	0.635	0.171	0.185	0.001 (-.015, .018)	-0.016 (-.071, .075)
Total income			0.306	0.405					(.289, .322)	(.371, .457)
Thessaly										
Agricultural income	0.606	0.842	0.339	0.394	0.843	0.952	0.498	0.872	-0.108 (-.128, -.084)	0.030 (.004, .055)
Subsidies	0.394	0.158	0.550	0.635	0.805	0.461	0.502	0.128	0.108 (.084, .128)	-0.030 (-.055, -.004)
Total income			0.348	0.362					(.329, .368)	(.345, .380)
Central Greece-Aegean Islands-Crete										
Agricultural income	0.801	0.785	0.350	0.446	0.952	0.967	0.815	0.868	0.014 (-.011, .039)	0.083 (.065, .099)
Subsidies	0.199	0.215	0.533	0.477	0.572	0.501	0.185	0.132	-0.014 (-.039, .011)	-0.083 (-.099, -.065)
Total income			0.328	0.390					(.305, .354)	(.361, .431)

*: 95% bias-corrected bootstrapped percentile confidence intervals in parentheses.

5.3 Decomposing Inequality by Subpopulations

In this subsection, total inequality is decomposed into the above mentioned between group and within group inequality. Using the individual farm data and differentiating farms by location, the between groups component accounts for just 3.4% of the overall inequality, whereas the within groups share is 9.1% for the year 1998 (Table 4). This means that the elimination of income differences between groups of farms will not reduce total inequality by more than 3.4%. Accordingly, policies aiming at the reduction of inequalities within each farm category will contribute more to the reduction of total income inequality. Under the Agenda 2000, both figures increase so that the total Gini coefficient increases by 18%. The redistributive effect of the within groups component still exceeds that of the between groups. Similar arguments can be derived differentiating farms by specialisation. However, when farms are grouped by their economic size, the impact of the within groups component is much lower than that of the between groups. In general, it can be argued that between groups inequality arises from systematic differences in farms economic size, whereas within group inequality is associated with differences in the level of support between commodity regimes. The results obtained using only government support are in accordance with those for total farm income. Finally, the lower part of the table presents the Gini coefficients for income and support when differentiating farm by their economic size and specialisation. It appears that farms' specialisation is a dominant factor in determining differences in the levels of support.

The additional measures of inequality are presented in Table 5. The Generalized entropy measure of inequality is used with different choices of θ, which reflects a measure of the degree of sensitivity to transfers at each income level. Decompositions of total income and government support inequalities by economic size are also provided. The within group inequality is the dominant component of the overall inequality and is rising with Agenda 2000. This trend is observed regardless of the inequality measure used. Moreover, the between group component is also rising. The lowest economic size group generally has the higher inequality, which decreases in the next economic size group, but thereafter increases as the economic size of the group increases.

The Atkinson inequality index is also shown in Table 5. Along with the three Atkinson inequality measures (A(0.5), A(1), A(2)), the between and the

Table 4: Gini decomposition by subpopulations

Income						
	ESU		*Region*		*Specialisation*	
	1998	2002	1998	2002	1998	2002
Between group inequality	0.222	0.280	0.034	0.024	0.009	0.010
Overlap inequality	0.037	0.031	0.196	0.245	0.073	0.090
Within group inequality	0.061	0.067	0.091	0.109	0.238	0.278
Total Gini	0.320	0.378	0.320	0.378	0.320	0.378

Subsidy						
	ESU		*Region*		*Specialisation*	
	1998	2002	1998	2002	1998	2002
Between group inequality	0.286	0.266	0.183	0.061	0.018	0.028
Overlap inequality	0.135	0.151	0.211	0.322	0.106	0.111
Within group inequality	0.124	0.130	0.151	0.163	0.421	0.408
Total Gini	0.545	0.547	0.545	0.547	0.545	0.547

	Income		*Subsidy*	
	1998	2002	1998	2002
0-<4	0.268	0.288	0.458	0.531
4-<8	0.214	0.247	0.445	0.475
8-<16	0.212	0.233	0.465	0.429
16-<40	0.240	0.246	0.478	0.494
>40	0.274	0.331	0.472	0.678

	1998	2002
	Income	
Crop	0.328	0.380
Livestock	0.276	0.366
	Subsidy	
Crop	0.568	0.574
Livestock	0.373	0.395

within group inequality is used to check the sensitivity of the results. The results confirm that there is an increase in total farm income as well as government support inequality. This can actually support the claim that market price support payments are relatively ineffective in income transfer efficiency terms. These findings are robust to the choice of the measure used in the inequality calculations. The decomposition of income and subsidies inequalities between different economic size groups is further presented using the Atkinson inequality measure. For government support the within group inequality dominates the between group inequality component and becomes worse in Agenda 2000 relative to the MacSharry regime. The within group inequality for total farm income accounts for a significant proportion of inequality and becomes better in Agenda 2000 relative to the MacSharry regime. More im-

Table 5: Generalised entropy and Atkinson measures

		Total inequality		Between group inequality		Within group inequality		Total inequality by ESU									
								0-<4		4-<8		8-<16		16-<40		>40	
Generalized entropy measures																	
		1998	2002	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002
E(-1)	*Income*	0.197	0.348	0.087	0.151	0.110	0.197	0.122	0.152	0.082	0.130	0.084	0.130	0.111	0.220	0.154	0.606
	Subsidy	1.610	1.453	0.151	0.144	1.459	1.310	0.865	0.927	0.999	0.858	1.289	1.051	1.313	1.170	1.592	4.387
E(0)	*Income*	0.171	0.248	0.085	0.138	0.086	0.110	0.116	0.141	0.076	0.107	0.075	0.096	0.098	0.110	0.128	0.222
	Subsidy	0.550	0.541	0.141	0.128	0.409	0.413	0.364	0.404	0.371	0.384	0.418	0.358	0.436	0.441	0.486	0.938
E(1)	*Income*	0.178	0.262	0.088	0.141	0.090	0.121	0.126	0.157	0.077	0.110	0.074	0.093	0.101	0.101	0.121	0.269
	Subsidy	0.453	0.544	0.151	0.131	0.302	0.413	0.278	0.352	0.264	0.344	0.292	0.251	0.315	0.330	0.334	1.204
E(2)	*Income*	0.232	0.477	0.099	0.164	0.132	0.313	0.160	0.218	0.087	0.139	0.081	0.113	0.121	0.110	0.131	0.561
	Subsidy	0.629	3.108	0.190	0.157	0.440	2.950	0.285	0.495	0.263	0.737	0.296	0.243	0.326	0.357	0.333	6.663
Atkinson measures																	
		1998	2002	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002	1998	2002
A(0.5)	*Income*	0.083	0.118	0.041	0.065	0.044	0.057	0.058	0.071	0.038	0.052	0.037	0.046	0.048	0.051	0.060	0.110
	Subsidy	0.218	0.226	0.067	0.049	0.161	0.186	0.146	0.169	0.143	0.160	0.157	0.137	0.167	0.172	0.180	0.394
A(1)	*Income*	0.157	0.219	0.078	0.121	0.086	0.112	0.110	0.131	0.073	0.101	0.072	0.091	0.094	0.104	0.120	0.199
	Subsidy	0.423	0.418	0.118	0.084	0.346	0.364	0.305	0.333	0.310	0.319	0.342	0.301	0.354	0.357	0.385	0.609
A(2)	*Income*	0.283	0.410	0.139	0.169	0.167	0.290	0.197	0.234	0.141	0.206	0.143	0.206	0.182	0.305	0.235	0.548
	Subsidy	0.763	0.744	0.163	0.123	0.717	0.708	0.634	0.650	0.667	0.632	0.720	0.678	0.724	0.701	0.761	0.898

portantly, the results show that the dominance of the within group inequality increases with an increase in the 'inequality aversion'. In other words, the greater the weight that is given to poorer farms, the higher is that component of inequality that is due to the within group differences. These results are, therefore, possibly due to the different CAP regimes that have given support aiming different goals.

6 Conclusion

In order to formulate appropriate policy instruments to aid farmers, it is clear that an understanding of the composition of incomes earned by farmers is necessary. In addition, the potential impacts of income changes from different sources should be understood. This paper examined the average contributions of incomes from agricultural and non-agricultural activities and government support in different CAP regimes, as well as the extent to which policies contributed to the observed situation. The distribution of income among Greek farmers, decomposed by income source and subpopulations, was analysed using grouped and individual farm data, while differentiating farms by their location, specialisation and economic size. The focus was on the alternative distributional effects of income from government support, and on the implications of these effects for policy.

The results show that income inequality has increased, the farms degree of dependency on support is decreasing and agricultural income presents a rather stable share in total farm income over time. However, the larger the share of agricultural income to total income, the larger the distribution of income inequality appears to be. Disparities are also linked to structural factors such as size, specialisation and region, owing mainly to subsidies tied to output. Disparities between farm types are linked to differences in the level of support by commodity, whereas disparities between regions stem from specialisation and natural features specific to each region.

On the other hand, the importance of government support in alleviating farm income inequality should be highlighted. Income disparity tends to increase owing at least partially to continuous CAP reforms. The distribution of support is rather unequal, as most support goes to larger farms, often the richer. Some forms of support targeted to less favoured areas are effective, but they account for a small share of total support. Although support linked to production levels is provided to all farms, whatever their income situation, in some cases, support has even increased income disparities. For instance, area payments are less equally distributed than other instruments of government support and agricultural income. As far as farm location and specialisation is concerned, research findings indicate that farm income inequality is highest for farms located in Northern Greece and for those farms producing crops. Increases in government support have differential effects between regions, while differences in the distribution of income and support across farm types or size classes are less than across regions.

Overall, decoupled payments broke the link between production and the receipt of subsidies and they are currently an important source of farm income. As the entitlements are based on historical payment receipts, the impact of decoupling on the ability to target support in an efficient and effective manner depends on the strength of the correlation between the indicator employed to allocate entitlements and pre-support income. The results indicate that decoupled payments have partially offset the increase in inequality produced by the other subsidies provided to farmers by the Fischler regime, though they still lead to higher inequality than Agenda 2000. It should also be mentioned that decoupled payments are often capitalised into the value of land, so that benefits do not alleviate current income deficiencies. Those buying or renting land to enter the sector or to expand most likely do not reap any net economic benefit from the support because the prices they have to pay reflect the expected value of support.

Consequently, government support may not be an effective tool for social policy, since agricultural subsidies are dependent on agricultural production or land ownership and as a result non-poor farmers and landowners reap the bulk of the aid while poor non-farmers are disadvantaged. If government support focuses on social income equality, it should be targeted at (non-)farms with low income and wealth. A possible implementation of a flat rate after 2013 may not then lead to the expected decrease of income inequality, if it is associated with land ownership or production.

In summary, analysis gives rise to some quite interesting policy considerations. It is obvious that new policy instruments represent both an opportunity and a challenge. Support policies, whatever their objectives, have raised farm income to some extent, and have reduced income variability, but with significant leakage to unintended beneficiaries. The use of indicators other than farms' income to target agricultural support inevitably results in some degree of income inequality due to the provision of different levels of support to farms with identical pre-support incomes. Since government support does not have a neutral impact upon the distribution of farm income, a government with a stand in favour of reducing inequalities may wish to alter its magnitude. One should also take into account the fact that although a society concerned with equity will try to adjust unequal income distribution by means of government transfers, concern with economic efficiency dictates that small, uncompetitive farms should not receive support. New policies should be, therefore, carefully weighed before implementing to achieve income equality via the promotion of rural development, sustainability and environmental protection.

ANNEX

A1. Common Agricultural Policy

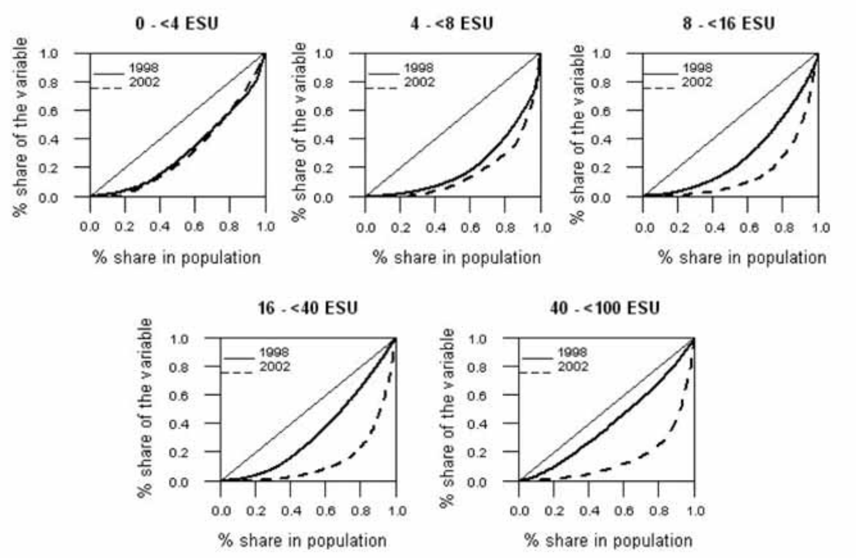
Table A1: Common Agricultural Policy

CAP in a nutshell	
1958	CAP was initiated as part of the Treaty of Rome
1963	CAP went into effect with four basic principles: – A *unified market* for the free movement of agricultural products in the EU; – *Financial solidarity* (costs covered by the European Fund for Orientation and Agriculture Guarantee); – *Community preference*; and – *Parity and productivity*. *Common Market Organizations* were also introduced, setting minimum prices.
1984	The EU began its systematic reform to deal with overproduction, negative impacts on the environment and dumping: – Introduction of milk *quotas*.
1992	Mac Sharry reform: – Direct payments were introduced to compensate for the decrease of the price support. – Subsidies for good environmental practices were also introduced.
1999	Agenda 2000: – The 2nd pillar within CAP was created to take into account the *multifunctionality* of farming activities (3 main measures were proposed: agro-environmental schemes, support to LFAs and investment assistance to enhance productivity and competitiveness). – The *modulatio*n principal was also introduced to allow for fund transfers between the 1st and 2nd pillar.
2003	Fischler reform: – *Decoupled* direct payments were introduced (Single farm payments). – *Cross-compliance* (land should be kept in good agricultural and environmental condition).

A2. Regional Analysis: The Case of Thessaly

Figure 1a shows government support adjusted based on farms' assets in Thessaly. Apart from the very small farms, Agenda 2000 has increased inequality, while inequality becomes larger as we move along the distribution towards largest farms. It is also worth mentioning that government support among farms larger than 40 ESU was more equally distributed under the MacSharry reform than in any other economic size group. Given that total farm income was more equally distributed with Agenda 2000 than the previous regime, a result that is originates from market revenues, it is obvious that Agenda 2000 falls short in achieving the operational criterion of equity of agricultural policies, since it is directed towards larger and wealthier farms. Concentrating support on the largest farms does not encourage farmers to improve performance and hence has a cost in terms of the sector's economic efficiency.

Figure 1a: Evolution of the concentration of government support in Thessaly



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The Evolution and Composition of the Agricultural Labour Force in Greece: 1998-2008*

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Abstract

According to LFS figures, employment in agricultural activities in Greece declined by 29–30 per cent during 1998–2008, despite the economy-wide rise (fall) in the number of employed (unemployed) people. We study the changes in the size and makeup of the population that engaged primarily in agriculture by isolating the seasonal, medium and longer-term effects exhibited by the various gender, age, qualification, occupational and regional groups—identifying those that are significant at the 1 per cent level. The detection of (i) a seasonal attachment to agriculture by certain segments of the population, and (ii) longer-term increases in the figures of certain subgroups yield a number of glimpses into the evolving composition of the sector's workforce. These are potentially useful for policy purposes.

1 Introduction

The article sets out to investigate and describe the composition and evolution of the Greek labour force that engages primarily in agricultural activities by empirically studying changes in its size and makeup during the last decade (1998–2008). Agricultural activities involve the cultivation of crops, farming of animals and hunting. In this instance, the changing composition of

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the labour force engaging in such activities attracts our interest on account of the sector's fundamental importance for the residents of a large part of the Greek countryside,[1] the substantial job-losses that seem to have taken place in the period under examination, and the little or no research that the issue has attracted.

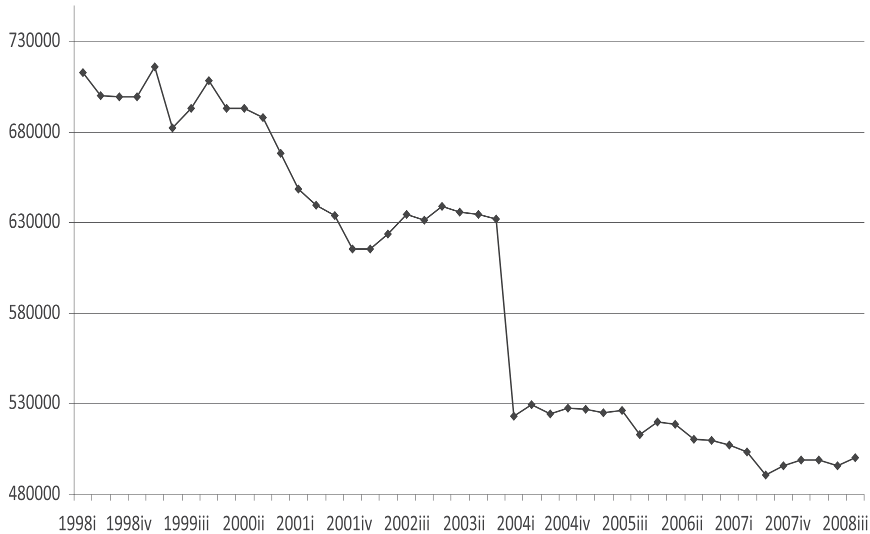
Indeed, according to the quarterly *Labour Force Survey* estimates, participation in agricultural activities seems to have fallen in 2008 by 199–214 thousand people (29–30%) compared to the number of 700–713 thousand estimated ten years earlier (Figure 1).[2] Though the contraction may be attributed to some extent to a change in the sampling method in 2004 (a change not specifically applied to the agricultural sector), it is clearly the largest observed in terms of absolute numbers across the country's economic sectors in the course of the decade—equivalent to about 5.0–5.4% of the total workforce of Greece in 1998, involving the sum of employed and unemployed people aged 15 years and older. To keep things in perspective, it should be noted that in the course of 1998–2008:

- Overall employment in Greece increased by about 542 thousand people, up 13.5% from the average figure of 4.018 million in 1998. At the same time, unemployment decreased by about 130 thousand (down 25.6% from the opening figure of 508 thousand). As a result of these shifts, the share of

[1] Using disaggregated data from the *2001 Census,* Prodromídis (2008) finds that the inhabitants of 638 municipalities (three fourths of the country's surface) concentrate on agricultural and forestry activities in the sense that local involvement in such activities exceeds the national average by 25% or more. Additionally, the level of correlation between (a) the localities in question and (b) the localities in which involvement in another industry exceeds the national average by 25% is negative. This suggests that there is probably very little diversification over a large part of the countryside, and that agriculture and forestry constitute the production backbone of rural Greece. The participation ratio between the two latter activities is estimated at 80:1.

[2] The numbers are quarterly. Hence, they are provided here in range-format to allow for comparisons between same quarters and reduce confusion on account of seasonality. More specifically, the left-hand numbers in each of the two ranges (i.e., 199–214 and 700–713 thousand) concern the estimated workforce numbers in the first quarters of 1998 and 2008, respectively; and the right-hand numbers pertain to their forth quarter counterparts, respectively. Likewise, the left-hand number of the 29–30% range captures the change between the first quarters of 1998 and 2008, and the right-hand number describes the change observed in terms of (i.e., between) the final quarters during the period in question.

Figure 1: The evolution of primary involvement in agriculture, husbandry and hunting activities between the 1st quarter of 1998 (1998i) and the 4th quarter of 2008 (2008iv) in Greece (All persons aged 15 years or older)



Note: The quarterly samples of 2004-8 are based on the *2001 Census*, while the figures pertaining to 1998-2003 are based on re-weightings of the relevant samples.
Source: National Statistical Service of Greece (2009).

those involved in agriculture among all employed in the economy declined from 15.5% in 1998 to 10.1% in 2008.

- If measured in terms of annual work unit figures instead of participants,[3] agricultural labour inputs appear relatively unchanged (-4.4%) compared to the reductions that occurred in most European Union (EU) countries.[4] (Figure 2 displays the situation in the ten countries with the largest agri-

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[3] The annual work unit corresponds to the work performed by one person who is occupied with an agricultural holding on a full-time basis. In essence, a person with a minimum working time of 1,800 hours annually (i.e., 225 working days of 8 hours each) is considered a full-time worker and counted as one annual work unit. Taking into account that a year consists of 52.1 weeks, the annual work units is roughly equivalent to 34.5 weekly hours. The performance of part-time workers is converted into such units pro rata.

[4] For the finding to be consistent with the 29–30% decline in the absolute number of full-time and part-time agricultural labour force participants, it must be the case that many of those who exited the sector were part-timers.

cultural labour inputs.) It turns out that with the exception of the small, insular nations of Cyprus and Malta, where the annual work unit numbers did not change much either, in the other EU member states reductions ranged from -53.5% (in the case of Estonia) to -14.4% (in Austria). Hence, it seems that worker mobility out of agriculture into other sectors, unemployment or retirement was probably more rigorous in most of the EU member-states compared to Greece.[5] At the same time, the decline in the sector's gross value contribution (from the upper 7 million to the lower 6 million euro) in Greece was more pronounced in relative terms (-20.9%) compared to the EU-15 average (-16.6%). Figure 3 implies that the turning point dates to 2004–2006, when modifications in the *Common Agricultural Policy* decided by the EU-15, aiming at the removal of subsidies towards particular crops in favor of land stewardship, came into effect.[6]

- Greek agricultural labour inputs account for about 4.7–6.0% of all EU-27 agricultural labour inputs. This may seem disproportionably high compared to the rest of the EU both in terms of (a) the country's population (Greece hosts about 2.2% of the EU-27 population) and (b) acreage (Greece occupies about 3.1% of the EU-27 landmass). However, it may not be very surprising considering that the country's landscape is quite fragmented, mainly on account of its idiosyncratic geomorphology, necessitating the need for more intensive labour.[7]

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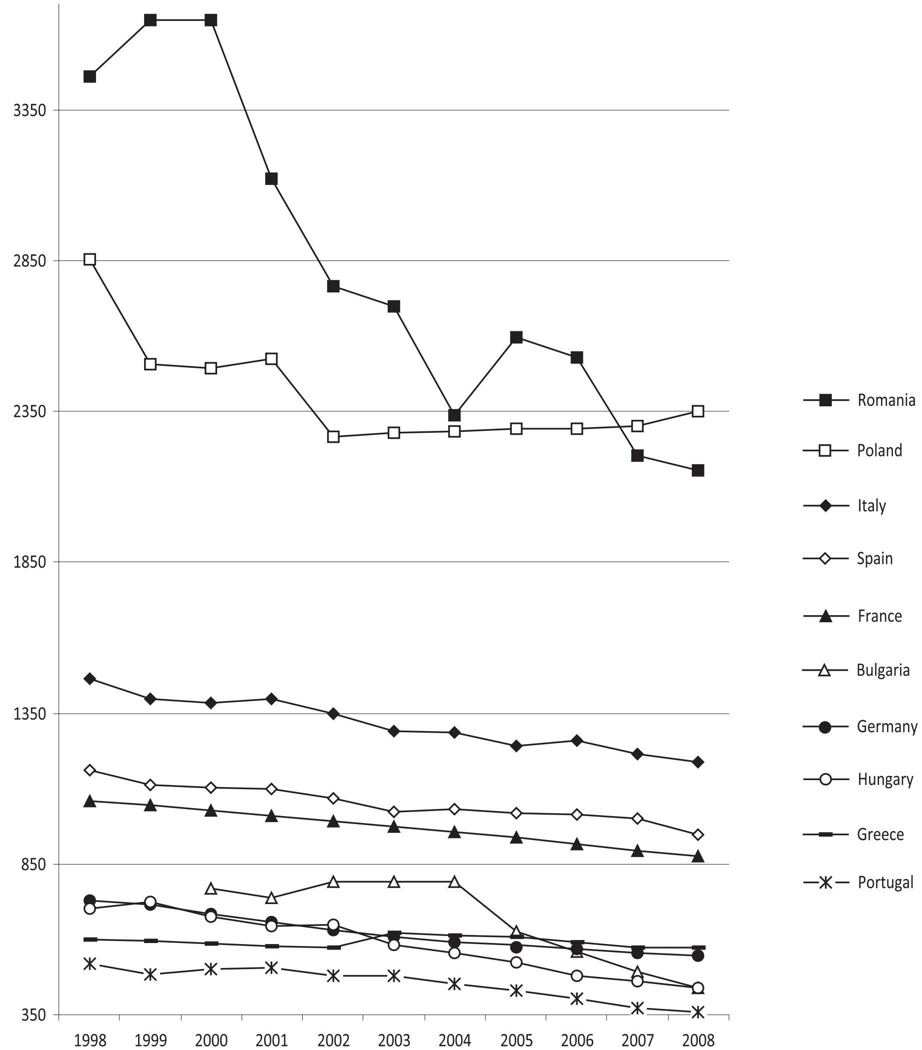
[5] This may be attributed to differences in (a) the decline of certain agricultural sub-sectors, (b) the introduction of new technologies in the sector, (b) the growth of other sectors and the shortage of (native or foreign) workers in these sectors, (d) all of the above (Baraldi at al., 2007).

[6] A simultaneous rise in total financial support for Greek agriculture, notwithstanding (Karanikolas et al., 2008).

[7] Indeed, the country's landscape is dominated by mountain-chains (about 42.2% of the country's surface), small valleys traversed by rivers or inlayed with lakes, narrow coastal strips, a multitude of islands (35.1% of the country's surface), and an inordinately jagged coastline (corresponding to 13.6% of the EU-27 total), all packed in a rather small area (about 3.1% of the EU's landmass). These natural features greatly fragment the country into a host of tiny districts. The road, rail and sea transport system linking the coastal strips, plateaux and islands, in its present state of development, partially ameliorates the situation, though may cause incidental farm fragmentation (this is usually of limited significance). In Greece, land distribution schemes and a number of local practices (e.g., inheritance and dowry customs, piecemeal sales and acquisitions of land due to lack of money, etc.) exacerbate the fragmentation and

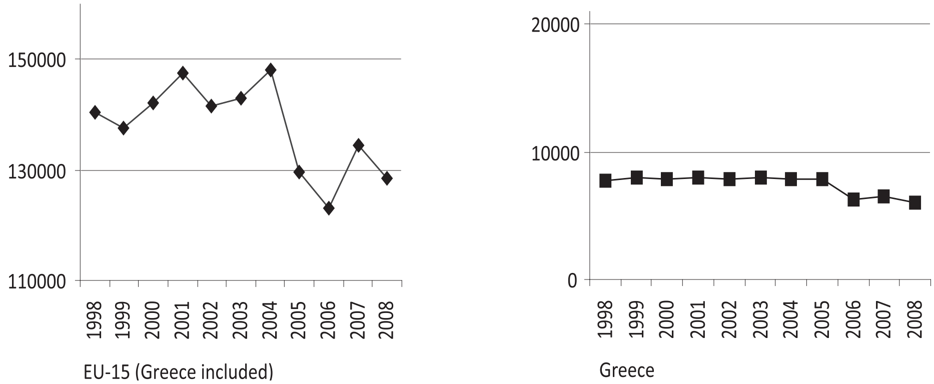
Figure 2: The top ten agricultural labour inputs in the EU during 1998-2008 (in thousands of annual work units)



Source: Eurostat (2009).

dispersal of agricultural holdings. This entails a waste of manpower, draft power, equipment, land, and for a long time impeded the modernization and mechanization of agriculture (e.g., Thompson, 1963; Ward, 1963). According to our estimates fragmentation has declined over time as the total number of holdings, about 1.007 million in 1950, fell by 5.7% between 1950 and 1977 and by 9.4% between 1977 and 2007 to about 860 thousand (Lianos and Parliarou, 1986; Eurostat, 2009).

Figure 3: Gross Value Added in the Agricultural Industry at basic prices in the EU-15 and Greece (in million ECU or euro)



Source: Eurostat (2009).

At the beginning of the period under examination, it was predicted that the country's agricultural labour force would shrink due to: (a) increased liberalization at the international level, which, in turn, would result in lower prices and, hence, the acquisition of less income for a given quantity of agricultural products; (b) reduced EU emphasis (i.e., provision of incentives) on the quantity of agricultural production; (c) desertification; (d) little or no planning; and (e) demographic ageing. The latter was expected to affect a reduction in the number of self-employed farmers and unpaid family members, and an increase in the number of people entering into contractual relationships as employers and employees (Karanikolas and Martinos, 1999; Tsimpoukas and Tsoukalas, 1999). However, there is scant evidence pertaining to developments in the size and the internal composition of the agricultural labour force, e.g., the personal interviews of a small number of women who became professional farmers (Gidarakou et al., 2008).

To gain insights into what transpired in Greece, we turn our attention to the evolution of people's primary involvement in agricultural or other economic activities, and study the seasonal and longer-term phases or patterns exhibited by the various gender, age, qualification, occupational or regional groups that constitute the agricultural labour force.[8] To visually aid the reader, the medium

[8] The study of migrant groups, whether foreign nationals or natives relocating within the country, though desired (the information was solicited in the survey), is not feasible at this stage.

and longer-term patterns are provided alongside the text, in Figures 4–12 and wherever space is not sufficient in Figures A.1-3 in the Appendix. The presentation and discussion of the empirical results are provided in Section 2, and the conclusions in Section 3. The econometric results, on the basis of which the aforesaid figures are drawn, are supplied in the Appendix.

2 Empirical Findings

We commence our analysis by looking at a number of correlations in order to get a sense of how the evolution of people's involvement in agriculture fits with participation in other economic activities. First, we note that the decline in people's participation in agricultural activities bears a close resemblance to the patterns observed in people's participation in the manufacturing of (a) wearing apparel, dressing and dyeing of fur (r=95.9%), (b) textiles and textile products (r=77.46%), (c) leather and leather products (r=71.7%), (d) tobacco products (r=65.9%); as well as in (e) forestry, logging and related activities (r=72.6%). This suggests reliance on the same factors and, in some cases, the presence of sectoral connections and complementarities (Porter, 2003). Additionally, the declining participation in agricultural activities exhibits a positive correlation with the declining number of unemployed observed in Greece during the same period (r=71.2%), which may suggest that those exiting the agricultural workforce did not swell the ranks of the unemployed. At the same time, the declining participation in agricultural activities exhibits (i) modest or low levels of positive correlation with the declining participation in eleven other industrial sectors, and (ii) negative correlations with the evolution of non-participation, as well as the evolution of participation in some 42 sectors— especially, (a) public administration, defense and compulsory social security, (b) construction, (c) repair of personal/household goods and retail trade (except motor vehicles), (d) (domestic) personnel employment within households, among others (r<–90.0%). This may suggest that those exiting the agricultural sector tended to either enter such sectors or retire.

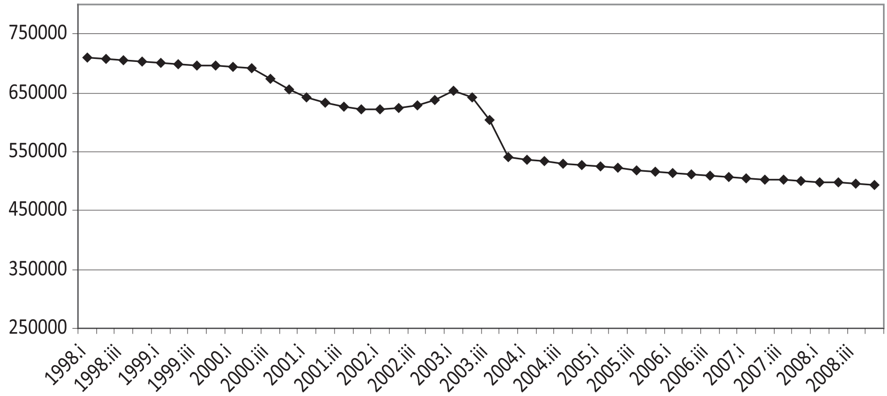
Shifting our attention to the econometric analysis, we ground ourselves on conventional labour economic theory. Understandably, to the extent that people's time-use choices originate from their preferences over consumption and leisure, subject to time and domestic technology constraints (Blundel and Macurdy, 2008), the sizes of the working-age population that opt to (a) participate in agricultural activities or other sectors of the economy, (b) look for jobs or (c) abstain from the workforce, are bound to be determined, to a considerable extent, by their characteristics (gender, age, qualifications etc.). Owing to the aggregate nature of the data at our disposal, these characteristics cannot be employed as explanatory variables in a multivariate participation or labour supply expression, as is usually done with disaggregated or individual data. Hence, we engage in econometric regressions with the aforementioned characteristics (more accurately, the population sizes of the agricultural labour force with such characteristics) serving as dependent variables of which the seasonal and longer-term features are isolated and the statistically significant effects (i.e., those exhibiting a very low probability of error, in our case less than 1%) are identified. These are discussed in subsections 2.i–2.iv.

i. Participation and Time Involvement

Our econometric analysis of people's participation in agricultural activities is conducted in conjunction with the participation observed in other sectors, unemployment and non-participation, within a seemingly unrelated regressions (SUR) framework: SUR is used because, in all likelihood, the disturbances across equations are not contemporaneously uncorrelated (Table 1). The coefficients reveal insignificant levels of seasonality and four longer-term phases net of the aforementioned seasonal effects. To facilitate the reader, these findings, except for those pertaining to the seasonal effects, are provided in the form of graphs. (See Figures 4 and A.1). The first phase seems to have taken place between the first quarter of 1998 and the second quarter of 2000, and is characterized by a slow decline in numbers. The second phase is characterized by more pronounced reductions in people's participation in agricultural activities until the first quarter of 2002, followed (and somewhat offset) by a brief surge that peaked in the first quarter of 2003. The third phase is characterized by a dramatic reduction in numbers until the last quarter of 2004; followed by the fourth phase, which is characterized by a slow decline in numbers.

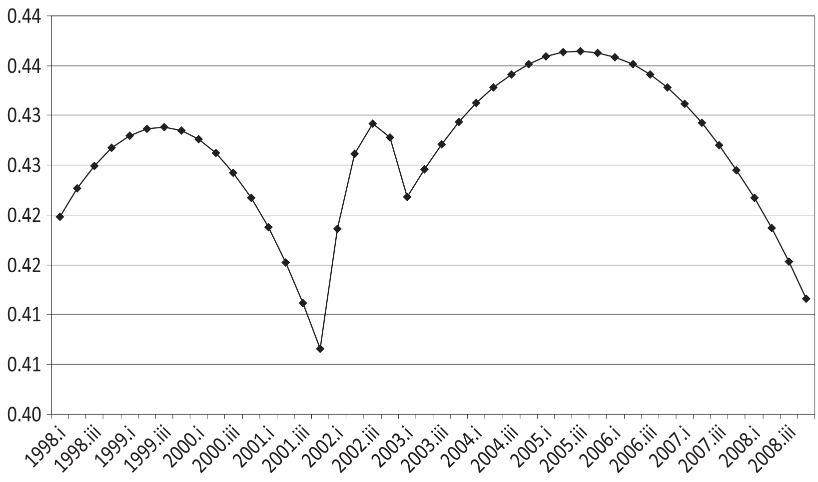
The correlation between the falling male and falling female participation numbers in agriculture is very high (r=97.35%); and a close examination of the numbers (see Table 2 or Figure 5) reveals successive cycles of small rises and falls in the female share of overall participation: one between the first

Figure 4: The medium- and longer-term pattern of participation in agricultural activities during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)



Source: Table 1.

Figure 5: The medium- and longer-term pattern in the female-to-male participation ratio of engagement in agricultural activities during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)

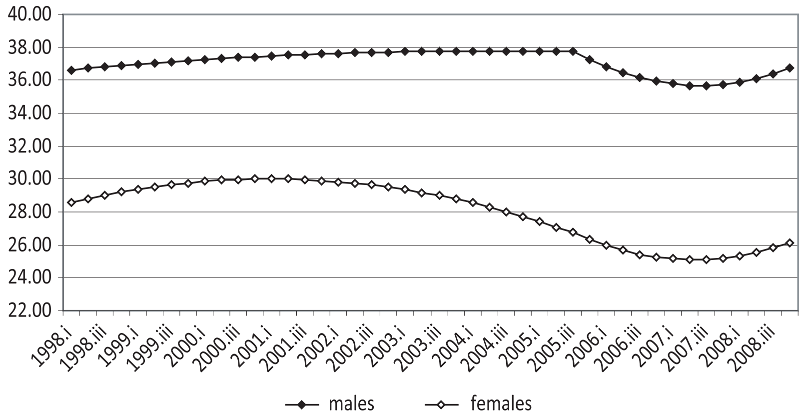


Source: Table 2.

quarter of 1998 and the fourth quarter of 2001 (from 42 to 43 to 41%), another between the fourth quarter of 2001 and the first quarter of 2003 (from 41 to 43 to 42%), a third between the first quarter of 2003 and the final quarter of 2008 (from 42 to 44 to 42%). Again, seasonal effects are not significant at the 1% level (i.e., when the probability of error is no more than 1%).

However, it turns out (Table 3) that both men and women engaged in more weekly hours of work in the 2nd–4th quarters compared to the 1st quarters. And if seasonal effects are set aside, it turns out that, on average, men declared or tended to work more hours than women (Figure 6). In fact, it seems that throughout the period, male contributions exceeded the figure of 34.5 weekly hours which corresponds to the full-time work equivalent mentioned in foonote 3. Hence, it would seem that relatively more women engaged in agricultural activities as part-timers rather than full-timers compared to men. Additionally, as the average number of hours contributed by women fell more than the average number of hours contributed by men, the disparity between the hours performed by each gender appears to have increased over time from about 7.4–8.7 weekly hours in the first couple of years (1998–1999) to about 10.4–10.9 weekly hours in the final couple of years (2007–2008).

Figure 6: The medium- and longer-term patterns of average hours of work per week declared by males and females engaging in agricultural activities during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)



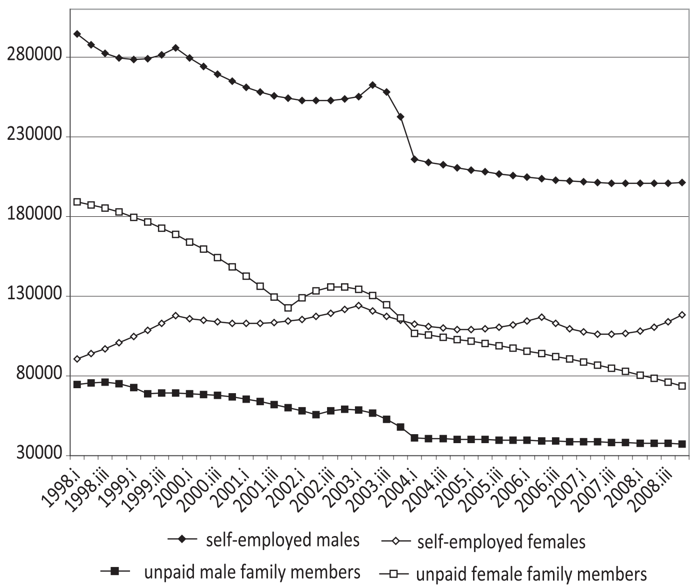
Source: Table 3.

ii. Changes in Occupational Composition

The consideration of participants' gender and occupational composition (Table 4) reveals that male employer numbers generally rose in the 3rd and 4th quarters vis-à-vis 1st quarters, while the number of self-employed males fell in the 2nd quarters. Setting seasonal effects aside, we note that the broad reduction in participation ought to be attributed to the departure of self-employed men and unpaid family members of both genders (i.e., three of the four largest sub-workforces) from agricultural activities. Indeed, the correlation coefficients (r_d) between (i) the non-seasonal (i.e., medium and longer-term) components of the overall sectoral workforce pattern and (ii) the corresponding components of the three constituent workforces exceed 96%. At the same time, the medium and longer-term components regarding: (a) the numbers of self-employed women (also one of the four largest such sub-

Figure 7: The medium- and longer-term patterns of participation in agricultural activities during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)

The four major gender and occupation groups in terms of participation



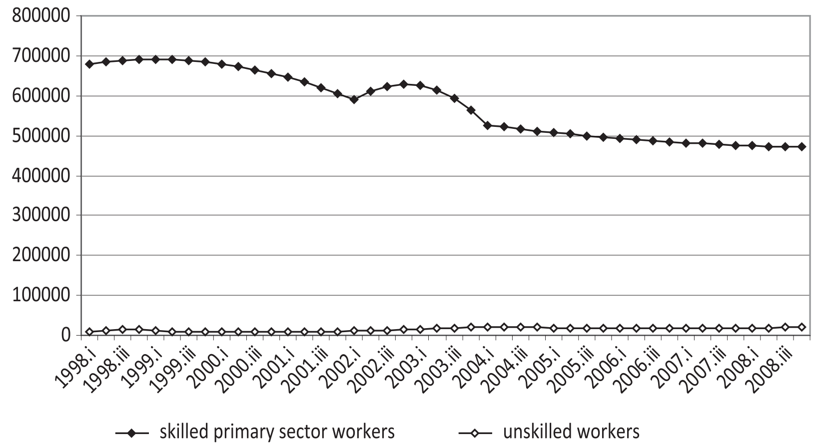
Note: The patterns of the other gender and occupation groups are provided in Figure A.2.
Source: Table 4.

workforces) and the numbers of female employees are rather indistinct (the respective r_ds range between 5 and -10%.); (b) the numbers of male employers appear to have fluctuated ($r_d \approx 70\%$); and (c) the numbers of male and female employees seem to have increased (the respective r_ds range between -38 and -85%.) See also Figures 7 and A.2.

In addition, if we study the figures from another perspective (Table 5), we observe that the overall medium and longer-term reduction in participation is driven by the drop in the number of skilled primary sector workers (r_d=99%).[9] In the background, the small numbers of unskilled workers, managers, machine operators, science/art professionals or other professions involved in agricultural activities (clerks, technicians, craft and service/sales workers) also declined initially and then either rebounded somewhat (man-

Figure 8: The medium- and longer-term patterns of participation in agricultural activities during 1998i-2008iv in Greece by type of profession, exclusive of seasonal effects (in thousands of people aged 15 years or older)

The two major profession groups in terms of participation



Note: The patterns of the other professions are provided in Figure A.3.
Source: Table 5.

[9] The medium and longer-term pattern of skilled primary sector workers is highly correlated with the corresponding pattern exhibited by the self-employed and unpaid males (r=98.9 and 98.7%, respectively), which suggests that the former group may overlap to a considerable extent with the other two groups.

agers (r_d≈22%)) or completely (machine operators (r_d≈42%)) or exceeded initial levels (science/art professionals, unskilled workers, others; the relevant r_ds range between -40 and -78%.) See also Figures 8 and A.3. There are no statistically significant seasonal effects at the 1% level, other than a fall in the number of science/art professionals in the 2nd quarters compared to the number involved in the 1st quarters.

iii. Developments Across Regions

A detailed analysis at the regional level (Table 6) reveals that a number of seasonal effects turn out to be statistically significant. In East Macedonia and Thrace, male and female figures are generally higher in the 2nd, 3rd and 4th quarters vis-à-vis the 1st quarter; in West Macedonia, female figures are higher in the 2nd and 3rd quarters; in Central Macedonia, female figures are higher in the 3rd quarters; and in Western Greece, male figures are higher in the 4th quarters. At the same time, in Crete and the South Aegean islands, male figures are lower in the 3rd quarters; in the North Aegean islands, female figures are lower in the 3rd quarters; in the Ionian islands and Epiros, male figures are lower in the 2nd–3rd and 3rd–4th quarters, respectively.

Seasonal effects aside, the contraction of the sectoral workforce turns out to be associated with reductions in the male workforces of Central Macedonia,[10] Western Greece, Thessaly,[11] Crete, East Macedonia and Thrace that engaged in agricultural activities, as well as with reductions in the female workforces of East Macedonia and Thrace, Crete, Western Greece[12] that engaged in similar activities (i.e., five out of the six largest regional male workforces, and three out of the six largest regional female workforces in the

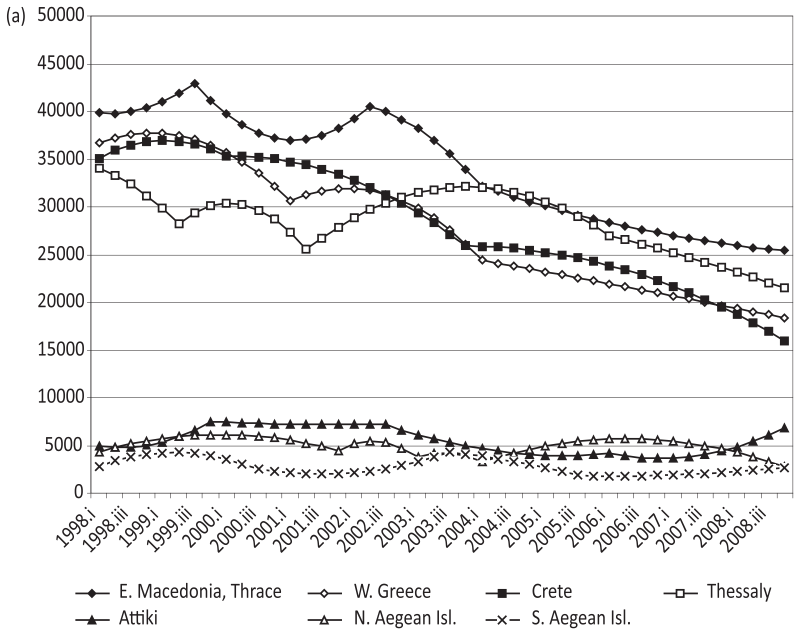
[10] The medium and longer-term pattern of the male agricultural workforce in Central Macedonia is highly correlated with the corresponding pattern exhibited by the self-employed males (r=98.1%) and skilled primary sector workers (r=98,3%), which suggests that it may overlap to a considerable extent with the other two groups.

[11] The medium and longer-term pattern of the male agricultural workforce in Thessaly is highly correlated with the corresponding pattern exhibited by the skilled primary sector workers (r=98.8%), which suggests that the two groups may overlap to a considerable extent.

[12] The medium and longer-term pattern of the female agricultural workforce in Western Greece is highly correlated with the corresponding pattern exhibited by the unpaid female family members (r=98.1%) and skilled primary sector workers (r=98.6%), which suggests that it may overlap to a considerable extent with the other two groups.

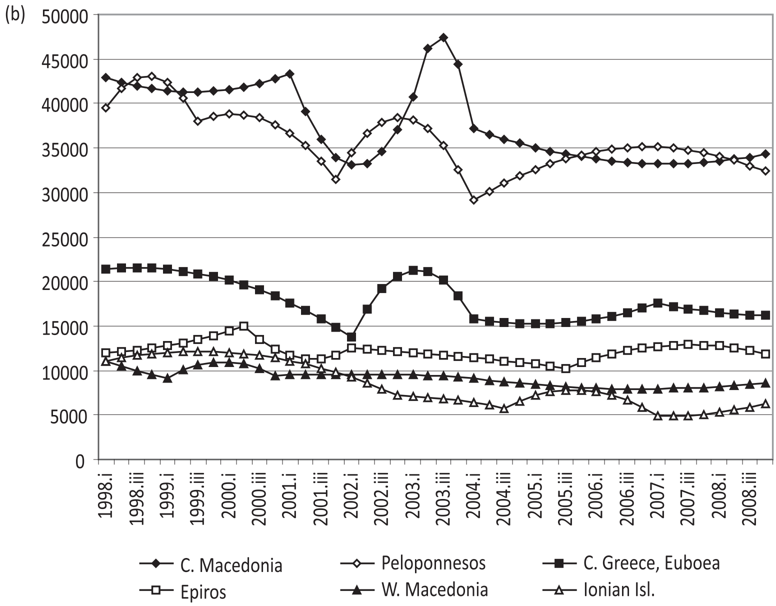
sector, respectively). Indeed, the correlation coefficients of the (non-seasonal) sectoral workforce pattern (see Table 1, expression A) and the aforementioned (non-seasonal) regional forces (i.e., the r_ds) exceed 93%. On the other hand, male numbers in Attiki,[13] female numbers in Epiros, and male and female numbers in the North Aegean turn out to have fluctuated around the initial level, and in the case of the former, even increased. (The respective r_ds range between 30 and 49%.) See Figures 9 and 10.

Figure 9: The medium- and longer-term patterns of female participation in agricultural activities during 1998i-2008iv in Greece by region, exclusive of seasonal effects (in thousands of people aged 15 years or older)



[13] Modern-day Attiki comprises ancient Attica and Megaris, the Saronic isles, a slice of the neighbouring Peloponnese and a number of isles off the east Peloponnesian coast. Modern-day Peloponnesos comprises the eastern and southern parts of the Peloponnese, and modern-day Central Greece comprises the parts of the mainland which are located south of Thessaly and Epiros minus the territories of Attica, Megaris, Aetolia and Akarnania.

Figure 9 (continued)



Source: Table 6.

Figure 10: The medium- and longer-term patterns of male participation in agricultural activities during 1998i-2008iv in Greece by region, exclusive of seasonal effects (in thousands of people aged 15 years or older)

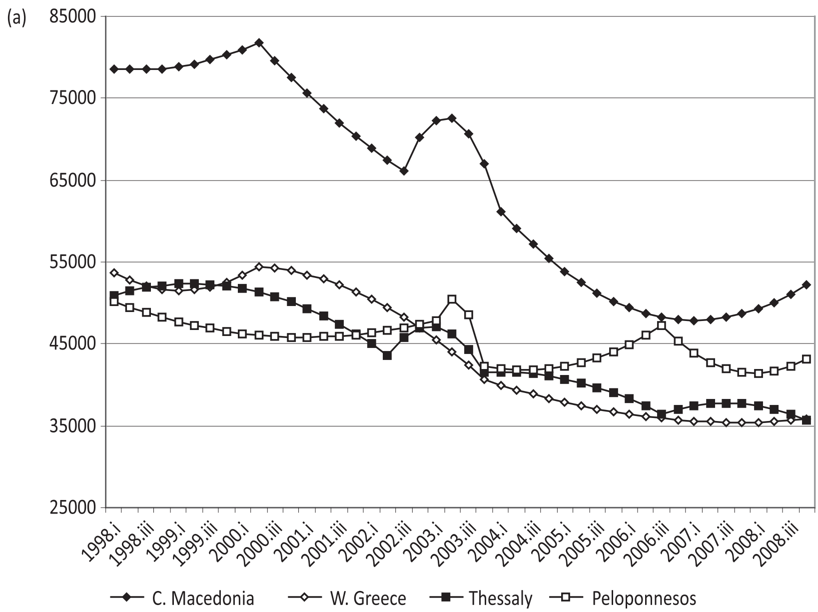
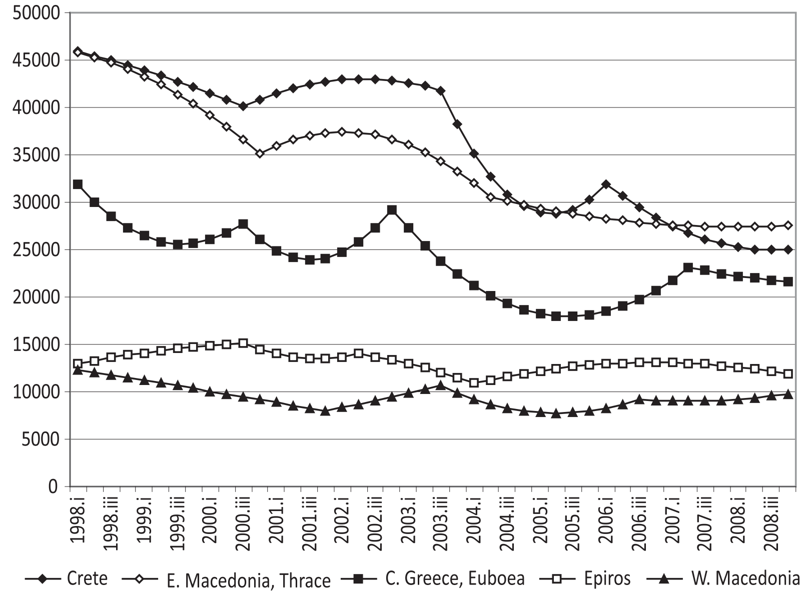
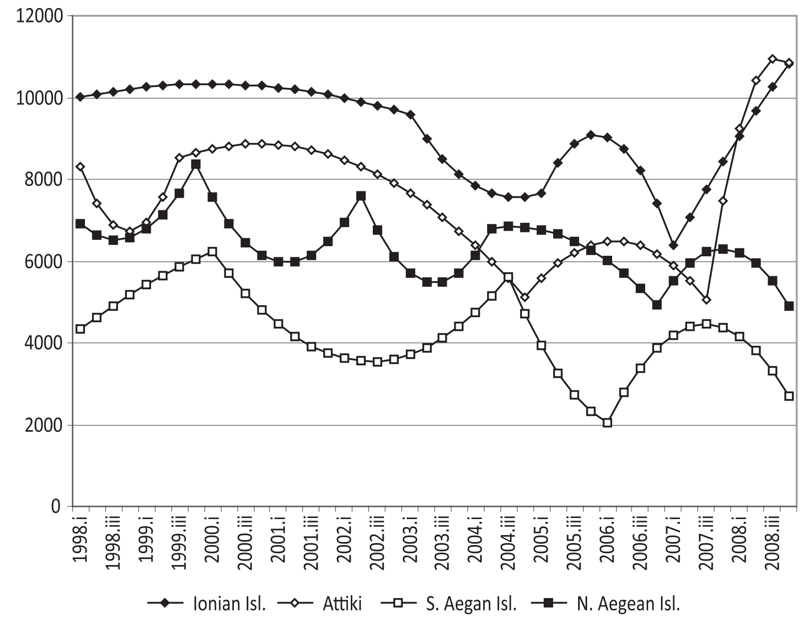


Figure 10 (continued)

(b)



(c)



Source: Table 6.

iv. Different Responses by Gender, Age and Qualification Groups

A similar analysis in terms of gender and age groupings (Table 7) traces the sector's declining participation pattern to the medium and longer-term contraction of (a) the two largest male and female workforces, namely those aged 45–64 years old;[14] and (b) males aged 20–24 years old involved in agricultural activities (r_ds≥96%). The corresponding numbers of the other gender and age groups diverge somewhat but generally decline. (The respective r_ds range between 80 and 95%.) See also Figures 11 (a) and (b). Of the seasonal effects, only those regarding the participation influx of males aged 15–19 years old in the 3rd–4th quarters and of females aged 15–19 in the 3rd quarters turn out to be statistically significant at the 1% level.

For the most part, the medium and longer-term sectoral pattern can be explained by the exit from agricultural activities of (a) men and (b) women with primary level educational qualifications,[15] and (c) women without formal schooling (r_d>97%).[16] Categories (a) and (b) used to comprise (and apparently still comprise) the largest sub-workforces in the sector. The numbers of men and women with some primary schooling,[17] along with the number of men

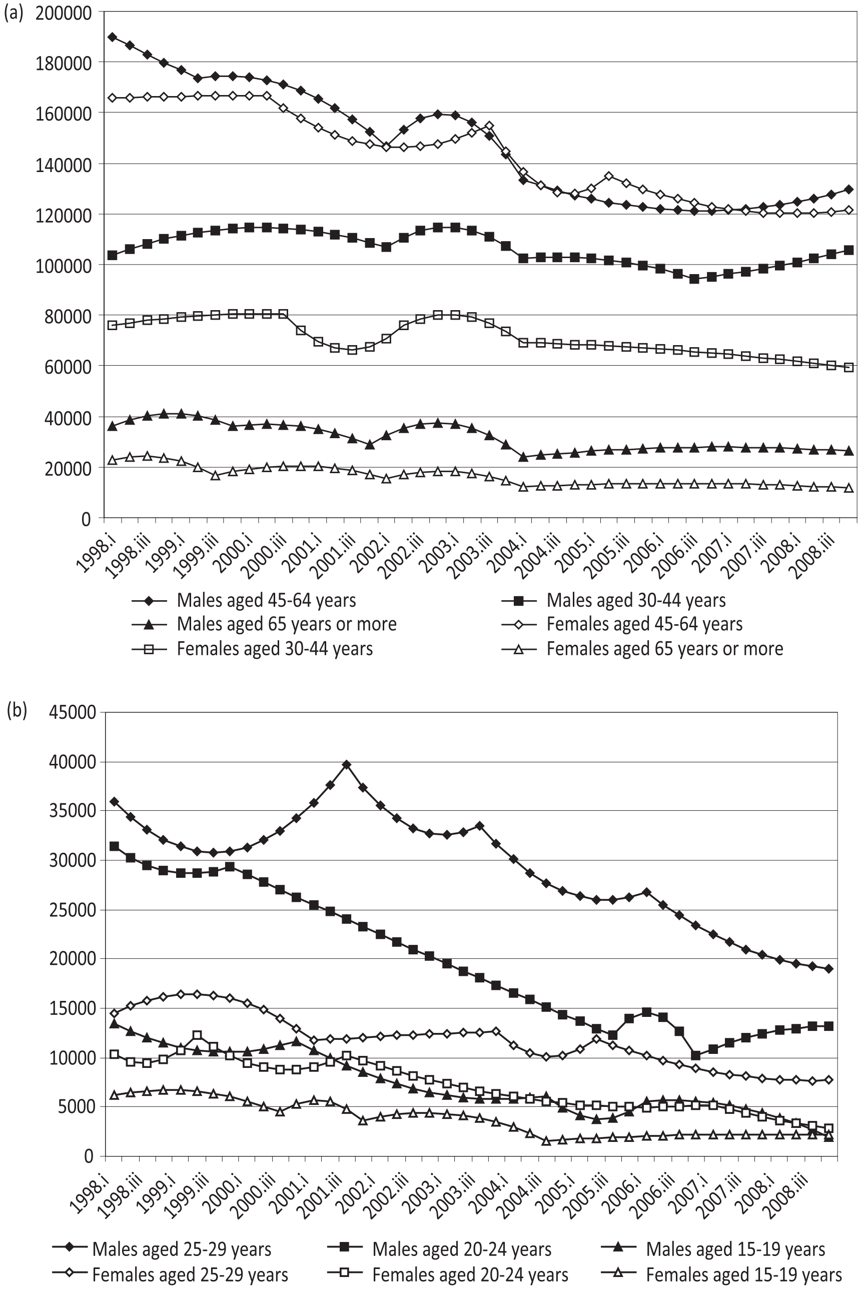
[14] The medium and longer-term patterns of the male and female agricultural workforces aged 45-64 years old are highly correlated with the corresponding pattern exhibited by skilled primary sector workers (r=98.2 and 98.4%, respectively) which suggests that they may overlap with it to considerable extent. Additionally, the pattern of the male agricultural workforce aged 45-64 is highly correlated with the corresponding patterns exhibited by the self-employed and unpaid males (r=98.4 and 98.8%, respectively), which suggests that it may overlap to a considerable extent with the other two groups.

[15] The medium and longer-term patterns of the male and female agricultural workforces with primary level educational qualifications are highly correlated with the corresponding pattern exhibited by the skilled primary sector workers (r=98.5% in each occasion), which suggests that they may overlap to a considerable extent. Additionally, the pattern of the male agricultural workforce with primary level educational qualifications is highly correlated with the corresponding pattern exhibited by the self-employed males (r=98.6%), which suggests that the two groups may overlap to a considerable extent.

[16] The medium and longer-term pattern of the female agricultural workforce without schooling is highly correlated with the corresponding pattern exhibited by skilled primary sector workers (r=98.5%) and the female agricultural workforce aged 45-65 years old (r=98.4%), which suggests that it may overlap to a considerable extent with the other two groups.

[17] The medium and longer-term pattern of females with some primary level schooling is highly correlated with the corresponding pattern exhibited by the unpaid female family members (r=98.3%), which suggests that the two groups may overlap to a considerable extent.

Figure 11: The medium- and longer-term patterns of participation in agricultural activities during 1998i-2008iv in Greece by gender and age group, exclusive of seasonal effects (in thousands of people aged 15 years or older)



Source: Table 7.

without formal schooling who engaged in agricultural activities, also dwindled in the course of the decade. (The respective r_ds range between 89 and 93%.) At the same time, the numbers of men and women with (upper or lower) secondary school qualifications and women with university degrees generally increased (the respective r_ds range between -50 and -84%), while the number of male university degree holders fluctuated around the initial level (r_d≈5%). The evolution of these groups in terms of their size is described in the form of equations in Table 8 and as diagrams in Figures 12 (a) and (b). Of the seasonal effects, only those pertaining to the reduced involvement of women with upper secondary school qualifications in the 4th quarters vis-à-vis the 1st quarters turn out to be statistically significant at the 1% level.

Figure 12: The medium- and longer-term patterns of participation in agricultural activities during 1998i-2008iv in Greece by gender and formal qualification group, exclusive of seasonal effects (in thousands of people aged 15 years or older)

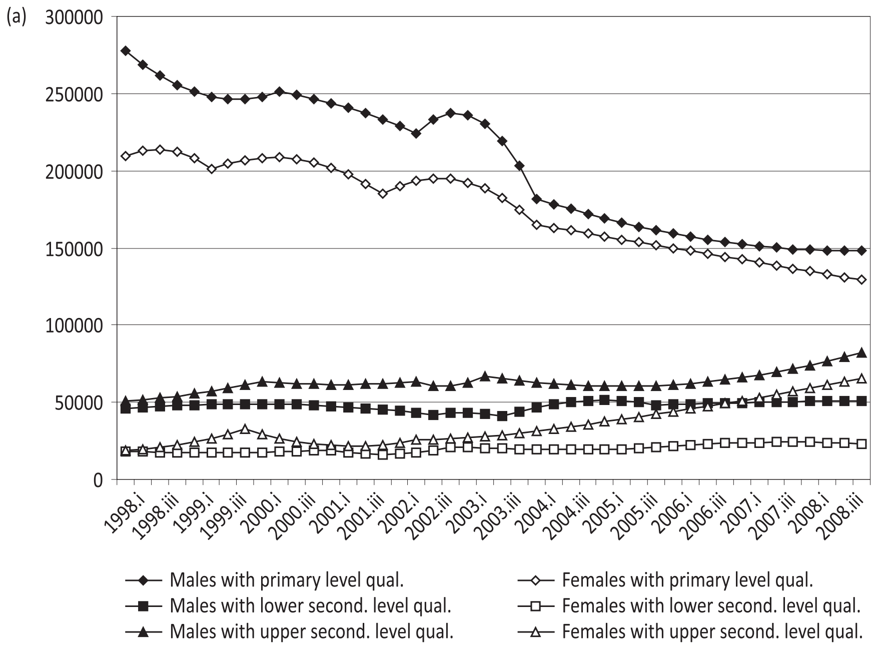
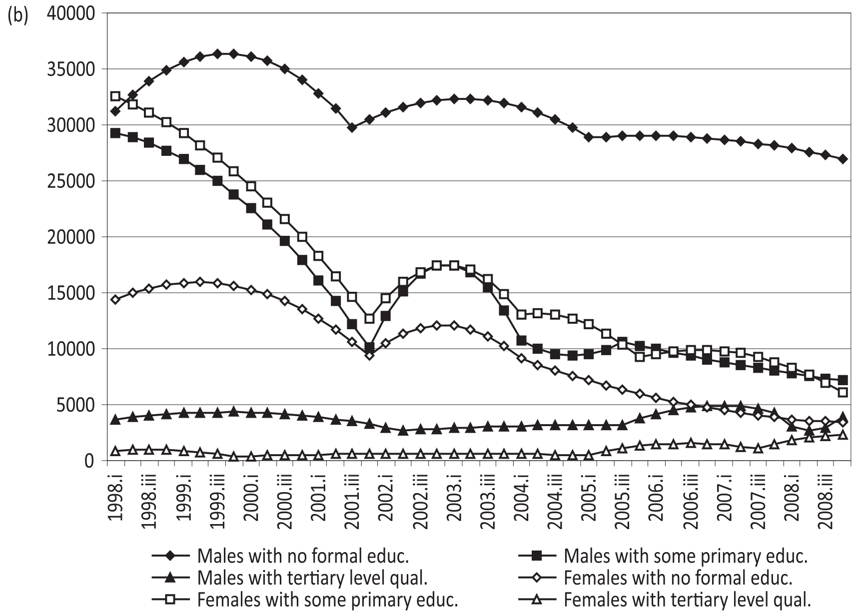


Figure 12 (continued)



Source: Table 8.

3 Conclusions

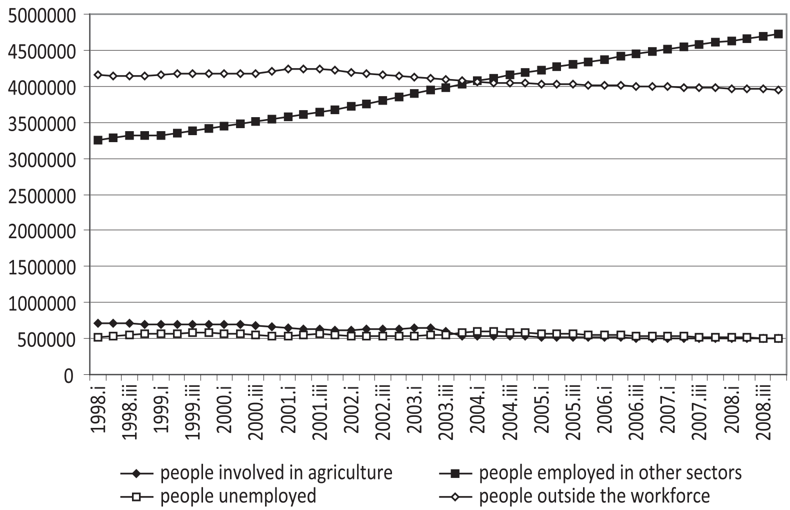
To sum up, we trace the contraction of the Greek agricultural labour force during 1998–2008 to medium and longer-term reductions in the numbers of (a) skilled primary sector workers, (b) self-employed men, (c) unpaid family members of both genders, (d) men aged 20–24, (e) men and women aged 45–64 years old, (f) men and women with primary level educational qualifications, (g) women without any schooling, (h) men in Central Macedonia and Thessaly, and (i) men and women in Western Greece, Crete, East Macedonia and Thrace that engage (or engaged) in agricultural activities. As the number of unemployed people went down, we suggest that those who exited the sector either (i) entered sectors in which participation grew (such as public administration and defense, construction, domestic employment, retail trade and repairs) or (ii) retired. We also come across obvious increases in the numbers of (a) male employees, (b) clerks, technicians, craft and service/sales workers, (c) unskilled workers, (d) men and women with secondary school qualifications, (e) women with university degrees, and (f) men in the urban district of Attiki who engage in agricultural activities. All things considered, one discovers a diversity of responses (by different segments of the population) to the changing economic environment, providing a potentially useful glimpse into the evolving composition of the sector's workforce. As the latter may signify the need for new arrangements or the presence of new possibilities, its early detection may be useful for policy purposes; for instance, adopting better tailored economic development approaches that might appeal to inhabitants who do not meet the traditional farmer's profile (especially as EU interest shifts from production to stewardship of the land). Indeed, steps could be taken to enhance young people's regard or appreciation for employment in agriculture and/or their expectations of long-term rewards. These could be facilitated via (a) the provision of positive imagery, broad, practical and versatile skills, as well as apprenticeships; (b) the availability of specialist advice regarding the suitability of particular crops and herds, diversification, returns, entrepreneurship etc.; (c) the promotion of synergies with sectors in higher stages of the value-chain (such as manufacturing, tourism, sales, tertiary level education and research etc.); (d) improvements in the management of the flow of goods, information and other resources between points of production and (domestic or foreign) consumption; and so on.

In addition, one observes seasonal swings in (i) the average hours of work performed by both men and women involved in the sector, as well as in (ii) the size of some of the groups engaging in such activities—namely, male employers, self-employed males, science/art professionals, female holders of upper secondary school qualifications, men in Crete, the South Aegean islands, the Ionian islands, Western Greece, and Epiros, women in the North Aegean islands, and Central and Western Macedonia, men and women in East Macedonia–Thrace, teenaged men and women. The pattern implies periodic attachment to agriculture by segments of the population (or lack of better options). It also begs the question as to whether the (seasonal) duration of increased employment opportunities might be prolonged and/or extended to other groups; and what the cost and benefits might be, especially if Greek regions are presumed to possess or wish to build a comparative advantage in agriculture or in other sectors. Obviously, in the trying times of the current economic crisis, a sector's capacity to provide more jobs during certain seasons ought not to be overlooked. Additionally, *ceteris paribus*, an enlarged agricultural production that affects lower prices may alleviate some of the household income losses caused by the recent austerity measures.

On the whole, it is hoped that this empirical exploration in the internal composition and evolution of the Greek agricultural labour force supplies insights into the issue, as well as stimuli for further study, of (a) particular subgroups of farmers (such as male employees, science/arts professional, men and women with upper secondary qualifications or others who are attracted to the agriculture), and (b) the segments of the population employed in other sectors.

APPENDIX

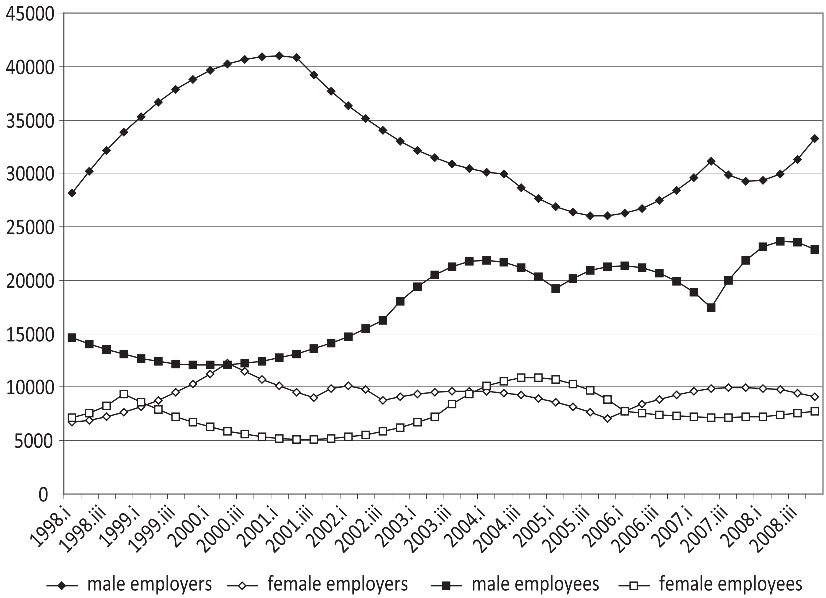
Figure A1: The medium- and longer-term pattern of participation in agricultural activities, other sectors, unemployment and non-participation during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)



Source: Table 1.

Figure A2: The medium- and longer-term patterns of participation in agricultural activities during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)

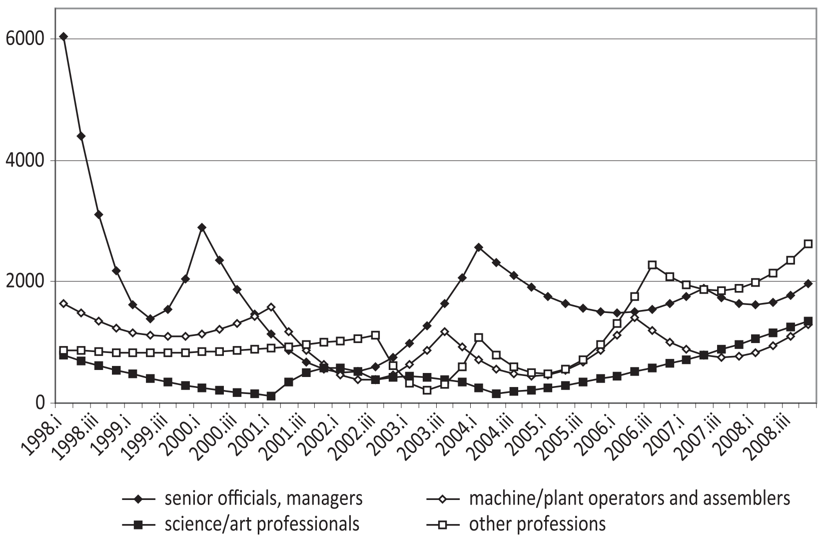
The four minor gender and occupation groups in terms of participation



Source: Table 4.

Figure A3: The medium- and longer-term patterns of participation in agricultural activities during 1998i-2008iv in Greece, exclusive of seasonal effects (in thousands of people aged 15 years or older)

The minor profession groups in terms of participation



Source: Table 5.

Table 1: SUR estimates of the population’s involvement in agriculture and related activities (A), other sectors (O), unemployment (U) and non-participation (NP) between the 1st quarter of 1998 ($Q98^{I}$) and 4th quarter of 2008 ($Q08^{IV}$) in Greece (All persons aged 15 years or older)

Economic Activities	R^2
$A = \mathbf{710811} - 2072\,(Q98^{I}\text{ etc.}) + 21\,(Q98^{I}\text{ etc.})^2 - \mathbf{19461}\,(Q00^{III}\text{ etc.}) + \mathbf{1549}\,(Q00^{III}\text{ etc.})^2 + 19047\,(Q03^{I}\text{ etc.}) - \mathbf{15062}\,(Q03^{I}\text{ etc.})^2 + \mathbf{75253}\,(Q04^{I}\text{ etc.}) + \mathbf{13543}\,(Q04^{I}\text{ etc.})^2 - 3269\,Q^{II} - 1773\,Q^{III} + 2148\,Q^{IV}$	99.03%
$O = \mathbf{3186891} + \mathbf{65960}\,(Q98^{I}\text{ etc.}) - \mathbf{8028}\,(Q98^{I}\text{ etc.})^2 + \mathbf{46192}\,(Q99^{II}\text{ etc.}) + \mathbf{8137}\,(Q99^{II}\text{ etc.})^2 + \mathbf{13105}\,(Q02^{II}\text{ etc.}) - 497\,(Q02^{II}\text{ etc.})^2 + \mathbf{46310}\,Q^{II} + \mathbf{46607}\,Q^{III} + 3433\,Q^{IV}$	99.59%
$U = \mathbf{495008} + \mathbf{22438}\,(Q98^{I}\text{ etc.}) - \mathbf{1545}\,(Q98^{I}\text{ etc.})^2 - 18298\,(Q00^{III}\text{ etc.}) + \mathbf{6897}\,(Q00^{III}\text{ etc.})^2 - \mathbf{44956}\,(Q01^{IV}\text{ etc.}) - 3193\,(Q01^{IV}\text{ etc.})^2 - \mathbf{32038}\,(Q04^{II}\text{ etc.}) - \mathbf{2045}\,(Q04^{II}\text{ etc.})^2 - \mathbf{42479}\,Q^{II} - \mathbf{46164}\,Q^{III} - \mathbf{20815}\,Q^{IV}$	96.72%
$NP = \mathbf{4188620} - \mathbf{27997}\,(Q98^{I}\text{ etc.}) + \mathbf{4278}\,(Q98^{I}\text{ etc.})^2 - \mathbf{29995}\,(Q99^{III}\text{ etc.}) - \mathbf{2802}\,(Q99^{III}\text{ etc.})^2 + \mathbf{33162}\,(Q00^{IV}\text{ etc.}) - \mathbf{7977}\,(Q00^{IV}\text{ etc.})^2 + \mathbf{19937}\,(Q02^{II}\text{ etc.}) + \mathbf{6455}\,(Q02^{II}\text{ etc.})^2 + \mathbf{12942}\,(Q04^{II}\text{ etc.}) + 3\,(Q04^{II}\text{ etc.})^2 - 3721\,Q^{II} - 7574\,Q^{III} + \mathbf{8399}\,Q^{IV}$	97.90%

Notes: (a) The quarterly samples of 2004-2008 are based on the *2001 Census*, while the figures pertaining to 1998-2003 are based on re-weightings of the relevant samples.
(b) Bold fonts denote significance at the 1% level.

Additional equation information:

A: $P>|z_1| = 0; P>|z_2| = 0.512; P>|z_3| = 0.931; P>|z_4| = 0; P>|z_5| = 0; P>|z_6| = 0.023; P>|z_7| = 0; P>|z_8| = 0; P>|z_9| = 0; P>|z_{10}| = 0.334; P>|z_{11}| = 0.604; P>|z_{12}| = 0.53.$

O: $P>|z_1| = 0; P>|z_2| = 0; P>|z_3| = 0.001; P>|z_4| = 0.001; P>|z_5| = 0.001; P>|z_6| = 0.005; P>|z_7| = 0.093; P>|z_8| = 0; P>|z_9| = 0; P>|z_{10}| = 0.642.$

U: $P>|z_1| = 0; P>|z_2| = 0; P>|z_3| = 0; P>|z_4| = 0.045; P>|z_5| = 0; P>|z_6| = 0; P>|z_7| = 0.012; P>|z_8| = 0; P>|z_9| = 0; P>|z_{10}| = 0; P>|z_{11}| = 0; P>|z_{12}| = 0.$

NP: $P>|z_1| = 0; P>|z_2| = 0; P>|z_3| = 0; P>|z_4| = 0; P>|z_5| = 0.005; P>|z_6| = 0; P>|z_7| = 0; P>|z_8| = 0.001; P>|z_9| = 0; P>|z_{10}| = 0; P>|z_{11}| = 0.993; P>|z_{12}| = 0.236; P>|z_{13}| = 0.016; P>|z_{14}| = 0.008.$

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

Table 2: Estimates with robust standard errors of the female participation share out of all persons aged 15 years or older involved in agriculture and related activities between the 1st quarter of 1998 ($Q98^{I}$) and 4th quarter of 2008 ($Q08^{IV}$) in Greece

Female participation share	R^2
0.4165 + **0.0036** ($Q98^{I}$ etc.) − **0.0003** ($Q98^{I}$ etc.)^2 + **0.0191** ($Q99^{III}$ etc.) − **0.0020** ($Q99^{III}$ etc.)^2 + **0.0111** ($Q03^{II}$ etc.) + **0.0021** ($Q03^{II}$ etc.)^2 − 0.0034 ($Q07^{III}$ etc.) + 0.0006 ($Q07^{III}$ etc.)^2 + 0.0022 Q^{II} + 0.0019 Q^{III} − 0.0008 Q^{IV}	91.44%

Notes: As in Table 1.

Additional equation information:
$P>|z_1| = 0$; $P>|z_2| = 0$; $P>|z_3| = 0$; $P>|z_4| = 0$; $P>|z_5| = 0$; $P>|z_6| = 0$; $P>|z_7| = 0$; $P>|z_8| = 0.016$; $P>|z_9| = 0.02$; $P>|z_{10}| = 0.098$; $P>|z_{11}| = 0.198$; $P>|z_{12}| = 0.556$.

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

Table 3: SUR estimates of the average number of weekly hours that men and women engaged in agriculture and related activities between the 1st quarter of 1998 ($Q98^{I}$) and 4th quarter of 2008 ($Q08^{IV}$) in Greece (All persons aged 15 years or older)

Average number of weekly hours worked by	R^2
men = **36.5420** + 0.0951 ($Q98^{I}$ etc.) − 0.0018 ($Q98^{I}$ etc.)^2 − 0.5275 ($Q05^{IV}$ etc.) + 0.0375 ($Q05^{IV}$ etc.)^2 + **7.3356** Q^{II} + **8.9065** Q^{III} + **3.0160** Q^{IV}	91.28%
women = **28.3402** + **0.2585** ($Q98^{I}$ etc.) − **0.0100** ($Q98^{I}$ etc.)^2 − 0.0891 ($Q05^{IV}$ etc.) + 0.0412 ($Q05^{IV}$ etc.)^2 + **7.0435** Q^{II} + **9.3513** Q^{III} + **4.0655** Q^{IV}	92.57%

Notes: As in Table 1.

Additional equation information:
men: $P>|z_1| = 0$; $P>|z_2| = 0.287$; $P>|z_3| = 0.494$; $P>|z_4| = 0.026$; $P>|z_5| = 0$; $P>|z_6| = 0$; $P>|z_7| = 0$; $P>|z_8| = 0$.
women: $P>|z_1| = 0$; $P>|z_2| = 0.004$; $P>|z_3| = 0$; $P>|z_4| = 0.74$; $P>|z_5| = 0.014$; $P>|z_6| = 0$; $P>|z_7| = 0$; $P>|z_8| = 0$.

Source: *Labour Force Surveys of 1998-2008*, National Statistical Service of Greece. Own calculations.

Table 4: SUR estimates of (i) gender and occupation groupings involved in agriculture and related activities, and (ii) male and female involvement in other sectors (O), unemployment (U) and non-participation (NP) between the 1st quarter of 1998 ($Q98^{I}$) and 4th quarter of 2008 ($Q08^{IV}$) in Greece (All persons aged 15 years or older)

Males in agriculture etc.	R^2	(r_d)
Self-employed = $\mathbf{303025} - \mathbf{9622}\,(Q98^{I}\text{ etc.}) + \mathbf{932}\,(Q98^{I}\text{ etc.})^2 - \mathbf{11813}\,(Q00^{I}\text{ etc.}) - \mathbf{612}\,(Q00^{I}\text{ etc.})^2 + \mathbf{11152}\,(Q03^{II}\text{ etc.}) - \mathbf{6012}\,(Q03^{II}\text{ etc.})^2 + \mathbf{30758}\,(Q04^{II}\text{ etc.}) + \mathbf{5749}\,(Q04^{II}\text{ etc.})^2 - \mathbf{1419}\,Q^{II} - 3390\,Q^{III} - 407\,Q^{IV}$	98.77%	(99.21%)
Employers = $\mathbf{25921} + \mathbf{2336}\,(Q98^{I}\text{ etc.}) - \mathbf{91}\,(Q98^{I}\text{ etc.})^2 - \mathbf{1497}\,(Q01^{III}\text{ etc.}) + \mathbf{156}\,(Q01^{III}\text{ etc.})^2 - \mathbf{1265}\,(Q04^{III}\text{ etc.}) + 59\,(Q04^{III}\text{ etc.})^2 - \mathbf{3143}\,(Q07^{II}\text{ etc.}) + \mathbf{194}\,(Q07^{II}\text{ etc.})^2 - 130\,Q^{II} + \mathbf{1349}\,Q^{III} + \mathbf{1569}\,Q^{IV}$	95.59%	(68.25%)
Employees = $\mathbf{15366} - \mathbf{744}\,(Q98^{I}\text{ etc.}) + \mathbf{42}\,(Q98^{I}\text{ etc.})^2 + \mathbf{1055}\,(Q02^{IV}\text{ etc.}) - \mathbf{202}\,(Q02^{IV}\text{ etc.})^2 + \mathbf{2446}\,(Q05^{II}\text{ etc.}) + 12\,(Q05^{II}\text{ etc.})^2 + \mathbf{4395}\,(Q07^{III}\text{ etc.}) - 181\,(Q07^{III}\text{ etc.})^2 + 817\,Q^{II} + 354\,Q^{III} + 136\,Q^{IV}$	94.84%	(−84.96%)
Unpaid family members = $\mathbf{71847} + 3239\,(Q98^{I}\text{ etc.}) - \mathbf{618}\,(Q98^{I}\text{ etc.})^2 + \mathbf{4517}\,(Q99^{III}\text{ etc.}) + 497\,(Q99^{III}\text{ etc.})^2 + \mathbf{5931}\,(Q02^{III}\text{ etc.}) - \mathbf{659}\,(Q02^{III}\text{ etc.})^2 + \mathbf{7357}\,(Q04^{II}\text{ etc.}) + \mathbf{780}\,(Q04^{II}\text{ etc.})^2 - 1769\,Q^{II} + 158\,Q^{III} + 44\,Q^{IV}$	97.45%	(97.83%)
Females in agriculture etc.		
Self-employed = $\mathbf{87890} + 2719\,(Q98^{I}\text{ etc.}) + 128\,(Q98^{I}\text{ etc.})^2 - \mathbf{6688}\,(Q00^{I}\text{ etc.}) + 57\,(Q00^{I}\text{ etc.})^2 - \mathbf{6887}\,(Q03^{II}\text{ etc.}) + 76\,(Q03^{II}\text{ etc.})^2 - \mathbf{7276}\,(Q06^{III}\text{ etc.}) + \mathbf{199}\,(Q06^{III}\text{ etc.})^2 + 1108\,Q^{II} - 80\,Q^{III} - 1736\,Q^{IV}$	87.67%	(−9.06%)
Employers = $\mathbf{6583} + 65\,(Q98^{I}\text{ etc.}) + \mathbf{50}\,(Q98^{I}\text{ etc.})^2 - \mathbf{1895}\,(Q00^{III}\text{ etc.}) - \mathbf{17}\,(Q00^{III}\text{ etc.})^2 + \mathbf{1726}\,(Q01^{IV}\text{ etc.}) - \mathbf{357}\,(Q01^{IV}\text{ etc.}) + \mathbf{1726}\,(Q02^{IV}\text{ etc.}) + \mathbf{286}\,(Q02^{IV}\text{ etc.})^2 + \mathbf{1370}\,(Q06^{I}\text{ etc.})^2 - 10\,(Q06^{I}\text{ etc.})^2 - 82\,Q^{II} - 199\,Q^{III} - 73\,Q^{IV}$	90.89%	(5.08%)
Employees = $\mathbf{7125} - 111\,(Q98^{I}\text{ etc.}) + 166\,(Q98^{I}\text{ etc.})^2 - \mathbf{2025}\,(Q99^{I}\text{ etc.}) - 128\,(Q99^{I}\text{ etc.})^2 + \mathbf{721}\,(Q03^{III}\text{ etc.}) - \mathbf{151}\,(Q03^{III}\text{ etc.})^2 + \mathbf{965}\,(Q06^{II}\text{ etc.}) + \mathbf{133}\,(Q06^{II}\text{ etc.})^2 + 693\,Q^{II} + 735\,Q^{III} + 327\,Q^{IV}$	86.76%	(−38.06%)
Unpaid family members = $\mathbf{190573} - 1232\,(Q98^{I}\text{ etc.}) - \mathbf{189}\,(Q98^{I}\text{ etc.})^2 + \mathbf{14742}\,(Q02^{I}\text{ etc.}) - \mathbf{836}\,(Q02^{II}\text{ etc.})^2 + \mathbf{9903}\,(Q04^{II}\text{ etc.}) + \mathbf{992}\,(Q04^{II}\text{ etc.})^2 - 625\,Q^{II} + 1888\,Q^{III} + 2785\,Q^{IV}$	98.45%	(96.48%)
Males and females in other economic activities		
$O = \mathbf{3183490} + \mathbf{69397}\,(Q98^{I}\text{ etc.}) - \mathbf{8610}\,(Q98^{I}\text{ etc.})^2 + \mathbf{51444}\,(Q99^{III}\text{ etc.}) + \mathbf{8590}\,(Q99^{III}\text{ etc.})^2 + \mathbf{14834}\,(Q02^{III}\text{ etc.}) - 378\,(Q02^{III}\text{ etc.})^2 + \mathbf{46472}\,Q^{II} + \mathbf{46538}\,Q^{III} + 3324\,Q^{IV}$	99.59%	
$U = \mathbf{503014} + \mathbf{18339}\,(Q98^{I}\text{ etc.}) - \mathbf{1183}\,(Q98^{I}\text{ etc.})^2 - \mathbf{27726}\,(Q00^{IV}\text{ etc.}) + \mathbf{7315}\,(Q00^{IV}\text{ etc.})^2 - \mathbf{45270}\,(Q02^{I}\text{ etc.}) - \mathbf{4192}\,(Q02^{I}\text{ etc.})^2 - \mathbf{28421}\,(Q04^{III}\text{ etc.}) - \mathbf{1881}\,(Q04^{III}\text{ etc.})^2 - \mathbf{42185}\,Q^{II} - \mathbf{46097}\,Q^{III} - \mathbf{20367}\,Q^{IV}$	96.57%	

NP = **4190453** − **29629** (Q98^{I} etc.) + **4537** (Q98^{I} etc.)^2 − **36129** (Q99^{IV} etc.) − 2333 (Q99^{IV} etc.)^2 + **31518** (Q01^{I} etc.) − **9055** (Q01^{I} etc.)^2 + **24434** (Q02^{III} etc.) + **6620** (Q02^{III} etc.)^2 + **14173** (Q04^{III} etc.) + 184 (Q04^{III} etc.)^2 − 3503 Q^{II} − 7719 Q^{III} + **8312** Q^{IV} 97.93%

Additional equation information

P>	$\lvert z_1\rvert$	$\lvert z_2\rvert$	$\lvert z_3\rvert$	$\lvert z_4\rvert$	$\lvert z_5\rvert$	$\lvert z_6\rvert$	$\lvert z_7\rvert$	$\lvert z_8\rvert$	$\lvert z_9\rvert$	$\lvert z_{10}\rvert$	$\lvert z_{11}\rvert$	$\lvert z_{12}\rvert$	$\lvert z_{13}\rvert$	$\lvert z_{14}\rvert$
Male involvement expressions														
• *Self-employed*	*0*	*0*	*0*	*0*	*0.004*	*0.001*	*0*	*0*	*0*	*0.351*	*0.028*	*0.791*		
• *Employers*	*0*	*0*	*0*	*0*	*0*	*0.005*	*0.015*	*0*	*0.002*	*0.775*	*0.003*	*0.001*		
• *Employees*	*0*	*0*	*0*	*0.002*	*0*	*0*	*0.716*	*0*	*0.024*	*0.041*	*0.376*	*0.737*		
• *Unpaid family members*	*0*	*0.06*	*0.006*	*0.001*	*0.023*	*0*	*0*	*0*	*0*	*0.056*	*0.866*	*0.962*		
Female involvement expressions														
• *Self-employed*	*0*	*0.067*	*0.389*	*0*	*0.693*	*0*	*0.054*	*0*	*0.001*	*0.295*	*0.94*	*0.105*		
• *Employers*	*0*	*0.705*	*0.001*	*0*	*0.722*	*0.001*	*0*	*0*	*0*	*0*	*0.189*	*0.596*	*0.214*	*0.645*
• *Employees*	*0*	*0.935*	*0.514*	*0.01*	*0.614*	*0.001*	*0*	*0*	*0*	*0.015*	*0.011*	*0.257*		
• *Unpaid family members*	*0*	*0.178*	*0*	*0*	*0*	*0*	*0*	*0.736*	*0.31*	*0.136*				
Male & female involvement in														
• *Other sectors (O)*	*0*	*0*	*0*	*0*	*0*	*0.001*	*0.157*	*0*	*0*	*0.652*				
• *Unemployment (U)*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*		
• *Non-participation (NP)*	*0*	*0*	*0*	*0*	*0.015*	*0*	*0*	*0*	*0*	*0*	*0.528*	*0.265*	*0.014*	*0.009*

Notes: As in Table 1. The r_d statistic relates the degree of correlation between (i) the non-seasonal component of the occupational equation and (ii) the sectoral equation "A" provided in Table 1 without its seasonal effects.

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

Table 5: SUR estimates of (i) professional groupings involved in agriculture and related activities, and (ii) involvement in other sectors (O), unemployment (U) and non-participation (NP) between the 1st quarter of 1998 ($Q98^{I}$) and 4th quarter of 2008 ($Q08^{IV}$) in Greece (All persons aged 15 years or older)

People in agriculture etc.	R^2	(r_d)
Senior officials, managers = $\mathbf{8027} - \mathbf{2174}\,(Q98^{I}\text{ etc.}) + \mathbf{178}\,(Q98^{I}\text{ etc.})^2 - \mathbf{1609}\,(Q00^{II}\text{ etc.}) - \mathbf{143}\,(Q00^{II}\text{ etc.})^2 - \mathbf{807}\,(Q04^{II}\text{ etc.}) - 18\,(Q04^{II}\text{ etc.})^2 - 368\,(Q07^{III}\text{ etc.}) + 19\,(Q07^{III}\text{ etc.})^2 + 270\,Q^{II} - 97\,Q^{III} - 246\,Q^{IV}$	70.05%	(21.71%)
Skilled primary sector workers = $\mathbf{672900} + \mathbf{6912}\,(Q98^{I}\text{ etc.}) - \mathbf{692}\,(Q98^{I}\text{ etc.})^2 + \mathbf{41885}\,(Q02^{II}\text{ etc.}) - \mathbf{3469}\,(Q02^{II}\text{ etc.})^2 + \mathbf{36213}\,(Q04^{II}\text{ etc.}) + \mathbf{4278}\,(Q04^{II}\text{ etc.})^2 - 3631Q^{II} - 917\,Q^{III} + 2266\,Q^{IV}$	97.81%	(98.89%)
Unskilled workers = $\mathbf{6569} + \mathbf{4363}\,(Q98^{I}\text{ etc.}) - \mathbf{623}\,(Q98^{I}\text{ etc.})^2 + \mathbf{2431}\,(Q99^{III}\text{ etc.}) + \mathbf{692}\,(Q99^{III}\text{ etc.})^2 - \mathbf{2914}\,(Q04^{II}\text{ etc.}) - 22\,(Q04^{II}\text{ etc.})^2 + 480\,Q^{II} - 21\,Q^{III} - 372\,Q^{IV}$	92.27%	(−78.02%)
Science/art professionals = $\mathbf{882} - \mathbf{96}\,(Q98^{I}\text{ etc.}) + 3\,(Q98^{I}\text{ etc.})^2 + \mathbf{278}\,(Q01^{II}\text{ etc.}) - \mathbf{38}\,(Q01^{II}\text{ etc.})^2 + \mathbf{216}\,(Q02^{IV}\text{ etc.}) + \mathbf{24}\,(Q02^{IV}\text{ etc.})^2 + \mathbf{143}\,(Q04^{III}\text{ etc.}) + \mathbf{14}\,(Q04^{III}\text{ etc.})^2 - \mathbf{112}\,Q^{II} - 73\,Q^{III} - 21\,Q^{IV}$	91.49%	(−40.28%)
Machine/plant operators and assemblers = $\mathbf{1834} - \mathbf{206}\,(Q98^{I}\text{ etc.}) + \mathbf{14}\,(Q98^{I}\text{ etc.})^2 - \mathbf{606}\,(Q01^{II}\text{ etc.}) + \mathbf{26}\,(Q01^{II}\text{ etc.})^2 - \mathbf{650}\,(Q03^{IV}\text{ etc.}) - 12\,(Q03^{IV}\text{ etc.})^2 - \mathbf{583}\,(Q06^{III}\text{ etc.}) - 5\,(Q06^{III}\text{ etc.})^2 + 201\,Q^{II} + 210\,Q^{III} + 142\,Q^{IV}$	72.50%	(41.50%)
Clerks, technicians, craft and service/sales workers = $\mathbf{896} - 22\,(Q98^{I}\text{ etc.}) + 2\,(Q98^{I}\text{ etc.})^2 - \mathbf{637}\,(Q02^{IV}\text{ etc.}) + \mathbf{96}\,(Q02^{IV}\text{ etc.})^2 - \mathbf{910}\,(Q04^{II}\text{ etc.}) - 53\,(Q04^{II}\text{ etc.})^2 - \mathbf{783}\,(Q06^{IV}\text{ etc.}) - \mathbf{17}\,(Q06^{IV}\text{ etc.}) + 46\,Q^{II} - 21\,Q^{III} - 17\,Q^{IV}$	82.59%	(−59.57%)
People in other economic activities		
$O = \mathbf{3218865} + \mathbf{44028}\,(Q98^{I}\text{ etc.}) - \mathbf{5201}\,(Q98^{I}\text{ etc.})^2 + \mathbf{33574}\,(Q99^{III}\text{ etc.}) + \mathbf{5342}\,(Q99^{III}\text{ etc.})^2 + \mathbf{13017}\,(Q02^{III}\text{ etc.}) - 531\,(Q02^{III}\text{ etc.})^2 + \mathbf{46750}\,Q^{II} + \mathbf{47857}\,Q^{III} + 4966\,Q^{IV}$	99.58%	
$U = \mathbf{500500} + \mathbf{19687}\,(Q98^{I}\text{ etc.}) - \mathbf{1311}\,(Q98^{I}\text{ etc.})^2 - \mathbf{20214}\,(Q00^{IV}\text{ etc.}) + \mathbf{6185}\,(Q00^{IV}\text{ etc.})^2 - \mathbf{37564}\,(Q02^{I}\text{ etc.}) - \mathbf{2987}\,(Q02^{I}\text{ etc.})^2 - \mathbf{29079}\,(Q04^{III}\text{ etc.}) - \mathbf{1800}\,(Q04^{III}\text{ etc.})^2 - \mathbf{42296}\,Q^{II} - \mathbf{45960}\,Q^{III} - \mathbf{20269}\,Q^{IV}$	96.60%	
$NP = \mathbf{4190427} - \mathbf{29856}\,(Q98^{I}\text{ etc.}) + \mathbf{4574}\,(Q98^{I}\text{ etc.})^2 - \mathbf{34737}\,(Q99^{IV}\text{ etc.}) - \mathbf{2809}\,(Q99^{IV}\text{ etc.})^2 + \mathbf{35468}\,(Q01^{I}\text{ etc.}) - \mathbf{8741}\,(Q01^{I}\text{ etc.})^2 + \mathbf{24033}\,(Q02^{III}\text{ etc.}) + \mathbf{6828}\,(Q02^{III}\text{ etc.})^2 + \mathbf{13436}\,(Q04^{III}\text{ etc.}) + 105\,(Q04^{III}\text{ etc.})^2 - 3561\,Q^{II} - 7665\,Q^{III} + \mathbf{8452}\,Q^{IV}$	97.95%	

Additional equation information:

P>	$\|z_1\|$	$\|z_2\|$	$\|z_3\|$	$\|z_4\|$	$\|z_5\|$	$\|z_6\|$	$\|z_7\|$	$\|z_8\|$	$\|z_9\|$	$\|z_{10}\|$	$\|z_{11}\|$	$\|z_{12}\|$	$\|z_{13}\|$	$\|z_{14}\|$
People in agriculture etc.														
• *Senior officials, managers*	0	0	0	0	0	0	0.024	0.249	0.648	0.328	0.729	0.382		
• *Skilled primary sector workers*	0	0.003	0	0	0	0	0	0.483	0.86	0.665				
• *Unskilled workers*	0	0	0	0.001	0	0	0.011	0.344	0.967	0.472				
• *Science/art professionals*	0	0.001	0.136	0	0	0.005	0.002	0.002	0.007	0.004	0.064	0.601		
• *Plant/machine operators and assemblers*	0	0.001	0.001	0	0	0	0.045	0	0.426	0.024	0.019	0.117		
• *Clerks, technicians, craft & service/sales workers*	0	0.029	0.325	0	0	0.002	0	0	0.782	0.462	0.01	0.008		
Male & female involvement in														
• *Other sectors (O)*	0	0	0	0	0	0	0.025	0	0	0.541				
• *Unemployment (U)*	0	0	0	0	0	0	0	0	0	0	0	0		
• *Non-participation (NP)*	0	0	0	0	0	0	0	0	0	0	0.19	0.23	0.017	0.009

Notes: As in Table 1. The r_d statistic relates the degree of correlation between (i) the non-seasonal component of the professional equation and (ii) the sectoral equation "A" provided in Table 1 without its seasonal effects.

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

Table 6: SUR estimates of regional male and female involvement in agriculture and related activities, and male and female involvement in other sectors (O), unemployment (U) and non-participation (NP) between the 1st quarter of 1998 (Q98^{I}) and 4th quarter of 2008 (Q08^{IV}) in Greece (All persons aged 15 years or older)

Males per region	R^2	(r_d)
Attiki = **9606** – **1472** (Q98^{I} etc.) + **189** (Q98^{I} etc.)^2 – **1033** (Q99^{IV} etc.) – **203** (Q99^{IV} etc.)^2 + **966** (Q05^{I} etc.) – **32** (Q05^{I} etc.)^2 + **3245** (Q07^{IV} etc.) – **266** (Q07^{IV} etc.)^2 – 250 Q^{II} – 32 Q^{III} – 49 Q^{IV}	91.05%	(30.26%)
C. Greece, Euboea = **33972** – **2289** (Q98^{I} etc.) + **156** (Q98^{I} etc.)^2 – **2995** (Q00^{IV} etc.) + **68** (Q00^{IV} etc.)^2 – **4295** (Q03^{I} etc.) – **127** (Q03^{I} etc.)^2 – **1754** (Q07^{III} etc.) – 83 (Q07^{III} etc.)^2 – 461 Q^{II} – 508 Q^{III} – 601 Q^{IV}	93.67%	(83.37%)
C. Macedonia = **78875** – 289 (Q98^{I} etc.) + 58 (Q98^{I} etc.)^2 – **3103** (Q00^{III} etc.) – 3 (Q00^{III} etc.)^2 + **6281** (Q02^{IV} etc.) – **1034** (Q02^{IV} etc.)^2 + **4486** (Q04^{II} etc.) + **1070** (Q04^{II} etc.)^2 + 468 Q^{II} + 882 Q^{III} + 107 Q^{IV}	98.78%	(97.76%)
Crete = **46350** – 421 (Q98^{I} etc.) – 13 (Q98^{I} etc.)^2 + **1513** (Q00^{IV} etc.) – 41 (Q00^{IV} etc.)^2 – **3375** (Q03^{IV} etc.) + **346** (Q03^{IV} etc.)^2 – **3305** (Q06^{II} etc.) – **222** (Q06^{II} etc.)^2 – 1228 Q^{II} – **1475** Q^{III} – 262 Q^{IV}	97.11%	(93.89%)
E. Macedonia, Thrace = **46237** – 360 (Q98^{I} etc.) – **47** (Q98^{I} etc.)^2 + **2378** (Q01^{II} etc.) – 40 (Q01^{II} etc.)^2 + **1137** (Q04^{II} etc.) + **102** (Q04^{II} etc.)^2 + **1146** Q^{II} + **1415** Q^{III} + **1605** Q^{IV}	97.51%	(95.05%)
Epiros = **12637** + 356 (Q98^{I} etc.) – 12 (Q98^{I} etc.)^2 – **798** (Q00^{IV} etc.) **+ 90** (Q00^{IV} etc.)^2 – **664** (Q02^{III} etc.) – **102** (Q02^{III} etc.)^2 + **1019** (Q04^{II} etc.) + 5 (Q04^{II} etc.)^2 – 150 Q^{II} – **530** Q^{III} – **552** Q^{IV}	81.71%	(68.02%)
Ionian Isl. = **9923** + 92 (Q98^{I} etc.) – 5 (Q98^{I} etc.)^2 – **506** (Q03^{II} etc.) + **54** (Q03^{II} etc.)^2 + **686** (Q05^{II} etc.) – **175** (Q05^{II} etc.)^2 + **1880** (Q07^{I} etc.) + **114** (Q07^{I} etc.)^2 – **957** Q^{II} – **922** Q^{III} – 265 Q^{IV}	87.24%	(67.92%)
N. Aegean Isl. = **7347** – 516 (Q98^{I} etc.) + **80** (Q98^{I} etc.)^2 – **1649** (Q00^{I} etc.) + 0 (Q00^{I} etc.)^2 – **1689** (Q02^{III} etc.) + 27 (Q02^{III} etc.)^2 – **692** (Q04^{III} etc.) – **133** (Q04^{III} etc.)^2 + **1140** (Q07^{I} etc.) – **62** (Q07^{I} etc.)^2 – 195 Q^{II} – 287 Q^{III} – 41 Q^{IV}	67.48%	(48.81%)
Peloponnesos = **50930** – **793** (Q98^{I} etc.) + **31** (Q98^{I} etc.)^2 + **4406** (Q03^{II} etc.) – **2288** (Q03^{II} etc.)^2 + **8257** (Q04^{I} etc.) + **2332** (Q04^{I} etc.)^2 – **3284** (Q06^{IV} etc.) + **97** (Q06^{IV} etc.)^2 – 524 Q^{II} – 276 Q^{III} + 1227 Q^{IV}	71.84%	(77.48%)
S. Aegean Isl. = **4014** + 324 (Q98^{I} etc.) – 9 (Q98^{I} etc.)^2 – **729** (Q00^{II} etc.) + **38** (Q00^{II} etc.)^2 – **1467** (Q04^{IV} etc.) + 33 (Q04^{IV} etc.)^2 + **1038** (Q06^{II} etc.) – **131** (Q06^{II} etc.)^2 – 274 Q^{II} – **460** Q^{III} – 271 Q^{IV}	89.30%	(55.97%)
Thessaly = **50319** + 694 (Q98^{I} etc.) – **59** (Q98^{I} etc.)^2 + **4072** (Q02^{III} etc.) – **436** (Q02^{III} etc.)^2 + **3388** (Q03^{IV} etc.) + **446** (Q03^{IV} etc.)^2 + **1676** (Q06^{III} etc.) – 35 (Q06^{III} etc.)^2 + 620 Q^{II} + 780 Q^{III} + 734 Q^{IV}	87.22%	(96.88%)
W. Greece = **54855** – **1304** (Q98^{I} etc.) + **126** (Q98^{I} etc.)^2 – **1373** (Q00^{III} etc.) – **186** (Q00^{III} etc.)^2 + **1181** (Q04^{I} etc.) + **80** (Q04^{I} etc.)^2 – 335 Q^{II} + 1089 Q^{III} + **1576** Q^{IV}	96.56%	(94.35%)
W. Macedonia = **12642** – **278** (Q98^{I} etc.) – 1 (Q98^{I} etc.)^2 + **666** (Q02^{I} etc.) + 4 (Q02^{I} etc.)^2 – **1234** (Q03^{IV} etc.) + **56** (Q03^{IV} etc.)^2 – **707** (Q06^{IV} etc.) – **39** (Q06^{IV} etc.)^2 + 23 Q^{II} + 297 Q^{III} + 443 Q^{IV}	88.79%	(64.82%)

Females per region	R^2	(r_d)
Attiki = $\mathbf{5340} - \mathbf{439}\ (Q98^{I}\text{ etc.}) + \mathbf{88}\ (Q98^{I}\text{ etc.})^2 - \mathbf{1047}\ (Q00^{I}\text{ etc.}) - \mathbf{84}\ (Q00^{I}\text{ etc.})^2 - \mathbf{589}\ (Q02^{IV}\text{ etc.}) + \mathbf{22}\ (Q02^{IV}\text{ etc.})^2 - \mathbf{444}\ (Q06^{II}\text{ etc.}) + \mathbf{24}\ (Q06^{II}\text{ etc.})^2 - 74\ Q^{II} - 89\ Q^{III} - 71\ Q^{IV}$	93.9%	(62.92%)
C. Greece, Euboea = $\mathbf{21128} + 248\ (Q98^{I}\text{ etc.}) - \mathbf{40}\ (Q98^{I}\text{ etc.})^2 + \mathbf{4589}\ (Q02^{II}\text{ etc.}) - \mathbf{363}\ (Q02^{II}\text{ etc.})^2 + \mathbf{2644}\ (Q04^{II}\text{ etc.}) + \mathbf{441}\ (Q04^{II}\text{ etc.})^2 - \mathbf{958}\ (Q07^{II}\text{ etc.}) - 15\ (Q07^{II}\text{ etc.})^2 - 328\ Q^{II} - 614\ Q^{III} - 32\ Q^{IV}$	86.44%	(77.40%)
C. Macedonia = $\mathbf{43491} - 653\ (Q98^{I}\text{ etc.}) + \mathbf{49}\ (Q98^{I}\text{ etc.})^2 - \mathbf{5430}\ (Q01^{II}\text{ etc.}) + \mathbf{511}\ (Q01^{II}\text{ etc.})^2 + \mathbf{3421}\ (Q03^{II}\text{ etc.}) - \mathbf{2672}\ (Q03^{II}\text{ etc.})^2 + \mathbf{8701}\ (Q04^{II}\text{ etc.}) + \mathbf{2137}\ (Q04^{II}\text{ etc.})^2 + 1140\ Q^{II} + \mathbf{1632}\ Q^{III} + 381\ Q^{IV}$	92.12%	(79.34%)
Crete = $\mathbf{34115} + \mathbf{1108}\ (Q98^{I}\text{ etc.}) - \mathbf{108}\ (Q98^{I}\text{ etc.})^2 + \mathbf{876}\ (Q00^{II}\text{ etc.}) + 64\ (Q00^{II}\text{ etc.})^2 + \mathbf{1281}\ (Q04^{I}\text{ etc.}) + 20\ (Q04^{I}\text{ etc.})^2 - 707\ Q^{II} - 396\ Q^{III} + 197\ Q^{IV}$	96.98%	(93.77%)
E. Macedonia, Thrace = $\mathbf{40064} - 349\ (Q98^{I}\text{ etc.}) + \mathbf{108}\ (Q98^{I}\text{ etc.})^2 - \mathbf{3067}\ (Q99^{IV}\text{ etc.}) + 46\ (Q99^{IV}\text{ etc.})^2 - \mathbf{1969}\ (Q02^{II}\text{ etc.}) - \mathbf{256}\ (Q02^{II}\text{ etc.})^2 + \mathbf{1358}\ (Q04^{II}\text{ etc.}) + \mathbf{112}\ (Q04^{II}\text{ etc.})^2 + \mathbf{1229}\ Q^{II} + \mathbf{1876}\ Q^{III} + \mathbf{1129}\ Q^{IV}$	97.24%	(94.89%)
Epiros = $\mathbf{11836} + 78\ (Q98^{I}\text{ etc.}) + 23\ (Q98^{I}\text{ etc.})^2 - \mathbf{2202}\ (Q00^{III}\text{ etc.}) + \mathbf{163}\ (Q00^{III}\text{ etc.})^2 - \mathbf{1050}\ (Q02^{II}\text{ etc.}) - \mathbf{191}\ (Q02^{II}\text{ etc.})^2 + \mathbf{862}\ (Q05^{IV}\text{ etc.}) - \mathbf{36}\ (Q05^{II}\text{ etc.})^2 + 24\ Q^{II} - 54\ Q^{III} - 420\ Q^{IV}$	81.64%	(41.75%)
Ionian Isl. = $\mathbf{10700} + \mathbf{410}\ (Q98^{I}\text{ etc.}) - \mathbf{29}\ (Q98^{I}\text{ etc.})^2 + \mathbf{711}\ (Q03^{I}\text{ etc.}) + 7\ (Q03^{I}\text{ etc.})^2 + \mathbf{1269}\ (Q04^{IV}\text{ etc.}) - \mathbf{78}\ (Q04^{IV}\text{ etc.})^2 + \mathbf{1073}\ (Q07^{II}\text{ etc.}) + \mathbf{132}\ (Q07^{II}\text{ etc.})^2 - 232\ Q^{II} - 473\ Q^{III} - 321\ Q^{IV}$	96.83%	(88.74%)
N. Aegean Isl. = $\mathbf{3871} + \mathbf{526}\ (Q98^{I}\text{ etc.}) - \mathbf{31}\ (Q98^{I}\text{ etc.})^2 + \mathbf{1324}\ (Q02^{I}\text{ etc.}) - \mathbf{172}\ (Q02^{I}\text{ etc.})^2 + \mathbf{1696}\ (Q03^{II}\text{ etc.}) + 37\ (Q03^{II}\text{ etc.})^2 + \mathbf{1302}\ (Q04^{II}\text{ etc.}) + 136\ (Q04^{II}\text{ etc.})^2 - 484\ Q^{II} - \mathbf{532}\ Q^{III} - 38\ Q^{IV}$	76.38%	(39.50%)
Peloponnesos = $\mathbf{36295} + \mathbf{3657}\ (Q98^{I}\text{ etc.}) - \mathbf{489}\ (Q98^{I}\text{ etc.})^2 + \mathbf{3938}\ (Q99^{IV}\text{ etc.}) + \mathbf{325}\ (Q99^{IV}\text{ etc.})^2 + \mathbf{5512}\ (Q02^{I}\text{ etc.}) - \mathbf{236}\ (Q02^{I}\text{ etc.})^2 + \mathbf{4906}\ (Q04^{II}\text{ etc.}) + \mathbf{353}\ (Q04^{II}\text{ etc.})^2 - 700\ Q^{II} - 536\ Q^{III} + 309\ Q^{IV}$	88.69%	(77.22%)
S. Aegean Isl. = $\mathbf{2163} + \mathbf{736}\ (Q98^{I}\text{ etc.}) - \mathbf{64}\ (Q98^{I}\text{ etc.})^2 + \mathbf{413}\ (Q00^{IV}\text{ etc.}) + \mathbf{99}\ (Q00^{IV}\text{ etc.})^2 - \mathbf{758}\ (Q03^{IV}\text{ etc.}) - \mathbf{49}\ (Q03^{IV}\text{ etc.})^2 + \mathbf{387}\ (Q05^{IV}\text{ etc.}) + 22\ (Q05^{IV}\text{ etc.})^2 + 117\ Q^{II} + 1\ Q^{III} - 190\ Q^{IV}$	85.57%	(57.42%)
Thessaly = $\mathbf{34542} - 413\ (Q98^{I}\text{ etc.}) - 106\ (Q98^{I}\text{ etc.})^2 + \mathbf{3008}\ (Q99^{III}\text{ etc.}) - 103\ (Q99^{III}\text{ etc.})^2 + \mathbf{3315}\ (Q01^{III}\text{ etc.}) + \mathbf{144}\ (Q01^{III}\text{ etc.})^2 + \mathbf{721}\ (Q06^{II}\text{ etc.}) + \mathbf{58}\ (Q06^{II}\text{ etc.})^2 + 807\ Q^{II} + 810\ Q^{III} - 223\ Q^{IV}$	91.24%	(60.19%)
W. Greece = $\mathbf{35974} + \mathbf{824}\ (Q98^{I}\text{ etc.}) - \mathbf{95}\ (Q98^{I}\text{ etc.})^2 + \mathbf{2393}\ (Q01^{II}\text{ etc.}) - 10\ (Q01^{II}\text{ etc.})^2 + \mathbf{1473}\ (Q04^{II}\text{ etc.}) + \mathbf{105}\ (Q04^{II}\text{ etc.})^2 + 475\ Q^{II} - 640\ Q^{III} - 107\ Q^{IV}$	96.23%	(97.28%)
W. Macedonia = $\mathbf{11685} - 667\ (Q98^{I}\text{ etc.}) + 33\ (Q98^{I}\text{ etc.})^2 + \mathbf{1319}\ (Q99^{II}\text{ etc.}) - \mathbf{169}\ (Q99^{II}\text{ etc.})^2 + \mathbf{978}\ (Q01^{I}\text{ etc.}) + \mathbf{130}\ (Q01^{I}\text{ etc.})^2 - 150\ (Q04^{I}\text{ etc.}) + \mathbf{16}\ (Q04^{I}\text{ etc.})^2 + 212\ Q^{II} + \mathbf{407}\ Q^{III} + \mathbf{373}\ Q^{IV}$	91.38%	(91.41%)

Table 6 (continued)

Males and females in other economic activities	
$O = \mathbf{3208794} + \mathbf{49153}\,(Q98^{I}\text{ etc.}) - \mathbf{5746}\,(Q98^{I}\text{ etc.})^2 + \mathbf{35668}\,(Q99^{III}\text{ etc.}) + \mathbf{5804}\,(Q99^{III}\text{ etc.})^2 + \mathbf{14782}\,(Q02^{III}\text{ etc.}) - 462\,(Q02^{III}\text{ etc.})^2 + \mathbf{46626}\,Q^{II} + \mathbf{47469}\,Q^{III} + 4475\,Q^{IV}$	99.58%
$U = \mathbf{495692} + \mathbf{21709}\,(Q98^{I}\text{ etc.}) - \mathbf{1458}\,(Q98^{I}\text{ etc.})^2 - \mathbf{19480}\,(Q00^{IV}\text{ etc.}) + \mathbf{6589}\,(Q00^{IV}\text{ etc.})^2 - \mathbf{43017}\,(Q02^{I}\text{ etc.}) - \mathbf{2893}\,(Q02^{I}\text{ etc.})^2 - \mathbf{33993}\,(Q04^{III}\text{ etc.}) - \mathbf{2093}\,(Q04^{III}\text{ etc.})^2 - \mathbf{42577}\,Q^{II} - \mathbf{46249}\,Q^{III} - \mathbf{20817}\,Q^{IV}$	96.64%
$NP = \mathbf{4177066} - \mathbf{19484}\,(Q98^{I}\text{ etc.}) + \mathbf{3174}\,(Q98^{I}\text{ etc.})^2 - \mathbf{18194}\,(Q99^{IV}\text{ etc.}) - \mathbf{2602}\,(Q99^{IV}\text{ etc.})^2 + \mathbf{40685}\,(Q01^{I}\text{ etc.}) - \mathbf{7563}\,(Q01^{I}\text{ etc.})^2 + \mathbf{24834}\,(Q02^{III}\text{ etc.}) + \mathbf{6657}\,(Q02^{III}\text{ etc.})^2 + \mathbf{15481}\,(Q04^{III}\text{ etc.}) + 278\,(Q04^{III}\text{ etc.})^2 - 3754\,Q^{II} - 7502\,Q^{III} + \mathbf{8256}\,Q^{IV}$	98.02%

Additional equation information

P>	$\lvert z_1\rvert$	$\lvert z_2\rvert$	$\lvert z_3\rvert$	$\lvert z_4\rvert$	$\lvert z_5\rvert$	$\lvert z_6\rvert$	$\lvert z_7\rvert$	$\lvert z_8\rvert$	$\lvert z_9\rvert$	$\lvert z_{10}\rvert$	$\lvert z_{11}\rvert$	$\lvert z_{12}\rvert$	$\lvert z_{13}\rvert$	$\lvert z_{14}\rvert$
Male involvement expressions														
• Attiki	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.201*	*0.872*	*0.806*		
• C. Greece, Euboea	*0*	*0*	*0*	*0*	*0.005*	*0*	*0*	*0*	*0.018*	*0.236*	*0.193*	*0.127*		
• C. Macedonia	*0*	*0.539*	*0.116*	*0*	*0.95*	*0*	*0*	*0*	*0*	*0.421*	*0.132*	*0.855*		
• Crete	*0*	*0.23*	*0.593*	*0*	*0.135*	*0*	*0*	*0*	*0*	*0.022*	*0.006*	*0.629*		
• E. Macedonia, Thrace	*0*	*0.136*	*0.002*	*0*	*0.018*	*0*	*0*	*0.004*	*0*	*0*				
• Epiros	*0*	*0.029*	*0.325*	*0*	*0*	*0.002*	*0*	*0*	*0.782*	*0.462*	*0.01*	*0.008*		
• Ionian Isl.	*0*	*0.16*	*0.062*	*0.002*	*0*	*0.002*	*0*	*0*	*0*	*0*	*0*	*0.183*		
• N. Aegean Isl.	*0*	*0.018*	*0*	*0*	*1*	*0*	*0.096*	*0*	*0*	*0*	*0*	*0.354*	*0.175*	*0.849*
• Peloponnesos	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.004*	*0.45*	*0.691*	*0.079*		
• S. Aegean Isl.	*0*	*0.032*	*0.524*	*0*	*0.004*	*0*	*0.031*	*0*	*0*	*0.054*	*0.001*	*0.061*		
• Thessaly	*0*	*0.041*	*0*	*0*	*0*	*0*	*0*	*0*	*0.425*	*0.498*	*0.396*	*0.428*		
• W. Greece	*0*	*0.005*	*0.001*	*0.001*	*0*	*0*	*0*	*0.571*	*0.067*	*0.008*				
• W. Macedonia	*0*	*0.001*	*0.836*	*0*	*0.791*	*0*	*0*	*0*	*0*	*0.896*	*0.096*	*0.014*		

Female involvement expressions														
• *Attiki*	*0*	*0.005*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.614*	*0.544*	*0.63*		
• *C. Greece, Euboea*	*0*	*0.105*	*0*	*0*	*0*	*0*	*0*	*0*	*0.634*	*0.395*	*0.113*	*0.935*		
• *C. Macedonia*	*0*	*0.041*	*0.014*	*0*	*0*	*0*	*0*	*0*	*0*	*0.032*	*0.002*	*0.478*		
• *Crete*	*0*	*0.004*	*0.001*	*0.005*	*0.052*	*0*	*0.037*	*0.142*	*0.413*	*0.686*				
• *E. Macedonia, Thrace*	*0*	*0.37*	*0.008*	*0*	*0.26*	*0*	*0*	*0*	*0*	*0.002*	*0*	*0.005*		
• *Epiros*	*0*	*0.611*	*0.046*	*0*	*0*	*0*	*0*	*0*	*0*	*0.901*	*0.779*	*0.031*		
• *Ionian Isl.*	*0*	*0*	*0*	*0*	*0.648*	*0*	*0*	*0*	*0*	*0.231*	*0.015*	*0.101*		
• *N. Aegean Isl.*	*0*	*0*	*0*	*0*	*0*	*0*	*0.54*	*0*	*0.018*	*0.017*	*0.009*	*0.855*		
• *Peloponnesos*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.167*	*0.293*	*0.547*		
• *S. Aegean Isl*	*0*	*0*	*0*	*0.001*	*0*	*0*	*0*	*0.003*	*0.034*	*0.224*	*0.995*	*0.198*		
• *Thessaly*	*0*	*0.531*	*0.189*	*0*	*0.225*	*0*	*0*	*0.007*	*0.002*	*0.057*	*0.058*	*0.604*		
• *W. Greece*	*0*	*0.01*	*0*	*0*	*0.673*	*0*	*0*	*0.389*	*0.248*	*0.848*	*0*	*0.01*		
• *W. Macedonia*	*0*	*0.022*	*0.457*	*0*	*0*	*0*	*0*	*0.055*	*0*	*0.085*	*0.001*	*0.003*		
Male & female involvement in														
• *Other sectors (O)*	*0*	*0*	*0*	*0*	*0*	*0*	*0.025*	*0*	*0*	*0.541*				
• *Unemployment (U)*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*		
• *Non-participation (NP)*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.19*	*0.23*	*0.017*	*0.009*

Notes: As in Table 1. The r_d statistic relates the degree of correlation between (i) the non-seasonal component of the regional version and (ii) the sectoral equation "A" provided in Table 1 without its seasonal effects.

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

Table 7: SUR estimates of gender and age group involvement in agriculture and related activities, and involvement in other sectors (O), unemployment (U) and non-participation (NP) between the 1st quarter of 1998 ($Q98^{I}$) and 4th quarter of 2008 ($Q08^{IV}$) in Greece (All persons aged 15 years or older)

Males	R^2	(r_d)
Aged 15-19 = $\mathbf{14406} - \mathbf{994}\,(Q98^{I}\text{ etc.}) + \mathbf{64}\,(Q98^{I}\text{ etc.})^2 - \mathbf{1500}\,(Q01^{I}\text{ etc.}) - 25\,(Q01^{I}\text{ etc.})^2 - \mathbf{1655}\,(Q04^{IV}\text{ etc.}) + \mathbf{187}\,(Q04^{IV}\text{ etc.})^2 - \mathbf{1144}\,(Q06^{II}\text{ etc.}) - \mathbf{266}\,(Q06^{II}\text{ etc.})^2 + 437\,Q^{II} + \mathbf{1229}\,Q^{III} + \mathbf{621}\,Q^{IV}$	97.27%	(90.13%)
Aged 20-24 = $\mathbf{32699} - 1456\,(Q98^{I}\text{ etc.}) + 130\,(Q98^{I}\text{ etc.})^2 - \mathbf{1399}\,(Q00^{I}\text{ etc.}) - 129\,(Q00^{I}\text{ etc.})^2 + \mathbf{2899}\,(Q05^{IV}\text{ etc.}) - \mathbf{523}\,(Q05^{IV}\text{ etc.})^2 + \mathbf{3779}\,(Q07^{I}\text{ etc.}) + \mathbf{475}\,(Q07^{I}\text{ etc.})^2 - 193\,Q^{II} - 34\,Q^{III} + 292\,Q^{IV}$	97.15%	(95.98%)
Aged 25-29 = $\mathbf{37805} - \mathbf{1986}\,(Q98^{I}\text{ etc.}) + \mathbf{141}\,(Q98^{I}\text{ etc.})^2 - \mathbf{4696}\,(Q01^{IV}\text{ etc.}) + \mathbf{71}\,(Q01^{IV}\text{ etc.})^2 - \mathbf{2910}\,(Q03^{IV}\text{ etc.}) - \mathbf{81}\,(Q03^{IV}\text{ etc.})^2 - \mathbf{1898}\,(Q06^{II}\text{ etc.}) - \mathbf{78}\,(Q06^{II}\text{ etc.})^2 - 196\,Q^{II} - 55\,Q^{III} + 790\,Q^{IV}$	97.96%	(80.56%)
Aged 30-44 = $\mathbf{101101} + \mathbf{2795}\,(Q98^{I}\text{ etc.}) - \mathbf{145}\,(Q98^{I}\text{ etc.})^2 + \mathbf{6708}\,(Q02^{II}\text{ etc.}) - \mathbf{495}\,(Q02^{II}\text{ etc.})^2 + \mathbf{6228}\,(Q04^{II}\text{ etc.}) + \mathbf{505}\,(Q04^{II}\text{ etc.})^2 + \mathbf{2857}\,(Q06^{IV}\text{ etc.}) + \mathbf{196}\,(Q06^{IV}\text{ etc.})^2 - 2042\,Q^{II} - 2388\,Q^{III} - 1486\,Q^{IV}$	88.51%	(82.78%)
Aged 45-64 = $\mathbf{193526} - 3644\,(Q98^{I}\text{ etc.}) + 54\,(Q98^{I}\text{ etc.})^2 + 4119\,(Q99^{III}\text{ etc.}) - 380\,(Q99^{III}\text{ etc.})^2 + \mathbf{13940}\,(Q02^{II}\text{ etc.}) - \mathbf{869}\,(Q02^{II}\text{ etc.})^2 + \mathbf{8898}\,(Q04^{II}\text{ etc.}) + \mathbf{1306}\,(Q04^{II}\text{ etc.})^2 - 793\,Q^{II} - 318\,Q^{III} - 1909\,Q^{IV}$	97.84%	(97.77%)
Aged ≥ 65 = $\mathbf{33078} + \mathbf{3573}\,(Q98^{I}\text{ etc.}) - \mathbf{399}\,(Q98^{I}\text{ etc.})^2 + \mathbf{3628}\,(Q00^{I}\text{ etc.}) + \mathbf{184}\,(Q00^{I}\text{ etc.})^2 + \mathbf{6871}\,(Q02^{I}\text{ etc.}) - \mathbf{319}\,(Q02^{I}\text{ etc.})^2 + \mathbf{6030}\,(Q04^{II}\text{ etc.}) + \mathbf{505}\,(Q04^{II}\text{ etc.})^2 - 132\,Q^{II} + 7\,Q^{III} + 90\,Q^{IV}$	93.44%	(92.18%)
Females		
Aged 15-19 = $\mathbf{5759} + 437\,(Q98^{I}\text{ etc.}) - \mathbf{50}\,(Q98^{I}\text{ etc.})^2 + \mathbf{1802}\,(Q00^{III}\text{ etc.}) - \mathbf{209}\,(Q00^{III}\text{ etc.})^2 + \mathbf{1874}\,(Q02^{I}\text{ etc.}) + \mathbf{205}\,(Q02^{I}\text{ etc.})^2 + \mathbf{895}\,(Q04^{IV}\text{ etc.}) + \mathbf{50}\,(Q04^{IV}\text{ etc.})^2 + 463\,Q^{II} + \mathbf{1322}\,Q^{III} + 374\,Q^{IV}$	93.09%	(95.07%)
Aged 20-24 = $\mathbf{11580} - \mathbf{1569}\,(Q98^{I}\text{ etc.}) + \mathbf{282}\,(Q98^{I}\text{ etc.})^2 - \mathbf{3128}\,(Q00^{I}\text{ etc.}) - \mathbf{163}\,(Q00^{I}\text{ etc.})^2 - \mathbf{1428}\,(Q05^{IV}\text{ etc.}) - \mathbf{103}\,(Q05^{IV}\text{ etc.})^2 - \mathbf{602}\,(Q07^{I}\text{ etc.}) + 2\,(Q07^{I}\text{ etc.})^2 - 43\,Q^{II} + 301\,Q^{III} + 209\,Q^{IV}$	97.48%	(92.15%)
Aged 25-29 = $\mathbf{13542} + \mathbf{1027}\,(Q98^{I}\text{ etc.}) - \mathbf{90}\,(Q98^{I}\text{ etc.})^2 + \mathbf{1431}\,(Q01^{II}\text{ etc.}) + \mathbf{86}\,(Q01^{II}\text{ etc.})^2 - \mathbf{1583}\,(Q04^{I}\text{ etc.}) + \mathbf{240}\,(Q04^{I}\text{ etc.})^2 - \mathbf{1937}\,(Q05^{III}\text{ etc.}) - \mathbf{212}\,(Q05^{III}\text{ etc.})^2 + 8\,Q^{II} - 23\,Q^{III} + 60\,Q^{IV}$	92.21%	(93.10%)
Aged 30-44 = $\mathbf{74964} + 1149\,(Q98^{I}\text{ etc.}) - 58\,(Q98^{I}\text{ etc.})^2 - \mathbf{7243}\,(Q00^{IV}\text{ etc.}) + \mathbf{1016}\,(Q00^{IV}\text{ etc.})^2 - \mathbf{2838}\,(Q02^{III}\text{ etc.}) - \mathbf{1553}\,(Q02^{III}\text{ etc.})^2 + \mathbf{4972}\,(Q04^{II}\text{ etc.}) + \mathbf{577}\,(Q04^{II}\text{ etc.})^2 - 244\,Q^{II} - 855\,Q^{III} - 780\,Q^{IV}$	95.36%	(88.16%)
Aged 45-64 = $\mathbf{165770} + 126\,(Q98^{I}\text{ etc.}) - 2\,(Q98^{I}\text{ etc.})^2 - \mathbf{5342}\,(Q00^{III}\text{ etc.}) + \mathbf{335}\,(Q00^{III}\text{ etc.})^2 - \mathbf{15203}\,(Q03^{IV}\text{ etc.}) + \mathbf{937}\,(Q03^{IV}\text{ etc.})^2 - \mathbf{8824}\,(Q05^{III}\text{ etc.}) - \mathbf{1139}\,(Q05^{III}\text{ etc.})^2 - 74\,Q^{II} + 327\,Q^{III} + 1388\,Q^{IV}$	96.61%	(98.56%)
Aged ≥ 65 = $\mathbf{20633} + \mathbf{2524}\,(Q98^{I}\text{ etc..}) - \mathbf{442}\,(Q98^{I}\text{ etc.})^2 + \mathbf{5308}\,(Q99^{IV}\text{ etc.}) + \mathbf{267}\,(Q99^{IV}\text{ etc.})^2 + \mathbf{3700}\,(Q02^{II}\text{ etc.}) - \mathbf{107}\,(Q02^{II}\text{ etc.})^2 + \mathbf{3010}\,(Q04^{II}\text{ etc.}) + \mathbf{263}\,(Q04^{II}\text{ etc.})^2 - 26\,Q^{II} - 6\,Q^{III} - 160\,Q^{IV}$	96.13%	(92.09%)

Males and females in other economic activities	R^2
$O = \mathbf{3209363} + \mathbf{50749}\,(Q98^{I}\text{ etc.}) - \mathbf{6126}\,(Q98^{I}\text{ etc.})^2 + \mathbf{39753}\,(Q99^{III}\text{ etc.}) + \mathbf{6106}\,(Q99^{III}\text{ etc.})^2 + \mathbf{15919}\,(Q02^{III}\text{ etc.}) - 396\,(Q02^{III}\text{ etc.})^2 + \mathbf{46846}\,Q^{II} + \mathbf{47597}\,Q^{III} + 4641\,Q^{IV}$	99.58%
$U = \mathbf{493914} + \mathbf{22556}\,(Q98I\text{ etc.}) - \mathbf{1519}\,(Q98I\text{ etc.})^2 - \mathbf{22668}\,(Q00^{IV}\text{ etc.}) + \mathbf{7317}\,(Q00^{IV}\text{ etc.})^2 - \mathbf{42945}\,(Q02^{I}\text{ etc.}) - \mathbf{3909}\,(Q02^{I}\text{ etc.})^2 - \mathbf{28611}\,(Q04^{III}\text{ etc.}) - \mathbf{1813}\,(Q04^{III}\text{ etc.})^2 - \mathbf{42429}\,Q^{II} - \mathbf{46315}\,Q^{III} - \mathbf{20772}\,Q^{IV}$	96.62%
$NP = \mathbf{4180481} - \mathbf{22090}\,(Q98^{I}\text{ etc.}) + \mathbf{3488}\,(Q98^{I}\text{ etc.})^2 - \mathbf{19587}\,(Q99^{IV}\text{ etc.}) - \mathbf{3006}\,(Q99^{IV}\text{ etc.})^2 + \mathbf{42843}\,(Q01^{I}\text{ etc.}) - \mathbf{7805}\,(Q01^{I}\text{ etc.})^2 + \mathbf{26858}\,(Q02^{III}\text{ etc.}) + \mathbf{7065}\,(Q02^{III}\text{ etc.})^2 + \mathbf{14452}\,(Q04^{III}\text{ etc.}) + 209\,(Q04^{III}\text{ etc.})2 - 3640\,Q^{II} - 7403\,Q^{III} + \mathbf{8432}\,Q^{IV}$	98.07%

Additional equation information

P>	$\lvert z_1\rvert$	$\lvert z_2\rvert$	$\lvert z_3\rvert$	$\lvert z_4\rvert$	$\lvert z_5\rvert$	$\lvert z_6\rvert$	$\lvert z_7\rvert$	$\lvert z_8\rvert$	$\lvert z_9\rvert$	$\lvert z_{10}\rvert$	$\lvert z_{11}$	$\lvert z_{12}\rvert$	$\lvert z_{13}\rvert$	$\lvert z_{14}\rvert$
Male involvement expressions														
• Aged 15-19	*0*	*0*	*0*	*0*	*0.028*	*0*	*0*	*0*	*0*	*0.042*	*0*	*0.004*		
•Aged 20-24	*0*	*0.04*	*0.067*	*0.009*	*0.066*	*0*	*0*	*0*	*0*	*0.692*	*0.945*	*0.558*		
•Aged 25-29	*0*	*0*	*0*	*0*	*0.008*	*0*	*0.006*	*0*	*0*	*0.563*	*0.871*	*0.021*		
•Aged 30-44	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.001*	*0.001*	*0.036*	*0.015*	*0.131*		
•Aged 45-64	*0*	*0.148*	*0.866*	*0.034*	*0.229*	*0*	*0*	*0*	*0*	*0.578*	*0.825*	*0.187*		
•Aged ≥65	*0*	*0*	*0*	*0*	*0.009*	*0*	*0*	*0*	*0*	*0.823*	*0.99*	*0.88*		
Female involvement expressions														
•Aged 15-19	*0*	*0.021*	*0.001*	*0*	*0*	*0*	*0*	*0*	*0*	*0.023*	*0*	*0.07*		
•Aged 20-24	*0*	*0*	*0*	*0*	*0.001*	*0*	*0*	*0*	*0.922*	*0.804*	*0.082*	*0.233*		
•Aged 25-29	*0*	*0*	*0*	*0*	*0*	*0.001*	*0*	*0*	*0*	*0.981*	*0.943*	*0.857*		
•Aged 30-44	*0*	*0.019*	*0.104*	*0*	*0*	*0*	*0*	*0*	*0*	*0.702*	*0.183*	*0.227*		
•Aged 45-64	*0*	*0.928*	*0.989*	*0*	*0.002*	*0*	*0*	*0*	*0*	*0.956*	*0.811*	*0.314*		
•Aged ≥ 65	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.933*	*0.986*	*0.616*		
Male & female involvement in														
•Other sectors (O)	*0*	*0*	*0*	*0*	*0*	*0*	*0.103*	*0*	*0*	*0.528*				
•Unemployment (U)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*		
•Non-participation (NP)	*0*	*0*	*0*	*0.001*	*0*	*0*	*0*	*0*	*0*	*0*	*0.424*	*0.246*	*0.019*	*0.008*

Notes: As in Table 1. The r_d statistic relates the degree of correlation between (i) the non-seasonal component of the age equation and (ii) the sectoral equation "A" provided in Table 1 without its seasonal effects.

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

Table 8: SUR estimates of gender and formal qualification group involvement in agriculture and related activities, and involvement in other sectors (O), unemployment (U) and non-participation (NP) between the 1st quarter of 1998 (Q98^{I}) and 4th quarter of 2008 (Q08^{IV}) in Greece (All persons aged 15 years or older)

Males	R^2	(r_d)
No formal educ. = **5254** + **1800** (Q98^{I} etc.) − **119** (Q98^{I} etc.)^2 + **2577** (Q01^{IV} etc.) + **57** (Q01^{IV} etc.)^2 + **1028** (Q05^{II} etc.) + **47** (Q05^{II} etc.)^2 + 487 Q^{II} + 535 Q^{III} + 98 Q^{IV}	94.85%	(89.95%)
Some primary educ. = **29599** − 227 (Q98^{I} etc.) − **62** (Q98^{I} etc.)^2 + **5470** (Q02^{I} etc.) − **292** (Q02^{I} etc.)^2 + **2281** (Q04^{II} etc.) + **490** (Q04^{II} etc.)^2 − 1130 (Q05^{IV} etc.) − 131 (Q05^{IV} etc.)^2 + 329 Q^{II} + 380 Q^{III} + 484 Q^{IV}	98.15%	(92.10%)
Primary level qual. = **288241** − **11192** (Q98^{I} etc.) + **747** (Q98^{I} etc.)^2 − **5653** (Q00^{III} etc.) − **926** (Q00^{III} etc.)^2 + **16164** (Q02^{III} etc.) − **2318** (Q02^{III} etc.)^2 + **19889** (Q04^{II} etc.) + **2595** (Q04^{II} etc.)^2 − 773 Q^{II} + 469 Q^{III} + 3458 Q^{IV}	98.87%	(97.84%)
Lower Secondary level qual. = **44649** + **1013** (Q98^{I} etc.) − **61** (Q98^{I} etc.)^2 + 2619 (Q02^{IV} etc.) − 342 (Q02^{IV} etc.)^2 + **5507** (Q03^{IV} etc.) + 96 (Q03^{IV} etc.)^2 + **2196** (Q06^{I} etc.) + **303** (Q06^{I} etc.)^2 − 841 Q^{II} − 360 Q^{III} − 465 Q^{IV}	75.05%	(−50.93%)
Upper Secondary level qual. = **49741** + 671 (Q98^{I} etc.) + 93 (Q98^{I} etc.)^2 − **3169** (Q00^{II} etc.) + 3 (Q00^{II} etc.)^2 − **4919** (Q02^{III} etc.) + **1129** (Q02^{III} etc.)^2 − **7507** (Q03^{III} etc.) − **1115** (Q03^{III} etc.)^2 − 1132 Q^{II} − 782 Q^{III} − 90 Q^{IV}	92.78%	(−62.85%)
Tertiary level qual. = **3479** + **227** (Q98^{I} etc.) − **15** (Q98^{I} etc.)^2 + **393** (Q02^{III} etc.) + 12 (Q02^{III} etc.)^2 + **610** (Q05^{IV} etc.) − **51** (Q05^{IV} etc.)^2 − **1209** (Q08^{I} etc.) + **421** (Q08^{I} etc.)^2 − 53 Q^{II} − 76 Q^{III} − 375 Q^{IV}	66.88%	(4.52%)
Females		
No formal educ. = **13740** + **742** (Q98^{I} etc.) − **63** (Q98^{I} etc.)^2 + **2501** (Q01^{IV} etc.) − **77** (Q01^{IV} etc.)^2 + **763** (Q04^{I} etc.) + **153** (Q04^{I} etc.)^2 + 583 Q^{II} + 749 Q^{III} + 247 Q^{IV}	95.62%	(97.36%)
Some primary educ. = **33088** − 538 (Q98^{I} etc.) − **46** (Q98^{I} etc.)^2 + **4094** (Q02^{I} etc.) − **180** (Q02^{I} etc.)^2 + **2180** (Q04^{II} etc.) + 120 (Q04^{II} etc.)^2 + **1671** (Q06^{I} etc.) + 53 (Q06^{I} etc.)^2 − 493 Q^{II} − 500 Q^{III} + 94 Q^{IV}	97.82%	(91.87%)
Primary level qual. = **203266** + **7537** (Q98^{I} etc.) − **1321** (Q98^{I} etc.)^2 + **12521** (Q99^{III} etc.) + **740** (Q99^{III} etc.)^2 + **13565** (Q02^{I} etc.) − **350** (Q02^{I} etc.)^2 + **8691** (Q04^{II} etc.) + **932** (Q04^{II} etc.)^2 + 1633 Q^{II} + 2040 Q^{III} + 2201 Q^{IV}	97.61%	(97.37%)
Lower Secondary level qual. = **18620** − 413 (Q98^{I} etc.) + 34 (Q98^{I} etc.)^2 − **2313** (Q01^{II} etc.) + **268** (Q01^{II} etc.)^2 − **2823** (Q03^{I} etc.) − **274** (Q03^{I} etc.)^2 + **864** (Q05^{III} etc.) − **79** (Q05^{III} etc.)^2 + 517 Q^{II} + 855 Q^{III} + 249 Q^{IV}	89.60%	(−79.47%)
Upper Secondary level qual. = **20315** + 53 (Q98^{I} etc.) + **208** (Q98^{I} etc.)^2 − **6884** (Q00^{I} etc.) + 77 (Q00^{I} etc.)^2 − **1989** (Q02^{III} etc.) + **198** (Q02^{III} etc.)^2 − **1536** (Q04^{II} etc.) − 65 (Q04^{II} etc.)^2 − 697 Q^{II} − 1006 Q^{III} − **1174** Q^{IV}	95.15%	(−83.82%)
Tertiary level qual. = **796** + 117 (Q98^{I} etc.) − **22** (Q98^{I} etc.)^2 + **274** (Q00^{I} etc.) **+** 20 (Q00^{I} etc.)^2 + **392** (Q05^{I} etc.) − **28** (Q05^{II} etc.)^2 + **749** (Q07^{IV} etc.) − 21 (Q07^{IV} etc.)^2 + 3 Q^{II} + 142 Q^{III} + 150 Q^{IV}	81.42%	(−63.29%)

Other males and females	R^2
$O = \mathbf{3198871} + \mathbf{57382}\,(Q98^{I}\text{ etc.}) - \mathbf{6879}\,(Q98^{I}\text{ etc.})^2 + \mathbf{40637}\,(Q99^{III}\text{ etc.}) + \mathbf{6988}\,(Q99^{III}\text{ etc.})^2 + \mathbf{13857}\,(Q02^{III}\text{ etc.}) - 513\,(Q02^{III}\text{ etc.})^2 + \mathbf{46500}\,Q^{II} + \mathbf{47128}\,Q^{III} + 4096\,Q^{IV}$	99.59%
$U = \mathbf{490349} + \mathbf{24699}\,(Q98I\text{ etc.}) - \mathbf{1750}\,(Q98I\text{ etc.})^2 - 9781\,(Q00^{IV}\text{ etc.}) + \mathbf{6063}\,(Q00^{IV}\text{ etc.})^2 - \mathbf{41909}\,(Q02^{I}\text{ etc.}) - 2051\,(Q02^{I}\text{ etc.})^2 - \mathbf{33006}\,(Q04^{III}\text{ etc.}) - \mathbf{2152}\,(Q04^{III}\text{ etc.})^2 - \mathbf{42581}\,Q^{II} - \mathbf{46021}\,Q^{III} - \mathbf{20862}\,Q^{IV}$	96.61%
$NP = \mathbf{4180758} - \mathbf{23513}\,(Q98^{I}\text{etc.}) + \mathbf{3828}\,(Q98^{I}\text{etc.})^2 - \mathbf{30937}\,(Q99^{IV}\text{ etc.}) - 1868\,(Q99^{IV}\text{ etc.})^2 + \mathbf{32259}\,(Q01^{I}\text{ etc.}) - \mathbf{8755}\,(Q01^{I}\text{ etc.})^2 + \mathbf{25713}\,(Q02^{III}\text{ etc.}) + \mathbf{6344}\,(Q02^{III}\text{ etc.})^2 + \mathbf{16441}\,(Q04^{III}\text{ etc.}) + 388\,(Q04^{III}\text{ etc.})2 - 3621\,Q^{II} - 7898\,Q^{III} + 7945\,Q^{IV}$	97.97%

Additional equation information P>	$\lvert z_1\rvert$	$\lvert z_2\rvert$	$\lvert z_3\rvert$	$\lvert z_4\rvert$	$\lvert z_5\rvert$	$\lvert z_6\rvert$	$\lvert z_7\rvert$	$\lvert z_8\rvert$	$\lvert z_9\rvert$	$\lvert z_{10}\rvert$	$\lvert z_{11}$	$\lvert z_{12}\rvert$	$\lvert z_{13}\rvert$	$\lvert z_{14}\rvert$
Male involvement expressions														
• *No formal education*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.075*	*0.051*	*0.722*				
• *Some primary education*	*0*	*0.26*	*0*	*0*	*0*	*0*	*0*	*0.013*	*0.017*	*0.412*	*0.345*	*0.231*		
• *Primary level qualifications*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.692*	*0.811*	*0.08*		
• *Lower Second. level qual.*	*0*	*0*	*0*	*0.026*	*0.184*	*0*	*0.703*	*0*	*0*	*0.217*	*0.602*	*0.501*		
• *Upper Second. level qual.*	*0*	*0.436*	*0.237*	*0.001*	*0.972*	*0.001*	*0*	*0*	*0*	*0.135*	*0.304*	*0.906*		
• *Tertiary level qualifications*	*0*	*0.005*	*0*	*0.003*	*0.049*	*0.001*	*0*	*0.008*	*0*	*0.777*	*0.689*	*0.054*		
Female involvement expressions														
• *No formal education*	*0*	*0*	*0*	*0*	*0*	*0.004*	*0*	*0.127*	*0.05*	*0.521*				
• *Some primary education*	*0*	*0.025*	*0*	*0*	*0*	*0*	*0.019*	*0*	*0.246*	*0.295*	*0.291*	*0.844*		
• *Primary level qualifications*	*0*	*0.001*	*0*	*0*	*0.01*	*0*	*0.003*	*0*	*0*	*0.372*	*0.267*	*0.234*		
• *Lower Second. level qual.*	*0*	*0.065*	*0.02*	*0*	*0*	*0*	*0*	*0.009*	*0*	*0.136*	*0.014*	*0.478*		
• *Upper Second. level qual.*	*0*	*0.925*	*0*	*0*	*0.181*	*0.001*	*0*	*0*	*0.186*	*0.118*	*0.025*	*0.009*		
• *Tertiary level qualification*	*0.006*	*0.374*	*0.1*	*0.007*	*0.126*	*0*	*0*	*0*	*0.387*	*0.98*	*0.186*	*0.165*		
Male & female involvement in														
• *Other sectors (O)*	*0*	*0*	*0*	*0*	*0*	*0.001*	*0.029*	*0*	*0*	*0.576*				
• *Unemployment (U)*	*0*	*0*	*0*	*0.15*	*0*	*0*	*0.027*	*0*	*0*	*0*	*0*	*0*		
• *Non-participation (NP)*	*0*	*0*	*0*	*0*	*0.02*	*0*	*0*	*0*	*0*	*0*	*0.126*	*0.248*	*0.012*	*0.012*

Notes: As in Table 1. The r_d statistic relates the degree of correlation between (i) the non-seasonal component of the qualification equation and (ii) the sectoral equation "A" provided in Table 1 without its seasonal effects.

Source: Labour Force Surveys of 1998-2008, National Statistical Service of Greece. Own calculations.

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Biofuel Options in Greece to Meet the 2020 Targets: Costs, GHG Emission Savings, Fiscal Impact and Land Use Requirements

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Abstract

The latest EU directive 2009/28/EC on the promotion of the use of energy from renewable sources established a 10% target of liquid biofuels use for transport in 2020. Today, only biodiesel is available in the Greek market, while there is no projection for bioethanol use in the near future. For 2010, the projected consumption for biodiesel is 182 thousand m^3 (5.7% of the automotive diesel). This quantity is expected to cover the 2.1% of the total transport fuel consumption in the country for the respective year. This paper reviews the existing legal framework and the current liquid biofuels market in Greece and defines the optimum biofuels choices for Greece to meet the 2020 EU targets. Selected first and second generation biofuel chains are evaluated under technical, economic and environmental parameters, in order to estimate their impacts for 2010 and 2020. The analysis addresses issues of interest to policy makers, such as cost of production, greenhouse gas (GHG) emissions, fiscal impact and land use requirements, which are expected to play a critical role in future planning for biofuels, as well as to provide recommendations for future policy formation. The cost of biofuels production is expected to be reduced during the next decade, especially for the second generation technologies. In order to achieve the 2020 targets and minimise the requirements for land, Greece should also promote the use of bioethanol from sugar feedstocks. Additionally, the use of second generation biofuels is expected to

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further increase the GHG emission savings and minimise the land requirements. Regarding policy, biofuels tax exemption, as an incentive measure, will have high fiscal impact for the government but it is expected to partly counterbalance the reduction of the cost for CO_2 rights.

1 Introduction

Today, transport fuels are classified into, basically, two different categories: fossil fuels that are mainly based on crude oil and natural gas and biofuels made from renewable sources. As concern for the negative environmental impacts from transport is increasing and as the finite quantities of fossil fuels are decreasing, the importance of biofuels is steadily growing. For the last decade, one of the main targets of EU policy is the promotion of the use of liquid biofuels for transport. In 2003, the European Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, established, for the first time, a binding target of 5.75% use of liquid biofuels for transport in EU countries, to be achieved by 2010. Recently, this directive has been replaced by the directive 2009/28/EC on the promotion of the use of energy from renewable sources. The latter sets the following targets by 2020:

- Reducing greenhouse gas (GHG) emissions by at least 20% (compared with 1990 levels);
- Improving energy efficiency by 20%;
- Raising the share of renewable energy to 20%;
- Increasing the level of biofuels in transport fuel to 10%.

On the other hand, during the last two years there was great criticism on the impact of liquid biofuels on food prices. It has become obvious that the production of biofuels from traditional biomass feedstocks (e.g. conventional oil, sugar and starch crops like rape, cereals, etc.) competes directly with other applications and utilisations such as food production. However, until now in Europe, the production of many agricultural products has been more than saturated and, for this reason, in order to guarantee profitable market prices, production limits were introduced and high premium was paid for agricultural products and set-aside land, which was an opportunity for growing biomass feedstock. But, the increased biomass demand in the future is expected to increase this competition (Rutz and Jenssen, 2008).

2 Aim and Approach

The aim of this work is to review the existing legal framework and the current state of the liquid biofuels market in Greece and to define optimum economic and environmental choices for biofuels in order to meet the 2020 EU targets. Both first and second generation biofuels are analysed taking into account technical and economic parameters, environmental impacts and land requirements, in order to estimate the impact of biofuel chains under analysis for 2010 and 2020. The work addresses issues of interest to policy makers, such as production cost, GHG emissions,[1] fiscal impact and land availability. These issues are expected to play a critical role in future planning for biofuels, as they have direct impact on their sustainability and cost effectiveness and to provide recommendations for future policy formation. The paper is presented in four parts. The *first* illustrates the current state of the liquid biofuels market in Greece. The *second* reviews the biofuels-related policy in Greece, within the framework of European policy, which plays a critical role in national policy formation (i.e. Biofuels Directive, Renewable Energy Directive, etc.). The *third* part of the paper provides technical, economic and environmental information for the biofuels chains that already exist or could be applied in the future. The *fourth* part evaluates the economic, environmental and land use impacts of biofuels production and use in Greece short-term (2010), as well as scenarios of selected biofuels chains that could be implemented in Greece long-term (2020).

3 Current State of the Energy and Biofuels Market in Greece

In 2008, the Gross Inland Energy Consumption[2] in Greece reached 32 million tonnes of oil equivalent (TOE), while the respective Final Energy Con-

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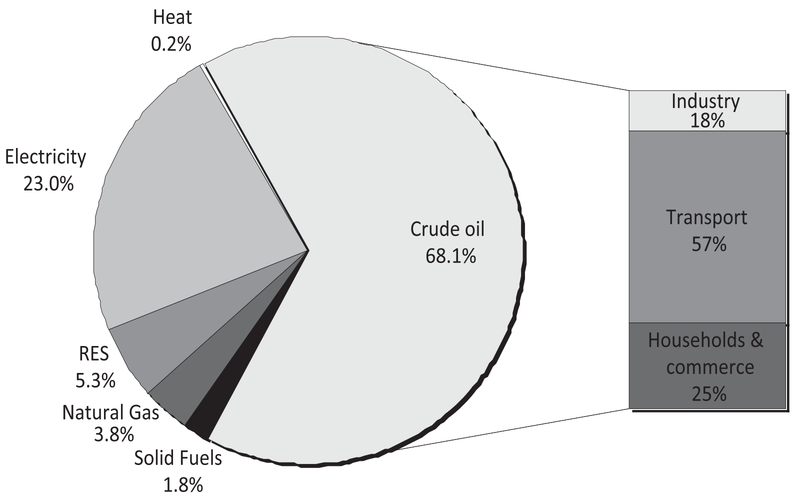
[1] In this paper, the GHG emission savings are measured into CO_2 equivalent (t CO_{2eq}/m^3 of biofuel), calculated based on the typical prices of GHG emissions of fossil fuels and biofuels, as they are presented in the directive 2009/28/EC.

[2] Gross inland consumption is the quantity of energy consumed within the borders of a country. It is calculated using the following formula: primary production + recovered products + imports + stock changes – exports – bunkers (i.e. quantities supplied to sea-going ships). (source: Eurostat)

sumption[3] was 21 million TOE. Crude oil is the most important source of energy and represents 68% of the final energy consumption (see Figure 1). In 2008, the final energy consumption of crude oil in Greece was 14 million TOE, of which 57% was consumed in the transport sector, 25% in households and commerce and 18% in industry. In the same year, only 62 thousand tonnes of crude oil was produced in Greece, while the rest is imported, mainly from Russia, Saudi Arabia and Iran.

Figure 1: Final Energy Consumption, Greece 2008



(Source of primary data: National Information system for the energy, Ministry of Environment, Energy and Climate Change, http://www.ypeka.gr)

During the last two decades, there is a great increase in fossil fuels consumption by the transport sector in Greece and, consequently, in the related CO_2 emissions. Figure 2(a) presents the fossil fuels consumed in the transport sector for the period 1992-2010[4]. Based on fuel consumption, the respective CO_2 emissions were estimated[5] and presented in Figure 2(b). For this

[3] Final energy consumption is the energy finally consumed in the transport, industrial, commercial, agricultural, public and household sectors. It excludes deliveries to the energy transformation sector and to the energy industries themselves (*source*: Eurostat).
[4] 2009 and 2010 consumption referred to estimations
[5] The estimations were based on the following data regarding the average fuels emissions: for petrol 2.3 t CO_{2eq}/m^3 and for diesel 2.7 t CO_{2eq}/m^3 (BFIN, 2010).

period, the final consumption of petrol increased from 2.9 to 5.0 million m^3 (73%), while the final consumption of diesel increased from 1.6 to 2.5 million m^3 (56%). This increase has a substantial negative effect on the environment. In 1992, the estimated CO_2 emissions resulting from petrol and diesel consumption were about 11 million tonnes, while, in 2001, the emissions increased to 14 million tonnes. Respectively, for 2010 the CO_2 emissions are expected to exceed 18 million tonnes. According to this, there will be a 66% increase of CO_2 emissions in the transport sector from 1992 to 2010.

Figure 2(a): Final Road Transport Fuels Consumption

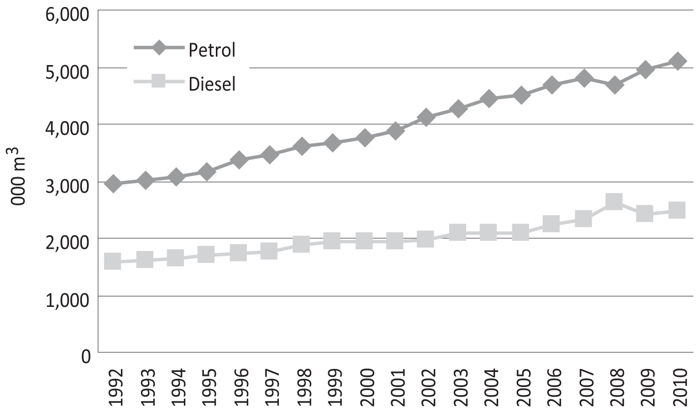
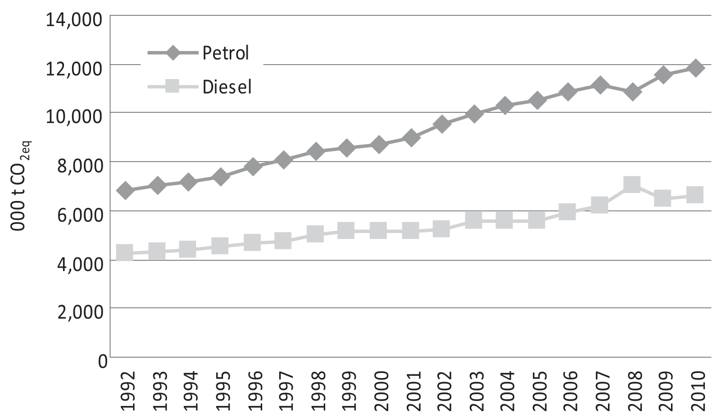


Figure 2(b): CO_2 Emissions



Source: Ministry of Environment, Energy and Climatic Change, 2010. "6th Report on the Promotion of Biofuels for Transport in Greece for the Period 2005-2010" (http://www.ypeka.gr).

Liquid biofuels for transport, especially, when produced from indigenous feedstocks are expected to play an important role in the reduction (a) of energy dependency of the country and (b) of inland GHG emissions. Early in 2005, the Greek Government, following the EU directive 2003/30/EC, formed a relevant law that introduces and regulates the biofuels market, as well as establishes an annual biofuels allocation system, starting from 2005. Between 2005 and 2009, the Greek biodiesel market has been rising (with a slower, as expected rate after 2007), as summarised in Table 1.

In 2005 and 2006, biodiesel production in Greece was lower than the allocated quantity, while in 2007 and 2008 the market was levelled. Today, the established capacity of biodiesel plants in the country is 715,000 tonnes. For the period July 2009-June 2010, 182,000 m^3 biodiesel was allocated into 13 biodiesel production companies (89% of the total allocated quantity) and 6 import companies (11% of total). This quantity is expected to cover the 5.7% of the automotive diesel consumption and the 2.1% of the total transport fuels market. It is important to notice that the established capacity is much higher than current demand and this can be seen as a challenge for producing biodiesel with highly competitive value chains which will not rely in the tax exception schemes.

Table 1: Biodiesel Quantities in Greece from 2005 to 2009

Year	Allocation (m^3)	Allocation (tonnes)	Installed Capacity (tonnes)	Production (tonnes)
2005	51,000	44,880	35,000	3,000
2006	91,000	80,080	75,000	42,000
2007	114,000	100,320	440,000	100,000
2008	123,000	108,240	565,000	107,000
2009-2010	182,000[1]	160,160	715,000	-

Source: Ministry of Environment, Energy and Climate Change (http://www.ypeka.gr) and European Biodiesel Board (http://www.ebb-eu.org)

[1] For the period from July 2009 - June 2010.

Regarding energy crops for biodiesel production in Greece (mostly rapeseed & sunflower), the respective figures show a steady rise in their cultivation during the last five years. According to the National Statistical Service of Greece (NSSG) and the Food and Agriculture Organisation (FAO), in 2005, there was no rapeseed production in Greece, while the cultivated area of sunflower was about 4,600 hectares. For 2007, the respective figures were 4,000 ha of rapeseed (for biodiesel production) and 14,000 ha of sunflower. The major part of the sunflower produced was used for non-food purposes and the contractual price offered in 2007, by the biodiesel industry ranged between 200 and 259 €/tonne (Illiopoulos and Rozakis, 2010).

Although the majority of arable crop land in Greece is covered by small grain cereals, maize and sugar beet, until now, there is no production of bioethanol in the country. As the market has not developed, there are also no bioethanol imports. According to the "6th Report on the Promotion of Biofuels for Transport in Greece for the Period 2005-2010," published in April 2010 by the Ministry of Environment, Energy and Climate Change, at the end of 2006, the Board of Directors of the Hellenic Sugar Industry announced that two of the sugar factories, one in Larissa and the other in Xanthi, will be converted to bioethanol plants. The capacity for each one was planned to be about 150 thousand m^3/year. Unfortunately, until November 2008, no strategic investor was found and the project was not realised. Recently, the Law 3769/2009 mentions that bioethanol will be introduced into the Greek market for the period 2010–2016 either as pure biofuel or as blend with petrol. In this case, priority will be given to bioethanol produced by indigenous energy crops. The 2010 biofuels report, mentioned above, concludes that there will be no bioethanol introduction in the Greek market during 2010.

4 Biofuels Policy in Greece

4.1 National Biofuels Legal Framework

The main law that deals with the fuel market in Greece is Law 3054/2002 for the Organisation of the Petroleum Products Markets, which covers all of the services such as refinement, trading, transport and storage for the crude oil and petroleum products.

Following the EU Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, the Greek government adopted the Law 3423/2005 for the "Introduction of Biofuels and Other Renewable Fuels into the Greek Market". This law is based on the Law 3054/2002 and its main objective is to define the biofuels categories for the

Greek market and to establish the production and trading system for biofuels. According to it, the blending of biofuels with petroleum products is performed only by the petroleum refineries. Also, the law established an annual biofuels allocation system until the end of 2010. According to this, every year, the Ministry of Environment, Energy and Climate Change and the Ministry of Rural Development, allocate an annual, predetermined quantity to applying biofuel companies (producers or importers). The allocated biofuel quantities fall under the special fiscal regime of the Law 2960/2001 (article 78). The allocation is based on the ability of the companies to meet specific criteria. Each parameter has a special weight factor for the procedure. Table 2 presents the criteria, according to the latest call for biodiesel allocation 2010.

Table 2: Criteria for the annual Greek Biodiesel Allocation

Criterion	Weight factor
Signed contracts for Greek energy crops production	25%
The demanded allocated quantity by each company	20%
The biodiesel quantities delivered by the company for previous allocations	15%
Estimated index based on the total cost and the profit of each company	10%
Estimated index based on the consequence of the company for the above biodiesel deliveries	7.5%
Purchase invoices for Greek, used vegetable oils, used frying oils and animal fats	7.5%
Purchase invoices for Greek cotton seed	5%
The research activity of the company, for example, contracts for research projects with universities and other research institutes	5%
The occupation of ISO certificate by the company	5%

In July 2009, the Law 3423/2006 was replaced by the article 22 of the Law 3769/2009. This law is based on the EU directive 2009/28/EC on the promotion of the use of energy from renewable sources and sets the 10% biofuels use target for 2020. The new point within this law is that biofuels blending with petroleum products can be performed not only by the refineries (as the previous law stated) but also by petroleum trading companies (if they import petrol). Every year, the Ministry of Finance, the Ministry of Environment, Energy and Climate Change and the Ministry of Rural Development and Food determine the annual biofuels quantities, regarding the period from the 1st of July (current year) to the 30th of June (next year) and allocate this between the applying biofuel companies. The law also records the criteria for the allocation of biofuels between companies and the penalties if conventional obligations are not met. Finally, according to this legislation, bioethanol will be sold in the Greek market for the period 2010-2016.

4.2 Fuel Taxes

Transport fuels in Greece are charged by the excise duty and VAT. Since 2005, both taxes are increasing continuously. Especially during 2010, increase of fuel taxes was very high. As regards to the excise duty of transport fuels, this is determined by the Law 2960/2001 of the Greek Parliament, as modified later by the Laws 3483/2006, 3775/2009, 3828/2010, 3833/2010 and 3845/2010. Table 3 presents the exact taxation figures. As shown, during 2010, the excise duty of petrol was increased by 63.4%, while for diesel, it was increased by 66.4%. Regarding the fuel VAT, it is applied to the fuel price after the excise duty and, this way, it increases the effect of the duty on fuel prices. Until April 2005, the VAT was 18% and increased to 19%. In March 2010, according to the Law 3833/2010, the VAT was increased to 21%. Starting from July 2010, Law 3854/2010 increased the VAT to 23%.

Table 3: Excise Duty in €/1,000 litres

Period	Unl. Petrol (RON< 96.5)[1]	Unl. Petrol (RON> 96.5)	Diesel for transport	Biodiesel	Respective Law
2001-2005	296	316	245	-	L.2960/2001
2006	313	327	260	Tax exempted	L.3483/2006
2007	331	338	276		
2008	350	349	293	293	
From 1/09 to 7/09	359	359	302	302	
From 7/09 to 2/10	410	410	302	302	L.3483/2006 & L.3775/2009
From 2/10 to 3/10	530	530	352	352	L.3828/2010
From 3/10 to 5/10	610	610	382	382	L.3833/2010
From 5/10 until today	670	670	412	412	L.3845/2010

[1] Road Octane Number (RON).

With regard to biofuels taxation, the allocated biodiesel volumes delivered to oil refineries, were under special tax exemption for the period 2005 to 2007. At this point, it should be stressed, that since January 2008, all biodiesel quantities in Greece are also charged with the same excise duty as fossil diesel. On the other hand, there is no specific reference for bioethanol taxation and, for this reason, it is assumed that it will also be charged with the same excise duty as automotive petrol.

4.3 Specific Policy Measures for Biofuels Promotion

Although biofuels have been used worldwide on a commercial scale for more than 10 years, the production cost still remains high and the price is not competitive to the price of fossil fuels. In particular, it was calculated that the EU average production costs of biofuels production at filling stations, ranges, from 23 to 40 €/GJ, while the respective cost for fossil fuels is about 7 €/GJ (Varela *et al.*, 2005). The production cost of various biofuels types, compared to the cost of fossil fuels, is discussed more extensively later in this paper. In order to make the price similar to petrol and diesel, it may be subsidised by three means: (a) subsidisation of the agricultural raw materials through the Common Agricultural Policy (CAP), (b) de-fiscalisation (de-taxation) and (c) laws requiring a minimum percentage of biofuels obligations, where the increased cost of biofuels blends is transferred to the final consumer (Russi, 2008).

As regards the subsidisation of agricultural feedstocks for biofuels production, the EU Regulation 1782/2003 (CAP) established, for the first time, the subsidisation of energy crops by 45 €/ha. Additionally, the recent CAP decouples the subsidy from the production of conventional crops. This fact enables energy crops to become more competitive than conventional crops (Lychnaras, 2008; Lychnaras and Rozakis, 2006).

As mentioned in the previous section, since January 2008, all biodiesel quantities in Greece are also charged with the same excise duty as fossil diesel. The increased cost of the minimum predetermined biofuels use is shifted directly to the final consumer's price.

5 Biofuels Chains: Current and Future Options

5.1 First Generation Biofuels

The most common first generation biofuels are biodiesel, produced from vegetable oils and fats and bioethanol, produced from starchy and sugar biomass.

Biodiesel today is most often used in 5%-20% blends (B5, B20) with fossil diesel, or even in pure B100 form (OECD/IEA, 2007). The main process for biodiesel production is based on trans-esterification of vegetable oils, through the addition of methanol (or other alcohols) and a catalyst. The main process to produce biodiesel includes: (i) oil extraction, (ii) transesterification of virgin oils from oil seeds – for the two-step process of biodiesel production – and (iii) transesterification of used oils and fats for biodiesel production from residue streams. This technology is long since used and is applied specifically for biodiesel production in Europe (most notably in Germany) since the early 1990s (De Wit *et al.*, 2009). This procedure gives glycerol as a by-product. Advanced processes include the replacement of methanol by bioethanol. The main feedstock is oil from sunflower, rapeseed, soy and palm oil seeds. The oil is extracted chemically or mechanically.

Bioethanol is mostly used in low 5%-10% blends with petrol (E5, E10) but, also, as E85 in flex-fuel vehicles (OECD/IEA, 2007). The main feedstock for bioethanol production is starchy raw materials, such as wheat and corn, and sugar, such as sugar beets, sugar cane and sweet sorghum. Bioethanol production from sugar and starch consists of two major process steps (i) the production of sugar and (ii) the fermentation of sugar to ethanol. Production of sugar from sugar crops (e.g. sugar beet) involves crushing and extraction of the sugar. Production of sugar from starch crops (e.g. wheat) involves milling of the grains to obtain the starchy material, dilution and heating to dissolve the starch and conversion of the starch to sugars by hydrolysis (De Wit *et al.*, 2009).

5.2 Second Generation Biofuels

First generation biofuel processes are, at the moment, the commercially available options but they have important limitations regarding competition with food supplies, in terms of land use, biodiversity, etc. Further, they are not cost competitive with existing fossil fuels such as oil and some produce only limited GHG emissions savings. Second generation biofuels can help solve these problems and can supply a larger proportion of our fuel supply sustainably, affordably, and with greater environmental benefits. Second generation biofuel technologies have been developed in order to overcome these limitations (Evans, 2007).

As described above, the production of first generation biofuels is mostly based on conventional food crops. So, when demand for biofuels is rising, food prices are expected to increase and shortages might be experienced, especially in third world countries. Additionally, some of the food crops used, such as corn, wheat and sugar beets, require high agricultural inputs in the form of fertilisers, pesticides, etc., which limits the GHG emissions reductions that can be achieved. The GHG emission savings for second generation biofuels are much higher than those obtained by first generation biofuels (estimates of more than 90% savings when compared with fossil petroleum are reported) (see Table 4).

The goal of second generation biofuel processes is to increase the efficiency of sustainable biofuel production by using residual lignocellulosic biomass or dedicated biofuel crops such as switchgrass, jatropha and, specifically, bred cereals with low grain. The scope is to extract useful feedstocks from woody or fibrous biomass, where the useful sugars are locked in by lignin and cellulose. New advanced technologies include the production of synthetic biodiesel via lignocellulosic biomass gasification and catalytic conversion to liquid using Fischer-Tropsch process (OECD/IEA, 2007).

Lignocellulosic ethanol is a second generation biofuel, used as a substitute for automotive petrol. Lignocellulosic ethanol is made by freeing the sugar molecules from cellulose using enzymes, steam heating, or other pre-treatments. Then, the produced sugar is fermented to produce ethanol in the same way as first generation bioethanol production. The by-product of this process is lignin, which can be burned as a carbon neutral fuel to produce heat and power (Edwards *et al.*, 2008). The process involves the lignocellulosic biomass pre-treatment to release cellulose and hemi-cellulose, hydrolysis to release fermentable 5- and 6-carbon sugars, fermentation of sugars and distillation of ethanol to fuel grade (OECD/IEA, 2007). Production of bioethanol from lignocellulose (LE) material is comprised of three major steps (i) pretreatment of the lignocellulose material, (ii) hydrolysis of the lignocellulose to break it down into sugars (C5 and C6-sugars) and (iii) fermentation of the sugars to convert it into bioethanol. Various processes are available to pre-treat lignocelluloses feedstocks that are required to reduce size and improve surface-to-volume ratio to make it suitable for hydrolysis (De Wit *et al.*, 2009).

Fischer-Tropsch Diesel (F-T Diesel) is a second generation biofuels for transport, used as a substitute for conventional diesel. The production of synthetic biodiesel is performed via solid biomass gasification and catalytic conversion to liquid, using Fischer-Tropsch process (OECD/IEA, 2007). The process from biomass to F-T (synthetic) diesel includes of three major steps, (i) the pre-treatment of the raw feedstock, (ii) the gasification of lignocellulose material to syngas (H2 and CO) and (iii) the F-T reactor where the syngas is used to synthesize F-T diesel, although a multitude of end products can be synthesized, e.g. kerosene (De Wit *et al.*, 2009).

5.3 Biofuel Chains

This work assesses the impact of current and future biofuels chains for Greece, in terms of cost, GHG emissions, land use requirements and fiscal impact. The biofuel chains under study are presented in Table 4.

Table 4: Current and Future Biofuels Chains for Greece

	Biofuel	Feedstock	Feedstock Category	Technology
1st generation	Biodiesel	Rapeseed	Oil	Trans-esterification
		Sunflower		
	Bioethanol	Sugar beets	Sugar	Fermentation
		Wheat	Starch	
		Maize		
2nd generation	Fisher-Tropsch Biodiesel	Short Rotation Coppice (SRC)[1]	Lignocellulosic Biomass	Fisher-Tropsch Gasification
	Lignocellulosic Ethanol			Fermentation

[1] Farmed Wood.

The basic technical parameters for each type of biofuel, as well as the key features of each impact category are highlighted in Table 5.

For comparative reasons, Table 6 presents the respective technical parameters and key figures for fossil fuels.

Table 5: Technical Parameters and Key Figures of Selected Biofuels Chains

	Biofuel	Feedstock	LHV[1] (MJ/kg)	Density (kg/l)	Biofuel Costs at filling station (€ $_{2002}$/ GJ)[2]		CO_2 Savings with respect to fossil fuels emissions[3]		Average Biofuel Yield (t/ha)[4]		Land requirements for the production of 1 tonne biofuel (ha)[5]	
					2005	2020	t CO_{2eq}/m^3	%	2005	2020	2005	2020
1st generation	Biodiesel	Rapeseed	38[5]	0.88[5]	23	21.6[6]	1.2	44%	0.78	0.85	1.28	1.18
		Sunflower					1.5	57%	0.68	0.80	1.47	1.25
	Bioethanol	Sugar beets	27[5]	0.79[5]	35.5	26.8[7]	1.6	70%	3.95	4.9[5]	0.25	0.2
		Wheat			32.9	27	1.1	48%	1.1	1.3	0.9	0.77
		Maize					1.5	66%	2.63	2.85	0.38	0.35
2nd generation	Fisher-Tropsch Biodiesel	SRC	44[8]	0.78[8]	35.5	28.7	2.5	95%	3.27[9]	4.7	0.31	0.21
	Lignocellulosic Ethanol		27[5]	0.79[5]	40.6	24.7[10]	2.2	94%	2.6[11]	4.4	0.38	0.23

Notes:

[1] Lower Heating Value – Energy Content.

[2] *Source*: Varela et al., 2005.

[3] *Source*: EU, 2009.

[4] *Source*: Panoutsou, et al., 2008.

[5] *Source*: BFIN, 2009.

[6] Reduction of 7% because although process costs will be reduced about 20%, feedstocks are expected to increase by 15%.

[7] Reduction of 25% is due to process & feedstock costs reductions of 5% & 17% respectively BUT mainly due to increased efficiencies by 25%.

[8] *Source*: Laohalidanond, Heil and Wirtgen, 2006.

[9] For 10t/ha of SRC in 2005 and 12 t/ha in 2020.

[10] Reduction of 40% is due to process & feedstock costs reductions of 24% & 15% respectively BUT mainly due to increased efficiencies by 40%.

[11] For 10t/ha of SRC in 2005 and 12 t/ha in 2020.

Table 6: Technical Parameters and Key Figures of Diesel and Petrol

	LHV (MJ/kg)[1]	Density (kg/l)[1]	Costs at filling station (€ $_{2002}$/ GJ)[2]		CO_2 Emissions (t CO_{2eq}/m^3)[1]
			2005	2020	
Diesel	43	0.84	7.1	9.4	2.7
Petrol	44	0.73	7.1	9.4	2.3

[1] *Source*: BFIN, 2009.
[2] *Source*: Varela et al., 2005.

Cost of production: Biofuels production cost varies based on the feedstocks and the process. Second generation technologies are more efficient and can exploit cheaper feedstocks, compared to those used for the production of first generation biofuels. On the other hand, both their capital and operational expenses are still very high and are cost effective only if very large-scale plants are considered. (OECD/IEA, 2007). Today, the cost of second generation biofuels is much higher than first generation but is expected to become more competitive in the future (see table 5). As mentioned before, today, the EU average cost of biofuels at filling station (23-40 €/GJ) is much higher than the cost of fossil fuels (about 7 €/GJ), as presented in Table 6. According to Viewls report (Varela *et al.*, 2005), future technological development is expected to contribute to cost reductions in biofuels (22-29 €/GJ), while the cost of conventional fuels is expected to increase (9.4 €/GJ). Nevertheless, biofuels cost is not expected to be competitive to that of fossil fuels. The increased cost could be covered by the CO_2 rights emissions savings from biofuels use.

GHG emissions: It has been reported in literature that the use of liquid biofuels for transport may reduce GHG emissions up to 95%, compared to fossil fuels (see Table 5). The extent of reduction strongly depends on the selected chain, i.e. the final product, the feedstock and the process technology used (first or second generation technologies). For the purposes of this paper, the GHG emission savings are measured into CO_2 equivalent (t CO_{2eq}/m^3 of biofuel), and calculated, based on the typical prices of GHG emissions of fossil fuels and biofuels, as they are presented in the directive 2009/28/EC.

Fiscal impact: As mentioned, biofuels production is usually subsidised indirectly by governments with de-taxation measures. In absolute terms, the exemption from the excise duty has a negative fiscal impact for the government (tax revenue losses). On the other hand, the benefits from biofuels could have a positive fiscal impact resulting in respective CO_2 emissions savings.

Land Use Requirements**:** Biofuel yield per land unit strongly depends on the type of feedstock. There are 'higher-productivity' crops that demand less land in order to produce a specific quantity of biofuels (Dehue and Hettinga, 2008). Previous research for biofuels has shown that land availability and quality will define the amount and type of feedstocks production in Greece (Panoutsou, *et al.*, 2008). According to the Hellenic Statistical Authority (EL. STAT, 2010), in 2007, the total Greek Utilised Agricultural Area (UAA) was about 3.7 million hectares, of which, about 2 million hectares were covered with arable crops and 470 thousand hectares was set-aside land. In order to minimise the competition between energy and food crops, the former should be basically cultivated on set aside land. The regions with high amount of set aside areas that could be used for biomass feedstock production are in southern Greece, the Peloponnese (21% of total set-aside land) and in northern Greece, Macedonia (20% of total). Alternatively, energy crops could be introduced on arable land, and substitute conventional, industrial crops with low opportunity cost in the Greek market, such as cotton and tobacco. Thessaly and Macedonia are the regions that show the greatest potential for energy crops production. Relative to this, one of the main goals of this paper is to analyse land use requirements for the biofuel chains under study, in order to achieve the targets for 2020 and, for this reason, the issue of land use options is discussed at greater length in the results of this paper.

6 Current and Future Biofuels Scenarios

Transport fuel consumption for 2010, in Greece, is expected to be 2.4 million tonnes diesel and 4.4 million tonnes petrol (Ministry of Environment, Energy and Climate Change, 2010[1]). According to the previous biofuels Directive 2003/30/EC, the target for 2010 was 5.75% share of biofuels (estimated based on the energy content). This means that to meet the target, Greece should have 161 thousand tonnes biodiesel consumption and 400 tonnes bioethanol consumption for 2010. As mentioned, the allocated biodiesel quantity for 2010 is 182 thousand m^3 (160 thousand tonnes) while there is no prediction for bioethanol use. Based on these figures, there will be a 5.7% biodiesel and 0% bioethanol share, or 2.1% biofuels share for transport. Respectively, for **2020**, the estimated fuel consumption is expected to be 2.5 million tonnes automotive diesel and 3.6 million tonnes petrol (Ministry of Environment, Energy and Climate Change, 2010[2]). The biofuels targets for 2020 are already determined at 10% share of liquid biofuels, by the Directive 2009/28/EC.

In this paper three scenarios are analysed:

- The first, called ***"2010 Case"*** deals with the expected liquid biofuel market in Greece for 2010.
- The second scenario, called ***"2020 Basic Scenario"*** deals with the idea of equal 10% replacement of biodiesel and bioethanol for 2020.
- The third, called ***"2020 Alternative Scenario"*** was created based on more realistic assumptions. During the last five years, the biodiesel market in Greece has developed very fast while there is no bioethanol market. Taking this fact into consideration, in this scenario, it is assumed that a minimum 5% replacement of petrol by bioethanol is easy to accomplish for 2020 con-

Table 7: Scenarios for Biofuels Use in 2010 and 2020[1]

Scenario	Biofuel Category	Biofuel	Consumption (000 tonnes)	Biofuels Use[2]	Total Use[3]
Case 2010	1st generation	Biodiesel	160	5.7%	2.1%
		Bioethanol	-	0.0%	
2020 Basic Scenario	1st generation	Biodiesel	283	10.0%	10.0%
		Bioethanol	566	10.0%	
	2nd generation	F-T Biodiesel	244	10.0%	10.0%
		Lignocellulosic Ethanol	564	10.0%	
2020 Alternative Scenario	1st generation	Biodiesel	485	17.1%	10.0%
		Bioethanol	283	5.0%	
	2nd generation	F-T Biodiesel	417	17.1%	10.0%
		Lignocellulosic Ethanol	282	5.0%	

[1] The replacement of fossil fuels with biofuels is estimated based on the energy content. For example, the diesel consumption for 2020 is expected to be 2,515 thousand tonnes, or 29,837 GWh (energy content of diesel: 34 GJ/t or 11.86 MWh/t). In order to achieve 10% replacement, 2,984 GWh should be covered from biodiesel. Knowing that the energy content of 1st generation biodiesel is 38 GJ/t or 10.53 MWh/t, 283 thousand tonnes of biodiesel should be consumed.

[2] Percentage of biofuel into fossil fuels blends. Blends of a) conventional diesel with biodiesel or F-T diesel and b) petrol with bioethanol or lignocellulosic ethanol.

[3] Total use of liquid biofuels for transport.

sumption, while the rest of the total biofuels target will be covered by biodiesel.

It is worthwhile to mention that, in the scenarios examined in this paper, the replacement of fossil fuels with biofuels is estimated based on the energy content. For this reason, in order to estimate the biofuel needs for 2020, the different specifications of first and second generation biofuels was considered (see Table 7). In the case of biodiesel, there is a difference between the energy content and the density of first generation biodiesel and the Fischer-Tropsch Diesel. For 2020 scenarios, the analysis estimates either the use of first generation or second generation biofuels (one category of biofuel per case). The effect of combined first and second biofuel options is not examined in the work. Table 7 shows the detailed assumptions for the scenarios.

7 Results

7.1 GHG Emissions Savings

In this analysis, the GHG emissions savings from the replacement of fossil fuels are estimated for each scenario and every biofuel production chain. At this point, it should be mentioned that the road transport are excluded from the European Union Greenhouse Gas Emission Trading System (EU ETS), even for the period 2013-2020. In order to estimate the benefit of GHG savings into fiscal quantities, referenced figures for 2010 and 2020, CO_2 prices are used. The relevant calculations are presented as the opportunity cost of a tonne of CO_2 emissions reduction. The specific figures used were 15 €/t CO_2 for 2010[6] and 42 €/t CO_2 for 2020 (Duer and Christensen, 2009). Table 8 shows for each scenario and for every biofuel production chain (i) the quantity of biofuel used as presented in Table 7, (ii) the respective GHG emission savings in tonnes of CO_2 equivalent and (iii) the estimated opportunity cost of the emission savings.

For 2010, the CO_{2eq} savings from biodiesel use will be between 182 and 240 t CO_{2eq}, depending on the mix of the feedstock (rapeseed or sunflower).

[6] Source: http://www.co2prices.eu/

Table 8: GHG Emission Savings

	Biofuel	Feedstock	Case 2010			2020 Basic Scenario			2020 Alternative Scenario		
			Biofuel	CO_2 Savings		Biofuel	CO_2 Savings		Biofuel	CO_2 Savings	
			000 t	000 t	mil €	000 t	000 t	mil €	000 t	000 t	mil €
1st generation	Biodiesel	Rapeseed	160	182	2.7	283	322	13.5	485	550	23.1
		Sunflower		240	3.6		426	17.9		727	30.5
	Bioethanol	Sugar beets	-	-	-	566	919	38.6	283	459	19.3
		Wheat		-	-		630	26.5		315	13.2
		Maize		-	-		871	36.6		435	18.3
2nd generation	Fisher-Tropsch Diesel	SRC	-	-	-	244	618	25.9	535	1.354	56.9
	Ligno-cellulosic Ethanol		-	-	-	564	1,240	52.1	282	620	26.0

For 2020, the use of second generation, instead of first generation biofuels, can maximise the GHG emission savings, either for the basic or the alternative scenario analysed. For the basic scenario, the use of second generation biofuels may save 1,860 t CO_{2eq}, while the respective figure for the alternative scenario is about 1,975 t CO_{2eq}. On the other hand, where the 2020 biofuel production is based on first generation biofuels technologies, the basic scenario (more bioethanol than biodiesel) proved to be more beneficial for the environment, compared to the alternative scenario (more biodiesel than bioethanol). Based on the results of this analysis, second generation biofuels and bioethanol are the optimal choices for higher CO_{2eq} savings.

7.2 Fiscal Impact of Biofuels Policy

As mentioned, since 2008, liquid biofuels in Greece are not excluded from the excise duty, which for 2010 increased to 670 euro/m^3 for petrol (or bioethanol) and 412 euro/m^3 for diesel (or biodiesel). This way, the increased cost of the minimum predetermined biofuels use shifts to the final consumer's price. The paper estimates the fiscal impact (reduction of energy taxes) for each of the scenarios, in the case where all biofuels quantities consumed in Greece were excluded from the excise duty. For 2020, the figures are estimated based on 2010 energy taxes. Table 9 presents the tax revenue losses and the estimated savings from the CO_2 rights (see Table 8) for each case.

Table 9: Fiscal Impact (in million €)

		Case 2010		2020 Basic Scenario		2020 Alternative Scenario	
		Tax Revenue Losses	CO_2 Rights Savings	Tax Revenue Losses	CO_2 Rights Savings	Tax Revenue Losses	CO_2 Rights Savings
Fiscal Impact Effect		(-)	(+)	(-)	(+)	(-)	(+)
1st generation	Biodiesel	75	3-4	133	14-18	227	23-31
	Bioethanol	-	-	480	27-39	240	13-19
	Total	***75***	***3-4***	***613***	***41-57***	***467***	***36-50***
2nd generation	Fisher-Tropsch Diesel	-	-	129	26	221	26
	Lignocellulosic Ethanol	-	-	479	52	239	57
	Total	***-***	***-***	***608***	***78***	***460***	***83***

For ***2010 case***, the biodiesel consumption in Greece is expected to be 160 thousand tonnes, while there will be no bioethanol consumption. Relative to biofuels tax exemption, the energy tax revenue loss for the country, taking into account the latest figures for the excise duties, is calculated at 75 million €. For ***2020 basic scenario***, in order to achieve the respective targets, consumption requirements include 283 thousand tonnes of biodiesel or 244 thousand tonnes of F-T Diesel and about 565 thousand tonnes of bioethanol or lignocellulosic ethanol. Again, in the case of biofuels tax exemption (assuming the figures for the excise duty of 2010), the fiscal cost for the country would be about 610 million € (about 20% because of biodiesel and 80% because of bioethanol). For the ***2020 alternative scenario***, where it is assumed that biodiesel will play the main role in the Greek biofuels market, the tax revenue losses are lower. In particular, the estimates cost for the government would be about 460 million euro (about 50% because of biodiesel and 50% because of bioethanol). In this case, the alternative scenario for 2020 looks more attractive for the government.

Assuming that, in the future, there will be a country base CO_2 trading market, the use of liquid biofuels for transport could have a positive fiscal impact for the country, since it is expected to reduce the cost for CO_2 rights. For ***2010 case***, where the estimated price of CO_2 rights is low, the savings are about 3 to 4 million €. For ***2020 basic scenario***, the CO_2 rights savings range between 41 and 57 million € (in the case of first generation biofuels production) and 78 million € (in the case of second generation biofuels production). The respective figures for the ***2020 alternative scenario*** are 36 to 50 million € (for first generation biofuels) and 83 million € (for second generation biofuels). It is obvious that the CO_2 savings are higher when second generation biofuels or bioethanol is chosen.

7.3 Land Requirements

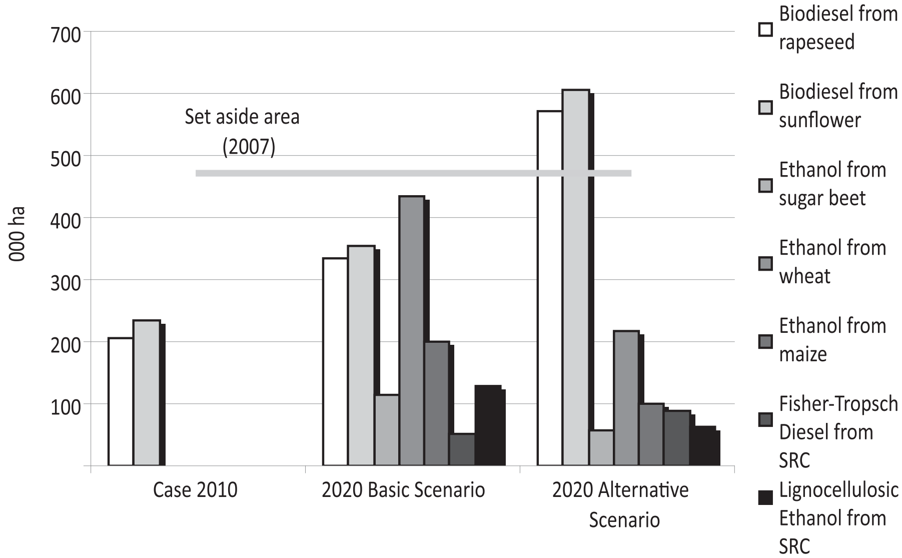
Figure 3 presents the land requirements in thousand hectares for the three scenarios and for each biofuel chain. It should be noted that this figure presents indicative illustration of the land requirements to meet all of the targets as described in the scenarios, by only one type of biofuel per case. The effect of combined biofuel options is not examined in the paper.

This figure also shows the set aside area in Greece, in comparison to the land requirements for biofuels feedstock production. As mentioned, in 2007, the total Utilized Agricultural Area (UAA) in Greece was about 3.7 million hectares, of which, about 2 million hectares were covered with arable crops and 470 thousand hectares was set aside area. According to this, set aside land could cover a great amount of the land needed for 2020 biofuels feedstock production, especially in the case of 2^{nd} generation biofuels production (see Figure 3).

More specifically, for 2010, about 200,000 hectares are needed to cover the domestic biodiesel consumption. This is about 5.5% of the UAA of Greece. The land that will be used for energy crops production in 2010 is substantially less than this figure. As mentioned, 11% of the biodiesel will be covered by biofuel imports. Obviously, a part of the rest is expected to be produced using imported feedstock, such as vegetable oils.

As expected, the production of second generation biofuels shows the minimum land requirements in order to meet the targets for 2020. In particular, for the basic scenario, 52 thousand hectares (1.4 % of UAA) and 128 thousand hectares (3.5% of UAA) are needed to cover the total requirements of

Figure 3: Land Requirements



F-T diesel and lignocellulosic ethanol. For the alternative scenario, the respective figures are 89 thousand hectares (2.4% of UAA) and 64 thousand hectares (1.7% of UAA). In both cases, the production of short rotation coppice or perennial grasses, as biomass feedstocks for second generation biofuels, could be performed on set aside land. This way there will not be any competition to food crops production.

On the other hand, in order to meet the targets for 2020 using first generation biofuels, land requirements are much higher. Regarding the basic scenario, the land requirements vary between 450 thousand (12% of UAA) and 790 thousand hectares (21% of UAA), depending on the feedstock. For the alternative scenario, where biodiesel is assumed to be the main biofuel, the respective figures vary between 630 thousand (17% of UAA) and 820 thousand hectares (22% of UAA). In this case, set aside land could cover only a small amount of the area that will be used for feedstock and other types of land should be used, such as arable land. This will increase the direct competition between energy and food crops and might increase the danger of future rises in domestic food prices and land opportunity costs.

Figure 3 shows that there are specific cases that maximise the land requirements for biofuels feedstock production. In particular, in order to meet the biodiesel targets of the alternative 2020 scenario, assuming sunflower as feedstock, about 600 thousand hectares are needed. Respectively, for the case of bioethanol production from wheat in the basic 2020 scenario, 435 thousand hectares are needed to meet the target. On the other hand, the production of bioethanol from sugar beets seems to be much more efficient on resource requirements. In particular, for the basic scenario, about 115 thousand hectares are needed, while for the alternative scenario the land requirements are less than 60 thousand hectares.

Based on these results, it is illustrated that the land requirements for covering 2020 biofuels targets will be very high in the case of first generation biofuels production and, especially, when the target is mostly met by biodiesel use. The extensive land use for biofuels production will increase the competition between energy and food crops and might cause rises in domestic food prices and land opportunity costs. In this case, future policy should give priority to second generation biofuels and bioethanol production.

8 Conclusions

This paper evaluated the most promising options for liquid biofuels in Greece, in order to meet the 2020 targets for 10% biofuels use in transport. The work assessed the impact of selected biofuel chains, in terms of cost, GHG emissions, fiscal impact and land use requirements. The analysis focused on short-term (2010) impacts of projected biodiesel use in Greece, as well as scenarios for selected biofuel chains that could be implemented in Greece by 2020.

The results showed that for 2010, the CO_{2eq} emission savings from biodiesel use will be low but for 2020 the figures could be very high, especially, when biofuels mixture in Greece consists mostly of second generation biofuels and bioethanol. Based on the analysis, these types of liquid biofuels appear to be the optimal choices for higher CO_{2eq} savings.

Regarding fiscal policy, the paper analysed the biofuels tax exemption as a support mechanism. Such a measure is expected to have high fiscal impact for the government. Since the excise duty of petrol is higher than the excise duty for diesel, the negative impact for the government will be higher when the use of bioethanol or lignocellulosic ethanol is higher than the use of biodiesel or Fisher-Tropsch diesel. On the other hand, it is worthwhile to mention that the tax revenue losses will partly counterbalance the reduction of the cost for CO_2 rights, after 2020. In this case, the use of second generation biofuels and the use of bioethanol show higher CO_2 rights savings.

The analysis also assessed the land use requirements in order to meet the 2020 targets. The results showed that bioethanol production from sugar feedstocks and second generation biofuels production are less land-demanding options. The use of these biofuels will decrease the pressure for land thus reduce direct competition between energy and food crops and minimise the danger of future rises in domestic food prices and land opportunity costs. Additionally, the feedstock for second generation biofuels could be produced on set aside land, in order to minimise the competition with food crops.

In conclusion, in terms of environmental and land use requirements, bioethanol, especially from sugar feedstocks, as well as second generation biofuels, appear to be the most promising options for the Greek future, biofuel market. Today, the higher cost of these biofuels is the main barrier but, in the future, cost reduction is expected. This will make these biofuels more competitive and represent economically attractive investments. Future policy formation in the country should, therefore, be based on an optimised biofuels mix that will minimise land use requirements and fiscal impacts along with maximising the CO_2 savings.

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Part IV
Institutions and Economic Performance

To What Extent Does Greece Underperform in its Efforts to Attract FDI Relative to Its Regional Competitors and Why?

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Abstract

This paper compares Greece's performance in attracting Foreign Direct Investment (FDI) relative to its GDP with 24 countries in its general geographic region. These 24 countries of the Southern Europe, Central and Eastern Europe, North Africa and Western Asia (SCENAWA) region are Greece's competitors as an export and FDI base, as well as where Greece places much of its own outward FDI. Greece is lagging behind most countries of the SCENAWA region, not only in FDI-GDP ratios, but, also, in the related indicators of technological development. From a brief review of the literature, useful measures of some of the factors shown to be important determinants of FDI are developed for as many of the 25 countries, as possible, in this region. Differences in means and highly selective cross-country regressions are then used to identify factors that would appear to help explain the recent shortfall of Greece in attracting FDI. Among the factors identified are its slow and costly legal system for resolving commercial disputes, the rigidities of its labour and product market regulations, its relatively high investment risk (which, in turn, seems to be related to its high and rising fiscal deficits and foreign debt), the pressure perceived by its firms to provide officials with gifts in return for services received, and, quite surprisingly, its tariff rates, which are now high relative to those of other SCENAWA countries. Greece also enjoys certain advantages, such as its location, natural advantages for tourism and residential living and the relatively high level of education of its domestic labour force. Yet, it may not be taking as much advantage of these factors as it could. Although the

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sample is too small and the applied analysis of the pure cross-section variety for the results to be considered anything more than very tentative, the factors identified appear to be potentially important and the suggested policy reforms worthy of serious consideration.

I Introduction

In absolute terms, Greece's inward flows of FDI have increased rapidly since the mid-1970s. Indeed, although Greece's FDI inflows have fluctuated quite substantially, on average, these inflows have increased some ten-fold since the late 1970s. Given that FDI is increasingly recognised as an important source of technological advancement and, at least, potentially, as a source, not only of greater competition in product markets and managerial expertise, but also of capital accumulation, FDI has, no doubt, contributed to the overall growth of the Greek economy. Indeed, Greece enjoyed the second highest growth rate in GDP per capita among the 12 Euro Zone countries and, also, among the 30 OECD countries between 1995 and 2005 (OECD Policy Brief May 2007).

Yet, in relative terms, Greece has increasingly lagged behind in FDI. Furthermore, Greece's FDI relative to GDP declined from over 1% of GDP between the mid-1970s and the mid- 1990s to an average of less than 1 percent of GDP through at least 2008 which, except for 2008, was a period when globally FDI flows increased several times as fast as GDP. Relative to world FDI flows, according to data from the UNCTAD's World Investment Report (Statistics-online), Greece's share declined from over 1 percent of the world total in the late 1970s to only a little over one tenth of one percent since 1997. This has happened despite a host of factors which would normally be deemed favourable to FDI inflows into Greece. These include Greece's accession to the European Union in 1992, considerable privatisation of state enterprises, and accession to the Euro Zone in 2002. As was indicated in the same OECD Policy Brief, which pointed to Greece's remarkable success in growth over the preceding decade, Greece ranked last among Euro Zone countries and 29th among the 30 OECD countries in FDI inflows as a percent of GDP in the decade prior to 2007. In this paper, we make use of comparisons between Greece and the twenty-four other countries occupying a region in Southern Europe, Central and Eastern Europe, North Africa and Western Asia, which we identify as SCENAWA. The other countries of the SCENAWA region are Greece's competitors and have, also, served as hosts for much of Greece's outward FDI in recent years (Bitzenis, 2005). As shown in the first row of Table 1, during the 2001-8 period, inward FDI flows averaged 5.5 percent of GDP in the rest of the SCENAWA region but only 0.9 percent in Greece. Another disappointing characteristic of the limited FDI inflows that Greece experienced during the 2001-2008 period (and even earlier) is that it consisted almost exclusively of mergers and acquisitions of existing Greek firms, rather than new "Greenfield" investments that would be likely to involve transfer of technology, additional employment opportunities and platforms for exports.[1]

Low and falling FDI might not constitute a serious problem if Greece were performing well in technological innovation or in other sources of long-term capital flows. Yet, in both respects, this has not been the case. Relative to other sources of long term capital movements, as in the world as a whole, the other sources (portfolio investment, bank flows and foreign aid) have been declining quite sharply relative to FDI (Hsiao et al 2008). With respect to technology, based on data obtained from comparable enterprise surveys for recent years undertaken by the World Bank, as of 2005, only 11.72 percent of Greek firms said that they reported having internationally recognised quality certifications. Not only is this far below the country averages in East Asia and other high performing regions, but it is even below the Sub-Sahara Africa average. Greece's 11.72 percent is, also, well below the average of 22.4 percent for the other 24 countries in SCENAWA. While country coverage on R&D expenditures as a percent of GDP from the World Bank's World Development Indicators is less complete than for some of the other aforementioned measures, Greece's R&D expenditures of 0.6 percent of GDP is well below both the mean and median of such percentages for the SCENAWA region and much further below the regional leader (Israel) with 5.1 percent for the 1997-2002 period.

For these reasons, Greece's limited ability to attract FDI and thereby both long-term capital and foreign technology in the last decade would seem very problematic. The purpose of this paper is to explore possible alternative rea-

[1] Stergiou (2009), moreover, documents that Greece's inward FDI has remained almost exclusively in the form of mergers and acquisitions to the present and almost entirely in non-export industries, such as banks, cement companies and services.

sons for the declining ability of Greece to attract FDI over the period 2001-2008, which was a period of rapidly growing FDI inflows world-wide. Why and how has Greece, which had earlier done so well in attracting FDI inflows, become one of the laggards in the SCENAWA region in this respect.

Our presentation is organised as follows. Section II provides a brief summary of relevant literature, identifies available measures for some of the relevant explanatory variables and compares Greece with the other 24 SCENAWA countries on each of these measures. Section III presents our quantitative analysis for the limited number of SCENAWA countries for which comparable information exists. Section IV provides our conclusions and policy recommendations.

II Review of the Literature, Measures and their Application to Greece

There is, of course, a huge literature on the determinants of FDI. The factors identified in this literature as important determinants of FDI inflows can be classified into five main categories: (1) the exploitation of natural resources, (2) privatisation of large state enterprises where large foreign enterprises or multinationals may be among the few investors able to buy large chunks of these state enterprises, (3) the receiving country's market size and degree of openness, (4) the availability of either skilled labour or low cost but disciplined unskilled labour, and (5) the country's infrastructural, institutional and policy environment.

Some of these may seem of little relevance to Greece as a host country for FDI. For example, Greece has no appreciable quantities of petroleum or natural gas and only relatively modest endowments of minerals, which help explain why otherwise rather backward countries like Angola and Equatorial Guinea have ranked at or near the highest in the world in FDI-GDP ratios in recent years. But, since beautiful beaches and historical monuments in exquisite locations serve as important attractions for investments in hotels, transport and tourism services, even for Greece, the country's natural resources may constitute a positive influence on FDI. Privatisation programs, especially of large state monopolies, which Greece has undertaken in the last decade or two (OECD 1994, 2007), should presumably have constituted another relatively positive influence on FDI inflows into Greece in recent years.

In any case, since Greece's attractiveness with respect to categories (1) and (2) would hardly seem to have diminished over time, these categories seem unlikely factors to explain the downward trend in the size of Greece's FDI inflows relative to those of other countries. More likely, the factors that help explain both the explosive growth of FDI globally and Greece's disappointing performance in this respect, would therefore seem to be factors (3) – (5) above. Each of these is examined, in turn, at least briefly, and, in each case where there seems to be, at least, a prima facie basis for considering it of potential importance, we attempt to identify relevant measures.

With respect to (3), as in the gravity model, FDI is generally thought to be attracted by large market size. This is because large market size allows any new investment to be able to take advantage of scale economies. Since an economy open to the outside world caters to a market that is, in effect, much larger than a similarly sized economy closed to the outside world, openness to trade and capital flows should, also, put a country in a better position to attract FDI from abroad. Even when the country is open, however, exchange risk can constitute an important barrier to investment. For this reason, any country participating in a common currency union should be in a more advantageous position for attracting FDI than one which is not, ceteris paribus.

How does Greece rate in each of these respects in recent years? As a comparatively small country with a population of less than 11 million, one might think that Greece would be relatively disadvantaged in terms of market size. But, with a comparatively high per capita income, Greece's market size can hardly be said to be a disadvantage relative to its neighbours in the SCENAWA region. This is reflected in the figures presented in the fourth row of Table 1, showing that Greece's GDP is about 75 percent larger than the average GDP for the remaining countries of the region. With respect to Openness, Greece is certainly quite open to capital flows and, as a member of the EU, it implies that it has essentially free trade with respect to countries that are EU members and association partners which includes several countries of the SCENAWA region. As noted in the row labeled BMP, Greece, also, benefits from a much lower black market premium than other countries in the SCENAWA region.[2] Finally, as a member of the European Monetary Union, FDI flows into Greece from a number of very important investing countries are free of the

[2] The black market premium is an important component of the commonly used Sachs-Warner

Table 1: Descriptive Statistics on Relevant Variables for Greece and Other Countries of Southern Europe, Central and Eastern Europe, North Africa and Western Asia (SCENAWA)

Variable	Data Source	Greece	24 Other Countries in the SCENAWA Region	T Value of Statistical Difference
FDI/GDP 2001-8 Average	World Investment Report (UNCTAD) and World Bank WDI	0.009	0.055	-7.4
TECH CERT	Enterprise Surveys (World Bank)	11.72	22.4	-6.1
R&D as % of GDP	World Bank (WDI)	0.60	0.98	-2.4
GDP 2008 ($ billions)	World Bank WDI)	357	201	3.2
DURTIC	Djankov et al (2003) and World Bank Doing Business in 2004	315.0	405.9	-1.55
EDUC	Barro and Lee Data Set	8.51	7.70	1.85
AV. TAR	Econ. Freedom of the World	9.2	7.05	3.54
FDEV	Econ. Freedom of the World	0.473	0.489	-0.18
REG	Enterprise Surveys (World Bank)	8115	967.5	29.49
RISK	International Country Risk Guide	73.3	68.05	2.61
EXPGIFTS	Enterprise Surveys (World Bank)	55.9	13.34	9.07
LEGSYS	Econ. Freedom of the World	5.70	6.43	-3.18
BMP	Sachs and Warner (1995), Rodrik and Rodriguez (2001)	1.24	12.88	4.24
DEMOC	POLITY IV	10.0	7.41	2.93
RIGEMPI (2007)	World Bank Doing Business in 2007	58	40.9	3.5
FIRINGC (2007)	World Bank Doing Business in 2007	69	41.8	2.9
PROCCOMP	World Bank Doing Business in 2004	64	50.5	1.86
CPI (2009)	Transparency International	71	71	0.0

exchange risk that acts as a constraint on FDI in many other countries, including several of the SCENAWA region that have relatively volatile exchange rates. The one criterion in category (3) which is not so favourable for Greek FDI inflows is tariff rates on countries outside the EU. Even though the common external tariff rates of the EU are not especially high, as noted in the

index of trade openness (Sachs and Warner, 1995) , which Rodrik and Rodriguez (2001) have shown to exert an especially strong effect not only on the overall index of openness but also on the rate of economic growth.

row AV. TAR of Table 1, relative to its fellow members of the SCENAWA region, many of which have undertaken substantial tariff reductions in the last decade, Greece's tariff rates are now significantly above the mean (9.2 versus 7.05). AV.TAR is, therefore, a factor that will be retained for further investigation below.[3]

With respect to labour endowments and, hence, factor (4) above, it is clear that Greece is not a country well endowed with cheap low- skilled labour but seems willing to allow quite a bit of such labour to be imported. Immigrant labour is estimated to constitute approximately 20 percent of the total labour force. As easily seen in the EDUC row in Table 1, with respect to education, the Greek labour force is comparatively well endowed (8.51 years on average compared to an average of 7.7 in the other 24 SCENAWA countries). Notably, also, based on his own firm survey, Souitaris (2002) demonstrates that much of Greece's limited R&D and adoption of modern managerial techniques is limited to those firms with relatively large numbers of highly educated workers. Something which could be of concern, however, is the efficiency of the Greek educational system, due to the fact that on a quality-adjusted basis the skill level of Greek workers (and students) may not be as high as the country's expenditures on education would seem to justify. It has been claimed that the Greek educational system may be excessively dominated by the public sector and characterised by a relatively weak incentive system (Tsipouri, 1991; Souitaris, 2002; OECD, 2007). Greek university professors and scientists, moreover, are reported to lag behind those in some other SCENAWA countries in a number of respects.

That leaves us with factor (5) and, hence, the role of institutions and policies in explaining what would seem to be the decline in Greece's relative ability to attract FDI inflows. Among the relevant institutions and policies that have, at least, been mentioned in the literature are regulations on the labour market, product markets and prices, business start-ups, dispute settlement, the tertiary educational system and weaknesses in macroeconomic and tax policy.

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[3] One other factor which in relative terms may have contributed to Greece's loss in comparative ability to attract FDI flows is the greater number of reductions in restrictions on FDI in other SCENAWA countries than in Greece (UNCTAD, each year 2000-2009).

We begin with labour market rigidity. Allard (2005) provides the most consistent time series of comparable indices of Employment Law Protection (EPL) for 21 OECD countries for the period 1950-2003. These indices were constructed on the basis of scores on 36 sub-indicators, each aiming to capture a certain aspect of restrictiveness in the labour market regulations. While most OECD countries have, until recently, at least, increased their EPL scores over time as a result of increasing concern for social protection as their economies have become more productive and wealthier, Greece has gone further in this direction than any other OECD country in Allard's study. Greece's score rose from 0.8 in 1950 to 1.7 in 1955, 3.7 in 1983 and 3.8 between 1988 and 2003. Its 3.8 score was the highest among all 21 of these OECD countries. This was a major change since, as recently as 1982, Greece's EPL index score of 1.7 was lower than 12 of the 21 countries. Campos and Nugent (2009) have put together various over time estimates of the labour market rigidities (LAMRIG).

Higher scores on this index imply greater rigidity or lack of flexibility in labour markets, more difficult and more expensive to lay off workers and, therefore, higher expected costs in hiring new workers. While controversial, much of the literature making use of this or similar but less complete and comparable indices, have demonstrated that higher EPL indices are associated with higher youth unemployment rates, lower labour force participation rates of females and higher degrees of informality among firms and their workers. As in most countries where this index is high, enforcement of the restrictive laws is often not very stringent, particularly among small enterprises and their workers and especially foreign workers. This, no doubt, explains why some 20 percent of the Greek labour force is foreign and, mainly, working in low wage jobs in small enterprises.

The relevance of this to FDI and Greece is that large and foreign-owned enterprises are less likely to chance being caught violating the laws and more likely to (and probably correct in doing so) anticipate that the laws would be more vigorously enforced with respect to them than to small private, domestically-owned enterprises. As a result, any country like Greece with an especially high EPL score on LAMRIG should be expected to discourage foreign firms from making large investments and hiring many workers. For cross section analysis, as in the present study, however, there are two alternative measures from a single source analysis that might be more appropriate. The source is the World Bank's Doing Business Surveys which presents data on two indices for a large number of countries including all 25 SCENAWA countries. One of these is an index very similar to the EPL in what it tries to cover. This we call the Rigidity of Employment Index (RIGEMPI). The other is the firing cost (FIRINGC measured in weeks of salary that must be paid for the dismissal of a regular employee). As shown by the corresponding entries for these variables in Table 1, on both these indices Greece's index is significantly above the average of the remaining 24 SCENAWA countries. Indeed, for RIGEMPI, Greece is second highest [and, indeed, only very slightly below the highest (Spain)]. Still another feature of Greek regulations of relevance to the labour market are those concerning retirement. Notably, the incentives for early retirement are said to be among the strongest among OECD countries (OECD, 2007).

Given the aforementioned characterisations concerning labour market regulations, it is not surprising that even in the very prosperous year 2005, when the employment rate among prime age males was second highest among the 12 countries of the European Monetary Union, Greece's employment rates among older workers, young workers and women were 7th, 7th and 11th highest, respectively, among the same set of countries (OECD 2007).[4] Given the strength of the evidence backing up these concerns for the effect of labour market and pension rigidity on FDI attraction, we shall make use of the RIGEMPI and FIRINGC indices in our subsequent quantitative analysis of Section III.

A second important set of regulations that is thought to impede competition and, thereby, both the incentive for technological change and FDI inflows, refers to product markets. Several measures of this type allow comparisons between Greece and other countries. One of these is the cost of starting a new business (based on legal fees to register a new firm) and, thereby, of complying with the requirements of the Corporate Law, Commercial Code or other specific regulations. The World Bank's Doing Business

[4] OECD (2007, p. 6) attributes the disincentive to continue working at older ages to "high statutory replacement rates, with tenuous links between contributions and benefits and a range of special provisions that allow early retirement before the normal retirement age of 65". Apparently, these special provisions apply to 40 percent of all male retirees, and in general are more favourable to those workers who are least in need of support.

Survey 2004 presented estimates of these costs for a large number of countries including those of the SCENAWA region. The estimate of this measure (labeled REG) for Greece in Table 1 is, by far, the highest in the SCENAWA region and, indeed, was second only to Senegal out of the 117 countries evaluated in this respect. Since new firms are often a source of technological change and new products, not surprisingly, a consequence of this high cost of firm start-up can be observed by comparing the average age of randomly selected firms in the World Bank's Enterprise Surveys, which show that Greek firms are, on average, some 5 years older than those of other SCENAWA countries surveyed.

According to OECD (2007) product market regulation and price regulations including licensing requirements are especially damaging to competition in retail industries, professional services of various sorts and to the ability of foreign firms to compete in tourist resorts and network industries, including public utilities, and broadband communications.

Another area in which institutions can hurt the competitiveness of businesses and serve as a deterrent to foreign investors is the time and other costs of resolving disputes with customers through the courts. Two relevant indicators are the number of days it takes, on average, to collect on a bad check (DURTIC) and an index of procedural complexity concerning such cases (PROCCOM). Estimates of the former were obtained for a large sample of countries by Djankov et al (2003) and have been extended to additional countries in the World Bank's Doing business Surveys for 2004-2009. Djankov et al. (2003) showed that the time it takes to settle a dispute over payment of a bad check was closely related to the number of mandatory procedures involved and their degree of complexity. They also showed that these procedural complexities were often related to the particular legal system upon which the country's laws and legal system were based. In particular, they showed that the French Civil Law system led to the mandating of more procedures and ones of greater complexity and difficulty of fulfillment than German or Scandinavian Civil Law and, especially, English Common Law systems. They also showed how these same characteristics applied to a wide variety of institutions relavant to investment, such as the degree of development of financial markets, labour regulations, entry regulations, and so on. (La Porta et al., 2008). For present purposes, because of their availability across a large number of countries and because they are likely to be correlated with other somewhat relevant indicators, in Table 1 we present the means for Greece and the other 24 SCENAWA countries of both DURTIC and PROCCOM. Since both Greece and the vast majority of other countries in the SCENAWA region are French Civil Law countries, one might not expect so much of a difference between them, but, perhaps, a larger difference with respect to countries with English Common Law traditions. As shown in Table 1, Greece had a lower score on DURTIC than the average of the other 24 SCENAWA countries but a higher one on PROCCOM. In both cases, these differences were not statistically significant at the 5 percent level. Yet, since the region as a whole was relatively high on both these indicators, these variables will also be retained for further use in the analysis below.

Another institutional indicator which is deemed to both add to the cost of investment and serve as a deterrent to FDI, is corruption. One commonly used index is the Corruption Perception Index (CPI), a ranking of countries put together by Transparency International based on a number of different indicators. The CPI is actually an inverse measure of corruption, a high score on the index representing freedom from corruption. Again, as can be seen from Table 1, on this index, despite its relatively high per capita income, Greece is ranked no higher than the SCENAWA mean of 71st. The other index we used is one based strictly on the report of firms operating in the country coming from the World Bank's Enterprise Surveys. While not available for as many countries as the CPI, this index (labeled EXPGIFTS in Table 1) is one of particular relevance to firm costs since it represents the percent of firms which indicate that one is expected to provide gifts to officials in order to obtain needed government services. With respect to this indicator, Greece ranks extremely high, with 55.9 percent of the surveyed firms indicating that such gifts are expected compared to only 13.4 percent, the average for the other SCENAWA countries. In this case, the difference between Greece and the 15 country sample of the remaining countries in the region, is highly significant.

As noted above, the legal system origins have been found to be related to the degree of development of various financial markets (La Porta et al., 1998). Because many foreign firms prefer to finance some of their FDI in domestic credit markets of the FDI host countries, the magnitude and character of financial market development is thought to be very relevant to FDI. In Table 1 we present two measures, one FDEV representing the degree of development of financial markets, and the other RISK, indicating the degree of risk represented by investing in the host country. In both respects, Greece's scores seem to be less favourable than in the average of the remaining SCENAWA countries. In the case of FDEV, Greece's index is below the average of the other countries in SCENAWA, but not significantly so. With respect to the RISK indicator, Greece's score indicates that investments in Greece represent significantly greater financial risk than the remaining countries in SCENAWA.

Finally, to represent another institutional measure that has been frequently cited as being favourable to FDI and investment in general and, therefore, to long-term growth, we present an index for the strength of property rights (LEGSYS) taken from the World Business Environment Survey. This index is based on a ten-point scale with Greece having a score of 5.7, which is significantly below the average of remaining SCENAWA countries of 6.43 and the world-wide average of 6.2.

III Comparative Analysis

The purpose of this section is to extend our exploration of the factors that might be considered as contributors to Greece's lagging ability to attract FDI in a somewhat more quantitative direction. Specifically, we make use of a number of the aforementioned cross country indices presented for Greece and other countries in the SCENAWA region as explanatory variables in explaining the observed differences in average FDI-GDP ratios for 2001-2008 via regression analysis. The basic results are in Table 3. Since, there are only 25 countries in the sample and, in some cases, only 15 or 16 because of missing data in one or more of the included indices or average FDI-GDP ratios, and the fairly high correlations among some of these explanatory variables as shown in the correlation matrix presented in Table 2, the results must be considered extremely tentative and exploratory.

Our basic estimating equation is:

$$\text{FDI-GDP Ratio} = b_0 + b_1(\text{DURTIC}) + b_2(\text{GERM}) + b_3(\text{EDU}) + b_4(\text{AV.TAR}) + b_5(\text{FDEV}) + b_6(\text{REG}) + b_7(\text{RISK}) \quad (1)$$

where, as indicated above, DURTIC represents the number of days it takes on average to collect on a bad check, GERM is a dummy variable for having a legal system of German Civil Law origin, EDUC is the average years of education of members of the labour force, AV.TAR is the average tariff rate on im-

Table 2: Correlation Matrix Based on the SCENAWA Sample

	DURTIC	DURTICPR	EDUC	FDEV	AV.TAR	RIGEMPL	FIRINGC
DURTIC	1.0000	.6930	.2888	-.2032	.0316	.4027	.0064
DURTICPR	.6930	1.0000	.6245	-.2467	.1905	.2056	-.2890
EDUC	.2888	.6245	1.0000	-.4107	.0855	-.4042	-.5759
FDEV	-.2032	-.2467	-.4107	1.0000	.4645	.2867	.4082
AV.TAR	.0316	.1905	.0855	.4645	1.0000	.1093	.0203
RIDEMPI	.4027	.2056	-.4042	.2867	.1093	1.0000	.6731
FIRINGC	.0064	-.2890	-.5759	.4082	.0203	.6731	1.0000

ports, FDEV is the degree of development of financial markets, REG is the cost of registering a new firm, and RISK is the degree of risk represented by investing in the host country. For robustness tests, we also experimented by adding combinations of the remaining explanatory variables, namely, the index of strength of property rights (LEGSYS), the percentage of firms saying that they are expected to provide gifts to officials in order to obtain needed government services (EXPGIFTS) and an index of the rigidity of labour laws (RIGEMPI).

In Table 3 we present only three of the many possible combinations of explanatory variables. The selection was largely based on ex ante judgments about the relative importance of the various determinants of FDI-GDP ratios, from inspection of the correlation matrix in Table 2, and the desire to reduce the collinearity problem to the extent possible. In the latter respect, we looked for combinations of explanatory variables for which the results seemed to be at least somewhat robust to changes in specifications. DURTIC, GERM, EDUC and AV.TAR were included in all specifications because of the consistency and statistical significance of their effects across different specifications. While, in principle, we should have included dummy variables for each of the other legal origins in addition to GERM, since almost all the remaining countries in SCENAWA were French Civil Law countries, the effect of GERM represents the effect of that legal origin relative essentially to the excluded French Civil Law countries. Another reason for including EDUC, AV.TAR and FDEV in all specifications presented is that each of these variables represents a quite different type of FDI determinant.

Table 3: OLS and 2SLS Estimates of Equation (1) for FDI/GDP

	OLS	2SLS	OLS	2SLS	OLS	2SLS
Variable						
Constant	0.1148** (.0505)	0.0707 (.0540)	0.1052* (.0556)	0.0512 (.0582)	0.1687** (.0712)	0.1748** (.0556)
DURTIC	-0.00007** (.00003)	-0.0002** (.00007)	-0.00007** (.00003)	-0.0002** (.00007)	-.00007*** (.00003)	-.0002*** (.00005)
GERM	0.0448** (.0175)	0.0457** (.0179)	0.0420* (.0189)	0.0426** (.0183)	0.0498** (.0180)	.0647*** (.0151)
EDUC	0.0077* (.0040)	0.0141** (.0049)	0.0077* (.0042)	0.0144** (.0050)	0.0092* (.0042)	.0197*** (.0043)
AV. TAR	-0.0163** (.0070)	-0.0134* (.0072)	-0.0145 (.0080)	-0.0100 (.0081)	-0.0170** (.0069)	-.0138** (.0054)
FDEV	0.0337 (.0271)	0.0381 (.0281)	0.0300 (.0290)	0.0327 (.0289)	0.0386 (.0273)	.0529** (.022)
REG			-0.00002 (.00004)	-0.00003 (.00004)		
RISK					-0.0010 (.0009)	-.0021** (.00075)
R^2	0.654	0.673	0.664	0.705	0.693	0.833
ehat	t-value .563		t-value .608		t-value 1.418	

Notes: *, ** and *** represent significance at the 10, 5 and 1 percent levels respectively. The numbers in parentheses indicate the standard errors of the coefficients immediately above them.

FDI/GDP: Average FDI/GDP ratio (2001-8)

DURTIC: Number of days it takes on average to collect on a bad check.

GERM: Dummy variable for countries with German civil law origin.

EDUC: Average level of work force education.

AV. TAR: External tariff rate (Average 1990-99)

FDEV: Index representing the degree of financial markets development.

REG: Index for the cost of registering new business.

RISK: Index of a country's economic security.

Two different estimation techniques are employed, OLS and 2SLS. In the latter case DURTIC is treated as a potentially endogenous variable estimated in a first stage equation with a number of variables shown to serve as good instruments in Nugent and Glezakos (2008) based in large part on the analysis of Djankov et al. (2003). However, as shown by the t-values of the ehat variable from the first stage equation for DURTIC for each specification pair the outcome of the Hausman test for endogeneity of DURTIC rejects endogeneity. Therefore the OLS estimates are satisfactory, explaining, also, the similarity between the OLS and 2SLS estimates.[5]

All the results in Table 3 indicate significance levels (with stars) and the standard errors immediately below the parameter estimates. As expected, DURTIC has a significant negative impact on FDI/GDP in each column of the table. The German legal system dummy and EDUC have the expected positive effects on the FDI-GDP ratios in each of these regressions. In most of the columns AV. TAR, also, has the expected negative effect on the dependent variable. While FDEV has the expected sign of positive effect in each of the columns, only in the last column of the table (with the other dimension of the financial environment RISK also included) is the effect of FDEV positive and significant. REG and, alternatively RISK, are added, one at a time, in the results presented in the remaining columns of Table 3 (columns 3-6). The indicator for the cost of registering a new business (REG), an indicator on which Greece was way above the SCENAWA average, had the expected negative sign in both columns 3 and 4 but was not statistically significant. As noted above, RISK has a negative and significant influence only in the 2SLS estimates.

As a further check on the robustness to the use of alternative specifications, we have also experimented with the addition of various other measures to the specification in the first column of Table 3. Among these were the property rights indicator LEGSYS, the mild corruption index EXPGIFTS and the labour market rigidity index RIGEMPI. Yet, since in no case, were these variables found to be significant and, in no case, were the other effects reported in Table 3 affected, these results are not reported here but are available on request.

[5] Due to the single period cross-section nature of the data, especially that on DURTIC, it is not possible to introduce lags and thereby use GMM estimation techniques.

IV Conclusions and Suggestions for Policy and Further Research

The data on FDI-GDP ratios for the 2001-2008 period presented in Table 1 showed that Greece has indeed lagged significantly behind the countries in the region of South, Central and East Europe, North Africa and Western Asia (SCENAWA), which we believe constitutes a relevant comparison group for Greece. Greece, also, was found to have both a significantly smaller percentage of firms in its Enterprise Survey of 2005 indicate that they had an internationally recognized technology certification and a lower percentage of R&D expenditures in GDP than the other SCENAWA counties.

Then, based on the review of the literature on the determinants of FDI in Section II, we identified measures for most of the factors considered in that literature as potentially important determinants of FDI-GDP ratios. In order to help direct attention to factors which may have contributed to the lagging ability of Greece to attract FDI from abroad, we first compared the means of these measures for Greece over the period under consideration (2001-2008) with those for the remaining countries of the SCENAWA region. Comparisons of some of these factors, especially market size (GDP), DEMOC, the black market premium (BMP) and the average level of education of its workforce (EDUC), showed Greece to be in a relatively favorable situation for attracting FDI. Quite a few of the other measures, however, revealed Greece to be in a disadvantageous position relative to the other countries in this region in this same respect. Among these were the Average Tariff rate (an inverse measure of openness), the cost of registering a new business (REG), the measure of financial risk (RISK), the mild corruption measure (EXPGIFTS), the strength of property rights (LEGSYS), one measure of complexity of legal procedures to collect on a bad check (PROCCOM) and the two indicators of labour market rigidity, FIRINGC and RIGEMPI. On each of these measures the score for Greece was significantly less favorable than for the corresponding average for the other SCENAWA countries.

Finally in Table 3 we present the results of an additional step taken in the direction of demonstrating some factors that could well underlie the Greek other SCENAWA comparisons. This was a series of cross-country regressions for FDI-GDP ratios. On the basis of the OLS and 2SLS estimates presented in this table, the positive effects of the favorable EDUC are supported. At the same time, the hypothesized negative effects of AV.TAR and DURTIC are, also, quite strongly supported. Since most of the countries in the SCENAWA region, like Greece, were of the French Civil Law tradition, the significance of the dummy variable GERM is, also, confirmation of the negative influence of French Civil Law tradition on FDI-GDP ratios.

Because of the extremely small size of the sample and, of course, the fact that omitted variables could be correlated with some of the included explanatory variables, both these results and the conclusions which follow should be treated with considerable caution and regarded as extremely preliminary.

Nevertheless, together with evidence from a number of studies in the literature, as well as some policy evaluations from international agencies, our analysis points to several potential factors contributing to the relatively weak inward FDI performance of Greece and, at the same time, to policy changes that might improve Greece's future competitiveness in this and other respects.

(1) Since trade openness has been found to be a positive determinant of export-oriented FDI, Greece's average tariff rates (the EU common external tariffs), are now high relative to many of its competitor countries in the SCENAWA region. This is, despite the fact, that they are not high relative to the world in general. While by itself, Greece may be unable to reduce its external tariff rates, it may be able to offer incentives for exports that would tend to offset this relatively recent disadvantage.

(2) Although again not anything that Greece may be able to do much about directly, Greece's French Civil Law tradition seems to exert a significant negative effect [via the positive coefficient for (GERM) on FDI/GDP and indirectly through its positive influence on DURTIC]. This unfavorable heritage of history may also be related to the relatively high values for Greece on REG, FIRINGC, and RIGEMPI, all of which seem to have negative effects (even if not statistically significant ones) on the FDI-GDP ratios.

(3) Nevertheless, even if the French legal origin of its legal system cannot be changed, as Nugent and Glezakos (2008) have shown, there are many ways in which a country's values of unfavorable legal procedures indica-

[6] In particular, these authors showed several administrative reforms that countries made

tors like DURTIC, REG, and PROCCOM can be reduced.[6]

(4) The absence of exchange rate risk derived from Greece's membership in the European Monetary Union is, no doubt, an important contributor both to overall openness of the country and financial risk reduction. Thereby, these characteristics should be expected to exert positive influences on Greece's ability to attract FDI. Nevertheless, despite this, Greece's score on the Financial Risk indicator (RISK) is significantly higher than the mean of other SCENAWA countries. This may well be due to the country's increasingly large fiscal deficits (which for several years now have already been well beyond EMU rules). These deficits have also raised Greece's foreign debt, which, at present, is expected to rise to over 125 per cent of GDP (*Economist* 2009). Combined with the fixed Euro exchange rate relative to both the US dollar and, especially, the currencies of the other SCENAWA countries, these deficits may have contributed both to the higher rates of inflation and higher nominal interest rates experienced by Greece relative to its other Euro members. Both of these influences have, no doubt, helped to undermine Greece's competitiveness in trade and FDI. These same considerations may, also, have been responsible for Greece's somewhat unfavorable score on the Financial Development index (FDEV).

(5) As emphasized in OECD (2007) and by the significantly higher scores of Greece on RIGEMPI and FIRINGC, Greece's labour market and pension system regulations seem badly in need of reform if the potentially negative influences of these indicators on Greece's ability to attract FDI are to be overcome. As indicated above and, especially, in OECD (2007), Greece's pension system rules need to be purged of the many distortions with respect to special rules for those in specific occupations that make early retirement possible and financially attractive to adult workers. Similarly, its rules for compensation on dismissal need to be adjusted so that

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which dramatically reduced the time and other costs of enforcing contracts, such as allowing reduction in the number of procedures required and assuring that they can all be accomplished in a single court. When Tunisia did this in the late 1990s it became one of the countries with the fastest and less costly legal procedures in the world.

the compensation required better matches with length of experience and reasonable needs of workers. So, too, its relatively high minimum wage requirements which have, also, increased with inflation should be revised for new entrants and female re-entrants to the labour force so as to reduce the disincentive for firms to hire such workers. This could go a long way to reduce the growing informality of the labour force, which may be unfavorable for both employers and workers. These factors may be especially important for FDI attraction given the likely greater propensity of foreign firms to abide by regulations than small domestically owned private firms.

(6) Although not something explicitly analysed in this paper, considering Greece's apparent advantage on the EDUC index and the evidence presented here that EDUC seems to have, at best, only a rather marginally significant positive influence on FDI/GDP in the SCENAWA sample, it might be worthwhile giving serious consideration to the recommendation of OECD (2007) to reform the allegedly overly centralised rules of Greece's higher educational system. In particular, it would seem desirable both to strengthen the relation between the skills needed by Greece's private sector and those provided by the country's universities, and to increase the efficiency of the system.

(7) Finally, as noted above, Greece has a no worse than average score among SCENAWA countries on the more serious inverse measure of corruption (CPI), and the EXPGIFTS index was not found to have a significant negative influence on FDI/GDP in Table 3. Yet, the fact that several times as high a percentage of firms in the Greek Enterprise Survey of 2005 said that they were expected to make gifts to officials for services received (EXPGIFTS) than the average of other SCENAWA firms in comparable surveys, is certainly a worrisome statistic. The Greek administrative service could do well to carefully examine what can be done to reduce this impression on the part of firms, whatever the cause.

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Interweaving between Politics and the Media: A Note[1]

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Abstract

The entanglement between Politics and Business is a well researched phenomenon in social science. More specifically, rent seeking has been studied in Public Choice Theory. The Political-Military Nexus has also been denounced in the press and studied in the literature. The ability of elites of wealth to influence politics in capitalist countries – the propaganda model – has been an object of study, although no tools of economic analysis have been applied. In this note we are interested in the phenomenon of entanglement between Politics and the Media, termed "Interweaving", which lies at the center of public interest in Greece. In this note we attempt to study some of the causes and implications of interweaving by applying elementary tools of economic analysis and concepts of social psychology.

The findings in this note have not been mentioned before, although they are derived by use of simple economic tools. Yet their implications deliver a strong blow to the ability of the press to perform its role in the checks and balances that form part of a modern democracy. What is more, it leads to the spread of corruption in other parts of the economy through the role of media in influencing values in the society. This negative influence might be counteracted through the creation of an Independent Authority to fight interweaving or corruption in general. Its task will be assisted by the transparency of business dealings offered by the Internet.

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[1] I am indebted to Professor G.E. Drakos for a few insightful comments made for an earlier (greek) version of this note. The note benefitted also from the discussion that followed its presentation in a meeting organised by the Center of Planning and Economic Research.

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1 The Media Industry

The media industry has traditionally been the object of study of disciplines other than economics. This is partly due to the importance of its products in helping us to understand our societies and our value systems. It is also due to the fact that the Press, usually called "Fourth Estate", is expected to play an important role in contemporary democracies since "public enlightenment is the forerunner of justice and the foundation of democracy."[2] The disciplines interested in the media industry, politics, sociology, psychology and ethics are not famed for their use of analytical and mathematical techniques.

On the other hand, some of the main characteristics of the media industry violate the broad assumptions of conventional economic theory. This prevents its immediate application to the behavior of media organisations.

- The industry produces and sells two kinds of goods: content (information and entertainment) and access to audiences[3] which is usually sold to advertisers. The production of these two goods is interrelated and dual production is not the standard case in economic analysis[4] of production.
- Several media organisations offer content for free: it is done traditionally by state run firms in the audiovisual and broadcasting sector and, more recently, by firms freely distributing their newspapers. Free distribution of goods is not the behaviour of firms assumed in the usual analysis where the conditions for the best allocation of resources are derived.
- Large number of products of media organisations exhibit public good characteristics: listening to a radio programme or watching a TV show does not consume it nor does it prevent other people from doing the same. Thus, the production of the industry's products is subject to economies of scale: the marginal cost of production is lower than average cost.
- Finally, media organisations enjoy the so-called "economies of scope": synergies in production reduce the costs of parallel production of several products making diversification a profitable strategy.

These are the main peculiarities hindering the application of standard eco-

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[2] Excerpt from the Preamble of the Code of Ethics of the American Society of Professional Journalists, http://www.spj.org/ethicscode.asp.
[3] Gillian Doyle *(*2002), Chapter 1.
[4] Picard, Robert (1989), Chapter 1.

nomic theory to the study of media organizations.

The Press is a branch of the industry which suffers losses most of the time.[5] The situation in Greece is even grimmer. The following table contains data drawn from all (52) firms of the sector publishing their balance sheets. They appear in the relevant Branch Study of ICAP S.A.[6] As one can see net pre-tax profit as a percentage of sales, as well as the ratio of pretax profits as a percentage of the total liabilities side of balance sheets is negative throughout the five year period. Surprisingly, the number of titles circulating nationally does not fall – it actually registers a slight increase!

Persistent losses in all media existed before 2003 as mentioned in the chapter on Greece included in Kelly (2004).

"In effect, all television stations face severe financial problems – in fact most of the media are in the red. This has made analysts wonder about the real intentions of their owners. It seems that Greece has entered a new era of 'interplay' between media owners and politicians. In the new game each party tries to gain tactical advantages because each needs the other. The entry of business interests on to the media scene is an important way in which these interests try to influence public opinion and to exert pressure in the political arena for their business interests."[7]

Table 1: Profitability of the Press (newspapers) in Greece

Index	2003	2004	2005	2006	2007	Five-year average
Net pre-tax profit (% over sales)	-2.08	-3.37	-0.67	-3.28	-3.67	-2.62
Rate of return of total engaged capital (% of total liabilities)	-5.86	-12.73	-3.83	-5.05	-2.2	-5.93
Number of newspaper titles circulating nationally (in parentheses sports newspapers are excluded)	79 (61)	82 (64)	86 (66)	90 (68)	99 (66)	

Source: Published balance sheets, ICAP S.A. 2008, pp. 90-91.

[5] The phenomenon is usual in European countries, as mentioned in the relevant country chapters of Kelly (2004). The opposite is true in the US where each newspaper functions as a monopoly in its own market. See Picard R. in Alexander (2003) p. 110.
[6] See ICAP (2008).
[7] Ibid., p. 99.

Losses continue to persist since all but one Greek media firms listed in the stock exchange registered losses during the first semester of the 2010.[8]

2 Definition of Interweaving

In the New Greek Language Dictionary compiled by G. Babiniotis we find the following comment attached to the explanation of the meaning of the verb «διαπλέκω» which literally means "interweave":[9]

> *The term interwoven interests or simply "the interwoven" was coined during the decade of the 80's (by the prime minister K. Mitsotakis) and its adoption spread gradually. The term refers to the illegitimately entangled interests that develop backstage between politicians and businessmen, who engage in the field of information (as editors of newspapers or as owners of radio or TV stations) so as to mutually accommodate their political and business goals (promotion and propaganda on the part of politicians and pecuniary benefits on the part of businessmen).*

According to the above excerpt we could define "interweaving" as the phenomenon of clandestine offer of the services of a firm or of a group of firms to the ruling officials (or contestants of power) in exchange for favourable behaviour to the firm. In essence, what we have here is an illegitimate surrender of (or promise to surrender) part of some power of a political body to a firm in exchange for its services to acquire power.

3 Analysis of Political Behaviour

The main trait of democratic regimes is that power is granted or removed by decision of the majority of voters (citizens). The ability to influence the opinion of voters is therefore, of the utmost importance to the suitors of

[8] *Oikonomiki Kathimerini*, Sunday 5 September 2010, p. 7.

[9] G. Babinioti (1998), p. 497. We translate here the verb «διαπλέκω» as "interweave", which is its literal meaning. However, the verb entangle is used in places where the syntax is better served by it.

power.[10] How, then, is the opinion of voters formed? If the voter behaves rationally he will vote for the party, or the representative of the party, able to persuade him that it/he will use its/his power in order to maximise the voter's benefit. He expects to promote this way the interests that he, as citizen, considers as more important. This may lead to the deplored "customer" relations of voters with their representatives, personally or as a group, where they expect to draw significant benefits from the party they vote for,[11] a phenomenon called rent seeking.

However, rent seeking is not always feasible, especially on a national scale. In a world of rapidly increasing complexity, where citizens see the opportunities of pleasurable use of their time expanding in number and diversity,[12] they form their judgment relying on limited information and on rules of thumb. Consequently, the most important issue for the suitors of power is to secure the collaboration of those individuals or firms who are able to exploit this kind of behaviour on the part of the citizens in order to create the appropriate impressions and to help them influence public opinion in their favour.

Economists who insist that voters behave rationally would argue that rules of thumb leading to wrong decisions will be abandoned. What is being overlooked, though, is that, when voting is not obligatory, as is the case in contemporary democracies, rational behaviour may dictate dropping the whole process of decision making altogether! In view of the substantial cost (rather, in view of the impossibility) of judging the effects of different policies on his own welfare and in view of the minimal value and weight of his vote on the outcome of the election, a rational voter may not show up at the polls. This may explain the phenomenon of rising abstention from voting observed in all democratic countries.

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[10] The analysis follows the model of political behaviour of parties and voters introduced by Anthony Downs (1957).

[11] This sort of behaviour, called rent seeking, is the main object of study in the second generation of research in the field of Public Choice. See Mueller (1997) Ch. 1.

[12] Almost all households possess radio and TV sets, through which they can connect with a large variety of emitting stations, a vast number newspapers and magazines and books can be bought or read in public libraries, not to mention CD's and DVD's and other entertaining material, freely distributed or downloaded.

In his celebrated book "The Psychology of Persuasion" Robert Cialdini (1973), Professor of Social Psychology, world acclaimed guru of Persuasion, mentions six rules that influence the judgment of people and persuade them to comply with requests. These rules are:

1. Reciprocation: we tend to respond favorably to requests of individuals who have treated us favorably.

2. Consistency in commitment: we tend to behave consistently to commitments that we have undertaken.

3. Social Proof: we tend to adapt our behavior to that of other persons belonging to our social environment, especially in conditions of uncertainty.

4. Authority: we tend to obey those who seem to have knowledge and prestige.

5. Liking: we tend to agree with people we like.

6. Scarcity: we tend to appreciate more the things we are afraid we might lose.

In the words of the author,[13]

> "…some of these principles possess a tremendous ability to direct human action. ….. (Furthermore,) they manipulate human action without the appearance of manipulation. Even the victims themselves tend to see their compliance as determined by the action of natural forces rather than by the designs of the persons who benefit from that compliance."

To these principles we must add the context within which decisions are made, since experiments have proven that the context can considerably affect our judgment. There is proof that our judgment is not objective and inalterable: it depends on the events that have immediately preceded[14] and on circumstances, irrelevant at first sight,[15] which prevail at the moment the de-

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[13] See Cialdini (1973) pp. 9, 11.

[14] A feature of human perception, called the contrast principle, is that it tends to overstate the difference between two things that are presented one after the other. If we enter a dark room leaving a well lit room we will feel that it is much darker than if we enter the dark room leaving a totally lightless one.

[15] Experiments have shown that individuals do not always make the same decisions under different, but at first sight irrelevant, conditions. For instance, in several experiments most of

cision is made.

Applying these principles in matters of political decisions, we may conclude that:

- According to the rule of authority, voters will be persuaded by those who are deemed knowledgeable in assessing public policy;
- Reciprocation will influence more particularly – but not exclusively – rent-seekers.
- The influence of social proof will depend on the principles of the social group[16] to which the individual belongs. It is assumed that such influence is reduced, due to spread of liberal mentalities in families and other social groups of advanced countries in our time.
- The rule of consistency influences mostly those who had actively participated in a political group in the past and explains the behaviour of voters who vote consistently for the same political party.
- The rule of liking forecasts that voters will be influenced by the physical attractiveness, similarity, professional success, eloquence, humor, contact and past cooperation, association with positive experiences, fame, affluence, and other social values characterising the candidate requesting their vote.
- The rule of scarcity is most potent in a negative way – citizens will vote against parties who threaten to abolish their established interests.[17]

Media organisations produce and transmit messages. The content of the messages may be:

- Information
- Stimulation of emotions and of imagination
- Persuasion, and

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the individuals who admit that they would be ready to travel a certain distance in order to save 10 out of the price of 40 Euros that a watch they intend to buy costs, they declare that they would not travel the same distance in order to pay 490 Euros for a video camera costing 500 Euros. This means that although the absolute amount saved and the sacrifice required are exactly the same in both cases, their decision is different.

[16] The family and the regional tradition influence the political affiliation of individuals.

[17] Cialdini, op.cit., pp. 257-261. The abolition of newly established rights or benefits is considered by social scientists as a primary cause of political turmoil and violence. J.C. Davies (1969) gathered persuasive evidence supporting this view and explains a large range of revolutions, revolts and internal wars with its application.

• The execution of rituals.

Firms engaged in the production and transmission of continuous and up to date messages can influence public opinion swiftly. Consequently, media of mass communications and persuasion organisations present the greatest interest and can offer most valuable[18] services to the contestants of power.

As we already have mentioned, except for firms whose business is communication, isolated individuals can also influence public opinion. Especially able to influence public opinion are individuals who substantiate one or more social values and can exploit the rules of authority, liking and reciprocation cited above.

4 Use of Opinion Leaders by the Contestants of Power

Enterprises engaged in the production and transmission of messages offer their services at a price. This reduces the persuasive power of the messages transmitted since the firms producing them have an interest in supporting these opinions. When voters realize that the senders of the messages are not impartial they dispute the objectivity of their messages.[19] It is easier to persuade the public through messages transmitted by objective sources than by sources having vested interests in the point of view they support. This is one reason why contestants of power are reluctant to use overtly firms producing and transmitting messages. Another reason emanates from the restriction of expenditure instituted in most advanced democracies limiting the amount of resources that can be allocated for this purpose. These restrictions do not permit power contestants to buy services to the extent they would like to from mass media.

As far as individuals are concerned, these are exploited by the suitors of power directly and indirectly. Drafting individuals who embody social values and their impressive electoral success is a widespread phenomenon. It concerns:

• Professional distinction in areas with public recognition, like for instance by athletes, actors, musicians, journalists, lawyers, doctors, university profes-

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[18] Of course, in the longer run, artists, individuals or firms involved in art, can influence political developments.

[19] Aristotle, in his «Rhetoric», includes impartiality among the qualities that an orator must have in order to be persuasive.

sors,

- Physical attractiveness, eloquence, wit, and other characteristic of actors, models, journalists, lawyers, etc.

Individuals belonging to these categories are drafted, all the more in our days, without any proof of long service and commitment to party committees and other bodies, for the simple reason that they can influence positively public opinion. The decline of ideologies helps in this direction, since it allows the employment of individuals who do not subscribe to the stated ideology of political parties, at least in its detail. The main explanation for the decline of ideologies is the tendency of parties of power to converge to the center of the preferences of the voting body, as they try to maximize voter support.[20] It is also due to the impossibility of drawing up a detailed program of action that will attract large numbers of voters. Anyway, the employment of ideologically neutral candidates leads to a further decline of political ideologies.

5 Economic Analysis of Interweaving

According to neoclassical theory of competitive markets, equilibrium in a competitive market is achieved when the profit of firms operating in it is equal the level of 'normal profit' i.e. the minimum profit required by entrepreneurs in order to continue investing their funds in this market. A change in the demand for the good or service produced by some sector, i.e. an increase in demand, will upset this equilibrium, increasing the profits of enterprises operating in it above their normal level. The result will be an inflow of new enterprises in the sector, so that the number of firms rises and the demand for the good each enterprise produces falls and profits return to their normal level. If the form of the market is monopolistic competition then the return of profits to their normal level can be partly achieved through a rise in the remuneration of factors of production to which particular firms owe their greater success in the market.

In general, "normal" profit should be the same in all branches of the economy. Some branches, though, have characteristics influencing positively or

[20] Downs, op.cit., p. 297.

negatively the desire of investors to invest funds in them. For instance, the production and or the demand in some branches may depend on unforeseen factors, in which case profits will exhibit large fluctuations in time; firms operating in such a branch risk failure unless they are supported by the banking system or by the wealth of their owners. Other branches imply publicity and social prestige for firm owners. This may explain why investors might be willing to invest funds in these branches even if the profit rate is lower than what they could get elsewhere.

Let us assume that branch ‘i’, the branch of mass media, has the power to influence public opinion. In order to facilitate analysis, let us assume that this power of the branch’s firms can be estimated as a percentage of invested capital.[21] If the ability to influence public opinion is desirable, then it represents a moral (non pecuniary) benefit to the managers/owners of firms in branch ‘i’. In this case the equilibrium profit rate in branch ‘i’, will be smaller than the normal profit rate prevailing in the economy. Let us denote by ‘n’ the normal rate of profit in the economy that we are examining, with ‘ξ_i’ the monetary valuation of the ability to influence public opinion as percentage of invested capital and with ‘μ_i’ the equilibrium rate of profit of invested capital in branch ‘i’. Then ‘μ_i’ will be equal to:

$$\mu_i = n - \xi_i$$

The size of ξ_i will depend on several factors:

1. On the power of branch ‘i’ to influence public opinion
2. On the willingness of carriers or suitors of power to employ the firms in branch ‘i’ in order to influence covertly public opinion
3. On the monetary resources that carriers of power have at their disposal to spend in order to compensate firms of branch ‘i’ for their services
4. On the wealth of firm owners and/or on their willingness to get involved in

[21] This is an acceptable hypothesis since a firm with large invested capital, will normally have a larger audience and, consequently, a greater possibility of influencing public opinion than a smaller firm.

[22] Sometimes firms influencing public opinion blackmail the carriers of power, warning them of their power to influence public opinion adversely, if they do not come to terms with them on their own accord.

clandestine undertakings with carriers or contestants of power[22]
5. On the restrictions set by the institutional framework upon the realization of such clandestine undertakings.

Factors 2-5 relate to almost all branches of the economy. The first factor, however, depends on the characteristics of the branch, so that 'ξ_i' and consequently 'μ_i' will differ from branch to branch. Let us note that in branches with strong ability to influence public opinion when other factors are favorable, 'ξ_i' can be so high that the equilibrium profit rate in the branch may be negative.

The striking conclusion here is that even firms that do not wish to participate in illegitimate transactions will be obliged to suffer losses, if they insist on operating in branches with high 'ξ_i'. Of course no firm can go on operating in the long run if it is unable to cover its costs unless the owner is willing to compensate for the losses with own funds. This means that the owner is sufficiently wealthy and/or that he has the ability of drawing funds from other sources.

A legal source of funds would be the profits of other profitable undertakings of the owner. In order to facilitate the flow of funds between firms conglomerates might be formed. Both predictions match reality since owners of mass media are in general members of wealthy families while firms in the information and entertainment sector (which are profitable) tend to merge and form huge conglomerates.[23]

Another totally illegal source is extortion through which the owners of some firms in sector 'i' can extract funds from the carriers or contestants of power.

A third source of funds comes from the profits of firms belonging to the same owner working in sectors producing public goods by subcontract from the government. If they get ex gratia favorable contracts, the excess profits constitute an indirect way to cover the losses of firms in branch 'i'. It represents indirect payment for the services they provide to the government. It is then expected that the owners of mass media firms will find it expedient to include in their conglomerates firms producing public goods, the profits of which may cover the losses of mass information firms. This particular cycle lies

[23] See Herman & Chomsky (2002) Introduction to the updated version of the Propaganda Model, pp. xi-xix.

in the basis of modern thoughts concerning interweaving.

Analysis of interweaving led us to the following striking conclusion, which has not been noted before: it drives out of the branches that influence public opinion law abiding firms, that is, those not willing to offer covert services to the contestants of power! In a sense, that is, the system threatens to corrupt honest investors. This happens because a company not willing to exploit its ability to draw funds covertly, will have to suffer lower profit (possibly at loss) compared to what it could earn in other branches, that do not posses the power to influence public opinion.

According to the analysis above we would expect low[24] profits to characterise the information providers, mainly the press – maybe even losses. Of course in the real world it is possible that some firms in the branch may still enjoy profits, because they possess a comparative advantage: in management, in the access to information, in synergy with other media, in the employment of high quality personnel, etc. Competition among firms in the branch will see to it that the factor responsible for the comparative advantage gets the surplus. It is only when the comparative advantage cannot be acquired or copied by competitors that the successful firm may be able to survive without sacrificing its honesty. The successful firm may still leave the branch if its advantage is not exclusive to branch 'i', but of a general[25] nature: if its comparative advantage can be applied in other sectors as well, then the successful firm is punished by operating in the branch of mass media, since in some other branch of the economy it would be able to reap higher profits.

It is reasonable to think that honest owners of firms who influence public opinion can draw personal satisfaction from the social prestige attached to their power to do so, and that they might be willing to pay the price of the 'fourth estate'. Of course, if the branch shows a continuous deficit, they must be very wealthy in order to be able to hold on to their firms for long periods despite unfavorable conditions.

6 The Recent Exacerbation of the Phenomenon

Interweaving is expected to appear in market economies. As we have

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[24] Low in comparison with the profits observed in other branches.
[25] If they, for instance, have better management.

mentioned above (factors 1-5), its extent depends on the mentality of those in positions of power and those contesting these positions and on the mentality of the entrepreneurs, on the obstacles that the institutional framework sets on clandestine dealings and on the extent of the resources disposable for this end.

What we now wish to examine is the reason why this phenomenon has spread significantly during the recent decades.

From the factors referred to above (1-5), the third has changed significantly during the last decades: i.e. governments have now at their disposal many more funds in order to finance the private production of public goods and services. This is due to the following reasons:

1. Up to the decade of the 70's it was considered self-evident that public goods should be produced in the public sector. The disillusionment concerning the efficiency of public services and firms led to, among other things, the separation of financing and production of public goods. Thus, while the designation of a good as public good destines it for public financing, it is not necessary that it must be produced in the public sector, which is deemed to operate under conditions limiting its efficiency. Thus governments started outsourcing the production of public goods to private firms while at the same time public firms were privatized. This means that the resources flowing from the public sector towards private firms have increased significantly during the last decades in all market economies.
2. The preferences in modern advanced societies tend to favour goods of public or semi-public character: health, education, better environment, etc. This tendency may be due to the characteristics of these goods, i.e. they have a "luxury" character and the proportion of income spent on them rises with income. Another reason might be the bias of technological progress that took place during the second half of the 20th century: the introduction of new private consumption goods slowed down after the Second World War. Cars, aeroplanes, domestic appliances, even colour televisions had been invented before 1940. Since then, most progress has centred on computers, which are to a great extent production rather than private goods. Thus the expansion of the range of goods available to consumers in modern societies is biased towards goods of public or semi-public character.
3. The branches presenting the greatest development due to the rapid tech-

nological progress, i.e. communications and transport, require large investments in infrastructure, which have, in general, semi-public character.

We can conclude therefore that the preferences of modern societies, the nature of technological progress and the dominant opinions concerning the efficiency of the private sector inflated the flow of resources from the government toward the private sector. The existence of increased resources at the disposal of current and potential governments which could be channeled toward the private sector promotes – ceteris paribus – interweaving. In order to keep the level of interweaving constant both the legal framework must be instituted and implemented or the behavior of the parties involved must change.

7 The Situation in Greece

Interweaving may emerge when the rate of profit in the sector is very low or even negative and the level of corruption is high. Control of the phenomenon is extremely difficult because those who should denounce it and/or eliminate it are those who profit from it.[26] Consequently, even if laws are instituted in order to fight interweaving their enforcement will be problematic.

Titles of print media circulating in Greece,[27] including local and national newspapers and magazines, are around 6.000, a number extremely large in comparison with the size of the population. Furthermore, the average profitability of newspapers, at least during the last six years, was negative, as evidenced by their balance sheets.[28] Despite the fact that total circulation is falling new titles are introduced in the market. In fact most media in Greece, including broadcast and TV are in the red.[29]

As far as corruption is concerned our country fares unfortunately very

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[26] This would be equivalent to entrusting smokers and cigarette producers to eliminate smoking!

[27] Data for Greece are drawn from the branch study of ICAP (2008) and from the relevant chapter of Kelly and Ass. (2004).

[28] ICAP, p. 44. The data are set out in Table 1 above.

[29] Kelly, ibid., p. 99.

[30] See the tables drawn up by Transparency International concerning corruption perception indices http://www.transparency.org/policy_research/surveys_indices/cpi/2009/cpi_2009_table

badly in the list drawn by Transparency International,[30] and the phenomenon seems to worsen in time.

Wealthy families own the five largest publishing firms and their involvement in broadcasting is important. As noted in Kelly (2004),

> "The entry of businessmen and shipping owners and other business interests on to the media scene is an important way in which these interests try to influence public opinion and to exert pressure in the political arena for their business interests".

The legal framework ruling media in Greece is rather strict and covers almost all aspects mentioned, but it is not consistently implemented. A detailed account of the relevant laws and ministerial decisions is set out in the branch study of ICAP pp. 9-11. The law allows courts to scrutinize the finances of the press, but no action has ever been taken.[31] The law limits the number of newspapers that a publisher can own, and forbids owners of firms engaging in public works to own more than 5% of the shares of a media company. These laws do not seem to have been implemented either.

The importance of the finding that interweaving drives honest firms out of the market cannot be overestimated. As already stated, the press and other information media play a significant role as watchdogs of the public interest. On the other hand, media influence in large part the values in our society. Corruption in a competitive media sector is therefore the worst form of corruption, since it will spread and worsen the phenomenon everywhere else.

We have argued that media themselves and politicians cannot be relied upon to eliminate interweaving. Can we imagine a fifth estate? May the creation of an Independent Authority to prevent Interweaving succeed in limiting or even eliminating the phenomenon? An Independent Authority assigned with the task of preventing corruption in general might possibly help with interweaving as well. Independent authorities have not been particularly successful in Greece, but their failure is attributed to their inappropriate staffing. One of the main innovations of the constitutional review of 2001 (article 101A) was the establishment of Independent Authorities.[32] Furthermore, the

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[31] Kelly, ibid., p. 98.

[32] Chryssogonos (2006).

Internet, with its ability to increase the transparency of the developments in the economy, could help in limiting the phenomenon, provided this new technological medium is not dominated by corrupt business interests striving to promote their views.

7 Conclusion

The above analysis shows that:

1. Most citizens nowadays surrender their vote to politicians on the basis of superficial impressions created mostly through the mass media. Due to the complexity of the issues involved, rationality does not lead them to abandon the rules of thumb used in decision making, when choices are proven unsatisfactory. They go on using rules of thumb or they are driven away from the polls altogether.
2. The power of mass media to influence public opinion is almost irresistible and it increases the willingness of politicians to exploit it in order to attract citizen votes. Clandestine payment for this help is realized through assignment of public contracts ex gratia to firms related to media organisations.
3. Interweaving can be strongly suspected when companies in the mass media sector, and, specifically, in the press, exhibit low profits – compared to the normal level for the relevant economy - or even suffer losses, especially when new firms enter the sector despite negative returns.
4. The result of interweaving is to drive law abiding firms away from the media sector. Thus interweaving delivers a serious blow to the ability of the press to play its role in democratic societies.
5. Interweaving is a phenomenon that will tend to appear in market economies depending positively on the extent of corruption. The appearance of interweaving worsens corruption, on the one hand, since it erodes the credibility of the press which is supposed to be the guardian of the public interest and watchdog of the activities of the government, and, on the other, since the media industry is the sector influencing values in society.
6. Interweaving represents shifting the attraction of citizen votes, traditionally earned through offering employment in the public sector, to earning it through mass persuasion with the help of the media.

7. Interweaving is exacerbated –ceteris paribus– by the increasing outsourcing, the production of public goods by the private sector,
8. Controlling the phenomenon is extremely difficult because it should be carried out by those who profit from its existence or have no interest in denouncing or constraining it. Thus, the legal framework in Greece is sufficient to prevent interweaving but it is not implemented.
9. The creation of an Independent Authority to prevent Interweaving, or corruption in general, might be a solution, although independent authorities did not have an impressive record in Greece.
10. Attempts must be made to exploit the increase in transparency offered by the Internet in order to limit the phenomenon, either independently or in assisting the Independent Authority, if and when one such is created.

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Are Retail Oil Price Adjustments Asymmetric?
Evidence from Greece and Selected Eurozone Countries

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Abstract

The purpose of this paper is to examine the transmission mechanism of crude oil prices to retail gasoline prices in Greece and selected Eurozone member-states, namely Germany, France, Italy and Spain. We examine whether crude oil prices are transmitted in the long run to retail gasoline prices and test the symmetry hypothesis. A decomposed general-to-specific model is applied for the estimation of the oil price pass-through effectiveness and asymmetric behaviour in these economies. Our results show that rigidities in the transmission process are present but variations exist across the selected Eurozone member-states. The retail gasoline prices' speed of upward/downward adjustment behaviour is considered as symmetric in most of the economies analysed. We believe that our results can be useful for the Greek and EU energy authorities, as well as antitrust policy-makers in their attempt to monitor the competitiveness of their energy sectors.

1 Introduction

Standard macroeconomic texts ascertain that there are both aggregate demand and aggregate supply transmission effects from oil prices to eco-

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nomic activity. First, a change in oil prices affects the after-tax income of households and thus aggregate consumption, as well as investment by increasing companies' costs. Secondly, oil—as an important raw material in the production process—affects the cost of production and, consequently, the aggregate supply of goods. For more than a decade, the world's crude oil prices, even when adjusted for inflation, have been almost steadily rising on an annual basis. These increases have significantly affected the price that consumers pay for gasoline. Since the demand for transport fuels is very inelastic, owing to the absence of direct substitutes, households across the world have experienced reductions in their disposable incomes. This phenomenon has triggered wide media attention and sparked many researchers to observe, analyse and interpret the effects of oil prices.

The adjustment of retail gasoline prices, that is, diesel (DSL hereafter) and unleaded gasoline (UNL hereafter) in response to changes in wholesale prices—that is, crude oil prices—is a fundamental element of the oil price transmission mechanism. Wholesale prices are exogenous to retailers located in the domestic economy (if it is not an oil producing country). If the oil price transmission mechanism is efficient, any change in crude oil prices will be transmitted to retail gasoline prices, ultimately influencing both aggregate domestic demand (through the after-tax income of households and the aggregate consumption) and output produced. On the one hand, if retail gasoline prices are rigid upward, this would imply that they adjust rapidly to declining crude oil prices but are slow to adjust in response to increasing crude oil prices. On the other hand, if retail gasoline prices are rigid downwards, this would imply that they adjust rapidly to increasing crude oil prices but are slow to adjust in response to declining crude oil prices. For these reasons, the regular monitoring and assessment of the oil price pass-through is critical for energy authorities and antitrust policy-makers in their attempt to monitor the competitiveness of their energy sectors.

In this paper, we focus on whether responses to upward and downward crude oil price changes are symmetric or asymmetric in Greece, Germany, France, Italy and Spain. Symmetry hypothesis tests the magnitude of the negative and positive adjustment of the retail gasoline prices in response to changes in crude oil prices. In conjunction with this issue, we analyse how effectively the wholesale process is transmitted to the retail oil prices. We employ the disaggregated general-to-specific (hereafter GETS) methodology to examine the long-run rigidities (elasticities) between crude oil prices and DSL, as well as crude oil prices and UNL regarding the symmetric or asymmetric behaviour in the economies selected. To the best of our knowledge, this study is the first to assess the impact of crude oil price changes on the level of retail oil prices by using GETS econometric methodology. The empirical results are mixed regarding both the price transmission process and the Pass Through (hereafter PT) completeness. It is evident from our results that rigidities in the transmission process, variations across the countries analysed and non-completeness, at least in some cases, are present. The retail gasoline prices' speed of upward/downward adjustment behaviour is considered as symmetric in most of the economies analysed.

Studies of crude oil price PT to retail gasoline prices, along with the adjustment process, have been conducted by a number of scholars—mostly examining the US retail gasoline market. Such studies include Radchenko (2005), Bettendorf, Van der Geest and Varkevisser (2003), Borenstein and Shepard (2002), Godby, Stengos, Lintner and Wandschneider (2000), Balke, Brown and Yücel (1998), Borenstein, Cameron and Gilbert (1997), Shin (1994), Karrenbrock (1991) and Bacon (1991), Rasche and Tatom (1981), Darby (1982), Hamilton (1983), Gisser and Goodwin (1986), Mork (1989), Hamilton (1996), Hooker (1996), Hamilton (2003) and Kilian (2007, 2008a). Other studies focused on non-US economies include Burbidge and Harrison (1984), Mork (1994), Jiménez-Rodríguez and Sánchez (2005) and Kilian (2008b). For example, Galeotti, Lanza and Manera (2003) focus on the issue of presumed asymmetries in the transmission of shocks to crude oil prices onto retail prices of gasoline in Germany, France, UK, Italy and Spain from 1985 to 2000 by using monthly data. They argue that, in most countries examined, different operators exist in the distribution sector that increase upward rigidity. Results from different studies in the literature are mixed since findings depend mainly on the country/regions examined, the time period analysed, the frequency of data used and the econometric methodology applied. Overall, there is no consensus in the empirical literature to ascertain whether retail gasoline prices increase faster than they decrease.

A number of empirical studies have focused on the Greek oil market. Kalantzis (2007) empirically identifies the factors that affect retail diesel and unleaded gasoline prices during the 1979–2005 period. He employs a VAR model and co-integration methodology and concludes that there is a long-run relationship between the retail prices of diesel and unleaded gasoline with the price of crude oil (Brent). In the same study, he also applies an ARDL model to determine the demand for oil products in different sectors of the economy by using a number of macroeconomic variables as explanatory variables. According to his results, there is a positive relationship between consumption, price of oil products and income. In a more recent study, Revelos (2009) applies an ECM model to examine the pass-through of Brent oil prices to the unleaded gasoline prices by using weekly data for the period 2002–2009. He finds that a long-run relationship between Brent and unleaded gasoline prices exists. He also tests for the existence of asymmetries in the Greek oil market by employing an ECM-GARCH model and he finds that asymmetries are present. Finally, Gkagka and Zarotiadis (2008) focus on the regional differentiation of gasoline prices in Greece. They apply cross sectional data from 52 major Greek cities, using retail prices for five different gasoline types. They argue that transportation costs, together with economic and geopolitical characteristics of the different areas/cities examined, are a crucial input for regional price determination. Also, they find that oil prices are higher in remote areas, which has a negative effect on economic growth.

A number of explanations regarding the symmetric/asymmetric adjustment (that is, gasoline prices respond more quickly when crude oil prices rise than when they fall) of retail gasoline prices to crude oil prices, are presented in the relevant literature. Bacon (1991) provides two explanations regarding the slow response of gasoline prices to crude oil price changes, namely *relative demand* and *exchange rate* explanation. The former states that asymmetric adjustments occur owing to exogenous changes in demand; the latter, that gasoline retail prices do not fully adjust to exchange rate changes. Borenstein, Cameron and Gilbert (1997) argue that *market power* and *oligopolistic coordination* (when a few dominant firms in the industry are engaged in unspoken collusion to maintain higher profit margins) can explain price rigidities in the market for gasoline. Balke, Brown and Yucel (1998) discuss the *customer reaction* explanation— that is, customers react strongly to gasoline price increases if they have the bargaining power to do so. They also argue that asymmetric reaction in the gasoline price changes might occur due to differences in *accounting methods* in estimating the value of the oil stocks that refiners possess. According to the *costly adjustment* hypothesis (Borenstein and Shepard 2002), levels of production and inventories are costly to alter and thus firms tend to spread the adjustment costs over time. Regarding the *search cost* hypothesis (Johnson 2002), price differentiation among gasoline retailers could differ owing to their spatial distribution and the different products and services they offer. Finally, Davis and Hamilton (2004) argue that asymmetric adjustment of gasoline prices could be partly attributed to the *menu costs hypothesis*—that is, costs related to obtain information regarding the optimum price, as well as other administrative costs.

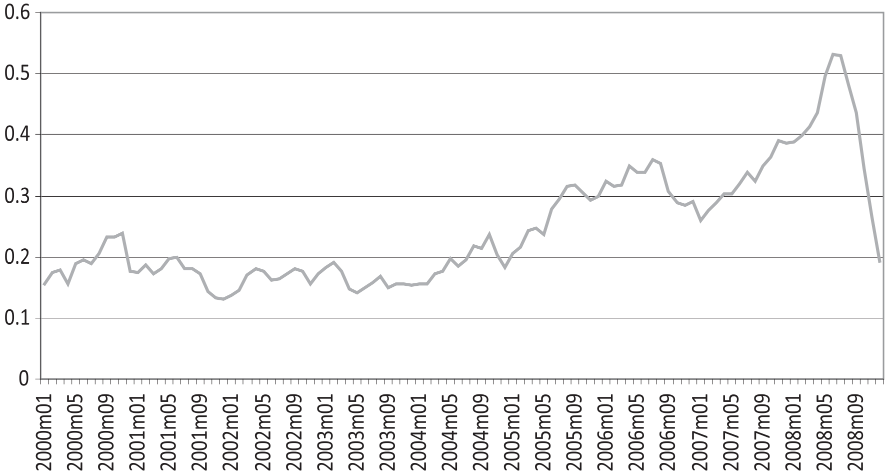
The paper is structured as follows. Section 2 discusses recent developments in international oil prices and presents the market structure for gasoline products in Greece and the EU countries under analysis. In Section 3 the theoretical framework and econometric methodology of crude oil price transmission channel to retail oil prices are presented. The empirical results are given in Section 4 and Section 5 concludes the paper.

2 Recent Developments in the EU and the Greek Retail Market for Gasoline

The short and long-run demand for oil products are influenced by a combination of economic and other factors such as income, prices and the structure of the economy (Portney et al. 2003, Jorgenson and Wilcoxen 1993). Retail gasoline prices have been characterised by high volatility, especially during the oil market crises in 2008. As is evident from Figure 1, international crude oil prices rose by almost 105% between January 2007 and the middle of 2008.

Such increases in crude oil prices were transferred to the retail gasoline prices in Greece and the other selected EU member states. In Tables 1A and 1B (available in Appendix A), we present the descriptive statistics for both DSL and UNL prices for the selected economies from 2000:1 to 2008:12, while Figures 1–5 present the evolution of the gasoline retail prices. As shown in Table 1A, Germany has the highest average diesel and unleaded prices. Greece has the lowest compared with the rest of the economies, which is in line with Kalantzis (2007). He attributes this to the fact that taxation on the Greek gasoline products is among the lowest in the EU region. The demand for such products is influenced by different taxes imposed by the authorities in order to generate revenues for the state and to manage the negative externalities to the environment caused by oil usage. The retail prices of gasoline products are partially determined by direct and indirect taxes. Two types of taxes are imposed on the retail prices of gasoline—that is, direct taxes (VAT) and indirect taxes (see Table 1 below).

Figure 1: Monthly Crude Oil Prices*, euro/litre (2000–2008)



[*] Crude oil prices refer to average prices from all major markets.
Source: International Financial Statistics, IMF and authors' calculations.

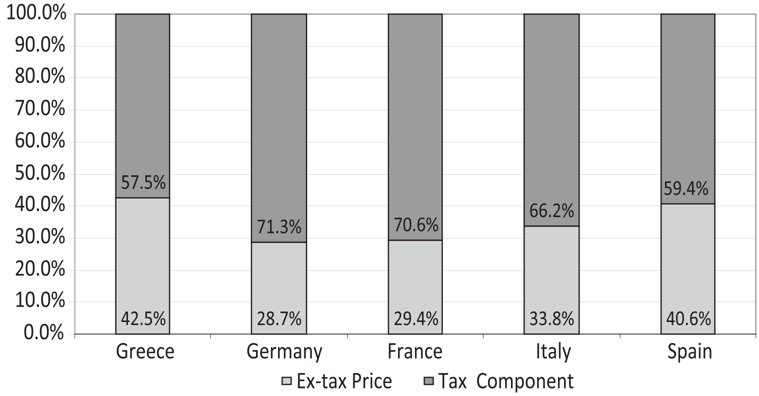
Table 1: Direct and Indirect Taxes for Gasoline Products (2009:Q2)

	Direct taxes (VAT)		Indirect taxes (€/1000 litres)	
	UNL	DSL	UNL	DSL
France	19.6%	19.6%	606.2	427.90
Germany	19%	19%	654.5	470.40
Greece	19%	19%	418.52[1]	309.99[2]
Italy	20%	20%	564.0	423.00
Spain	20%	20%	436.53	340.38

Source: Directory for Energy, European Commission (2009)
[1] According to Greek Law 3775/2009.
[2] According to Greek Law 3483/2006.

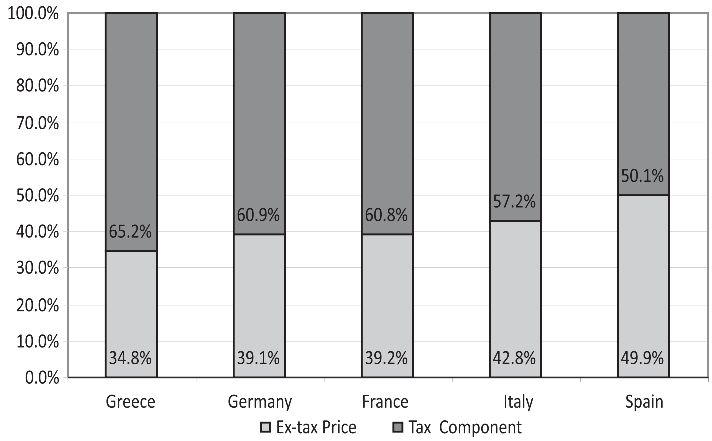
Figure 2 and 3 below present the percentage share of taxation in the retail DSL and UNL prices in Greece, Germany, France, Italy and Spain.

Figure 2: Unleaded gasoline prices and taxes in EU member-states (2009:Q1)



Source: International Energy Agency and authors' calculations.

Figure 3: Diesel prices and taxes in EU member-states (2009:Q1)



Source: International Energy Agency and authors' calculations.

2.1 The Greek Oil Market

The Greek oil industry has a number of characteristics regarding its wholesale and retail market. We can distinguish three levels of activities in the Greek oil industry—refineries, wholesale and retail markets. The refineries sub-market is dominated by a partially state -owned company (Hellenic Gasoline), which controls approximately 79% of the market. The rest of the market supply is satisfied by the production of the privately owned company, Motor Oil Hellas (IEA, 2006b). The wholesale sector of the Greek oil market is serviced by a number of domestic and multinational oil corporations, including among others Hellenic Gasoline, BP and Shell. Retail outlets in Greece consist of 7,500 gasoline stations which serve on average roughly 1,500 persons and 800 vehicles.[1] This distribution is driven by the geographical nature of the country, with its dispersed island settlements. In Table 2 we present the corresponding distribution in the other two southern European countries (Italy and Spain).

Table 2: Number of Gasoline Stations, Persons and Vehicles Served (2006)

	Number of gasoline stations	Number of persons served per station	Number of vehicles served per station
Greece	7500	1500	800
Italy	26000	2600	1600
Spain	8700	4700	2600

Source: International Energy Agency (2002 and 2006).

According to the Greek Competition Committee (GCC, 2008) there are a number of rigidities that prevent competition in this particular industry. First, there is no transparency in the procedure followed by wholesale suppliers for the discounts offered to retailers. This creates inequalities, favouring retailers who have high turnover and thus distorts competition. Secondly, the average duty in the distribution of oil products from wholesalers to retailers is considered to be high. Thirdly, the Greek Competition Committee believes that there is a lack of transparency in the contracts between retailers and distribution companies, owing to subjective criteria regarding retail price deter-

[1] Law 3054/2002 retains the right to introduce price ceiling in case competition is distorted by monopolistic tactics. In addition, Laws 3775/2009 and 3483/2006 exogenously set the tax rates on unleaded and diesel gasoline for household consumption.

mination and favouritism among members of the retail network. Overall, the Competition Committee argues that lack of storage infrastructure creates fraud in the oil industry in Greece. According to the International Energy Agency (IEA, 2006) the Greek government should monitor the refinery market to prevent potential abuse of market power.

2.2 The Spanish Oil Market

The Spanish oil market is in a transition phase from a fully regulated to a fully liberalised system (IEA, 2007). Spanish energy supply is provided by the private sector in all areas of the oil market, where the government (namely the National Energy Commission) regulates the natural monopoly aspects of the energy system to ensure, for example, third-party access and transparency by private companies. The distribution network of Spain can be characterised as a quasi-monopoly, as it is owned by the major oil companies operating in the country. The Hydrocarbon Logistics Company has a dominant role in the distribution network, as it possesses around 255 outlets in the market. Spain is well served with refineries, with a total capacity that is close to covering Spanish demand levels for oil products overall. Around 90% of the refining capacity is in the hands of the two successor companies that were established when the market was liberalised in 1992 (namely, RepsolYPF and Cepsa). The Spanish retailing market for oil products can be divided into direct sales and sales through filling stations (36% and 64% of the market respectively). According to IEA (2007b), the profit margins for the dealers regarding sales of diesel in the filling station market is considered to be high, compared to other European countries. One reason for this could be that Spain has a relatively low density of filling stations (because of local planning restrictions) compared to some other countries in Europe. The retail market is dominated by RepsolYPF (3,616 stations, 41.6%) and Cepsa (1,550 stations, 17.8%). IEA (2008b) has characterised the Spanish oil sector as heavily concentrated, despite the possibility of relatively open access. In addition, the organisation argues that "*…there is a lack of new entrants into the oil market, while it is uncertain how much this affects competition across the value chain*". Finally, IEA (2008) recommends the close monitoring of the market and promotion of further competition by encouraging new entrants (such as hypermarkets) and removing planning obstacles.

2.3 The Italian Oil Market

The Italian oil market is fully liberalised as imports, exports, trade and prices are set without constraints (IEA, 2009). The government intervenes only to protect competition and to avoid abuse of dominant position. Distribution in the market is principally undertaken by integrated oil companies. The former state oil company, Eni, maintains a dominant position in the Italian refining oil sector. Currently the company has the largest share of the market (30%). In addition, there are three foreign companies operating in Italy (Tamoil, Kuwait Gasoline and Lukoil), where their combined market share of the Italian retail distribution is around 18% and approximately 17% of the wholesale market. In the distribution market for oil products, competition is hampered to some extent by the State. According to IEA (2004b and 2009) there are persistent restrictions on entry conditions into the market for companies that are not vertically integrated. This has led to an unsatisfactory degree of modernisation of the distribution network, high prices and more generally an insufficient degree of competition in the market at the expense of consumers.

According to the Italian competition authority (Autorità Garante Della Concorrenza E Del Mercato, 2009), barriers to the opening of new retail outlets exist because of a number of legal definitions (i.e. mandatory minimum distances between pumps and minimum areas designated for commercial activities). According to the latest report of IEA (2009), although liberalisation and market reform have had a visible impact on the wholesale markets for oil products, work remains in the reform of the distribution and retail sectors. The organisation argues that the sale of gasoline and diesel on the retail forecourt is still governed by outdated legislation, which has a negative impact on retail prices and is hampering competition. Finally, the organisation recommends the development of a strategy for oil supply infrastructure for the medium to long-term, including a commitment to continue to improve the infrastructure planning and permitting process.

2.4 The German Oil Market

Germany's oil market is fully liberalised and characterised by a relatively large number of market participants. It should also be noted that no government ownership exists in any sector of the country's oil market—that is, refineries, the distribution network and retailing. Nine companies are active in the oil refining market, with three holding nearly 65% of the capacity share (Shell Deutschland Oil, Deutsche BP and Total Deutschland). In the retail oil market, the German government promotes the use of diesel in passenger vehicles. As IEA (2007a, 2008a) notes, competition is active in all sectors of the German oil market.

2.5 The French Oil Market

The French market for oil products has a number of characteristic features. First, with respect to the refinery market, 13 plants operate in metropolitan France plus several overseas. According to IEA (2006a), there are significant discrepancies between refining capabilities and demand, when considered on a product-by-product basis. In other words, there is mismatch in refining capacity versus demands for products in the French market for oil products. The present discrepancy between refining capacity and domestic consumption results in middle distillate imports and gasoline exports. Secondly, the French retail market for gasoline consists of retail outlets (owned by oil companies) and hypermarkets. At the end of 2007 their market share was around 44% for the retail outlets and 56% hypermarkets. In general, the retail market for gasoline products is considered to be highly competitive. According to IEA (2006a, 2004a) competition in the retail market and the resulting decrease in retail price margins have forced the closure of numerous gasoline outlets.

3 Econometric Methodology and Data

The PT literature is mainly related to the way crude oil price changes are transmitted to DSL and UNL prices. Such PT equations usually take the following simple algebraic long run form:

$$UNL_t = \phi_0 + \phi_1 \times Oil_t + e_t \tag{1a}$$

and

$$DSL_t = \psi_0 + \psi_1 \times Oil_t + u_t \tag{1b}$$

where, UNL_t stands for the premium unleaded gasoline price,
DSL_t stands for the diesel gasoline price,

Oil_t stands for the crude oil prices expressed in Euros,
ϕ_1 and ψ_1 are the two long-run elasticities and
e_t and u_t are the two error terms.

Additionally, the two simple Error Correction Models (hereafter ECM) are given by equations (2a) and (2b), respectively:

$$\Delta UNL_t = c + \sum_{i=1}^{n} \rho_i \times \Delta UNL_{t-i} + \sum_{i=0}^{n} \Delta\lambda_i \times Oil_{t-i} - \theta_1 \times e_{t-1} + \xi_t \quad \text{(2a)}$$

and

$$\Delta DSL_t = c + \sum_{i=1}^{n} \gamma_i \times \Delta DSL_{t-i} + \sum_{i=0}^{n} \Delta\eta_i \times Oil_{t-i} - \theta_2 \times u_{t-1} + v_t \quad \text{(2b)}$$

where, Δ stands for first difference operator,
ρ_i γ_i, λ_i and η_i are the short-run elasticities,
θ_1 and θ_2, are the coefficients of the error correction terms (e_{t-1} and u_{t-1} respectively) and
ξ_t and v_t are the two error terms.

There are two main theoretical issues which are worth examining. First are the long-run and short-run rigidities (the ϕ_1 and ψ_1 coefficients in eqs. 1a and 1b and the ρ_i γ_i, λ_i and η_i coefficients and eqs. 2a and 2b, respectively) from the crude oil price to UNL and DSL prices. Secondly, note the speed of price adjustment initiated from the crude oil price changes (θ's coefficients of the error correction term in eqs. 2a and 2b). The empirical literature on PT transmission models[2] concentrates mostly on the simple ECM model. However, in the simple ECM (eqs. 2a and 2b) DSL and UNL price changes—as well as the speed of adjustment coefficients (θ_1 and θ_2)—cannot be analysed separately when the crude oil price changes are increasing or decreasing. Bachmeier and Griffin (2003) and Rao and Rao (2009, 2008) present an alternative dynamic approach originating from the LSE-Hendry GETS methodology which tackles the above issues. The disaggregated GETS model[3] could be presented in the following form:

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[2] For a complete survey of econometric models of asymmetric price transmission see Frey and Manera (2007).
[3] Equation 3 is tested by the Non-Linear Least Squares methodology.

$$\Delta UNL_t = \sum_{i=1}^{j1} \beta_{R,i}^{-} \, \Delta UNL_{t-i}^{-} + \sum_{i=0}^{j2} \beta_{W,i}^{-} \, \Delta Oil_{t-i}^{-} + \theta_1^{-} \left(UNL_t - \varphi_0 - \varphi_1 Oil_t\right)_{t-1} +$$

$$+ \sum_{i=0}^{j3} \beta_{W,i}^{+} \, \Delta Oil_{t-i}^{+} + \sum_{i=1}^{j4} \beta_{R,i}^{+} \, \Delta UNL_{t-i}^{+} + \theta_1^{+} \left(UNL_t - \varphi_0 - \varphi_1 Oil_t\right)_{t-1} + \delta T + \xi_t \qquad (3)$$

where, θ_1^- and θ_1^+ are the speed of adjustment coefficients in the positive and negative cases, respectively, and T is the time trend. The same GETS methodology is applied between oil price changes and DSL price change.

As Rao and Rao (2008) point out, the (+)/(–) superscript on the coefficients indicate a positive/negative change in the variables included in the model. For any positive change in the independent variable (ΔOil_t>0), a corresponding response of all positive coefficients (β^+, θ_1^+) is expected. On the other hand, the corresponding negative coefficients (β^-, θ_1^-) will respond in any negative change of the dependent variable (ΔOil_t<0).[4] The disaggregated GETS methodology used has two main advantages: a) it can jointly and simultaneously test the short-run and long-run stickiness/rigidities within the same PT dynamic model (Rao and Singh, 2006); and b) it can be used to test the existence of symmetric or asymmetric transmission behaviour (disaggregated GETS) between the examined variables.

Data used for crude oil prices refer to average prices of Brent offered by all major markets and they are collected from the International Financial Statistics, produced by the International Monetary Fund. Retail unleaded (Euro 95) and diesel prices are collected from Eurostat.[5] All product prices are transformed into euro/litre, using the US dollar/euro exchange rates provided by the International Financial Statistics. We use monthly data for the five examined economies and the time period ranges from 2000:1 to 2008:12.

4 Empirical Results

Before we proceed to the disaggregated GETS model implementation, we discuss whether it is necessary to test for the number of co-integrated vectors

[4] In econometric terms the corresponding “activation” will be triggered in eq. 3 with the use of dummy variables. More specifically, all positive coefficients will take the value 1 when a positive change in the dependent variable occurs and 0 otherwise.
[5] Both diesel and unleaded gasoline prices include taxes.

between the dependent and the independent variables. Hendry[6] has repeatedly stated that if the underlying economic theory is correct, then the variables in the levels must be co-integrated and, therefore, a linear combination of the I(1) levels of the variables must be I(0). As this approach holds for the GETS model, it does not need to be pre-tested for cointegration. It can be said that the relationship between the dependent variable (UNL and DSL) and explanatory variable (crude oil prices) in their levels, are a linear combination of the I(1) levels of the variables and, thus, must be I(0). Regarding the unit root tests, we apply the augmented Dickey and Fuller (1979) procedure for our data series. Prior expectation that crude oil and retail gasoline prices should be I(1) in their levels is confirmed.[7] We test for the optimal lag length of all variables in the model. Five different lag selection criteria are implemented. These include the modified Likelihood Ratio test statistic (LR), the Final Prediction Error test (FPE), the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SC) and finally the Hannan-Quinn information criterion (HQ). In most of the examined cases, the aforementioned selection criteria do not all agree about the optimal lag length. In such a case, the majority rule is applied as a sub-optimal solution.[8]

4.1 Speed of Adjustment Estimates and the Degree of Pass Through Completeness

We estimate the disaggregated GETS model for the two types of gasoline products (UNL and DSL) in five countries. For Greece, the coefficients of the two error correction terms θ^{+} and θ^{-} are statistically significant when either UNL or DSL is used as the dependent variable (Table 1A, columns 1 and 2 in Appendix B). This means that crude oil price increases and decreases are both transmitted to UNL and DSL prices in the long run. We continue our analysis by examining the degree of PT completeness between crude oil prices and UNL and DSL in Greece. The sum of the coefficients ϕ_0 and ϕ_1 (in equation 3) measures the degree of PT in the long-run. Complete PT exists when ϕ_0 + ϕ_1 =1,

[6] See Hendry, Pagan and Sargan (1984), Hendry (1987) and Hendry and Krolzig (2005).
[7] Augmented Dickey and Fuller tests results are available from the authors upon request.
[8] Results are available from the authors, upon request.

which implies that all changes in crude oil prices will be transmitted to retail prices of the two gasoline products in the long run. The crude oil PT is incomplete in the long run ($\phi_0 + \phi_1 = 0.64$) and is statistically significant when UNL retail prices are used (Table 1A, column 3). In addition, when the DSL is the retail price, the long run elasticity is 0.76, which indicates high but not complete PT (Table 1A, column 3). In other words, most of the change in the crude oil price is transmitted to the DSL retail prices.

In France the coefficients of the two error correction terms are statistically significant when either UNL or DSL is used as the dependent variable (Table 2A, columns 1 and 2). This means that crude oil price increases and decreases are both transmitted to UNL and DSL prices. We continue our analysis by examining the degree of PT completeness between crude oil prices and UNL and DSL in France. The oil PT is almost complete in the long run ($\phi_0 + \phi_1 = 0.89$) and is statistically significant when UNL retail prices are used (Table 2A, column 3). In addition, when the DSL is the retail price, the long run elasticity is 0.83, indicating again an almost complete PT (Table 2A, column 3). Thus, most of the change in crude oil prices is transmitted to the DSL retail prices.

As far as Italy is concerned, we also estimate the disaggregated GETS model for the two types of gasoline products. According to Table 3A (column 2), the coefficient of the error correction term θ^{-} is statistically significant when either UNL or DSL is used as the dependent variable. This implies that crude oil price decreases are transmitted to the UNL and DSL prices. Regarding the degree of PT completeness between the two types of gasoline products in Italy, the long run crude oil elasticity is rather complete (0.73) when UNL retail prices are used (Table 3A, column 3). Furthermore, when DSL is the retail price, the long run elasticity is 0.81, which indicates high but incomplete PT (Table 3A, column 3).

We continue our analysis with Spain. The coefficients of the two error correction terms θ^{+} and θ^{-}, are statistically significant when UNL is used as the dependent variable (Table 4A, columns 1 and 2). Once again this means that crude oil price increases and decreases are transmitted to UNL prices. In contrast, when DSL is used as the dependent variable, only the coefficient of the error correction term θ^{-} is statistically significant (Table 4A, column 2). As far as the degree of PT completeness is concerned between the two types of gasoline products in Spain, the oil PT is incomplete in the long-run (0.55) when UNL retail prices are used (Table 4A, column 3). On the contrary, when DSL is the retail price, the long run elasticity is 0.80, indicating a very high level of PT completeness (Table 4A, column 3).

Finally, our estimations for Germany reveal that the coefficients of the two error correction terms θ^{+} and θ^{-}, are statistically significant when either UNL or DSL is used as the dependent variable (Table 5A, columns 1 and 2). This means that crude oil price increases and decreases are both transmitted to UNL and DSL prices. We continue our analysis by examining the degree of PT completeness between crude oil prices and UNL and DSL in Germany. The oil PT is incomplete in the long run when either UNL or DSL retail prices are used (ϕ_0 + ϕ_1 = 0.44 and 0.51, respectively) (Table 5A, column 3).

4.2 Testing the Symmetry Hypothesis

We now ask what is the effect of an upward or downward change in crude oil prices on retail prices in the EU countries analysed. In other words, we test the symmetry hypothesis that $\theta^{+} = \theta^{-}$. The existence of a symmetric speed of adjustment is tested by using the Wald x^2-test. For Greece (Table 1B) our empirical tests show that when either UNL or DSL are used as retail gasoline prices there is symmetry, which means that crude oil price increases and decreases are equally passed on UNL and DSL prices in the long run. The magnitude of the increase/decrease of the UNL (DSL) prices is given by the long run elasticity which, according to Table 1A, is 0.64 (0.76). Thus, for a 1% increase/decrease in the crude oil price, 0.64% and 0.76% of that increase/decrease is passed on to the end user of UNL and DSL gasoline products in the long run, respectively.

The symmetry hypothesis in France (Table 2B) shows that when either UNL or DSL are used as the retail oil prices there is symmetry, which means that crude oil price increases and decreases are equally passed on to UNL and DSL prices. According to the long-run elasticity (Table 2A), for a 1% increase/decrease in the crude oil price, 0.89% and 0.83% of that increase/decrease is passed on to the end user of UNL and DSL products, respectively. The same symmetry results apply to the German oil market (Table 5B). Given the long-run elasticities (Table 5A), we can infer that for a 1% increase/decrease in the crude oil price, 0.44% and 0.51% of that increase/decrease is passed on to the end user of UNL and DSL products, respectively.

Continuing with Italy (Table 3B) our empirical tests regarding the symmetry hypothesis show that when either UNL or DSL are used as retail gasoline prices there is a negative asymmetry. This means that only crude oil price decreases are transmitted to UNL and DSL prices. The magnitude of the decrease of UNL (DSL) prices in this case is given by the long-run elasticity which, as we see in Table 3A, is 0.73 (0.81). Thus, for a 1% decrease in crude oil price, 0.73% (0.81%) of that decrease is transmitted to the end user of UNL (DSL) oil products.

Finally, the results for Spain are presented in Table 4B. Our empirical tests show that when either UNL or DSL is used as retail oil price there is asymmetry, which means that crude oil price increases and decreases are equally transmitted to UNL prices. The magnitude of the increase/decrease of UNL price is 0.55 (see Table 4A). In contrast, when DSL is used, there is a negative symmetry. This means that only crude oil price decreases are transmitted to DSL prices. The magnitude of the decrease of DSL price in this case is given by the long run elasticity which, as we saw in Table 4A, is 0.80.

5 Conclusions

This study focuses on how the long run transmission process works between crude oil and retail gasoline prices, the likely PT completeness and the effect of an upward or downward change in crude oil prices to unleaded gasoline and diesel prices in Greece and four other European countries. The empirical results are mixed regarding the price transmission process and the PT completeness. More analytically, we show that rigidities in the long run transmission process are present and significant variations across the five countries exist as well as non-completeness, at least in some cases. Our results for Greece confirm previous findings by Revelos (2009) regarding the positive long-run relationship between crude oil price changes and the two retail gasoline prices. Additionally, symmetry seems to prevail in both oil markets, which imply that the customer reaction hypothesis is satisfied in the long-run (Brown and Yucel 1998). Concerning the other European member states, our findings are consistent with the results of Galeotti, Lanza and Manera (2003), although they examine a different time period. Also, our results are in line with the analysis offered by IEA (2008a, 2006, 2008) regarding the increased levels of competition in the retail oil markets for Germany and France and, to a lesser extent, for Spain. Once more, the symmetric behaviour that these economies present in their oil market is theoretically consistent with the customer reaction hypothesis. An exception to the above findings are the empirical results estimated for Italy, where the negative asymmetry for both oil retail markets prevails**.** This result is in line with the analysis regarding the Italian market structure provided by IEA (2009), where the retail oil sector suffers from outdated legislation, which has a negative impact on retail prices and hampers competition. Nevertheless, as Peltzman (2000) argues, asymmetry (or symmetry) itself is not indicative of a monopolised (competitive) market. In the case of Italy, any market power that might exist at the retail level appears to be related to the cost of product differentiation—mostly in the form of locational differences.

Concluding, we believe that our results can be useful for the regulatory energy authorities and antitrust policy-makers in their attempt to monitor the competitiveness of the domestic oil markets analysed.

Appendices

Appendix A. Crude oil prices, Diesel prices and Unleaded prices, 2001:1-2008:12 (in euros)

Figure 1: France

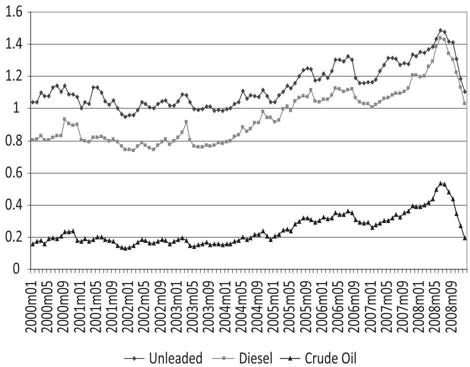

Figure 2: Germany

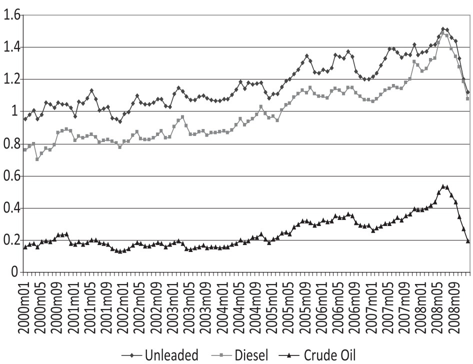

Figure 3: Italy

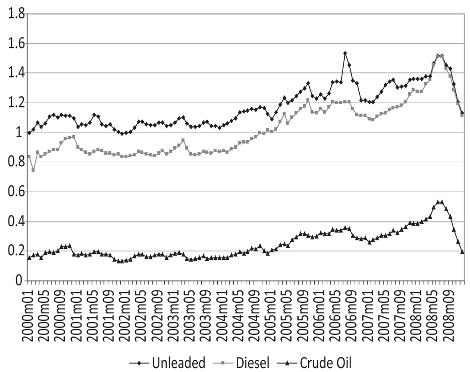

Figure 4: Spain

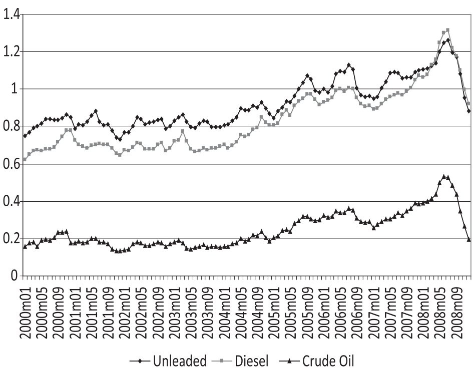

Figure 5: Greece

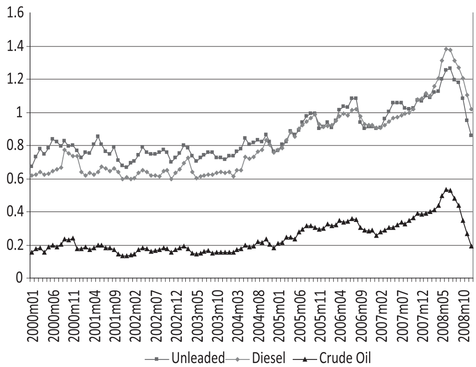

Table 1A: Descriptive statistics for Diesel prices, 2001:1-2008:12 (in euros)

	mean	st. dev.	min	max
France	0.95	0.17	0.73	1.44
Germany	0.99	0.17	0.70	1.48
Greece	0.81	0.20	0.59	1.38
Italy	1.02	0.17	0.74	1.51
Spain	0.83	0.16	0.62	1.31

Table 1B: Descriptive statistics for Unleaded prices, 2001:1-2008:12 (in euros)

	mean	st. dev.	min	max
France	1.13	0.13	0.94	1.48
Germany	1.17	0.14	0.93	1.51
Greece	0.86	0.14	0.66	1.26
Italy	1.17	0.13	0.98	1.53
Spain	0.92	0.12	0.73	1.26

Appendix B. Empirical Results

Table 1A: Long-Run Estimates for Speed of Adjustment and Elasticity, Greece

Independent variable $\Delta LOIL_t$			
	(1)	(2)	(3)
	Positive Speed of Adjustment (θ^+)	Negative Speed of Adjustment (θ^-)	Long-Run Elasticity ($\varphi_0+\varphi_1$)
Dependent variable: *Unleaded* ($\Sigma\Delta LUNL_t$)			
2000-2008	-0.43 (-4.60)	-0.45 (-4.91)	0.64
Dependent variable: *Gasoline* ($\Sigma\Delta LDES_t$)			
2000-2008	-0.12 (-1.92)	-0.12 (-1.96)	0.76

Note: Independent Variable: Crude OIL Prices ($\Sigma\Delta LOIL_{t-1}$). t-ratios are reported in parentheses.

Table 1B: Long-Run Asymmetry Results, Greece

Model	Time Period	Hypothesis H_0: $\theta^+ = \theta^-$	Result
$LOIL_t$ vs. $LUNL_t$	2000 - 2008	1.49	Symmetry
$LOIL_t$ vs. $LDES_t$	2000 - 2008	0.08	Symmetry

Note: We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 (5% conf. interval) and 5.02 (2.5% conf. interval).

Table 2A: Long-Run Estimates for Speed of Adjustment and Elasticity, France

Independent variable $\Delta LOIL_t$			
	(1)	(2)	(3)
	Positive Speed of Adjustment (θ^+)	Negative Speed of Adjustment (θ^-)	Long-Run Elasticity ($\varphi_0+\varphi_1$)
Dependent variable: *Unleaded* ($\Sigma\Delta LUNL_t$)			
2000-2008	-0.52 (-4.15)	-0.35 (-2.40)	0.89
Dependent variable: *Gasoline* ($\Sigma\Delta LDES_t$)			
2000-2008	-0.36 (-3.11)	-0.28 (-2.28)	0.83

Note: Independent Variable: Crude OIL Prices ($\Sigma\Delta LOIL_{t-1}$). t-ratios are reported in parentheses.

Table 2B: Long-Run Asymmetry Results, France

Model	Time Period	Hypothesis H_0: $\theta^+ = \theta^-$	Result
$LOIL_t$ vs. $LUNL_t$	2000-2008	0.72	Symmetry
$LOIL_t$ vs. $LDES_t$	2000-2008	0.83	Symmetry

Note: We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 (5% conf. interval) and 5.02 (2.5% conf. interval).

Table 3A: Long-Run Estimates for Speed of Adjustment and Elasticity, Italy

Independent variable	$\Delta LOIL_t$	$\Delta LOIL_t$	$\Delta LOIL_t$
	(1)	(2)	(3)
	Positive Speed of Adjustment (θ^{+})	Negative Speed of Adjustment (θ^{-})	Long-Run Elasticity ($\varphi_0+\varphi_1$)
Dependent variable: *Unleaded* ($\Sigma\Delta LUNL_t$)			
2000-2008	-0.38 (-1.81)	-0.54 (-4.12)	0.73
Dependent variable: *Gasoline* ($\Sigma\Delta LDES_t$)			
2000-2008	-0.04 (-0.48)	-0.51 (-4.48)	0.81

Notes: Independent Variable: Crude OIL Prices ($\Sigma\Delta LOIL_{t-1}$). t-ratios are reported in parentheses.

Table 3B: Long-Run Asymmetry Results, Italy

Model	Time Period	Hypothesis H_0: $\theta^{+} = \theta^{-}$	Result
$LOIL_t$ vs. $LUNL_t$	2000-2008	Only the negative change (θ^{+}) is statistically significant	Negative asymmetry
$LOIL_t$ vs. $LDES_t$	2000-2008	Only the negative change (θ^{-}) is statistically significant	Negative asymmetry

Notes: We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 (5% conf. interval) and 5.02 (2.5% conf. interval).

Table 4A: Long-Run Estimates for Speed of Adjustment and Elasticity, Spain

Independent variable $\Delta LOIL_t$			
	(1)	(2)	(3)
	Positive Speed of Adjustment (θ^+)	Negative Speed of Adjustment (θ^-)	Long-Run Elasticity ($\varphi_0+\varphi_1$)
Dependent variable: *Unleaded* ($\Sigma\Delta LUNL_t$)			
2000-2008	-0.44 (-3.72)	-0.71 (-5.14)	0.55
Dependent variable: *Gasoline* ($\Sigma\Delta LDES_t$)			
2000-2008	-0.11 (-1.34)	-0.46 (-3.67)	0.80

Note: Independent Variable: Crude OIL Prices ($\Sigma\Delta LOIL_{t-1}$). t-ratios are reported in parentheses.

Table 4B: Long-Run Asymmetry Results, Spain

Model	Time Period	Hypothesis H_0: $\theta^+ = \theta^-$	Result
$LOIL_t$ vs. $LUNL_t$	2000-2008	2.08	Symmetry
$LOIL_t$ vs. $LDES_t$	2000-2008	Only the negative change (θ^-) is statistically significant	Negative asymmetry

Note: We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 (5% conf. interval) and 5.02 (2.5% conf. interval).

Table 5A: Long-Run Estimates for Speed of Adjustment and Elasticity, Germany

Independent variable $\Delta LOIL_t$			
	(1)	(2)	(3)
	Positive Speed of Adjustment (θ^{+})	Negative Speed of Adjustment (θ^{-})	Long-Run Elasticity ($\varphi_0+\varphi_1$)
Dependent variable: *Unleaded* ($\Sigma\Delta LUNL_t$)			
2000-2008	-0.38 (-3.39)	-0.44 (-2.86)	0.44
Dependent variable: *Gasoline* ($\Sigma\Delta LDES_t$)			
2000-2008	-0.21 (-2.00)	-0.27 (-2.19)	0.51

Note: Independent Variable: Crude OIL Prices ($\Sigma\Delta LOIL_{t-1}$). t-ratios are reported in parentheses.

Table 5B: Long-Run Asymmetry Results, Germany

Model	Time Period	Hypothesis H_0: $\theta^{+} = \theta^{-}$	Result
$LOIL_t$ vs. $LUNL_t$	2000-2008	0.08	Symmetry
$LOIL_t$ vs. $LDES_t$	2000-2008	0.12	Symmetry

Note: We test the symmetry hypothesis by applying the Wald (x^2) test. The critical value of x^2 statistic with one degree of freedom is 3.84 (5% conf. interval) and 5.02 (2.5% conf. interval).

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Aristotle's Macroeconomic Model of the City-State

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Abstract

In Aristotle's Politics, particularly Book VII, one can find the elements for the construction of a macroeconomic model of the economy of the city-state. The elements with which this model can be constructed are the following: the territorial size of the city, the division of the land between public and private, the size of the population, and the desired per capita product which is determined on the basis of the concept of good life. The model describes the long-run equilibrium position of the economy of the city-state, which is reached and sustained through changes in population. The equilibrium position is not a result of individual actions based on maximising behaviour and technological parameters but a result of population changes which occur by means of birth controls.

1 Introduction

Hidden in Aristotle's *Politics* there is a macroeconomic model of the economy of the city-state. The elements of which this model is constructed are the following: the territorial size of the city, the division of the land between public and private, the size of the population, and the Aristotelian notion of good life. The model describes the long-run equilibrium position of the economy of the city-state, which is reached through changes in population. The equilibrium position is not a result of individual actions based on maximising behaviour and technological parameters but a result of population changes and implicit technological parameters. Population changes occur by means of birth control policies.

Aristotle's ideas on population in relation to the welfare of the city have

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received much less attention than the other parts of his economic thinking. Although reference is often given to his suggestion for birth controls (e.g. Spengler and Allen, 1960) this part of economics is largely neglected. Malthus, in the first edition of his *Essay on the Principle of Population* which appeared anonymously in 1798, does not even mention Aristotle, despite the close similarity of some of his arguments to those of Aristotle. However, in the next editions of the *Essay*, Malthus gives credit to Aristotle for seeing the relationship between population increases and poverty and for suggesting birth controls. It is very likely that Malthus felt that he needed the intellectual support of Aristotle and other classical writers in the controversy that followed the publication of the *Essay.* As it has been recently noted, in *Politics*, population is a recurring topic, extensively discussed and integral to the overall argument" (Kreager, 2008). The present paper makes explicit the central role of population changes to the economy of the city-state.

The model presented here is not to be found in Aristotle's writing in the form in which it appears. It is constructed on the basis of his thoughts that appear in various places in his *Politics*. In this sense, this model logically combines the various components of a macroeconomic system which are implicit in *Politics*. Also, it does not contain the usual variables one can find in the usual Keynesian macroeconomic models, but those that are relevant in Aristotle's analysis, namely population, land, division of land into public and private, and the notion of good life.

2 The Size of the City-state

The territory of the city should be within a lower and an upper limit. The lower limit is determined by the need of autarky, a situation in which the city can produce everything and in which the citizens need nothing more. The upper limit is that territory where the city can easily defend against invaders. The idea that there is a maximum size beyond which the city cannot be easily defended probably has to do with size of the population, the ways of organising the army, the technology of war, the speed with which armies can move, the transportation system etc.

In Aristotle's words

"Very much the same holds good about its territory. As to the ques-

> tion what particular kind of land it ought to have, it is clear that everybody would command that which is most self-sufficing (and such is necessarily that which bears every sort of produce, for self-sufficiency means having a supply of everything and lacking nothing). In extent and magnitude the land ought to be of a size that will enable the inhabitants to live a life of liberal and at the same time temperate leisure" (1326b, 28-34)
>
> "the same thing holds good of the territory that we said about the size of the population – it must be well able to be taken in at one view, and that means being a country easy for military defense." (1327a, 2-4)

The definition of self-sufficiency given in the above quotation refers to a state of affairs where the state is fully realised, "… and in principle a state is fully realised only when it comes to pass that the community of numbers is self-sufficing" (1261b, 13-14). However, Aristotle recognises that there are degrees of self-sufficiency: "if therefore the more self-sufficient a community is the more desirable is its condition, then a less degree of unity is more desirable than a greater" (1261b, 14-15). These quotes are part of Aristotle's discussion and criticisms of Plato's *Republic*.

The land is divided into public and private land. Aristotle favours private ownership on the grounds that common ownership discourages work and interest in the property items and reduces responsibility. Private property is under the management of the household and the produce belongs to the owner but it can be taxed. The produce of the public land or, in general, the revenues from it can be used for two purposes. First, to finance a system of common tables, through which subsistence to all citizens in ensured. Second, to finance religious ceremonies and worship of gods.

> "As to common meals, all agree that this is an institution advantageous for well-organised states to possess; … But the common meals must be shared by all its citizens, and it is not easy for the poor to contribute their assessed share from their private means and also to maintain their household as well. And moreover the expenses connected with religion are the common concern of the whole state. It is necessary therefore for the land to be divided into two parts, of which one must be common and the other the private property of individuals; of the com-

> mon land one portion should be assigned to the services of religion, and the other to defray the cost of the common meals". (1330a, 3-14)

3 The Size of Population

The size of the population of the city should be within limits. The lower limit is that below which the autarky of the city is lost and thus the reason for its creation and development is negated. The upper limit of the population size is determined by considerations related to the effective administration of the city. If the size of population is too big, it is difficult to run the city effectively and to enforce the law. For example, it would be difficult to find a town crier with a stentorian voice. Also if the population is too big, it would be difficult to make the correct decisions regarding the distribution of public offices according to merit, because this requires adequate knowledge of individuals, something difficult in a overcrowded city.

The composition of the population is also important. Slaves and metics may be necessary for the economy of the city, but their participation in the political life of the city is a danger to the political system. In an overcrowded city it is possible that aliens, metics and slaves can pass as citizens and this is another reason for which the population should not exceed a certain limit.[1]

In Aristotle's words,

> "Similarly a state consisting of too few people will not be self-sufficing (which is an essential quality of the state), and one consisting of too many though self-sufficing in the mere necessaries, will be so in the way in which a nation is, and not as a state, since it will not be easy for it to possess constitutional government – for who will command its over-swollen multitude in war? or who will serve as its herald, unless he who have the lungs of Stentor? It follows that the lowest limit for the existence of a state is when it consists of a population that reaches a minimum number that is self-sufficient for the purpose of living the

[1] Aristotle's discussion of the composition of the population may be a reaction to Xenophon's suggestion to provide various incentives to metics that would result in higher revenues for the city (*On Revenues*, II). Xenophon was writing *On Revenues* probably in 365 B.C. and *Politics* was written in 350 B.C.

> good life after the manner of a political community. It is possible also for one that exceeds this one in number to be a greater state, but, as we said, this possibility of increase is not without limit, and what the limit of the state's expansion is can easily be seen from practical considerations." (1326b, 2-13)
>
> "All the same, even if it is right to judge the state by the test if its multitude, this ought not to be done with regard to the multitude of any and every class (for states are doubtless bound to contain a large number of slaves and resident aliens and foreigners), but the test should be the number of those who are a portion of the state – the special parts of which a state consists." (1326a, 17-22)
>
> "but in order to decide questions of justice and in order to distribute the offices according to merit it is necessary for the citizens to know each other's personal characters, since where this does not happen to be the case the business of electing officials and trying law-suits is bound to go badly; haphazard decision is unjust in both matters and this must obviously prevail in an excessively numerous community. Also in such a community it is easy for foreigners and resident aliens to usurp the rights of citizenship, for the excessive number of population makes it not difficult to escape detection." (1326b, 14-24)

Clearly, Aristotle suggests that increasing population up to a certain size goes along with increasing capability of the state to perform its function efficiently but after a certain size strong diseconomies appear. Therefore, between the two extremes there is an optimal population size. The actual optimal size is related to the territory of the city and notion of good life.

4 Property and Population

In criticising Plato and the Chalcedonian Phaleas, Aristotle makes two important points. First, it is not sufficient, as Plato says (*Laws*), for each citizen to have property of a size that would provide him the means for a wise life. A wise life may at the same time be a miserable life. According to Aristotle the size of property that every citizen should have should be of a size sufficient to provide the means of a life that would be wise and generous, i.e. that would allow the citizen to live a comfortable life but not a luxurious and wasteful one. Second, it is not sufficient to determine the size of property, be that small or big, of each citizen. In addition, it is necessary to determine the number of children per family because otherwise the laws concerning property would be inactive and citizens would fall in poverty.

> "But those who bring in legislation of this sort must also not overlook this point, which is overlooked at present, that when regulating the amount of property legislators ought also to regulate the size of the family; for if the number of children becomes too large for the total property, the law is quite sure to be repealed, and apart from the repeal it is a bad thing that many citizens who were rich should become poor." (1266b, 8-14)
>
> "And it is also strange that although equalising properties the writer (i.e. Plato) does not regulate the number of the citizens, but leaves the birth-rate uncontrolled." (1265a, 39-41)
>
> "And one might think that restriction ought to be put on the birth-rate rather than on property, so as not to allow more than a certain number of children to be produced, and that in fixing their number consideration should be paid to the chances of its happening that some of the children born may die, and to the absence of children in the other marriages; but for the matter to be left alone, as it is in most states, is bound to lead to poverty among citizens, and poverty produces sedition and crime." (1265b, 8-13)

Property, for Aristotle, is important for the well-being of citizens, not as a collection of material goods of certain quantity but as a means to a virtuous life. It is the use of property that gives value to it, not the quantity. And he criticizes Plato (*Laws*) for not defining the amount of property clearly.

> "Also the amount of property requires consideration … The writer (i.e. Plato) says that it ought to be sufficiently large for the citizens 'to live a temperate life' – as if one were to say 'to live a good life'; but really that phrase is too general, since it is possible to live temperately yet miserably. But a better definition would be 'to live temperately and liberally' (for if the two are separated a liberal mode of life is liable to slip into luxury and a temperate one into a life of hardship), since surely

> these are the only desirable qualities relating to the use of wealth – for instance you cannot use wealth gently or bravely, but you can use it temperately and liberally." (1265a, 29-38).

The condition of a temperate and liberal (or wise and generous) life is not an average that should hold for the city as a whole. It is a condition that should hold for every citizen individually. According to Aristotle, the eudaimonia of the city depends on the eudaimonia of the citizens, if not all, of the biggest possible number. You cannot have a happy city with unhappy citizens: "But it is not possible for the whole to be happy unless most or all of its parts, or some of them, possess happiness" (1264b, 18-20). Happiness, says Aristotle, is not like an even number that may belong to a whole but not to either of the two odd numbers of which it is the sum.

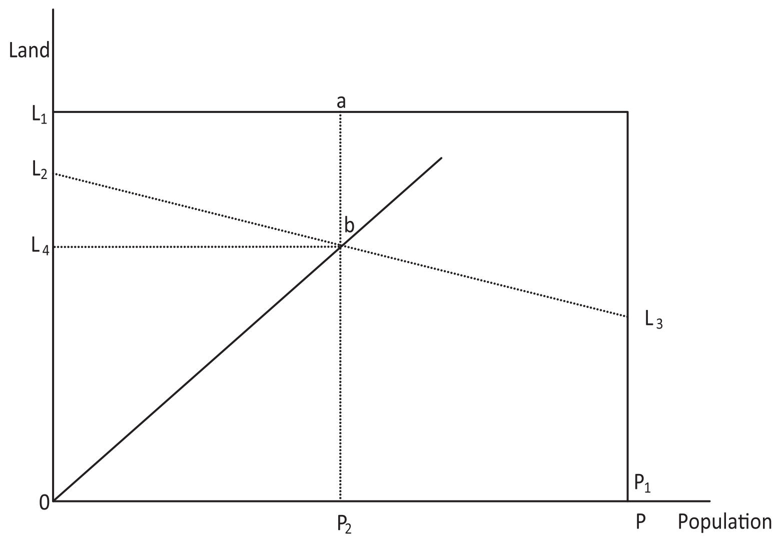
The possession of property and wealth is important for a happy life. Aristotle makes that very clear in the beginning of Book VII when he classifies goods in three categories, namely in external goods (wealth, riches), goods of the soul, and goods of the body, and states that "assuredly nobody would deny that the ideally happy are bound to possess all three" (1333a, 24-27). After a brief discussion of the priorities of the three groups of goods for the best life, Aristotle concludes: "For the present let us take it as established that the best life, whether separately for an individual or collectively for states, is the life conjoined with virtue furnished with sufficient means for taking part in virtuous actions" (1323b, 40-1324a, 2).

The "sufficient means" in the above quotation is equivalent to the amount of wealth that is sufficient for a temperate and liberal life. Thus, for Aristotle, the critical magnitude which is basic for the happiness of the citizens and therefore for the happiness of the city is the property per capita, or equivalently the land-population ratio, that produces enough material goods so that the citizens can live a wise and generous life, comfortable but not wasteful nor luxurious. This is the optimal land-population ratio. The specific land-population ratio that is proper for a city would depend on the fertility of land and the technology of production. If the existing ratio deviates from the optimal, the size of the city or the population, or both, must change. Aristotle does not mention changes in the size of the city probably because this may involve wars. Also, he does not mention the establishment of new colonies as a way for returning to the optimal land-population ratio, although the major Greek city-states had long histories of establishing colonies in the Adriatic, in Southern Italy, in Ionia, etc. The reason for not mentioning colonies probably is that colonies would be temporary solutions, and without birth controls the deviation from the optimal will reappear after some time.

5 Aristotle's Macroeconomic Model: Graphical Exposition

The above elements can be combined in a simple diagram. The vertical axis of Diagram 1 shows the size of land. The beginning of the axis at point 0 corresponds to the minimum population size required for autarky and point L_1 corresponds to the maximum size so that the city can be defended effectively. The horizontal axis measures the size of population. The beginning of the axis at point 0 corresponds to the minimum size required for autarky and point P_1 corresponds to a population size beyond which serious diseconomies become effective. The doted line L_2L_3 divides the land in private and public. When the size of population is at the beginning of the axis, the public land which is needed to finance common tables and religious worship is L_1L_2 and the remaining OL_2 is private land. When population increases to P_2, the needed public land also increases to ab. In other words, as the size of population increases, more public land is required.

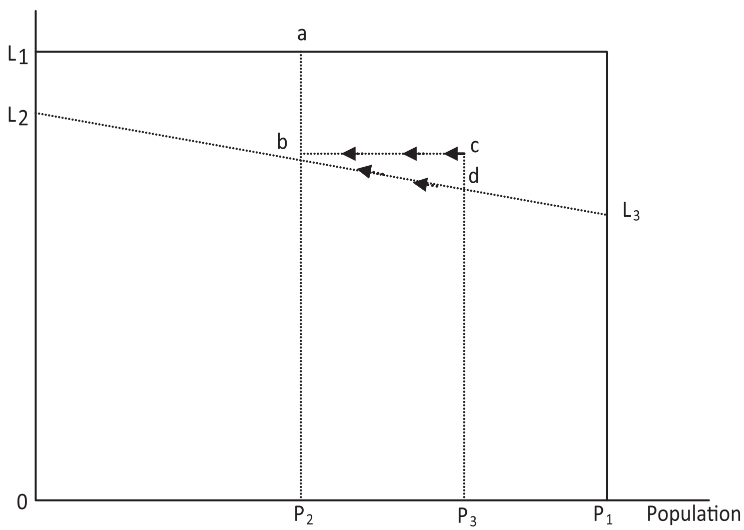
Diagram 1



Every point in the area $0L_2L_3P_1$ represents a feasible combination of private land and population. But the actual combination should be on the L_2L_3 line because otherwise parts of private land would be unutilised. The point actually chosen would depend on the combination of the land-population that produces output per citizen sufficient for a wise and generous life. If such a combination is, for example, the one corresponding to b, then the size of the population would be P_2, the size of private land would be OL_4 and the rest of land of a size L_4L_1 or ab would be public land the proceeds from which would cover the expenses for common tables and religious worship and ceremonies. The land-population ratio is equal to the slope of the line going through the origin and point b.

From this graph it becomes obvious that as soon as the limits of land and population are determined, the critical factor for the determination of the actual land-population ratio are two: (a) the division of land between private and public and (b) the optimal per capita output. It should be noted that the optimal per capita output is not the maximum average product of labour except by chance. In Aristotle's thinking, the biggest size or the maximum quantity is not necessarily optimal. Optimality is defined in terms of what constitutes the best life.

Diagram 2



6 Population Changes

Suppose that because of loose birth controls, the population of the city increases from P_2 to P_3 in Diagram 2. In this case, public land must increase by cd because greater population implies greater needs for common tables and religious worships. Thus, private land will decrease and the optimal land-population ratio will not hold. The actual ratio will be dP_3 divided by $0P_3$ which is less than the previous one which was bP_2 divided by $0P_2$. Even if it is decided, by the rulers of the city, that the private land be left unchanged, i.e. cP_3 which is equal to bP_2, the optimal land-population ratio will be disturbed. It will now be cP_3 divided by $0P_3$, which is lower than the optimal. In either case, population will have to be reduced by stricter birth controls, until the land-population combination corresponds to point b on the diagram. Similar reasoning applies to the case where population declines because of aging, wars, famines, etc.

7 Population and Poverty

Aristotle recognises that in every society there will always be rich and poor people. What stabilises the social system is a large class of people that posseses the means for a comfortable life:

> "But surely the ideal of the state is to consist as much as possible of persons that are equal and alike, and that similarity is most found in the middle class." (1295b, 26-27)
>
> "It is clear therefore also that the political community administered by the middle class is the best, and that it is possible for those states to be well governed that are of the kind in which the middle class is numerous." (1295b, 35-38).

Poverty is a danger to the city, and there are two ways to deal with poverty. One is the welfare system. Aristotle believes that the welfare system can offer temporary relief but does not solve the problem "because this way of helping the poor is the legendary jar with a hole in it" (1320a, 32-33). On the contrary, it perpetuates the problem. However, common tables as part of a welfare system is accepted and recommended. The other way to reduce poverty is through substantial financial aid to the poor citizens in order to buy property and start some productive activity or allow them to use land for the same purpose:

> "Measures must therefore be contrived that may bring about lasting prosperity. And since this is advantageous also for the well-to-do, the proper course is to collect all the proceeds of the revenues into a fund and distribute this in lump sums to the needy, best of all, if one can, in sums large enough for acquiring a small estate, or, failing this, to serve as capital for trade or husbandry…" (1320a, 35-40)

In Aristotle's analysis, social stability depends on the existence of a large middle class of citizens that can live a comfortable life. Crucial to the achievement of this, is a proper relation between land and population. Overpopulation will lead to poverty and this involves dangers for the stability of the city.

8 Comments

The model presented above has a long-run equilibrium position which is reached through birth rate controls. Citizens can support a life that is wise and generous, comfortable but not wasteful nor luxurious, and thus social stability is achieved. The political and ethical views of Aristotle included in this analysis, perhaps explains his neglect of what today is called economic growth theory. Although he seems to recognise the distinction between consumer goods and capital goods (*Rhetoric* 1361a, 16-18), he does not explore the consequences of the nature of capital goods. At the long-run equilibrium the political and moral requirements for a good life are satisfied and growth beyond that is meaningless. In this context, capital accumulation is not an issue for analysis. Perhaps, this explains Aristotle's views on the rate of interest, namely that it should be zero. Indeed, if capital accumulation is zero, the need for a money market at the macroeconomic level disappears, and thus the payment of interest is not justified. In that sense money is sterile.

Aristotle is credited with the development of some fundamental economic ideas such as the theory of money, the theory of exchange, and the distinction between use value and exchange value of commodities. Although reference is sometimes given to his emphasis on the need for birth control so that the population is restricted to proper level, the central role of the land-population ratio for the stability and the welfare of the city-state has not been acknowledged so far.

9 Summary

The above exposition can be summarised in a simple model like the one below

$L = \bar{L}$	size of the city-state	
$L = L_1 + L_2$	L_1 = public land,	L_2 = private land
$L_2 = \beta - \lambda P$	P = population	
$Q = \alpha\sqrt{P}\sqrt{L_2}$	Q = production	
$\frac{Q}{P} = Q^*$	the desired optimal product per capita	

This simple system can be solved in terms of the desired optimal production per capita Q^* that is sufficient for a wise and generous life, the parameter β which is the size of private land when public land is at the minimum (distance $0L_2$ in the diagrams), i.e. when population has the minimum size required for autarky, the parameter λ which shows how private land declines as population increases, and the technology parameter α in the production function. For this specific system the solution for the values of the endogenous variables are

$$P = \frac{\alpha^2 \beta}{\alpha^2 \lambda + Q^{*2}}$$

$$L_2 = \frac{\beta Q^{*2}}{\alpha^2 \lambda + Q^{*2}}$$

$$L_1 = \bar{L} - L_2$$

and

$$Q = \frac{\alpha^2 \beta Q^*}{\alpha^2 \lambda + Q^{*2}}$$

The solution is possible not because of some automatic economic mechanism, as for example a maximising principle, but because of the given value of Q^* which is predetermined on the basis of ethical considerations of what constitutes a good life.

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