ADVANCES IN SPATIAL SCIENCE

Peter Nijkamp
Iulia Siedschlag
Editors

Innovation, Growth and Competitiveness

Dynamic Regions in the Knowledge-Based World Economy

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Innovation, Growth and Competitiveness

Dynamic Regions in the Knowledge-Based World Economy

Springer

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This book includes a selection of research papers from the international project "Dynamic Regions in a Knowledge-Driven Global Economy: Lessons and Implications for the EU" co-funded by the European Community 6th Framework Programme under the Socio-Economic Sciences and Humanities Programme (Contract No. CIT5-028818).

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Preface

A major trend in the world economy in recent years has been the dynamic growth in a number of regions including China, India, Brazil, Mexico, Russia and the new European Union member states in Central Europe. The strong economic performance of these regions will generate a major shift in world competitiveness with important implications for Europe. Compared to this dynamism, economic growth in Europe has been weak in recent years.

The noticeably different growth experience in the various parts of the world raises a number of important questions which need to be answered if effective policies are to be designed. Most importantly it is necessary to understand what the underlying factors of the growth performance in these dynamic regions are and what role will they play in a world economy driven increasingly by knowledge and innovation. Is there a role for research, innovation, education and access to knowledge in the development strategies of the dynamic growth regions? What are the risks and consequences of dynamic growth on patterns of world growth and development, competitiveness, inequalities, and convergence? What development strategies should be promoted at national and international levels for a growing and more sustainable world economy? What are the implications of the emerging of these new world competitors for Europe's competitiveness?

To address these important questions it is necessary to employ a range of integrated and complementary methodological approaches including endogenous growth theory, evolutionary economics, international trade, new economic geography, institutional economics, regional science, sociology, and business science.

This book includes a selection of research papers from an international project[1] focused on economic growth, innovation and competitiveness in a knowledge-based world economy. The contributions included in this book advance the current state-of-the art by blending together a series of complex theoretical and

[1]"Dynamic Regions in a Knowledge – Driven Global Economy: Lessons and Policy Implications for the EU" co-funded by the European Community 6th Framework Programme under the Socio-Economic Sciences and Humanities Programme. Further information can be found on the project's website: www.esri.ie/dynreg.

methodological approaches aimed at understanding the factors behind the emergence of dynamic spaces in the world economy, in a context of greater global interaction. They entail a combination of subject and territorial approaches aimed at filling a current gap between theories mainly developed in economics (such as the neoclassical and endogenous growth theories or the new economic geography), with theories of a more institutional nature and multi-disciplinary background, such as the theories on national and regional innovation systems, human resources and foreign direct investment-led growth.

The innovation of this research effort consists of using an integrated framework of analysis, where regional growth questions are put in an international framework and examined from a new perspective, incorporating parallel and rarely interacting strands of literature. By blending these different research strands in order to address the important knowledge gaps, and given the particular policy focus of the project, the main result of this book is a fuller understanding of which development strategies and policies work in order to generate sustainable economic growth.

Amsterdam, The Netherlands — Peter Nijkamp
Dublin, Ireland — Iulia Siedschlag

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Editors

Peter Nijkamp is Professor in Regional and Urban Economics and in Economic Geography at the VU University, Amsterdam. His main research interests cover quantitative plan evaluation, regional and urban modelling, multicriteria analysis, transport systems analysis, mathematical systems modelling, technological innovation, entrepreneurship, environmental and resource management, and sustainable development. In the past years he has focussed his research in particular on new quantitative methods for policy analysis, as well as on spatial-behavioural analysis of economic agents. He has a broad expertise in the area of public policy, services planning, infrastructure management and environmental protection. In all these fields he has published many books and numerous articles. He is member of editorial/advisory boards of more than 30 journals. He has been visiting professor in many universities all over the world. According to the RePec list he belongs to the top-30 of well-known economists world-wide. He is past president of the European Regional Science Association and of the Regional Science Association International. He is also fellow of the Royal Netherlands Academy of Sciences, and past vice-president of this organization. From 2002 to 2009 he has served as president of the governing board of the Netherlands Research Council (NWO). In addition, he is past president of the European Heads of Research Councils (EUROHORCs). He is also fellow of the Academia Europaea, and member of many international scientific organizations. He has acted regularly as advisor to (inter) national bodies and (local and national) governments. In 1996, he was awarded the most prestigious scientific prize in the Netherlands, the Spinoza award.

Iulia Siedschlag is Associate Research Professor and Head of the Centre for International Economics and Competitiveness at the Economic and Social Research Institute in Dublin. Her key areas of expertise include international and European economic integration; international trade and investment; economic growth in open economies, open economies macroeconomics; new technology diffusion, innovation and productivity; applied econometrics. Her research has been published in leading international journals and books. She has received several research awards from private and public organisations. She has been appointed as an international expert to the European Commission, European Central Bank, World Bank, Inter-American Development Bank, Asian Development Bank Institute, and the World Economic Forum. She has been awarded a significant number of research grants and projects involving European research organisations and universities.

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Chapter 1
Economic Growth, Innovation and Competitiveness in a Knowledge-Based World Economy: Introduction

Peter Nijkamp, Iulia Siedschlag, and Donal Smith

The theory of economic growth has regained much interest and popularity in recent years. Both the theoretical scope and its empirical basis have been significantly enriched in recent years thanks to the emergence of spatial endogenous growth concepts, the rise in interest in agglomeration externalities as expressed by new economic geography, new innovation theory as a basis for understanding complex spatial dynamics, and the recent creativity paradigm as a source for spatial revitalisation (see also Nijkamp 2009). In all these contributions more emphasis has been placed on economic actors in space, in particular on the way they interact through networks, learning mechanisms, institutional constellations and spatial externalities at various geographical levels.

In the history of regional and urban economics much attention has been paid to density and proximity externalities (Hoover 1948; Isard 1960), where the distinction was often made between scale, localization and urbanization economies. The density externalities perspective takes for granted that an area has a competitive growth potential as long as the economies of concentration outweigh the diseconomies. According to the density externalities framework, agglomerations offer prominent socio-economic and cultural advantages that are far higher than any other settlement pattern. In particular, in our modern age, urban regions or metropolitan areas offer spatial advantages related to knowledge spillover effects and an abundant availability of knowledge workers in the labour market (Acs et al. 2002). Spatial concentration of activities, involving spatial and social proximity, increases the opportunities for interaction and knowledge transfer. The resulting spillover effects reduce the cost of obtaining and processing knowledge. In addition, knowledge workers preferably interact with each other in agglomerated environments to reduce interaction costs and they are more productive in such environments (Florida 2002). Following

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this argumentation, urban areas are the cradle of new and innovative industries. Companies in the early stages of the product and company life cycle – when dealing with manifold uncertainty – prefer locations where new and specialized knowledge is abundantly available for free (see e.g. Audretsch 1998; Camagni 1991; Cohen and Paul 2005). Urban areas offer an enormously rich potential for a wide array of business opportunities.

Clearly the spatial extent of knowledge spillovers is limited due to various kinds of geographic impediments, e.g. a wide daily activity system where people can meet easily and where people change jobs in the course of their careers, or smaller areas such as quarters in a central business district or university premises where people see each other, often by chance (e.g. Rosenthal and Strange 2001). The need for spatial proximity to benefit from knowledge spillovers seems, however, at odds with the impacts of the recent telecommunication revolution, i.e. the costs of electronic communication have drastically declined while advanced ICT allows for long-distance videoconferencing, data-mining, virtual design, computer-assisted decision making, etc. ICT offers an unlimited spectrum of virtual communication opportunities. But does it affect urban size?

To understand this paradoxical situation in the geography of knowledge spillovers we need to look into the type of knowledge concerned (Howells 2002). On the one hand there is codified knowledge (partly just information) that can easily circulate electronically over large distances, e.g. prices determined at a stock exchange and statistical data. On the other hand there is tacit knowledge and its context, these are critical in the innovation processes. The knowledge concerned is vague and difficult to codify and, accordingly, spreads mainly through face-to-face contact of the persons involved. Tacit knowledge is transferred through observation, interactive participation and practice. Furthermore, there is contextual knowledge which is achieved through long-term and interactive learning, often in relatively open (unstructured) processes (Bolisani and Scarso 2000). All such density externalities when present in a modern region offer a very powerful tool to survive and to grow and to become hubs in a space-economy.

The conventional spatial growth paradigm has exerted a strong influence on regional and urban economic analysis, but has often failed to explain jumps and anomalies in spatial systems. Research in the spatial sciences is at present increasingly influenced by evolutionary perspectives, notably learning perspectives. Since the early 1990s concepts such as learning regions, smart cities, creative cities, science-based regional development, etc. have received increasing attention among regional economists, economic geographers and regional policymakers. This development marks the recognition that factors determining the economic growth of regions (cities) are increasingly intangible, like institutions and culture, and increasingly mobile, like capital, codified knowledge, and – in part – human capital. It also reflects the awareness that innovation by companies is not a linear process, running from invention and commercialization to market introduction, but a cyclic and interactive process within networks of many different actors. In this view of innovation, emphasis is increasingly put on diversity of the networks and boundary-spanning activity of the network actors. Learning in this context not only means to adapting to new circumstances, like stronger competition, but also to reflect critically on internal institutions and learning processes. In a positive scenario, the networks consist of loosely coupled relations that enable both openness and integration, and create perspectives for action. In a negative scenario of "lock-in", however, networks become conservative and inward-oriented – thereby preventing any learning-based action – or they become subject to confusion leading to high transaction costs and inefficient adaptation (see also Acs et al. 2002). In other words, the quality of the network dynamic is highly important; but much remains unknown to date, for example concerning the key influences on network dynamics and turning points in the quality of the networks.

One of the prominent scientists who addressed the learning region as a paradigm was Florida (1995). Earlier seminal work underlying the learning regions paradigm was done by Aydalot (1986), Camagni (1991), Maillat (1991) and others, while the paradigm was developed from different angles in regional studies, like the ones that have their origins in innovation systems, technology complexes (including knowledge spillover phenomena), post-Fordism and clusters, and ones in technology policy, local and regional institutions and community action (see e.g. Benner 2003; Morgan 2002; Ratti et al. 1997; Cooke 1998; Maskell and Malmberg 1999; Gertler and Wolfe 2002). The learning regions approach has the advantage over other approaches that it explicitly addresses the quality of policymaking and of other institutional conditions in the regional economy and society. In particular, it is a regional development concept in which the emphasis is put on improving the individual and collective learning processes of the regional actors involved through open and flexible networks (OECD et al. 2001). This concept does not imply that the learning is exclusively between regional partners. Regional actors (e.g. policy institutes and companies) learn through both regional (local) and global networks.

Many governments today deliberately try to enhance high-technology activity in their regions and often embrace the learning regions paradigm to improve policymaking. However, there is a long way to go and the path is littered with stumbling blocks. Barriers in policymaking reside in policy organizations themselves and in the nature of knowledge policies. A framework that can be used in clarifying these issues is given by evolutionary approaches. Evolutionary thinking allows for an explanation of qualitative change, the rise of radical uncertainty, the role of institutions in reducing uncertainty, variation between organizations and technology, and it provides useful concepts for a better understanding of policymaking under such circumstances (Saviotti 1997; Van den Bergh and Fetchenhauer 2001). Learning appears to become an increasingly powerful paradigm in understanding spatial dynamics against the background of economic competition in a struggle for survival. Slow evolutionary dynamics and infrastructure provision are essentially two closely connected phenomena.

In the same vein, we have observed an increasing popularity of endogenous growth theory, in which knowledge, innovation and infrastructure play a key role in spatial dynamics (see e.g. Romer 1986, 1990; Lucas 1988; Nijkamp and Poot 1998; Stimson et al. 2002; Reggiani and Nijkamp 2009).

New methodological research directions in spatial economic research are using ideas from spatial complexity theory, in which inter alia non-linear evolution, chaos principles, synergics, evolutionary biology, and learning algorithms play a critical role (see Nijkamp and Reggiani 1999). In this context, there is also due attention given to innovation, creativity, entrepreneurship and leadership.

The various trends sketched above point at various strands in spatial economic growth research: increase in realism, systemic complexity, and spatial networks orientation. There is a clear need for a new wave of effort in analytical modeling that would study cities from a computable equilibrium perspective, with a balance between (1) growth-inducing and growth-hampering factors, (2) multiple (from micro to macro) layers of actors and structures in a region, and (3) intra-regional and extra-regional force fields. Against the background of these observations, a plea for a complex spatial growth theory seems warranted which may lead to the design of an operational systems economics approach to regions. We may thus conclude that there is wide scope for renewed interest in the drivers and effects of spatial economic growth in an open world.

This book includes a selection of research papers from an international project[1] focused on economic growth, innovation and competitiveness in a knowledge-based world economy. These research contributions advance the current state-of-the art by blending together a series of complex theoretical and methodological approaches aimed at understanding the factors behind the emergence of dynamic spaces in the world economy, in a context of greater global interaction. They entail a combination of subject and territorial approaches aimed at filling a current gap between theories mainly developed in economics (such as the neoclassical and endogenous growth theories or the new economic geography), with theories of a more "institutional" nature and multi-disciplinary background, such as the theories on national and regional innovation systems, human resources and foreign direct investment-led growth and sociology. The innovation of this research effort consists in using an integrated framework of analysis where regional growth questions are put in an international framework and examined from a new perspective incorporating parallel but rarely interacting literatures. By blending these different research strands in order to address the important knowledge gaps, and given the particular policy focus of the project, the main result of this book is a more complete understanding of which development strategies and policies work in order to generate sustainable economic growth.

Part I provides novel insights into the process of economic growth with special attention given to the role of knowledge and innovation, human capital, foreign direct investment, entrepreneurial clusters and social capital in fostering growth at firm, industry, region and country levels. Part II focuses on the impact of globalisation on economic growth and competitiveness. Finally, Part III analyses public policies aimed to foster economic performance and innovation at the firm, industry, region and country levels.

[1] "Dynamic Regions in a Knowledge – Driven Global Economy: Lessons and Policy Implications for the EU" (DYNREG). Information about this research can be found on the project's website: www.esri.ie/dynreg.

Part I: Economic Growth in a Knowledge-Based Economy

In Chap. 2, *Paschalis Arvanitidis and George Petrakos* discuss the emergence of the knowledge-based economy and assess existing indicators of economic performance such as real GDP per capita, and composite indicators constructed in an attempt to capture country-specific innovation performance and technological achievement. They argue that these measures are limited and propose a theory-based new composite indicator to capture the various dimensions of the knowledge-driven economic dynamism, the Economic Dynamism Indicator. The authors define this indicator as the potential of an economy to maintain high rates of economic performance driven by its knowledge capacity. It covers four dimensions, namely: human capital, innovation ability, information access and economic performance. The variables used to construct the composite indicator are chosen on the basis of their availability for a large number of countries and international comparability. The data source is the World Bank. Having tested the validity of the Economic Dynamism Indicator, the authors construct country rankings based on this composite indicator. The results of this analysis contribute to a better understanding of the knowledge-driven economic performance of countries.

Chapter 3 by *Panagiotis Artelaris*, *Paschalis Arvanitidis* and *George Petrakos*, examines determinants of knowledge-based economic growth as measured by the Economic Development Indicator introduced in the previous chapter. They test the significance of a large number of factors identified by existing theory and empirical evidence over the period 1990–2002 for 64 countries. They use improved econometric techniques to account for the different size of the analysed countries and non-linear effects in the underlying relationships. The research results indicate that knowledge-based growth was positively correlated with factors such as foreign direct investment, accessibility, density, regulation, openness to trade, and institutions. Furthermore, geography and agglomeration economies appear to play an important role. In addition, the authors identify a number of non-linear effects on economic dynamism in particular with respect to initial economic conditions, government size, openness to trade, and institutions. On the basis of this research the authors suggest that policy making should consider fostering agglomeration economies and the quality of institutions as important drivers of knowledge-based growth. In addition, the evidence on non-linear effects indicates that policy should be adapted at country-specific conditions and that an "one-size-fits all" policy approach might be harmful.

Patricia van Hamert and Peter Nijkamp provide further empirical evidence on factors driving the knowledge-based economy in Chap. 4. They analyse the responses of experts to a survey on factors driving the knowledge-based economy conducted in the European Union.[2] In particular, they focus on the opinions of

[2]Survey results are available from http://www.esri.ie/dynreg.

experts in the Netherlands. Using a multivariate factor analysis they find that in the opinion of Dutch experts, economic dynamism is mainly linked to increasing returns to scale, knowledge creation and knowledge transfer. Their econometric analysis suggests that the Dutch experts support the view that the economic landscape of a particular region is shaped mainly by the interplay between knowledge development and institutional dynamics. The authors conclude that understanding economic dynamism would benefit from insights of an evolutionary economics approach which accounts for interactions between economic agents and dynamism in the relationship between knowledge and economic growth. This approach complements more mainstream economics approaches in international trade and economic growth theories.

In Chap. 5, *Michaela Trippl and Gunther Maier* analyse the relationship between the mobility of highly-skilled labour and knowledge flows. In particular, they consider the role of knowledge transfer via mobility of top scientists ("knowledge spillover agents") on regional development and innovation, characteristics of knowledge spillovers thorough labour mobility, as well as key factors shaping the location of highly-skilled labour and the emergence of "brain gain" policies. Building on existing relevant theoretical and empirical literature, the authors propose an original model of knowledge circulation which is used to analyse interregional and international knowledge interactions following the mobility of talented scientists and their impact on regional development and innovation. To capture dynamic effects, the model distinguishes between "initial knowledge flows" and "subsequent knowledge flows". Furthermore, the model identifies effects of the mobility of top scientists on the economy and the scientific system in both the sending and receiving regions. The authors argue that given interregional knowledge circulation, scientific gains are possible for both sending and receiving regions. Further, the impact of mobility of "star scientists" is conditioned on the specialisation and existing knowledge base and the duration of the stay in the receiving region. It appears that the main factor for attracting top scientists is the presence of centres of scientific excellence.

The location patterns of European-based top scientists and the knowledge transfer from them to their host regions are further investigated in Chap. 6 by *Michaela Trippl and Gunther Maier*. The analysis in this chapter is based on a survey of top scientists located in Europe conducted in 2008. Approximately 250 star scientists are identified as authors of highly cited research papers in published scientific journals over the period 1981–2002. The data source is the Institute for Scientific Information (ISI). The analysis finds that star scientists are highly concentrated geographically, with the top nine locations accounting for 40% of star scientists. Further, mechanisms through which star scientists may impact on the innovation performance of their host regions include connections to the academic environment in the region and to policy advisers as well as knowledge sharing with the industry/business community. The analysis also finds that star scientists value their engagement in sharing their knowledge with the purpose to contribute to innovation and growth in the host regions.

In Chap. 7, *Andrés Rodríguez-Pose* and *Vassilis Tselios* analyse determinants of educational inequality across regions in the European Union by using rich micro data from the European Community Household Panel over the period 1994–2001. For the purpose of this analysis, a broad definition of education is used which encompasses knowledge, skills, learning-by-doing, acquisition of information about the economic system, investment in reputation and personal relationships. The authors find empirical evidence showing that improved access to education, a higher quality of education as well as higher educational attainment are associated with less educational inequality for an average region in Western Europe. While income per capita does not appear to impact on educational inequality, higher income is positively associated with educational inequality. The results are robust with respect to the age of respondents, labour market participation, geography and religion. Further, the authors find that female's access to the labour market is associated with less educational inequality. In addition, the empirical evidence suggests the existence of a North–South as well as an urban-rural divide in educational inequality.

In the last chapter of Part I, *Jože Damijan, Črt Kostevc and Matija Rojec* examine the relationship between innovation and firm-level productivity in Slovenia over the period 1996–2002. A first set of research results suggest a positive effect of innovation on firm productivity growth. However, further empirical analysis reveals that this result is driven by the innovation performance of a group of service firms in the sample. Additional econometric analysis indicates that the positive effect of innovation on firm productivity is not robust to alternative econometric techniques. The authors argue that the source of these mixed results may be the qualitative nature of the innovation survey data and the short time dimension of the data set. Finally, they suggest that quantitative data on innovation and longer time series may be more suitable for this type of analysis.

There is growing empirical evidence showing a positive relationship between social capital and economic growth. Recent advances in the theory of social capital highlight three channels through which social capital may impact on economic growth: first, lower transaction costs allow a higher investment in innovation; second, enhanced trust in government institutions; third, enhanced co-operation following the sharing of social and ethical norms. Chapter 9 by *Luca Corazzini, Matteo Grazzi and Marcella Nicolini* analyse the relationship between social capital and growth across municipalities in Brazil. For this purpose, the authors estimate a growth model augmented with composite indicators of social capital such as social cohesion, social division, religious conviction, as well as political participation. The econometric analysis finds a positive relationship between measures of social capital and income per capita growth. The results are robust to additional controls for unobserved municipality-specific characteristics and time specific business cycle effects.

Part II: Globalisation, Competitiveness and Growth

In Chap. 10, *Christos Pitelis* discusses and applies insights from existing theories on foreign direct investment (FDI) and the multinational enterprise (MNE) to develop novel knowledge-based theory of FDI and the MNE. The author presents and discusses the existing theories of FDI and the MNE starting with Haymer's question of why firms engage in FDI as opposed to alternative methods of foreign operation (Hymer 1970, 1972) and concluding with John Dunning's Ownership, Location and Internationalisation (OLI) framework (Dunning 1977, 1988, 2000, 2003). The author argues that existing theories seem at odds with current MNE strategies in a modern knowledge-based globalized economy. These changing strategies are discussed and include the observed simultaneous adoption of internationalisation and externalisation strategies, the move from closed to open innovation, the portfolio strategies approach, global optimizer and leveraging motivations. The author then develops a knowledge-learning-based theory from existing Penrose theories (Penrose 1956, 1995). This is done in the context of Dunning's OLI theory as mentioned above. The new approach explains why firms engage in internationalisation in terms of the relative productive opportunity of firms and in terms of superior relative intra-firm ability for resource knowledge transfer and knowledge resource acquisition. The question of which country firms select in their internationalisation is also analysed in terms of productive opportunity and knowledge/resource acquisition advantages.

In Chap. 11 *Constantina Kottaridi, Marina Papanastassiou and Christos Pitelis* investigate the decision by MNE's headquarters to grant mandates to subsidiaries to set up own R&D laboratories in selected geographical regions based on internal subsidiary factors, regional characteristics and industry level factors. The authors note that in this field of research there is a gap in literature in relation to the allocation of mandates decision. The decision to decentralise R&D operations is analysed in relation to the competitive advantage, economic geography, international management and R&D laboratories literature. With this literature as a foundation, hypotheses are developed in relation to the importance of embeddedness and local linkages, subsidiary autonomy, the size, export orientation and entry mode of a subsidiary, agglomeration factors and local competencies such as the science base and skill level of the workforce. These hypotheses are tested using UK regional level data from 189 valid responses to a 1994–1995 survey of subsidiaries with a parent in the global Fortune 500 list. Results indicate that intra-firm factors are important in firm's decision and that external environment also matters. High performance regions with sophisticated local knowledge tend to be associated with higher order subsidiaries.

In Chap. 12 *Constantina Kottaridi, Marina Papanastassiou, Christos Pitelis and Dimitrios Thomakos* develop a framework to explore the role of multinational enterprise subsidiaries in the global sourcing of knowledge and MNE performance. The authors note that little has been done to connect the issues of international business and absorptive capacity (AC), or how multinational organisations assess and build their AC to enhance their ability and performance. The authors first offer a theoretical insight into AC and its role in the organisation of an MNE. This is followed by a conceptualisation of AC in relation to both potential absorptive capacity and realised absorptive capacity. An empirical evaluation of models concludes. The theoretical framework examines the historical development and current understanding of concepts of knowledge creation and AC. A synthesis of the Penroseian (Penrose 1995) as well as the Cohen and Levinthal view (Cohen and Levinthal 1990) form the basis of the conceptual framework. The empirical analysis examines three propositions (1) a subsidiary realised absorptive capacity (RAC) depends on its degree of autonomy, the existing RAC of the MNE group and the potential absorptive capacity (PAC) of the subsidiary; (2) the strength of a subsidiaries own RAC depends on its productive opportunity; (3) a subsidiary performance will be affected positively by the strength of its RAC and PAC. An econometric analysis of the results of 189 survey responses using both binary choice and regression models results indicates that the likelihood of establishing an R&D lab depends positively on prior PAC. Labs importance as a source of technology for subsidiaries significantly depends on the number of scientific personnel. RAC significantly increases the subsidiaries sales.

Part III: The Role of Public Policies in Fostering Innovation, Competitiveness and Growth

In Chap. 13, *Christos Pitelis* critically assesses existing perspectives on countries competiveness and catch up theories. A novel framework is then developed to explain competiveness and catch up and the role of FDI, clusters and government policy in this context. The framework builds on micro(firm level) foundations and addresses the issue of appropriability (or value capture). The concept of national competiveness is discussed along with an evaluation of the major existing frameworks for analysing competiveness and catch up, the neo-classical economic, the Japanese practice based, the innovators based and Michael Porter's Diamond approach (Porter 1990). From this review of theories the major limitations are identified as the limited discussion of micro level foundations, the lack of a link between micro, meso and macro level competiveness and lack of focus on superior value capture capabilities. In developing a framework to deal with these weaknesses the concept of value is explored as well as identifying the major determinants of value added at the firm and macro level to determine the wealth of a nation. Four factors are identified and a wheel concept developed to illustrate the interactions between different agents in determining country positioning. Even though actors and determinants in value added are identified a further problem of unrealised potential is highlighted and the idea of strategies for value capture is developed. It is suggested that countries need to diagnose their comparative advantages, pursue them and then position themselves on their most beneficial cost-differentiation location. Countries must also be flexible enough to adapt to changing circumstances.

Existing theory and empirical evidence suggest that public policies can play an important role in fostering innovation and growth. However, country-specific conditions such as absorptive capacity and distance to the technology frontier matter. In Chap. 14, *Marc Schiffbauer* discusses the relevant theory and empirical evidence on the role of public policies on innovation and growth and the related optimal policy mix. In particular, he focuses on several key determinants of innovation, technology diffusion and growth that could be either directly or indirectly affected by policy making such as human capital, openness to trade and foreign investment, infrastructure, macroeconomic policies, financial development, science, technology and industrial policies. On the basis of this overview the chapter concludes with a research agenda to advance the understanding of the role of public policy on innovation and growth.

In Chap. 15, *Ioanna Glykou* and *Christos Pitelis* critically assess existing perspectives on supply side competition (anti-trust) and industrial policies, in particular in relation to the case of the European Union. Alternative views on and the meaning of an industrial policy are explained. The dominant perspective of the neo-classical market failure based perspective; including industrial organisation, game theory and the Schumpter perspective (Schumpeter 1942) are critically assessed. The alternatives to this dominant theory, Coase's transaction costs and dynamic capabilities (Coase 1937) along with the evolutionary/resource and systems bases perspective (Porter 1990; Hall and Soskice 2001) are also assessed. The implication of these theories for state intervention and the state firm relationship are analysed. Topics raised are the continual growth of the government sector, the reasons for public enterprise and the relative efficiency of public versus private enterprises. The interaction between the two major institutions, the state and the multinational enterprise along with the reasons for international institutions are examined from both the neo-classical and radical left/Marxist perspective. A history of the market failure based policy in Europe and the more interventionist industrial policies in Japan are reviewed. The shift in EU policy towards a more evolutionary/system based approach is noted. A theory is then developed for value and wealth creation along with economic sustainability.

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Part I
Economic Growth in a Knowledge-Based Economy

Chapter 2
Defining Knowledge-Driven Economic Dynamism in the World Economy: A Methodological Perspective

Paschalis A. Arvanitidis and George Petrakos

Abstract Although economic progress has always been knowledge-based, the scope and role of knowledge to economic processes has fundamentally changed over the last years. On these grounds scholars have argued that a new, knowledge-based economy has emerged, presenting significant opportunities for economic growth and development. This chapter builds upon the concept of the knowledge-based economy to define knowledge-driven economic dynamism and to provide a methodology for assessing it. In particular, it argues that conventional measures of economic performance are not capable of capturing the qualities of the knowledge economy and, on these grounds it introduces an appropriate measure of knowledge-driven economic dynamism, called the Economic Dynamism Indicator (EDI).

Introduction

Economic development is and always has been knowledge-based. However, the scope and significance of knowledge to economic processes has fundamentally changed over the last years. On these grounds there have been many scholars (see for instance Dosi 1995; Neef et al. 1998; Burton-Jones 1999; David and Foray 2002; Rooney et al. 2005; Brinkley 2006; Dolfsma and Soete 2006; Leydesdorff 2006) who argued that a new, knowledge-based economy has emerged presenting significant opportunities for economic and social development.

This chapter builds upon the concept of the knowledge economy to define knowledge-driven economic dynamism and to provide a methodology for assessing it. In particular, it argues that conventional measures of economic performance are not capable of capturing the qualities of the knowledge economy and, on these

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grounds it introduces a new and more appropriate measure of knowledge-driven economic dynamism called the Economic Dynamism Indicator (EDI).

The chapter is structured as follows. The next section discusses the emergence of the knowledge economy and outlines its qualities. This provides the basis for the development of an appropriate conceptual framework in section, "A Framework for Knowledge-Driven Economic Dynamism" that enables us to define knowledge-driven economic dynamism and to specify its dimensions. This is followed by an overview of the existing measures of the knowledge-based economy. The fifth Section "Operationalising Knowledge-Based Economic Dynamism: The Economic Dynamism Indicator"considers some key methodological issues in the construction of composite indicators before it embarks to operationalise the concept of knowledge-driven economic dynamism by developing the Economic Dynamism Indicator. Last, the final section concludes the paper summarising the key findings.

The Emerging Knowledge-Economy Paradigm

The idea that knowledge plays an important role in the economy is not new (Harris 2001). All economic activity rests on some form of knowledge, and all economies, however simple, are based on knowledge (Smith 2002). However, the degree of incorporation of information and knowledge into economic processes is so great today that it causes substantial structural changes in the way economy operates and is organised (Brinkley 2006; Leydesdorff 2006). It this sense, new rules, practises and institutions come to light, declaring the emergence of a new economic structure, that of the knowledge economy.

Three major shifts in the understanding of the changing role of knowledge and its links to the economy have been identified (Soete 2006). In the first, emphasis is placed on knowledge as a commodity (Drucker 1998; OECD 1999). It has been asserted that knowledge is not an external, "black-box" factor, but instead is internal to the economic system and therefore economic principles can be applied to its production and exchange. Moreover, knowledge can be produced and used in the development of goods (or even of itself), which means that it is an input in the production process. Like all goods, knowledge may be subject to depreciation and obsolescence. This is the case when people no longer use certain knowledge, or when new knowledge is created superseding previous knowledge and thereby rendering it worthless.

However, knowledge differs from traditional commodities in a number of ways (and these differences have crucial implications for the way the knowledge economy should be organised). First, it does not have a physical appearance, though it is embedded in some specific blueprint form (such as a patent, an artefact, a composition, a manuscript or a computer programme), in human beings and in organisations (Soete 2006). Second, knowledge is non-rival, i.e. its consumption by one person does not preclude simultaneous consumption by others, and also non-excludable, that is, once discovered and made public no one can be excluded from consuming it or enjoying its benefits. Third, knowledge is not depleted by use; its consumption does not diminish in any way the amount available. In fact, the more people they use it, the greater the social return and its value become (Houghton and Sheehan 2000). As a result positive externalities arise.

The second shift highlights the role information and communication technologies (ICTs) play in the creation and transferability of knowledge (Lundvall and Foray 1996; Houghton and Sheehan 2000). ITCs have advanced the storage, speed, manipulation and interpretation of information, which enabled the codification of knowledge and made it much more accessible than before to all sectors and agents in the economy. It that sense knowledge has become globally available at low cost. For technologically leading countries or firms this "...implies increasing erosion of monopoly rents associated with innovation and shortening of product life cycles" (Soete 2006: 15).

The final shift has to do with the innovation processes. David and Foray (2002) have argued that, today, innovative capacity is related to great extent to the ability to both systematically combine and make new uses of existing knowledge, rather than discovering new technological principles. Thus, it is not the development of new knowledge that plays a significant role in the economic processes but its combination and reorganisation. This process is referred to as "innovation without research" (Soete 2006) and requires systematic access to state-of-the-art technologies and the establishment of procedures for the dissemination of the information.

A Framework for Knowledge-Driven Economic Dynamism

With generation and exploitation of knowledge at the centre of the economic processes, an economy it transformed into a knowledge economy. Such an economy effectively acquires, creates, disseminates and uses knowledge as the main engine for long-tern economic growth. In a sense, knowledge becomes its prime source of competitive advantage. On the bases of this, we define knowledge-driven economic dynamism as the potential an area has for generating and maintaining high rates of economic performance due to its knowledge capacity.

Chen and Dahlman (2005) indicate that a successful knowledge economy involves ingredients such as long-term investments in education, sufficient innovation capacity, adequate information infrastructure and an advantageous economic environment. On these grounds we argue that knowledge-driven economic dynamism embodies four building blocks. These are:

1. Human capital
2. Innovation ability
3. Information access and
4. Economic performance

Human capital refers to a well educated and skilled workforce. Such a labour base is essential to the creation, acquisition, distribution and utilisation of relevant knowledge, which enhances total factor productivity and economic growth. Basic education is essential because it improves peoples' capacity to learn and to use information. Higher education is also important since it is associated with both the production of new knowledge and efficient adaptation and innovative use of established knowledge. Moreover, an educated population tends to be technologically sophisticated. This gives rise to local quality-sensitive demand for advanced goods, encouraging local firms to innovate and develop technologically sophisticated products and production techniques.

There are a large number of studies which have found evidence suggesting that human capital is a key determinant of economic dynamism. Barro (1991) showed a significant positive association between real GDP per capita growth and education (proxied by school-enrolment rates) for 98 countries in the period 1960–1985. Mankiw et al. (1992) and Brunetti et al. (1997) provided similar findings. Interestingly, Barro and Sala-i-Martin (1995) found that higher education has the largest effect on growth compared to both secondary and primary schooling. More recently, Hanushek and Kimko (2000), measuring the quality of education with tests of mathematics and scientific skills for a sample of 31 countries, reaffirmed the significant and positive link between education and growth.

Innovation ability refers to the development of an effective innovation system of firms, research centres and other relevant organisations and institutions, that nurtures research and development (R&D) which results in new goods, new processes and new knowledge. Such a system is expected to sustain the knowledge economy not only by producing new knowledge, but also by drawing on the growing stock of global knowledge and assimilating it to local needs.

There have been a number of studies exploring the role innovation and R&D play in economic progress. For example, Fagerberg (1987) examining 25 industrial countries for the period 1960–1983 reported a close correlation between economic growth and technological development (measured by R&D and patent statistics). Lichtenberg (1992), using a sample of 74 countries, reaffirmed this strong link. So did Ulku (2004), who used panel-data techniques to examine the relation between R&D, innovation and growth for two groups of countries, developed and developing.

Information access has to do with the usage of information and communication technologies (ICTs). With relatively low usage costs and the ability to overcome distances, ICTs have revolutionised the transmission of information around the globe. The provision of a modern and adequate infrastructure is deemed to facilitate the effective communication, distribution, assimilation and development of ideas and knowledge.

ICTs is an essential ingredient of knowledge-based dynamism. Recently there have been a few studies exploring the links between ICT and economic growth. Thus, Schreyer (2000) has argued that ICT producing sectors induce large gains in total factor productivity at the level of the economy, whereas Oliner and Sichel (2000) and Whelan (2000) provided evidence that ICT usage increases productivity and contributes to economic growth.

The final element of knowledge-driven economic dynamism, but by no means the least, is economic performance. The idea behind this is that existing economic conditions affect to a great extent the ability of an economy to generate and exploit knowledge as a key engine of economic growth. Put differently, initial economic conditions determine the qualities and dynamics of a knowledge-based economy in a self-sustained way. On these grounds, a positive relation is envisaged: a weak economic basis is seen as a hindrance (and a robust economy as a supporter) to knowledge-driven economic dynamism.

The relation between past economic performance and current economic growth is well explored in the literature, and particularly in studies examining the issue of economic convergence/divergence (see for instance Kormendi and Meguire 1985; Baumol 1986; Grier and Tullock 1989; Barro 1991; Barro and Sala-i-Martin 1995; Fagerberg and Verspagen 1996; Sala-i-Martin 1996). This research has made clear that initial economic conditions do matter for economic dynamism.

Concluding this section it should be emphasised that all four constructive elements just examined are important for knowledge-driven economic dynamism and are necessary for sustained creation, adoption, adaptation and use of knowledge in domestic economic production, which will consequently result in higher value added goods and services. This would tend to increase the probability of economic success, and hence economic development, in the current highly competitive and globalised world economy.

Existing Measures of the Knowledge-Based Economy

There are literally hundreds of indicators and composite indices that have been developed throughout the world to assess economic (or socioeconomic) conditions at supranational, national, or local levels[1] (Sharpe 2004). Those discussed in this section are composite indices which are either widely known and used, or related specifically to the knowledge economy.

The real GDP[2] per capit*a* of an economy is the most widely used measure of economic performance. Accordingly, the rate of change in real GDP, commonly known as economic growth, is taken as a measure of economic change and, as such, constitutes a measure of economic dynamism. Although this approach has certain advantages, stemming from the fact that GDP is measured frequently, widely (worldwide coverage) and consistently, scholars have criticized its applicability as an indicator of economic health for a number of reasons (see Cobb et al. 1995; Hamilton 1998; Rowe and Silverstein 1999; Vaury 2003; Bergheim 2006). In the current context, GDP is deemed as a rather limited measure of knowledge-driven economic dynamism for two reasons. Firstly, it does not take into account positive

[1]For surveys on this literature see Booysen (2002), Freudenberg (2003), Gadrey and Jany-Catrice (2003), Share (2004) and Saisana et al. (2005).

[2]Simply put, GDP is the total value of all products and services bought and sold. It consists of consumption expenditures made by households, domestic investment, government purchases, and net exports.

externalities that may arise from education or knowledge development. Secondly, since it only counts monetary transactions, it misses other knowledge building activities that take place outside of the market system (such as tacit knowledge).

Some economists (Cobb et al. 1995; Rowe and Silverstein 1999; Lawn 2003) have created an alternative to GDP called Genuine Progress Indicator (GPI), which attempts to resolve many of the problems addressed to the former. The GPI basically consists of two blocks of measures: one for the current economic state (assessed using indicators of consumer spending, government payments, non-market production and leisure) and the other for the sustainability of economic development (assessed using indicators of depletion of resources, environmental damage, etc). Although it represents a much broader indicator of economic health, it does not take into account the knowledge dimensions of the economy; let alone the "... numerous technical difficulties" it encounters (Vaury 2003: 3).

Indicators related particularly to the knowledge economy are limited. A set of two composite indicators attempting to capture the complex multidimensional nature of the knowledge-based economy come from the European Commission's Structural Indicators exercise (see Saisana et al. 2005). The first indicator addresses crucial dimensions of investment in the knowledge-based economy (using measures such as R&D expenditure, number of researchers, etc), whereas the second assesses countries' performance in the transition to the knowledge-based economy (though patents and scientific publications produced). Both indicators are extremely relevant to the current context but they cover only EU-15 countries.

A particular aspect of the knowledge-based economy is innovation. Three relevant composite indices are generally acknowledged in the literature. The fist, developed by Porter and Stern (1999), is the Innovation Index which provides a quantitative benchmark of national innovative capacity for 17 OECD countries, using eight sub-indicators (including R&D expenditure and employment, expenditure on education, strength of protection of intellectual property, etc). The other is the Summary Innovation Index (SII) which is part of the European Innovation Scoreboard. SII utilises official EUROSTAT data to measure innovation capacity of the EU-25 countries. To do this it analyses 20 variables in four areas: human resources, knowledge creation, transmission and application of new knowledge and innovation finance, output and markets. The last index in this group is the Index of Innovation Performance (IIP), provided by Freudenberg (2003) to measure innovative performance in 26 countries. IIP utilises variables in three areas: generation of new knowledge (measured by R&D performance, GDP expenditure on research, PhD holdings, etc), industry/science linkages (measured by paper publications, patents, etc) and industrial innovation (measured by the number of researchers, number of firms introducing new knowledge, etc).

Another group of composite indicators places emphasis on countries' technological advancement. The Technological Achievement Index (TAI) is designed to capture the performance in creating and diffusing technology. The index uses data from eight indicators grouped in four dimensions: technology creation (as measured by the number of patents and license granted), diffusion of recent innovations (as measured by, *inter alia*, the number of Internet hosts), diffusion of old innovations (as measured by telephones and electricity consumption) and human skills (as measured by mean years of schooling and the gross tertiary science enrolment ratio). Another composite indicator, the General Indicator of Science and Technology (GIST), is provided by the National Institute of Science and Technology Policy (1995) to grasp major trends in Japan's Science and Technology activities and to enable comprehensive international comparisons and time-series analysis. GIST consists of 13 variables, five of which are classified as "input" (e.g. R&D expenditure, science degrees conferred, etc) and eight as "output" (e.g. scientific papers, paper citations, patents, technology exports, etc).

Operationalising Knowledge-Based Economic Dynamism: The Economic Dynamism Indicator

Having developed a framework for understanding knowledge-based economic dynamism, this section attempts to operationalise the concept providing an adequate measure. Before getting there, we briefly consider some methodological issues in the construction of composite indicators.

Methodological Considerations Towards the Development of Composite Indicators

Composite indicators are increasingly recognised as useful tools in analysis and public communication. This is because they are able to capture and describe complex concepts (e.g. sustainability, competitiveness, knowledge-based economy, etc.) with a simple measure that can be used to benchmark performance and to assist comparisons (both between places and across time). However, they may send misleading policy messages if they are poorly constructed or misinterpreted. The main advantages and disadvantages of using composite indicators are presented in Table 2.1.

As a result of all these merits and demerits composite indicators do stir controversy. Yet, over the last years we have seen a proliferation in their use in various policy domains. Reviewing the literature (see for instance Booysen 2002; Freudenberg 2003) it becomes evident that there is no commonly accepted methodology on constructing composite indicators. This is due to "... the intrinsic 'vagueness' or ambiguity of composite indicators" (Saisana et al. 2005: 2). However, there have been some serious attempts to provide guidelines and directions towards the development of good quality composite indicators (see, for example Booysen 2002; Saisana and Tarantola 2002; Freudenberg 2003; Saltelli et al. 2004; Saisana et al. 2005; Nardo et al. 2005). Succinctly, composite indexing involves five steps:

Table 2.1 Pros and cons of composite indicators

Pros	Cons
1. Can summarise complex or multi-dimensional issues in view of supporting decision-makers	1. May send misleading policy messages if they are poorly constructed or misinterpreted
2. Easier to interpret than trying to find a trend in many separate indicators	2. May invite simplistic policy conclusions
3. Facilitate the task of ranking countries on complex issues in a benchmarking exercise	3. May be misused, e.g. to support a desired policy, if the construction process is not transparent and lacks sound statistical or conceptual principles
4. Can assess progress of countries over time on complex issues	4. The selection of indicators and weights could be the target of political challenge
5. Reduce the size of a set of indicators or include more information within the existing size limit	5. May disguise serious failings in some dimensions and increase the difficulty of identifying proper remedial action
6. Place issues of country performance and progress at the centre of the policy arena	6. May lead to inappropriate policies if dimensions of performance that are difficult to measure are ignored
7. Facilitate communication with general public (i.e. citizens, media, etc.) and promote accountability	

Source: Saisana and Tarantola (2002)

1. Developing a theoretical framework.
2. Identifying and selecting the relevant variables.
3. Standardising variables to allow aggregation.
4. Weighting variables and aggregation.
5. Validating the composite indicator.

It is important to note that this process should not necessarily be seen as a sequential one and in many occasions these steps are taken concurrently (Booysen 2002).

Theoretical Framework

Since a composite indicator is in essence a summary of a phenomenon, the starting point for indexing should be the adoption of a theoretical framework that enables understanding of the phenomenon under study. Ideally, this framework should provide a clear definition of what it is that is being measured and indicate what kind of individual measures should be sought and weighted in a manner that reflects the dimensions of the concept under study.

Variables Selection

A composite indicator is the sum of its parts. As such, its quality depends largely on the quality of its constituent variables. Ideally, variables should be selected on the basis of their analytical soundness, measurability and relevance to the phenomenon under indexation, and not exclusively on the availability of data series. In practise, however, the lack of required data is the norm. Statistics may not be available either because a certain phenomenon cannot be measured or just because nobody has attempted to measure it. Proxy measures can be used in this case; a solution which should be adopted even when problems of cross-country comparability arise (Nardo et al. 2005).

Because there is no single definitive set of indicators for any given purpose, the choice of which variables should be selected in the indicator remains an inherently subjective exercise. Different variables can be selected to monitor progress in the same performance or policy area. Selection, however, requires a balance between simplification and complication which arises as a result of the tendency to keep on adding variables and components (Booysen 2002). Although capturing the full essence of the phenomenon under measure is significant, simplicity should be not undervalued. Finally, to have an objective comparison across countries of different size, scaling variables by an appropriate size measure (e.g. population, income, land area, etc.) is required.

Standardisation

Since all variables are not measured in the same units or scales, they need to be converted into common units to avoid problems of mixing different measurement units (avoid adding "apples" with "oranges"). This is known as standardisation or normalisation process. There are many techniques that can be used in this respect. Commonly used methods include[3]:

1. Standard deviation from the mean, which imposes a standard normal distribution (i.e. a mean of zero and a standard deviation of one). Thus, positive (negative) values for a given country indicate above (below)-average performance.
2. Distance from the group leader, which assigns 100 to the leading country and other countries are ranked as percentage points away from the leader.
3. Distance from the mean, where the mean value is given 100, and countries receive scores depending on their distance from the mean.
4. Distance from the best and worst performers, where positioning is in relation to the sample's maximum and minimum and the index takes values between zero (laggard) and a hundred (leader).
5. Categorical scale, where each variable is assigned a score (either numerical or qualitative in ordinal scale) depending on whether its value is above or below a given threshold.

[3]Details of each method can be found in Booysen (2002), Freudenberg (2003), Saisana et al. (2005) and Nardo et al. (2005).

Each method has its advantages and disadvantages. Different methods will produce different results. The selection, therefore, of the appropriate method is not trivial and requires special attention. It should take into account the properties of the data and the objectives of the composite indicator. Booysen (2002) argues that the most important criterion in selecting a scaling technique is to achieve a balance between the width of the range and the spread of index scores.

Weighting

Variables that are used for the construction of a composite indicator have to be weighted to reflect the significance, reliability or other characteristics of the underlying data. The weights that are given to different variables may substantially alter the outcomes of the composite indicator. For this reason, weights ideally should reflect the underlying theoretical framework adopted. However, it is sometimes quite difficult to provide weights based on theoretical grounds. As such, the most common practice is to give equal weights to all variables used, largely for reasons of simplicity. This implies, however, that all indicators in the composite have equal importance, which may not be the case.

Another way to identify appropriate weights is through empirical analysis, particularly using methods based on correlations among the variables used (e.g. regression analysis, principal components analysis, factor analysis etc.; for details see Saisana et al. 2005). However, it is not certain that the correlations will correspond to the real-world links between the phenomena being measured (Freudenberg 2003). Alternatively, weights can be established in co-operation with various stakeholders (e.g. experts, policy makers, etc.) on the condition that they understand the strengths, weaknesses and particularities of the data within a given theoretical framework. Yet, another approach is to attach weights in accordance with the quality and availability of data; an attempt that partially corrects for data problems.

Since different weighting techniques can produce quite different results, no weighting approach is above criticism. It is for this reason that Babbie (1995) argues that equal weighting should be the norm. Booysen (2002) seems to embrace such a view on the basis of simplicity in terms of composite construction and interpretation.

Validation

As discussed, several judgements are made with regard to selecting, weighting, standardising and aggregating variables into a composite indicator. Outcomes may depend largely on the approach selected. For this reason, sensitivity tests should be conducted to analyse the impact of including or excluding various variables, changing weights, using different standardisation techniques, etc., on the results of the composite indicator. A combination of uncertainty and sensitivity analyses can be used to assess the robustness of the composite indicator and to improve quality. Uncertainty analysis examines how uncertainty in the input factors propagates through the structure of the composite indicator and affects its values, whereas sensitivity analysis evaluates the contribution of the individual source of uncertainty to the output variance.

Composite indicators usually measure phenomena that are linked to well-known and measurable concepts (e.g. economic growth). These links can be used to test the explanatory power of a composite. Simple cross-plots provide a good means to illustrate such links. Correlation analysis is equally useful for validation, where high correlation indicates a composite indicator of high quality.

The Economic Dynamism Indicator

Having examined some key methodological issues in the construction of composite indicators, the chapter now turns to formulate such an indicator that measures knowledge-driven economic dynamism, called the Economic Dynamism Indicator (EDI).

As discussed, the first step in the construction of any indicator is to specify an appropriate theoretical framework which clearly defines the phenomenon to be measured and outlines its dimensions. This framework has been elaborated in section "The Emerging Knowledge: Economy Paradigm". On the bases of this, knowledge-driven economic dynamism has been defined as the potential an area has for generating and maintaining high rates of economic performance due to its knowledge capacity. Four fundamental dimensions of the concept have been identified: human capital, innovation ability, information access and economic performance. These four dimensions constitute the four components of the EDI.

The next step is to select appropriate variables that reflect the four components just described. The goal of the EDI is to provide a current assessment of economic dynamism for all countries in the world. In order to ensure data consistency, we decided to obtain data from one, but reliable, source, that is the World Bank. On these grounds the variables that have been selected to reflect EDI's components are:

Human capital

- EDU: Gross enrollment ratio in tertiary education
- LIT: Literacy rate as a percentage of adult population

Innovation ability

- RD: R&D expenditure as a percentage of GDP
- RE: Researchers in R&D per million inhabitants
- PT: Patents per million inhabitants

Information access

- W: Internet users per thousand inhabitants

Economic performance

- Y: Real GDP per capita in PPP (constant at 2000, measured in international dollars)
- g: Real GDP per capita annual growth in PPP (constant at 2000, measured in international dollars)

These variables were selected because internationally comparable data were available for a large number of countries. However, there were quite a lot of missing values. In order to improve the geographical coverage and reliability of data, instead of the value of the last year, we used the average of the last 4 years available for each country. This also has a "smoothing" effect on the data (since it reduced the influence of extreme values) improving their quality and reliability. Table 2.2 indicates the sizes of samples finally achieved.

The variables selected for the EDI are expressed in various units (e.g. RD is a percentage of GDP, PT is the number of patents per million people). The "minimum–maximum" method is used here to normalize or standardize the variables. This method transforms actual values into a number ranged between zero (laggard with minimum value) and one (leader with maximum value). For a given country, the index expresses their distance from the overall best and the worst performing countries:

$$SV = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}}, \tag{2.1}$$

where SV is the standardised value, x_i is the actual value, x_{max} is the maximum value and x_{min} is the minimum value.

The normalisation method does not affect the country rankings for individual indicators (since any normalisation method is just a simple transformation of the initial values). In contrast, it can affect the overall findings of a composite indicator, since individual indicators are not only normalised, but also aggregated into a composite.

Whereas the influence of the standardisation method on the results of composite indicators seems limited, the weights attached to individual indicators in contrast strongly influence the overall index. The weighting used in this study reflects the

Table 2.2 Indicators used and sample size

Variables (x_i)	No of countries with available data	Years of available data
EDU	104	1991, 2000–2004
LIT	104	1990, 1995, 1999
RD	101	1996–2004
RE	87	1996–2004
PT	116	1990–2004
W	197	1995–2004
Y	171	1990–2004
g	171	1990–2004

idea that knowledge-driven economic dynamism is a result of economic and knowledge characteristics. Or to put it differently it is the compound effect of the "pure economic" dynamism and the dynamism stemming from the knowledge elements of the economy. However, there is an important asymmetry here: knowledge economy is a relatively recent phenomenon whereas conventional economic dynamics have shaped a country's development path for a much longer time. On these grounds we assert that knowledge-driven economic dynamism should primarily reflect current economic performance which has to be adjusted for the knowledge characteristics of the economy. These four knowledge dimensions of dynamism are given equal weight.

On the basis of the above, the formula for calculating the EDI is as follows:

$$EDI = EP\left(1 + SV\sum_{i=1}^{n} SVx_i\right) \tag{2.2}$$

where x_i is the actual value of the sub-indicator i, SV is its standardised value and EP is a measure of economic performance.

Before we move to reveal the different forms of the EDI, it is necessary to make an important note here. As may have been noted, economic performance refers to the whole first part of the product in the equation presented above (EP), and also constitutes an element of its second part (x_i). This is because two different aspects of the economy are taken into account: one concerns the economic conditions which are currently exhibited in a country and the other reflects to the consequent effects of past economic dynamism or economic growth (i.e. the momentum of the past performance). Accordingly, two forms of the EDI can be envisaged, one [described by the (2.3)] which places higher value on the growth dynamics of the economy (i.e. g is the first part of the product of the equation), and the other [(described by (2.4)] which gives emphasis on the current economic performance.

$$EDI_a = g\left(1 + SV\sum_{i=1}^{n} SV(Y, x_i)\right), \tag{2.3}$$

$$EDI_b = Y\left(1 + SV\sum_{i=1}^{n} SV(g, x_i)\right). \tag{2.4}$$

The combination of different variables gives eleven EDI's for each one of the two EDI forms. Table 2.3 below presents the descriptive statistics. As can be seen, correlations between the EDIs and conventional measures of economic dynamism (Y, g) are quite high; an indication of the high quality of the EDIs produced. However, the quality of the indicators, in terms of the number of countries where data are available, reduces with the number of variables added. Thus, the EDIs

Table 2.3 Descriptive statistics of the developed EDIs

DI's form	EDI	x_i	N	Max	Min	Variance	Standard deviation	Mean	CV (%)	Correlation with Y	Correlation with g
	Y		171	59,880.27	568.25	99,092,573.7	9,954.52	9,469.33	105.12		
	g		171	1.476	0.030	0.012	0.111	0.102	109.12		
g(1 + SVΣSVx)	A1	Y,RD,RE,PT,EDU,W,LIT	40	0.2663	0.0627	0.0015	0.0389	0.1302	29.89		0.56
	A2	Y,RD,RE,PT	70	0.2778	0.0593	0.0017	0.0410	0.1246	32.90		0.61
	A3	Y,RD,PT	91	0.2806	0.0310	0.0016	0.0403	0.1163	34.63		0.60
	A4	Y,RD	99	0.2985	0.0307	0.0020	0.0448	0.1237	36.18		0.68
	A5	Y,EDU,W,LIT	82	0.2626	0.0398	0.0015	0.0391	0.1240	31.51		0.56
	A6	Y,EDU,W	120	0.2806	0.0366	0.0020	0.0452	0.1219	37.05		0.64
	A7	Y,RD,RE,PT,EDU,W	61	0.2784	0.0589	0.0018	0.0422	0.1334	31.62		0.55
	A8	Y,RD,PT,EDU,W,LIT	54	0.2672	0.0482	0.0015	0.0391	0.1266	30.86		0.53
	A9	Y,RD,PT,EDU,W	80	0.2800	0.0342	0.0019	0.0433	0.1261	34.30		0.59
	A10	Y,RD,EDU,W,LIT	55	0.2673	0.0483	0.0015	0.0389	0.1268	30.65		0.53
	A11	Y,RD,EDU,W	83	0.2839	0.0344	0.0019	0.0431	0.1278	33.73		0.61
Y(1 + SVΣSVx)	B1	g,RD,RE,PT,EDU,W,LIT	40	61,777.84	847.66	328,152,237.83	18,114.97	19,775.39	91.60	0.99	
	B2	g,RD,RE,PT	71	85,281.49	793.77	321,925,697.16	17,942.29	20,088.37	89.32	0.98	
	B3	g,RD,PT	89	76,445.78	797.82	252,036,544.53	15,875.66	16,395.49	96.83	0.98	
	B4	g,RD	97	84,712.56	803.62	282,796,113.96	16,816.54	16,816.06	100.0	0.98	
	B5	g,EDU,W,LIT	82	66,163.37	621.95	258,232,326.99	16,069.61	13,155.13	122.15	0.99	
	B6	g,EDU,W	120	64,892.07	569.04	277,461,421.35	16,657.17	14,303.26	116.46	0.99	
	B7	g,RD,RE,PT,EDU,W	61	63,909.55	789.67	337,174,796.03	18,362.32	22,127.87	82.98	0.98	
	B8	g,RD,PT,EDU,W,LIT	54	61,288.52	867.15	285,882,491.61	16,908.06	16,178.26	104.51	0.99	
	B9	g,RD,PT,EDU,W	79	62,458.00	789.67	302,702,571.63	17,398.35	18,448.63	94.31	0.99	
	B10	g,RD,EDU,W,LIT	55	61,249.24	870.53	284,381,197.84	16,863.61	15,948.36	105.74	0.99	
	B11	g,RD,EDU,W	82	64,311.94	789.67	317,832,111.58	17,827.85	18,603.47	95.83	0.99	

which combine all the variables that the theory has addressed (i.e. A1 and B1) maintain only 40 observations; which means that only 40 countries (out of the 218 in the world) avail of data on all the variables employed. These indicators, though valuable, give a rather partial picture at the world scale. However, the situation improves significantly when specific EDI's are considered. For instance, indicator A6, which highlights the element of human capital, retains a quite high number of observations (120). So does indicator A3, which stresses the innovation aspect of EDI and provides observations for 91 countries. Instead of examining all EDI's one by one, the rest of the section focuses on these two indicators (which highlight different but complementary sides of EDI) to shed further light on the qualities of the key indicator developed.

Figure 2.1 below presents the boxplots of the selected EDIs which are seen in comparison to the concept with which they are linked, i.e. the GDP growth (g). As can be seen the new indicators exhibit a greater dispersion compared to growth, and on these grounds we can argue that the former are able to magnify and highlight the differences between countries in terms of growth.

The same is also evident when we plot the selected EDIs against growth (see Fig. 2.2). What becomes clear is that the higher the economic growth exhibited the greater the dispersion of the EDI, indicating the ability of the developed indicator to provide a more accurate assessment of the phenomenon under study.

Having assessed (a least to a degree) the quality and validity of the new indicator the figures that follow portray the countries in accordance to the EDI score that they get. In particular, Figure 2.3 ranks the countries in terms of their economic growth

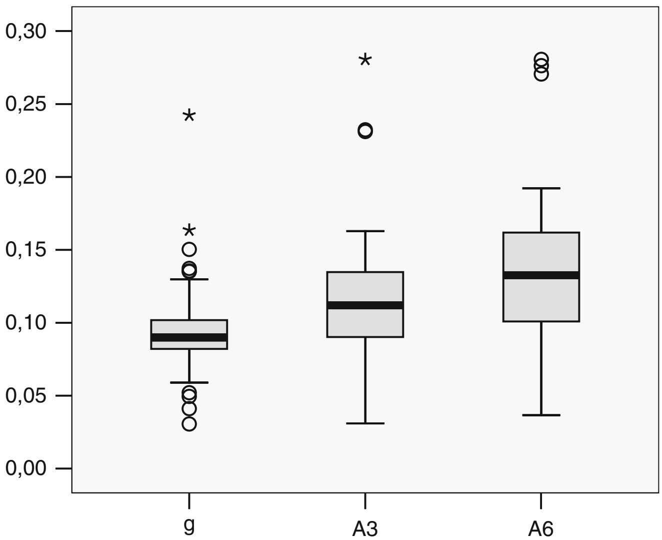

Fig. 2.1 Boxplots of selected EDIs

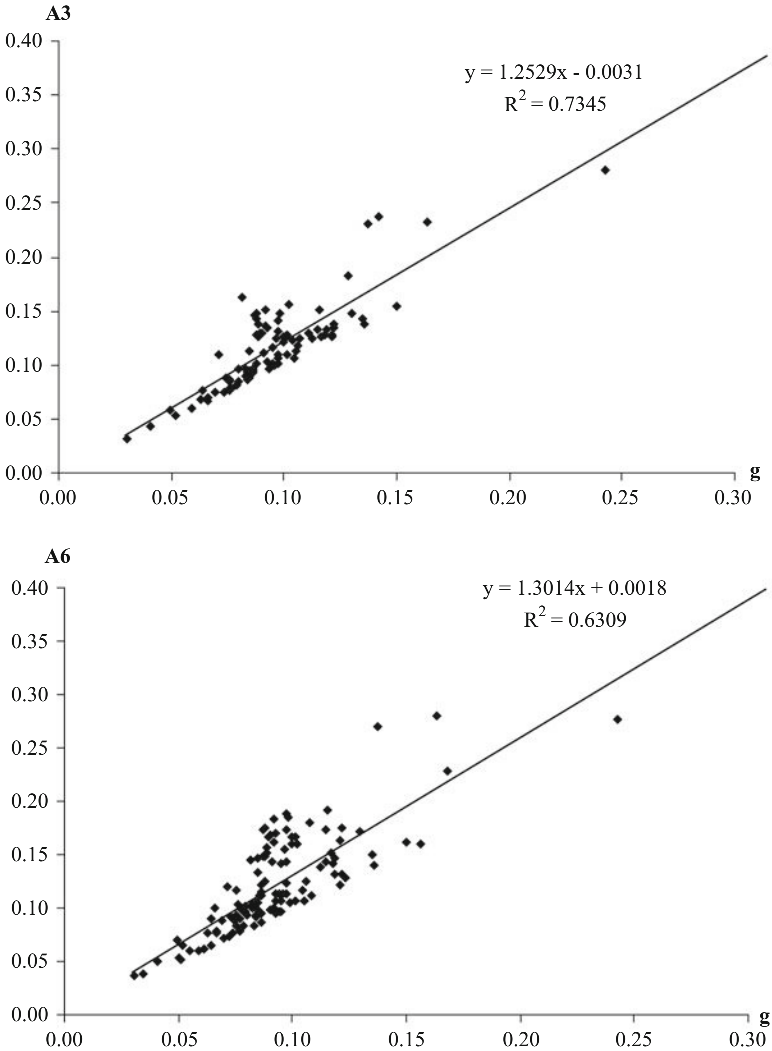

Fig. 2.2 Plotting selected EDIs against economic growth

and the respective EDI score they maintain, whereas Figs. 2.4–2.6 map the world in terms of the exhibited growth and the scores countries acquire for the selected EDIs. Finally, Table 2.4 presents the top-ten and bottom-ten countries for growth and EDI A3 and A6 respectively. A complete rank of all countries in terms of both EDI scores is provided in the Appendix.

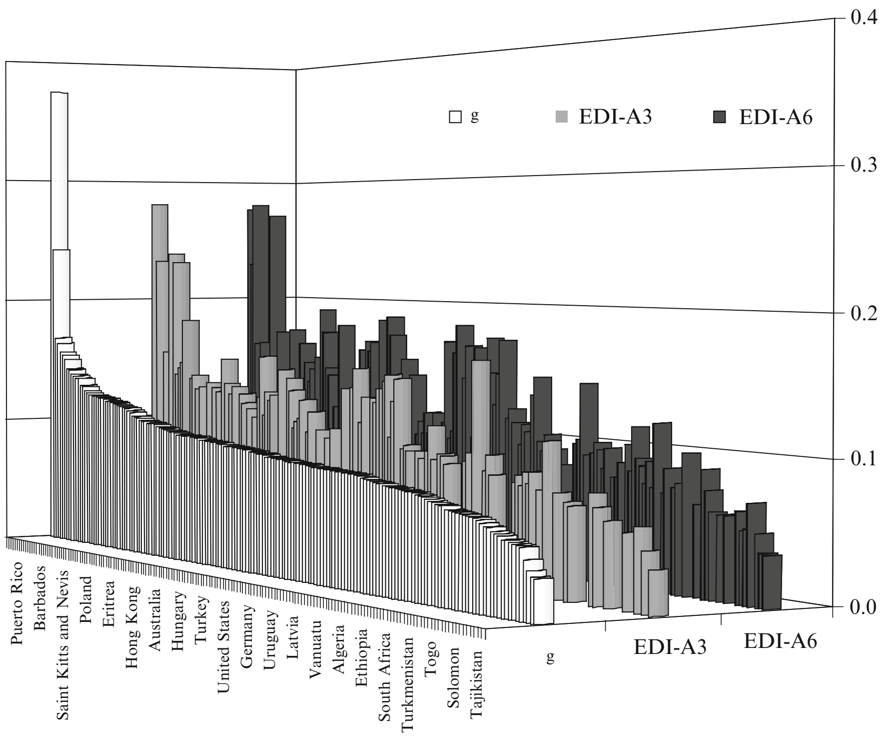

Fig. 2.3 Ranking of countries in terms of economic growth (g) and selected EDIs (A3, A6)

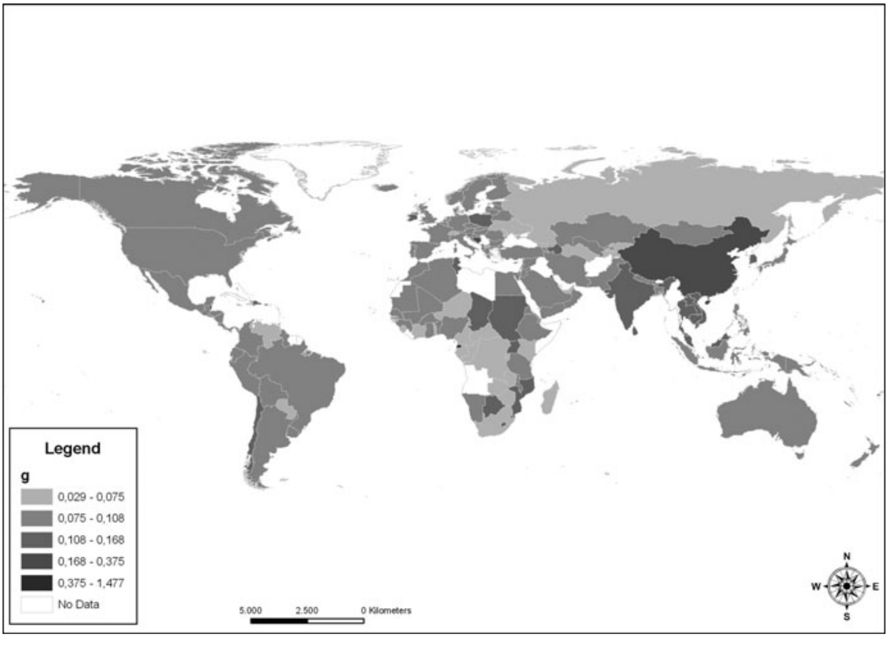

Fig. 2.4 Economic growth in the world

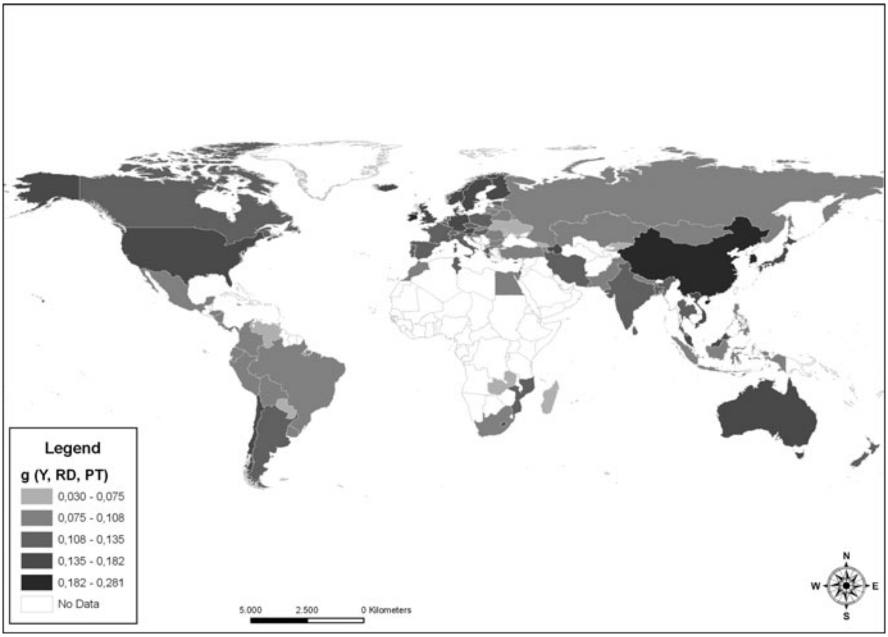

Fig. 2.5 Knowledge-driven economic dynamism in the world: the aspect of innovation (EDI-A3)

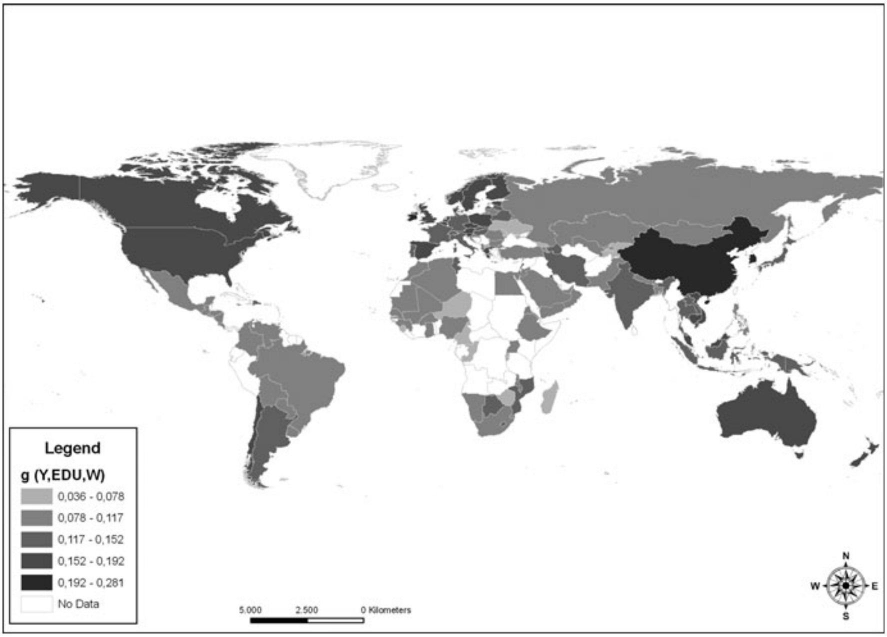

Fig. 2.6 Knowledge-driven economic dynamism in the world: the aspect of human capital (EDI-A6)

Table 2.4 Top-ten and bottom-ten countries

	Rank	Country	g	Country	EDI-A3	Country	EDI-A6
Top 10	1	Equat. Guinea	1.48	China	0.28	Ireland	0.28
	2	Bosnia	0.37	Luxembourg	0.24	China	0.28
	3	China	0.24	Ireland	0.23	Korea Rep.	0.27
	4	Lebanon	0.17	Korea Rep.	0.23	Lebanon	0.23
	5	Ireland	0.16	Singapore	0.18	Slovenia	0.19
	6	Cambodia	0.16	Japan	0.16	Australia	0.19
	7	Bermuda	0.15	Denmark	0.16	Norway	0.19
	8	Viet Nam	0.15	Viet Nam	0.15	USA	0.18
	9	Puerto Rico	0.14	Slovenia	0.15	Estonia	0.18
	10	Luxembourg	0.14	USA	0.15	Malaysia	0.17
Bottom 10	10	Guinea-Bissau	0.05	Jamaica	0.08	Angola	0.07
	9	Kyrgyzstan	0.05	Venezuela	0.07	Kyrgyzstan	0.06
	8	Burundi	0.05	Paraguay	0.07	Niger	0.06
	7	Zimbabwe	0.05	FYROM	0.07	Madagascar	0.06
	6	Ukraine	0.05	Zambia	0.07	Sierra Leone	0.06
	5	Haiti	0.05	Madagascar	0.06	Zimbabwe	0.05
	4	Georgia	0.04	Ukraine	0.06	Burundi	0.05
	3	Tajikistan	0.03	Kyrgyzstan	0.05	Georgia	0.05
	2	Moldova	0.03	Georgia	0.04	Tajikistan	0.04
	1	Congo Dem. Rep.	0.03	Moldova	0.03	Moldova	0.04

Conclusions

The knowledge-based economy has become an important concept of modern economic thought. The pervasive features of knowledge are now evident everywhere in the economy, in terms of new jobs, new products, new industries and new trading links created. Over the last 20 years or so, researchers have systematically theorised, empirically explored and developed further the idea of the knowledge-based economy, marking the advent of a new intellectual shift that places knowledge at the centre of economic analysis. On these grounds knowledge has been seen as a major source of economic growth and development. However, little progress has been done so far in measuring and assessing the knowledge-based economy and the degree of economic dynamism that it brings forward (Harris 2001).

The current paper has worked on this front. It has presented a framework of knowledge-driven economic dynamism and, building upon this, it has constructed a set of indicators (EDIs) which are able to assess the quality of an economy's knowledge-based dynamism. Although further research is required along this front there are indications that EDIs can provide a robust basis for measuring economic dynamism of this sort. Policy makers and assessors should be informed by these type of measures and make use of them if they wish to have a more precise and accurate picture of the knowledge-based dynamism (or lack of it) that economies exhibit.

Appendix

Ranking of countries by economic growth and EDIs A3 and A6

Rank by g	g	Rank by EDI-A3	EDI-A3	Rank by EDI-A6	EDI-A6
Equatorial Guinea	1.48	China	0.28	Ireland	0.28
Bosnia	0.37	Luxembourg	0.24	China	0.28
China	0.24	Ireland	0.23	Korea Rep	0.27
Lebanon	0.17	Korea Rep	0.23	Lebanon	0.23
Ireland	0.16	Singapore	0.18	Slovenia	0.19
Cambodia	0.16	Japan	0.16	Australia	0.19
Bermuda	0.15	Denmark	0.16	Norway	0.19
Viet Nam	0.15	Viet Nam	0.15	United States	0.18
Puerto Rico	0.14	Slovenia	0.15	Estonia	0.18
Luxembourg	0.14	United States	0.15	Malaysia	0.17
Samoa (American)	0.14	Israel	0.15	Finland	0.17
Korea Rep	0.14	Chile	0.15	New Zealand	0.17
Lesotho	0.14	Norway	0.15	Sweden	0.17
Azerbaijan	0.14	Sweden	0.15	Poland	0.17
Chile	0.13	Finland	0.14	Chile	0.17
Singapore	0.13	Azerbaijan	0.14	United Kingdom	0.17
Barbados	0.13	Australia	0.14	Netherlands	0.17
Laos	0.12	Iceland	0.14	Hong Kong	0.17
India	0.12	Germany	0.14	Czech Republic	0.17
Malaysia	0.12	Malaysia	0.14	Canada	0.17
Sri Lanka	0.12	Lesotho	0.14	Kuwait	0.16
Chad	0.12	Austria	0.14	Austria	0.16
Mozambique	0.12	United Kingdom	0.14	Viet Nam	0.16
Kuwait	0.12	India	0.13	Cambodia	0.16
Saint Kitts and Nevis	0.12	Maurutius	0.13	Greece	0.16
Maurutius	0.12	Poland	0.13	Denmark	0.16
Bostwana	0.12	New Zealand	0.13	Belgium	0.16
Trinidad and Tobago	0.12	Malta	0.13	Spain	0.15
Belize	0.12	Netherlands	0.13	Thailand	0.15
Thailand	0.12	Canada	0.13	Germany	0.15
Sudan	0.12	France	0.13	Azerbaijan	0.15
Slovenia	0.12	Trinidad and Tobago	0.13	Israel	0.15
Poland	0.11	Mozambique	0.13	France	0.15
Dominican Republic	0.11	Hong Kong	0.13	Italy	0.15
Tunisia	0.11	Belgium	0.13	Maurutius	0.15
Malta	0.11	Sri Lanka	0.13	Japan	0.14
Uganda	0.11	Czech Republic	0.13	Dominican Republic	0.14
Cape Verde	0.11	Thailand	0.13	Argentina	0.14
Estonia	0.11	Estonia	0.13	Portugal	0.14
Iran	0.11	Spain	0.12	Hungary	0.14
Eritrea	0.11	Tunisia	0.12	Trinidad and Tobago	0.14
Panama	0.11	Cyprus	0.12	Lesotho	0.14
French Polynesia	0.10	Greece	0.12	Tunisia	0.14
Indonesia	0.10	Iran	0.12	Latvia	0.13
Albania	0.10	Hungary	0.12	India	0.13
Cyprus	0.10	Panama	0.11	Bostwana	0.13

(*continued*)

Rank by g	g	Rank by EDI-A3	EDI-A3	Rank by EDI-A6	EDI-A6
Denmark	0.10	Italy	0.11	Laos	0.13
Bangladesh	0.10	Portugal	0.11	Iran	0.13
Hong Kong	0.10	Argentina	0.11	Slovakia	0.12
Greece	0.10	Switzerland	0.11	Papua New Ginea	0.12
Czech Republic	0.10	Bangladesh	0.11	Mozambique	0.12
Macao (China)	0.10	Costa Rica	0.11	Belarus	0.12
Yemen	0.10	Indonesia	0.11	Switzerland	0.12
Norway	0.10	Turkey	0.10	Indonesia	0.12
Tonga	0.10	Slovakia	0.10	Lithuania	0.12
Papua New Ginea	0.10	Nepal	0.10	Albania	0.12
Australia	0.10	Peru	0.10	Uruguay	0.11
New Zealand	0.10	Egypt	0.10	Egypt	0.11
Peru	0.10	Belarus	0.10	Turkey	0.11
Costa Rica	0.10	Pakistan	0.10	Oman	0.11
Argentina	0.10	Croatia	0.10	Costa Rica	0.11
Spain	0.10	Brazil	0.10	Uganda	0.11
Fiji	0.10	Latvia	0.09	Kazakhstan	0.11
Egypt	0.10	Uruguay	0.09	Romania	0.11
Hungary	0.10	Romania	0.09	El Salvador	0.11
Grenada	0.10	Mexico	0.09	Nepal	0.11
Mali	0.10	Kazakhstan	0.09	Eritrea	0.11
Nepal	0.09	Morocco	0.09	Bangladesh	0.11
Ghana	0.09	Antigua and Barbuda	0.09	Bolivia	0.11
Oman	0.09	Armenia	0.09	Mexico	0.10
Pakistan	0.09	Bolivia	0.09	Yemen	0.10
Syria	0.09	South Africa	0.09	Jordan	0.10
Turkey	0.09	Lithuania	0.09	Bulgaria	0.10
Bahrain	0.09	Nicaragua	0.09	Croatia	0.10
New Caledonia	0.09	Colombia	0.08	Uzbekistan	0.10
El Salvador	0.09	Bulgaria	0.08	United Arab Emirates	0.10
United Kingdom	0.09	Philippines	0.08	Brazil	0.10
Mauritania	0.09	Mongolia	0.08	Armenia	0.10
Uzbekistan	0.09	Ecuador	0.08	Saudi Arabia	0.10
Austria	0.09	Russia	0.08	Namibia	0.10
United States	0.09	Honduras	0.08	Pakistan	0.10
St. Vincent and Grenadines	0.09	Jamaica	0.08	Ghana	0.10
Portugal	0.09	Venezuela	0.07	Philippines	0.10
Netherlands	0.09	Paraguay	0.07	Mali	0.10
Djibouti	0.09	FYROM	0.07	Nigeria	0.10
Namibia	0.09	Zambia	0.07	Mauritania	0.09
Canada	0.09	Madagascar	0.06	Colombia	0.09
Belgium	0.09	Ukraine	0.06	Nicaragua	0.09
Germany	0.09	Kyrgyzstan	0.05	Mongolia	0.09
Iceland	0.09	Georgia	0.04	Guatemala	0.09
Finland	0.09	Moldova	0.03	Algeria	0.09
Israel	0.09			Jamaica	0.09
Slovakia	0.09			Morocco	0.09
France	0.09			Russia	0.09

(*continued*)

Rank by g	g	Rank by EDI-A3	EDI-A3	Rank by EDI-A6	EDI-A6
Sweden	0.09			Swaziland	0.09
Burkina Faso	0.09			Venezuela	0.09
Uruguay	0.09			South Africa	0.09
Belarus	0.09			Burkina Faso	0.09
Kazakhstan	0.09			Honduras	0.08
Seychelles	0.09			Malawi	0.08
Nigeria	0.09			Senegal	0.08
Romania	0.09			Paraguay	0.08
Bolivia	0.08			Guinea	0.08
Guyana French	0.08			Ethiopia	0.08
Latvia	0.08			Cameroon	0.08
Italy	0.08			FYROM	0.08
Armenia	0.08			Congo. Republic of	0.08
Guatemala	0.08			Rwanda	0.07
Mexico	0.08			Gambia	0.07
Morocco	0.08			Ukraine	0.07
Nicaragua	0.08			Angola	0.07
Benin	0.08			Kyrgyzstan	0.06
Vanuatu	0.08			Niger	0.06
Malawi	0.08			Madagascar	0.06
Dominica	0.08			Sierra Leone	0.06
Tanzania	0.08			Zimbabwe	0.05
Antigua and Barbuda	0.08			Burundi	0.05
Brazil	0.08			Georgia	0.05
Jordan	0.08			Tajikistan	0.04
Japan	0.08			Moldova	0.04
Algeria	0.08				
Bahamas	0.08				
Colombia	0.08				
Croatia	0.08				
Philippines	0.08				
Senegal	0.08				
Saudi Arabia	0.08				
Saint Lucia	0.08				
Ethiopia	0.08				
Guinea	0.08				
Swaziland	0.08				
Ecuador	0.08				
Bulgaria	0.08				
Honduras	0.08				
Lithuania	0.08				
Mongolia	0.08				
South Africa	0.07				
Cameroon	0.07				
Jamaica	0.07				
Rwanda	0.07				
Switzerland	0.07				
Gabon	0.07				
Gambia	0.07				
Venezuela	0.07				
Turkmenistan	0.07				

(*continued*)

Rank by g	g	Rank by EDI-A3	EDI-A3	Rank by EDI-A6	EDI-A6
Congo, Republic of	0.07				
Paraguay	0.07				
Zambia	0.07				
United Arab Emirates	0.07				
Kenya	0.07				
Comoros	0.07				
Angola	0.06				
Togo	0.06				
Russia	0.06				
FYROM	0.06				
Niger	0.06				
Central African Republic	0.06				
Madagascar	0.06				
Cote d Ivoire	0.06				
Sierra Leone	0.06				
Solomon	0.05				
Guinea-Bissau	0.05				
Kyrgyzstan	0.05				
Burundi	0.05				
Zimbabwe	0.05				
Ukraine	0.05				
Haiti	0.05				
Georgia	0.04				
Tajikistan	0.03				
Moldova	0.03				
Congo Dem Rep	0.03				

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Chapter 3
Explaining Knowledge-Based Economic Growth in the World Economy

Panagiotis Artelaris, Paschalis A. Arvanitidis, and George Petrakos

Abstract Building upon authors' previous work, the study develops econometric models in order to specify the determinants of knowledge-based economic growth at the international level. In doing so, it differs from other studies in the following ways: it makes use of a new composite indicator of growth which accounts for knowledge capacity, it runs WLS regressions, and it explores the existence of nonlinear relations between determinants and growth. The study confirms previous findings that variables such as investment and FDI are important determinants of growth but adds that geography, agglomerations and institutions play a vital role in economic performance. Furthermore, it indicates that the effect of initial economic conditions, size of government, openness to trade and institutions on growth is nonlinear: up to a critical level, these factors have a positive impact, whereas beyond that the effect diminishes and may become negative. These findings have important implications for both theory and policy.

Introduction

Over the last two decades the issue of economic growth has attracted increasing attention in both theoretical and applied research. Yet, our knowledge of the process underlying economic performance and growth is still largely fragmented (Easterly

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2001), something which can be partly attributed to the lack of a generalised or unifying theory and the incomplete way conventional economics approach the issue.

Despite the lack of a unifying theory, there are several partial theories that discuss the role of various factors in determining growth dynamics. For instance, the neoclassical perspective has emphasised the importance of investment and savings, the more recent theory of endogenous growth has drawn attention to human capital and innovation capacity, whereas the New Economic Geography has stressed the role of location and agglomeration economies in the process of economic development. From a macro perspective, other theoretical strands have emphasised the significant part non-economic (in the conventional sense) factors play on economic performance, giving rise to a discussion that distinguishes between “proximate” and “fundamental” or “ultimate” sources of growth (see Rodrik 2003; Snowdon 2003; Acemoglu et al. 2005). Thus, the New Institutional Economics has underlined the fundamental role of institutions and property rights, economic sociology stressed the importance of socio-cultural factors, political science focused its explanation on political determinants, and others shed light on the role played by geography and demography.

Theoretical developments have been accompanied by a growing number of empirical studies. Some researchers looked into the issue of economic convergence/divergence, which also worked as a validity test between the two main theories of growth (neoclassical and endogenous growth). Others focused on the factors determining economic performance. Both streams of research have been benefited by the development, over the years, of larger and richer databases (such as the Penn World Tables and the Maddison dataset) and the provision of more advanced statistical and econometric techniques. Artelaris et al. (2006) provided a comprehensive review of both lines of research, whereas Arvanitidis et al. (2007), through a questionnaire survey, explored the prevailing perspectives of three groups of experts with regard to the issues of economic dynamism and growth prospects.

In the vast majority of the empirical studies, the rate of change of per capita GDP has been used as the measure of economic performance and dynamism. Although this approach has certain advantages, stemming from the fact that GDP is measured frequently, widely (worldwide coverage) and consistently, scholars have severely criticized its applicability as an indicator of economic performance for a number of reasons (see Cobb et al. 1995; Hamilton 1998; Rowe and Silverstein 1999; Vaury 2003; Bergheim 2006). On these grounds Arvanitidis and Petrakos (see Chap. 2 in this volume) acknowledging that economies have increasingly become knowledge-based, have developed a new composite indicator of knowledge-based economic growth (EDI) to assist the assessment of economic performance, which does not suffer from the limitations of the simple GDP-growth variable.

The current chapter builds upon previous research of the authors to explore the qualities of knowledge-based economic dynamism. In particular, it develops econometric models to shed light on the factors that drive knowledge-based economic growth at a global scale. The analysis covers the period between 1990 and 2002.

The paper is organized as follows. Section Two summarizes the most important determinants of economic growth that have been identified in the literature. Section Three investigates econometrically the determinants of knowledge-based economic growth in the world economy. The final section concludes the paper summarising the key findings.

Determinants of Economic Performance

Many studies have investigated the factors underlying economic performance drawing on various conceptual and methodological frameworks. As such, a wide range of economic, political, socio-cultural, institutional, geographic and demographical factors have been identified and proposed as possible determinants of economic growth.

Investment is regarded as one of the most fundamental drivers of economic growth identified by both neoclassical and endogenous growth models. However, in the neoclassical perspective investment has an impact on the transitional period, while the endogenous growth models argue for more permanent effects. The importance attached to investment by these theories has led to an enormous amount of empirical studies examining the relationship between investment and economic growth (see for instance, Kormendi and Meguire 1985; De-Long and Summers 1991; Levine and Renelt 1992; Mankiw et al. 1992; Auerbach et al. 1994; Barro and Sala-i-Martin 1995; Sala-i-Martin 1997; Easterly 1997; Bond et al. 2001; Podrecca and Carmeci 2001). Nevertheless, findings are not conclusive.

Human capital is the main source of growth in several endogenous growth models as well as one of the key extensions of the neoclassical model. Since the term "human capital" refers principally to workers' acquisition of skills and know-how through education and training, the majority of studies have measured the quality of human capital using proxies related to education (e.g. school-enrolment rates, tests of mathematics and scientific skills, etc.). On these grounds, a large number of studies found evidence suggesting that an educated labour force is a key determinant of economic growth (see Barro 1991; Mankiw et al. 1992; Barro and Sala-i-Martin 1995; Brunetti et al. 1998; Hanushek and Kimko 2000). However, there have been other scholars who have questioned these findings and, consequently, the importance of human capital as substantial determinant of growth (e.g. Levine and Renelt 1992; Benhabib and Spiegel 1994; Topel 1999; Krueger and Lindhal 2001; Pritchett 2001).

Innovation and R&D activities can play a major role in economic progress increasing productivity and growth. This is due to the increasing use of technology that enables the introduction of new and superior processes and products. This role has been stressed by various endogenous growth models, and the strong relation between innovation, R&D and economic growth has been empirically affirmed by many studies (such as Fagerberg 1987; Lichtenberg 1992; Ulku 2004).

Economic policies and macroeconomic conditions have, also, attracted much attention in terms of their role in economic performance (see Kormendi and Meguire 1985; Grier and Tullock 1989; Barro 1991, 1997; Fisher 1993; Easterly and Rebelo 1993; Barro and Sala-i-Martin 1995), since they set the framework within which economic growth occurs. The literature has examined a number of economic policies that may affect economic performance, including investments in human capital and infrastructure, improvement of political and legal institutions and so on; however there is no consensus within the scientific community with regard to which policies are more conductive to growth. Overall, sound macroeconomic conditions are seen as necessary, though not sufficient, conditions for positive economic performance (Fisher 1993). A stable macroeconomic environment may favour growth through the reduction of uncertainty, whereas macroeconomic instability may have a negative impact on growth through its effects on productivity and investment (i.e. higher risk). Several macroeconomic factors that may affect growth have been identified in the literature, but considerable attention has been placed on inflation, fiscal policy, budget deficits and tax burdens.

Openness to trade is another important determinant of economic performance. There are firm theoretical reasons for arguing that there is a strong and positive link between openness and economic growth: openness facilitates the transfer of technology and the diffusion of knowledge, and, by increasing exposure to competition, contributes to exploitation of comparative advantage. A large and growing number of studies have explored this relationship in empirical research.[1] Findings, however, are not conclusive. Some researchers have found that economies which are open to both trade and capital flows exhibit higher GDP per capita and they grow faster (Dollar 1992; Sachs and Warner 1995; Edwards 1998; Dollar and Kraay 2000), whereas others have questioned these findings raising concerns about the robustness of the developed models (see for example, Levine and Renelt 1992; Rodriguez and Rodrik 1999; Vamvakidis 2002).

Foreign Direct Investment (FDI) has recently played a crucial role in internationalising economic activity and it is a primary source of technology transfer and economic growth. This major role is stressed in several models of endogenous growth theory. The empirical literature that examined the impact of FDI on growth has provided more-or-less consistent findings affirming a significant positive link between the two (e.g. Borensztein et al. 1998; Hermes and Lensink 2003; Lensink and Morrissey 2006).

[1] Openness is usually measured by the ratio of exports to GDP. However, other indicators have also been used. For example Sachs and Warner (1995) suggest one that takes into account the five following criteria: average quota and licensing coverage of imports are less than 40%, average tariff rates are below 40%, black market premium is less than 20%, no extreme controls are imposed on exports, and the country is not under a socialist regime.

[2] According to North (1990) the term “institutions” refers to the formal rules, informal constraints and their enforcement characteristics that together shape human interaction.

Although the important role institutions[2] play in shaping economic performance has long been acknowledged (e.g. Lewis 1955; Ayres 1962; Matthews 1986), it is not until recently that such factors have been examined empirically in a more consistent way (see Knack and Keefer 1995; Mauro 1995; Hall and Jones 1999; Rodrik 1999; Acemoglu et al. 2002, 2005; Rodrik et al. 2004). Rodrik (2000) highlights five key institutional structures (property rights, regulatory institutions, institutions for macroeconomic stabilization, institutions for social insurance and institutions of conflict management), which, he argues, not only exert direct influence on economic growth, but also affect other determinants of growth such as the physical and human capital, the investment decisions and technological developments. It is on these grounds that Easterly (2001) argues that none of the traditional factors would have an impact on economic performance if there had not been developed a stable and trustworthy institutional environment. Measures of institutional quality frequently used in the empirical literature include property rights and contract security, risk of expropriation, level of corruption, legal certainty and level of bureaucracy (Knack and Keefer 1995).

The relationship between political factors and economic growth has come to the fore in the work of Lipset (1959) who examined how economic development affects the political regime. Since then, research on these issues has proliferated making clear that political issues affect to a great extent the economy and its potential for growth (Kormendi and Meguire 1985; Scully 1988; Grier and Tullock 1989; Alesina and Perotti 1996; Lensink et al. 1999; Lensink 2001). For example, an unstable political environment is deemed to increase uncertainty, discouraging investment and hindering economic potential. But it is not only the stability of the regime that influences growth dynamics; it is also its type. For instance, the level of democracy is found to be associated with economic growth, though this relation is much more complex. Democracy may both retard and enhance economic growth depending on the various channels that it passes through (Alesina and Rodrik 1994). Over the years, a number of variables have been used in an effort to assess the quality and effect of political factors. Brunetti (1997) has put forward five categories of such variables that comprehensively describe the political environment: democracy, government stability, political violence, political volatility and subjective perception of politics.

Recently there has been a growing interest in how various socio-cultural factors may affect growth (see Granato et al. 1996; Huntington 1996; Temple and Johnson 1998; Landes 2000; Inglehart and Baker 2000; Zak and Knack 2001; Barro and McCleary 2003). Solid social relations and trust are important such determinants. Trusting economies are expected to have stronger incentives to innovate, to accumulate physical capital and to exhibit richer human resources, all of which are conductive to economic growth (Knack and Keefer 1997). Ethnic diversity may have a negative impact on growth by reducing trust, increasing polarization and promoting the adoption of policies that have neutral or even negative effects in terms of growth (Easterly 1997). Several other socio-cultural factors have been examined in the literature, such as ethnic composition and fragmentation, diversity in language, religion, beliefs, attitudes and the like, but their relation to economic growth seems to be indirect and unclear. For instance cultural diversity may have either a negative impact on growth due to emergence of social uncertainty or even to social conflicts, or a positive effect since it may give rise to a pluralistic environment where cooperation can flourish.

The important role of geography on economic growth has been long recognized. Though, over the last years there has been an increased interest in these factors since they have been properly formalised and entered into models (Fujita et al. 1999; Gallup et al. 1999). Researchers have used numerous variables as proxies for geography and location including absolute values of latitude, distances between countries, proportion of land within certain distance from the coast, average temperatures, soil quality and disease ecology (Hall and Jones 1999; Easterly and Levine 2003; Rodrik et al. 2004). There have been a number of recent empirical studies (Sachs and Warner 1997; Bloom and Sachs 1998; Masters and McMillan 2001; Armstrong and Read 2004) affirming that natural resources, climate, topography and "landlockedness" have a direct impact on economic growth affecting (agricultural) productivity, economic structure, transport costs and competitiveness. However, others (e.g. Easterly and Levine 2003; Rodrik et al. 2004) found no effect of geography on growth after controlling for institutions.

Moreover, agglomeration of people and economic activities in space is considered to have a positive impact on growth at both local and global levels (Martin and Ottaviano 2001; Davis and Henderson 2003; Henderson 2003; Bertinelli and Black 2004). This is due to positive externalities (known as agglomeration economies) arising as a result of either the concentration of single-sector activities (localisation economies) or availability of multiple urban-related services (urbanisation economies). Agglomeration economies create incentives (based on information/knowledge spillovers, forwards and backwards linkages and specialised labour market pooling) for the concentration of production at a limited number of locations that usually benefited from a head-start (Fujita and Thisse 2002). As a result, large and dense areas tend to attract economic activities at a higher rate and achieve growth in a self-reinforcing process (Ottaviano and Puga 1998). However, researchers (Henderson 2003; Wheeler 2003; Bertinelli and Black 2004; Bertinelli and Strobl 2007) have found that once density reaches a certain level, these positive externalities begin to peter out and agglomeration diseconomies (negative externalities due to high transport and land costs, crowding and congestion and intensification of competition) dominate, setting back growth prospects.

The relationship between demographic trends and economic growth has attracted a lot of interest particularly over the last years, yet many demographic aspects remain unexplored today. Of those examined, population growth, population composition and age distribution, and urbanisation, seem to play the major role in economic growth (Kormendi and Meguire 1985; Brander and Dowrick 1994; Kelley and Schmidt 2000; Barro 1997; Bloom and Williamson 1998). High population growth, for example, could have a negative impact on economic growth influencing the dependency ratio, investment and saving behaviour and the quality of human capital. The composition of the population may also have important implications: large working-age populations are deemed to be conductive to growth, in contrast to populations with many young and elderly dependents. Urbanisation, in turn, may be positively linked with economic growth as cities constitute the locus of the growing tertiary sector of the economy (Arvanitidis and Petrakos 2006). Despite these findings, however, these issues are still open for further investigation, since there have been studies reporting no (strong) correlation between economic growth and demographic variables (e.g. Grier and Tullock 1989; Pritchett 2001).

Determinants of Knowledge-Based Economic Growth at the International Level: Econometric Analysis

This section explores the drivers of knowledge-based economy. More specifically, for a cross-section of countries it investigates empirically which of the factors identified in Section Two are significant determinants of the knowledge-based economic dynamism as measured by the composite indicator (EDI) that has been developed by Arvanitidis and Petrakos in the Chap. 2 of the current volume.

Arvanitidis and Petrakos have conceptualised knowledge-based economic dynamism as the potential an area has for generating high levels of economic growth mainly due to its knowledge capacity. Informed by the relevant literature (such as Chen and Dahlman 2005), they identified four key dimensions of the concept: economic performance, human capital, innovation ability, and access to information. The variables that were selected (on the basis of availability and reliability of the source) to reflect these dimensions are: real GDP per capita annual growth (g), real GDP per capita (Y), Gross enrolment ratio in tertiary education (EDU), R&D expenditure as a percentage of GDP (RD), and Internet users per thousand inhabitants (W). However, these variables were not treated equally. In particular, the weighting applied in constructing the EDIs reflected the idea that economic dynamism is primarily the result of the economic growth which, however, has to be adjusted for the "knowledge" characteristics of the economy and the level of development reached (that is, the achieved level of economic performance). The knowledge and performance components were given equal weight.

Overall, Arvanitidis and Petrakos calculated the EDIs according to the following formula:

$$EDI = g\left(1 + SV\sum_{i=1}^{n} SVx_i\right), \qquad (3.1)$$

where g refers to growth (measured by annual changes in real GDP per capita) and x_i refers to the adjusting component i (that is, the "knowledge" and economic performance elements) which is standardised[3] with the "minimum–maximum" method according to the formula:

[3]This is necessary since the variables are measured in different units.

$$SV = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}}, \tag{3.2}$$

where x_{min} is the lowest and x_{max} the highest values of the sample.

The choice of the specific EDIs to be used in the current study was made primarily on the basis of data availability and sample-size adequacy. Two different EDIs were selected, each one exposing a slightly different but complementary aspect of the knowledge-based economy. Thus, EDI-A3 reflects innovation capacity taking into account issues of economic growth, research capacity, innovation and economic performance (assessed by g, RD, PT and Y, respectively), whereas EDI-A6 reflects human–capital quality, taking into account issues of economic growth, human capital, information flow and economic performance (assessed by g, EDU, W and Y, respectively).

The determinants of EDI are estimated econometrically in a cross-section framework. Following the conventional approach, the econometric model developed here has the following form:

$$y = a + b_1x_1 + b_2x_2 + \cdots + b_nx_n + \varepsilon_i, \tag{3.3}$$

where y is the vector of EDIs, x_i are vectors of explanatory variables for all countries considered, and ε_i is the error term with $\varepsilon \sim N(0, \sigma^2)$.

The period studied is from 1990 to 2002,[4] where country data are available for all variables examined. More than 60 variables were examined altogether, whereas relevant data have been collected from two different sources. Economic and population related variables were extracted from the World Bank database (World Development Indicators), while institutions-related variables (such as legal system and property rights as well as the size of government) were obtained from the Fraser Institute.[5] A detailed presentation of the variables used in the models developed as well as the list of the countries in the sample is provided in the Appendix.

All regressions are estimated using weighted least squares (WLS). As discussed elsewhere (Petrakos et al. 2005; Petrakos and Artelaris 2009) the majority of econometric studies tend to overlook the relative population size of each country treating all observations as equal (for exceptions see Grier and Tullock 1989; Edwards 1998; Folster and Henrekson 1999; Cole and Neumayer 2003). Yet, countries vary widely in terms of population at international level. WLS allow countries to have an influence on regression results which is analogous to their size, via the weight matrix W. The population of each country can be used as the diagonal element in the weighting non-singular positive definite matrix W_{nxn}, which has zero off-diagonal elements, as follows:

[4]All explanatory variables are measured at the beginning of the time period examined (i.e. in 1990), whereas EDIs reflects knowledge-based dynamism in the last reporting period.

[5]See Gwartney and Lawson (2005) for a detailed description of the variables availed by the Fraser Institute.

$$\mathbf{W}_{n\times n} = \begin{pmatrix} p_{11} & 0 & . & . & . & 0 \\ 0 & p_{22} & . & . & . & 0 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ 0 & 0 & . & . & . & p_{nn} \end{pmatrix}, \tag{3.4}$$

where

$$p_i = \frac{p_i}{\Sigma p_i} \tag{3.5}$$

In addition to the use of WLS, the study introduces another novelty. Instead of assuming a typical linear relationship between EDIs and explanatory variables, as the majority of studies do, it explores the existence of nonlinearities in the process underlying economic performance. Scholars (e.g. Rivera-Batiz and Romer 1991; Chatterji 1992; Baldwin and Sbergami 2000; Marino 2004) have established that linear econometric models suffer from problems of robustness whereas allowing for nonlinearity provides more valid econometric estimates.

Six variables have been examined in quadratic form in order to capture the nonlinear influence of them on EDI. These include GDP per capita (assessing the initial economic conditions) population density (assessing agglomeration economies), regulation (assessing state control of credit, labour and business), total trade as a percentage of GDP (assessing openness of the economy), size of government (assessing the size of the public sector), and legal system and property rights (assessing property rights security and enforcement). For these variables there are grounds to believe that they affect economic performance in a nonlinear/nonmonotonic way (Chatterji 1992; Baldwin and Sbergami 2000; Wheeler 2003; Artelaris et al. 2011), which means that after a threshold level positive effects diminish and negative outcomes appear.

Table 3.1 presents the econometric results for the first dependent variable (EDI-A3) whereas Table 3.2 for the second (EDI-A6). For each model we report the estimated coefficients, the t-statistic, the adjusted R^2 value of the regressions, and the number of observations. In all regressions, constant terms were included but the estimates are omitted here for simplicity.

As can be seen in Table 3.1, the first model includes several explanatory variables, all of which are statistically significant at or below the ten percent level. On these grounds our analysis confirms the findings of previous studies (see Section Two), that investment (measured by gross capital formation), FDI, population gravity (a measure of centrality and accessibility of each country),[6] life expectancy at birth, the number of personal computers and the impartiality/credibility of the legal system, all exert a positive impact on economic performance.

[6]Relatively high values of the index indicate countries with a more central place, while relatively low values indicate countries with a peripheral place in the world economic space.

Table 3.1 Determinants of knowledge-based economic growth, EDI-A3, 1990–2002

Variable	Model 1	
Gross capital formation	0.003	*4.193****
FDI, net inflows	0.026	*6.963****
Population gravity	6.39E-005	*6.911****
Life expectancy at birth	0.003	*4.542****
Personal computers	0.0001	*2.817****
Impartial courts	0.005	*1.574**
GDP per capita	5.59E-006	*3.429****
GDP per capita ^2	−2.23E-010	*−3.820****
Population density	0.0001	*2.172***
Population density ^2	−3.27E-008	*−1.838**
Regulation	0.043	*1.849**
Regulation ^2	−0.006	*−2.335***
Number of Observations	*46*	
Adjusted R^2	*0.48 (0.99)$^+$*	

*Significance at the 0.10 level
**Significance at the 0.05 level
***Significance at the 0.01 level
$^+$The statistic for adj. R^2 shown in the parenthesis is the weighted value

Table 3.2 Determinants of knowledge-based economic growth, EDI-A6, 1990–2002

Variable	Model 2	
Gross capital formation	0.003	*5.139****
FDI, net inflows	0.014	*5.078****
Population gravity	7.10E-005	*8.049****
Urbanization	0.001	*3.103****
Personal computers	0.000	*8.633****
Life expectancy at birth	0.001	*1.588**
Age dependency ratio	−0.077	*−2.369***
Trade (% of GDP)	0.002	*6.145****
Trade (% of GDP)^2	−1.74E-005	*−5.337****
Size of government	0.041	*5.247****
Size of government ^2	−0.004	*−5.084****
Legal system and property rights	0.056	*4.321****
Legal system and property rights ^2	−0.005	*−4.712****
Number of Observations	*64*	
Adjusted R^2	*0.46 (0.99)$^+$*	

*Significance at the 0.10 level
**Significance at the 0.05 level
***Significance at the 0.01 level
$^+$The statistic for adj. R^2 shown in the parenthesis is the weighted value

Moreover, the statistically significant coefficients of the nonlinear variables point out that initial economic conditions, agglomeration economies and economic regulation have a positive impact on EDI up to a critical level, beyond which adverse effects dominate. These critical levels are $12,533 of per capita GDP for initial conditions, 1,529 people per km^2 for agglomeration density and 3.6 out of 10 for degree of regulation.

Table 3.2 presents the regression results for the second dependent variable, EDI-A6. The model includes various explanatory variables, all of which are statistically significant at one percent level with the exception of the life expectancy at birth (significant at the ten percent level) and the age dependency ratio (significant at the five percent level). Investment (measured by gross capital formation), FDI net inflows, population gravity (a measure of centrality and accessibility), urbanisation (a proxy of tertiarisation of the economy), number of personal computers, and life expectancy at birth, all have a positive impact on EDI. On the other hand, age dependency ratio (that is, dependents to working-age population) is found to have a negative and significant effect on the dependent variable, implying that the reduction of working population reduces economic dynamism. All of these results are as expected and corroborate existing knowledge.

Moreover, some variables have been used in quadratic form. These are trade as a percentage of GDP (measuring openness), size of government, and legal system and property rights. The estimated coefficients suggest that beyond a certain level these factors start to have a negative impact on economic performance. This threshold level is 5.13 (out of 10) for the size of government, 114% of the GDP for trade (openness) and 5.6 (out of 10) for the legal system and property rights.

Conclusions

The current work builds upon previous research of the authors to explore the qualities of the knowledge-based economic dynamism. In particular, it develops econometric models in order to specify the determinants of knowledge-based economic growth at the international level. In doing so the study differs from typical studies of this sort in three ways. First, instead of measuring economic performance by the usual GDP growth, it employs a composite indicator of economic growth that accounts for the knowledge capacity and momentum of the economy. Second, all regressions are estimated using WLS analysis, allowing countries to have an influence that is analogous to their size. Third, it explores the existence of nonlinear relationships between explanatory variables and knowledge-based economic growth.

One of the key conclusions drawn is that there are a number of determinants such as: investment, FDI, accessibility (measured by population gravity), density, regulation, openness to trade, size of government and institutions, which are highly correlated with knowledge-based growth. This verifies previous studies arguing that variables such as investment and FDI are important determinants of growth, and highlights another point that geography, agglomerations and institutions also play a vital role and may constitute “fundamental determinants” of knowledge-based economic performance. Generally, this finding is in line with previous theoretical and empirical studies on the determinants of economic growth.

Furthermore, results indicated that the relationship between a few determinants, such as initial economic conditions, size of government, openness and institutions (proxied by economic regulation and legal system and property rights), and knowledge-based economic growth is, in essence, nonlinear. Up to a critical level, these factors have a positive impact on economic dynamism, whereas beyond that the effect diminishes and may become negative. Such a point has generally been ignored by the mainstream growth literature, and this might be the reason behind difficulties conventional research has encountered in establishing robust relationships between explanatory variables and economic performance.

From a policy perspective, these findings have some important implications. In order to stimulate and sustain knowledge-based economic growth, policy makers need to pay closer attention not only to traditional factors of economic growth favoured by the mainstream neoclassical school (e.g. investment) but to others factors, such as agglomeration and institutions, implied by less-conventional theoretical strands. All these factors are found to have a strong impact on economic performance.

This also emphasises the inadequacy of neoclassical theory in explaining growth dynamics and casts doubts on the policy (or, rather, no policy) suggestions it implies. We argue that the policy makers should not trust the ability of the market forces to generate spatially balanced growth; policy intervention is rather necessary.

Moreover, the evidence of nonlinearity for some factors (size of government, openness, institutions, etc.) raises doubts about the validity of relevant policies if applied without limits. Our results indicated that beyond a certain level, additional increases in these elements have negligible positive effects on the economy and may even have negative consequences.

Appendix

Table 3.3 Description and source of variables

Variable	Description	Source
Gross capital formation (% of GDP)	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements, plant, machinery, and equipment purchases, and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress" (It reflected the investments made)	World Bank
FDI, net inflows (% of GDP)		World Bank

(*continued*)

Table 3.3 (continued)

Variable	Description	Source
	Net inflows of Foreign Direct Investment in the reporting economy divided by the GDP	
Population gravity	It measures the degree of centrality and accessibility of each country in the global economic space. The gravity index is estimated according to the formula: $Gi = \Sigma(Pj/dij) + Pi$ where: Pi and Pj are the population (or market size) of the countries i and j and dij is the air-travel distance between the capitals of two countries i and j	Own elaboration, data are drawn from the World Bank
Life expectancy at birth	The number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life	World Bank
Personal computers (per 1,000 people)	Refers to self-contained computers designed to be used by a single individual	World Bank
Impartial courts	It assesses whether a trusted legal framework exists for private businesses to challenge the legality of government actions or regulation	Fraser Institute
GDP per capita (PPP, constant international dollars)	This is the real gross domestic product converted to international dollars using purchasing power parity rates	World Bank
Population density	The number of people per square kilometre (assesses the size of agglomeration economies)	World Bank
Regulation	This is a composite index (ranges from 0 to 10) that represents various aspects of economic regulation. It includes credit market regulations, labour market regulations and business regulations	Fraser Institute
Urbanization	Proportion of urban population in the total population (reflects the degree of tertiarisation of the economy)	World Bank
Age dependency ratio (% of working-age population)	The ratio of dependents (i.e. people younger than 15 or older than 64) to the working-age population (those aged between 15 and 64)	World Bank
Trade (% of GDP)	The sum of exports and imports of goods and services measured as a share of gross domestic product (assesses the degree of economic openness)	World Bank
Size of government	This is a composite index (ranges from 0 to 10) that includes general government consumption expenditures as a percentage of total consumption, transfers and subsidies as a percentage of GDP, government enterprises and	Fraser Institute

(*continued*)

Table 3.3 (continued)

Variable	Description	Source
	investment as a percentage of total investment, and top marginal tax rate (and income threshold to which it applies)	
Legal system and property rights	This is a composite index (ranged from 0 to 10) that includes judicial independence, impartial courts, protection of intellectual property, military interference in rule of law and the political process, and integrity of the legal system	Fraser Institute

Table 3.4 Descriptive statistics of Model 1 variables

Model 1 variables	Mean	Standard deviation	Min	Max
EDI-A3	0.1196	0.0365	0.0581	0.2806
Gross capital formation (% of GDP)	23.0929	5.2893	14.1589	37.0337
FDI, net inflows (% of GDP)	1.4945	1.7535	0	9.7185
Population gravity	96.5207	255.1096	0.3096	1,349.0301
Life expectancy at birth (years)	71.1499	5.4085	55.2285	79.0963
Personal computers (per 1000 people)	57.2112	66.9146	0.5365	253.2829
Impartial courts	6.2653	1.8336	2.9000	9.3500
GDP per capita (PPP, constant international $)	10,172.5584	9,838.6190	675.1660	32,317.8790
Population density (people per sq km)	208.4966	690.9285	2.2618	4,749.9998
Regulation	5.0776	1.2243	2.4732	6.8320

Table 3.5 Descriptive statistics of Model 2 variables

Model 2 variables	Mean	Standard deviation	Min	Max
EDI-A6	0.1379	0.0445	0.0526	0.2806
Gross capital formation (% of GDP)	23.2014	6.1595	13.5973	41.0422
FDI, net inflows (% of GDP)	1.3159	1.4237	−1.1545	7.4199
Population gravity	83.4087	219.0235	1.1012	1,349.0301
Urbanization (urban to total population)	65.4094	18.1342	15.0000	97.2000
Personal computers (per 1000 people)	43.8290	60.2611	0.3818	253.2829
Life expectancy at birth (years)	69.6842	6.7992	46.2916	79.0963
Age dependency ratio (% of working-age population)	0.6541	0.1720	0.4365	0.9997
Total trade (% of GDP)	61.2317	30.9513	14.9909	154.6453
Size of government	4.9778	1.5897	1.2374	8.3158
Legal system and property rights	6.4171	1.7765	2.8484	9.2783

Table 3.6 Sample of countries used

No	Model 1	Model 2
1	Argentina	Algeria
2	Australia	Argentina
3	Belgium	Australia
4	Bulgaria	Austria
5	Canada	Belgium
6	Chile	Bolivia
7	China	Bostwana
8	Colombia	Brazil
9	Czech	Bulgaria
10	Ecuador	Canada
11	Egypt	Chile
12	Finland	China
13	France	Colombia
14	Germany	Denmark
15	Hungary	Dominican Rep.
16	Iceland	Egypt
17	India	Finland
18	Indonesia	France
19	Israel	Germany
20	Italy	Ghana
21	Jamaica	Greece
22	Japan	Guatemala
23	Lithuania	Hungary
24	Morocco	India
25	Nepal	Indonesia
26	New Zealand	Iran
27	Nicaragua	Ireland
28	Norway	Israel
29	Philippines	Italy
30	Poland	Jamaica
31	Portugal	Japan
32	Romania	Jordan
33	Russia	Korea Rep
34	Singapore	Kuwait
35	South Africa	Malaysia
36	Spain	Mauritius
37	Sri Lanka	Mexico
38	Sweden	Morocco
39	Switzerland	Nepal
40	Trinidad and Tobago	Netherlands
41	Tunisia	New Zealand
42	Turkey	Nicaragua
43	Ukraine	Nigeria
44	United Kingdom	Norway
45	United States	Oman
46	Venezuela	Pakistan
47		Philippines
48		Poland
49		Portugal
50		Romania
51		Russia

(*continued*)

Table 3.6 (continued)

No	Model 1	Model 2
52		Senegal
53		South Africa
54		Spain
55		Sweden
56		Switzerland
57		Thailand
58		Trinidad and Tobago
59		Tunisia
60		Turkey
61		United Kingdom
62		United States
63		Venezuela
64		Zimbabwe

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Chapter 4
Critical Success Factors for a Knowledge-Based Economy: An Empirical Study into Background Factors of Economic Dynamism

Patricia van Hemert and Peter Nijkamp

Abstract During the past decade the notion of a knowledge-based economy has gained in popularity. The relationship between knowledge and economic growth is often studied in a conceptual and empirical context by addressing in particular the existence of correlations between factors of growth (on the basis of, for example, the new growth theory or endogenous growth theory). The present paper, however, takes an actor-oriented and more exploratory route to compare the knowledge-drivers in different regions. In our study, a sample of Dutch "knowledge experts" is used to identify the relative importance attached by these key-actors to the various factors that shape the force field of a knowledge-based economy, and their results are compared with those of a larger sample of European "knowledge-experts". The study in particular distinguishes between developed regions, developing regions, and semi-developed regions. Starting from the notions of mainstream growth theory, a factor analysis is carried out to trace the main determinants of growth. Empirical analysis shows that Dutch experts are of the opinion that economic dynamism is explained by increasing returns to scale and knowledge and business network effects, rather than by international free trade in a global economy. In particular, competitiveness is related to the location of industries and economies of agglomeration (i.e. linkages), whereby also social, cultural and institutional factors in the spatial economy play an important role. Furthermore, statistical regression and multivariate factor analysis show that Dutch experts are supportive of the notion that it is especially the interplay between knowledge development and institutional dynamics which shapes the economic landscape of a particular region. We, therefore, conclude that a more evolutionary view instead of the new trade theory or new economic geography may offer promising new insights.

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Introduction

Over the last two decades, the issue of economic growth has become a popular field of research. This has led to some interesting insights and results, yet the overall image of the processes underlying economic performance is still largely fragmented. There have recently been various attempts to provide a more integrated view of the issue, one being a European Commission Sixth Framework project called DYNREG, which stands for "Dynamic Regions in a Knowledge – Driven Global Economy: Lessons and Implications for the European Union".[1] The current research draws on the questionnaire survey that was addressed to various experts worldwide (academics, regional planners, policy makers and business people). In this paper, some of the general findings of this project are used, and applied to the case of the Netherlands. According to the DYNREG survey of the literature, two main theories that discuss the role of various factors in determining economic growth are dominant in the literature: the neoclassical growth model, based on Solow's growth model that especially emphasizes the importance of investment, and the theory of endogenous growth developed by Romer (1986) and Lucas (1988), which focuses on human capital and innovation capacity. Other theories that, inter alia, deserve mentioning here are Myrdal's cumulative causation theory, and the new economic geography school. In this paper, we will not go deeply into these different theories, but we will focus on some overall generalizations on the theoretical foundations that may explain the differences that exist in the field of research with regard to the issue of economic growth. In broad terms, it can be said that theories on economic growth seem to differ on the basis of three points: the factors that are regarded as key determinants of economic growth; the ways these factors are empirically weighed; and the extent to which long-run growth factors are taken into account. We will look into these differences in more detail in our study.

These more mainstream economic theories regard the economy as a static process, insofar as any notion of dynamics is limited to the unavoidable movement of an abstract economy, in abstract time, to some *ex ante* equilibrium state, regardless of where it started from. Evolutionary economics, however, which has emerged over the past two decades or so, rather seeks to understand how the real economy evolves through real time (see, for example Nelson and Winter 1982; Dosi et al. 1988; Hodgson 1993; Arthur et al. 1997; Foster 1997; Metcalfe 1998; Potts 2000; Fagerberg 2003; Dopfer 2004; Metcalfe and Foster 2004; Witt 2003, 2006). Here, the economy is a dynamic, irreversible and self-transformational system, and, as a result, innovation and knowledge are of central importance in evolutionary economics (Boschma and Martin 2007). This also influences the perspectives on how the broader economic landscape is shaped. According to the

[1]For a more detailed survey of the literature on economic growth, we refer to http://www.esri.ie/research/current_research_projects/dynreg/papers/. Here, the reader will find an overview of the papers published for the DYNREG project, and in particular the papers of Petrakos et al. (2007) and Artelanis et al. (2006), referred to later in Sect. 4.2.

ideas of evolutionary economics economic transformation proceeds differently in different places, and the mechanisms involved neither originate nor operate evenly across space. This is not a completely novel focus for economic geography; geographers have long been interested in uneven geographical development. Mainstream economics itself has also entered the geographers' disciplinary terrain in the form of a new spatial variant the "new economic geography" (see, e.g. Fujita et al. 1999; Brakman et al. 2001; Henderson 2005). According to Boschma and Martin (2007), given this opening up of the intellectual terrain of economic geography, the ideas of evolutionary economics certainly seem worth investigating. The findings of an on-line questionnaire[2] that was addressed to some 30 experts in the Netherlands in the areas of academia, innovation, regional development, public policy and business broadly underline this perspective. In the questionnaire the informed opinion of experts was asked about factors underlying the economic dynamism of regions and nations. By means of factor analysis, the results of two questions were selected for further analysis in order to be able to distinguish the variables that were regarded as most important for explaining economic dynamism. On the basis of these results, we aim to show that evolutionary economics can be useful for explaining economic dynamism, and may, in the long run, even prove valuable for improving interactions between business, policy and research, known as the triple-helix formations (Leydesdorff and Etzkowitz 1996).

Our article is structured as follows. After a brief overview of some of the most important growth theories from mainstream economics, we will introduce evolutionary economics as an alternative approach to explain competitiveness and knowledge creation at the aggregate levels of regions or nations. The theoretical part is followed by a discussion of the questionnaire itself and the main results. Hence, by means of the results of the factor analysis of Dutch experts' views on "theoretical backgrounds", "growth variables at different stages of development", and "opposite characteristics promoting economic dynamism", we aim to find support for the usefulness of the ideas of evolutionary economics for explaining economic dynamism and enhancing triple-helix interactions.

[2]This questionnaire is part of a larger research project entitled "Dynamic Regions in a Knowledge-Driven Global Economy: Lessons and Policy Implications for the EU (DYNREG)", a European Commission project funded from the Sixth Framework. The programme partners are as follows: University of Cambridge (United Kingdom), London School of Economics (United Kingdom), The Economic and Social Research Institute (Ireland), University of Bonn (Germany), University of Thessaly (Greece), VU University Amsterdam (The Netherlands), Free University Brussels (Belgium), University of Economics and Business Administration (Austria), University "Luigi Bocconi" (Italy), and University of Ljubljana (Slovenia). More information about the project is available at http://www.esri.ie/research/current_research_projects/dynreg/

Growth Theories from Mainstream Economics

In the Introduction, three main differences between theories on economic growth were highlighted: the factors that are regarded as key determinants of economic growth; the ways these factors are empirically weighed; and the extent to which long-run growth factors are taken into account. In this section, we will give an overview of the most important mainstream growth theories, especially with regard to the differences between these theories. Next, we will introduce the ideas of evolutionary economic geography as an alternative approach which appears to encompass many of the elements of mainstream economic growth theories.

First of all, using the above mentioned main theories of growth and competitiveness as a reference framework, each growth theory places emphasis on a set of different factors as key determinants of economic growth (Artelanis et al. 2006). In neoclassical growth theory, the rates of savings/investment (in the short run) are regarded as most important for the process of growth. Endogenous growth theories, on the other hand, highlight several "new" determinants of economic growth such as human capital and innovation activities. In a similar fashion, other perspectives have emphasized the significant role that other, non-economic, factors play in economic performance: institutional economics underlines the substantial role of institutions, and political science focuses its explanation on political determinants, both leading to a discussion that distinguishes between "proximate" and "fundamental" sources of growth. The first refers to issues such as accumulation of capital, labour and technology, while the latter to institutions, legal and political systems, socio-cultural factors, demography, and geography. Consequently, a wide range of economic, socio-cultural, political, demographical and institutional factors have been identified and proposed as possible determinants of economic performance in the literature. In the DYNREG project an attempt is being made to bring together these different factors as a first step towards developing a unifying theoretical model of economic growth. In Table 4.1, the main determinants of economic growth according to the DYNREG project are presented, together with their main literature sources [for a more extensive review of the literature, see Artelanis et al. (2006)]. The list of factors is by no means exhaustive, but since the interviews of the current study are based on these particular factors, we will limit ourselves to the set of factors listed in Table 4.1 below.

In the second place, theoretical developments have been accompanied by a growing number of empirical studies. Whereas research initially focused on issues of economic convergence/divergence, since this could provide a test of validity between the main growth theories (i.e. the neoclassical and the endogenous growth theory), eventually the focus shifted to factors determining economic growth. In this regard, one can think of seminal studies by Kormendi and Meguire (1985), Grier and Tullock (1989) and, especially, Barro (1991). This second "wave" of empirical studies has been facilitated by the development of larger and richer databases (such as the Penn World Tables – PWT) and more advanced statistical and econometric-techniques, which enabled the identification of determinants of economic growth

Table 4.1 Factor item classification and literature sources of mainstream economic theories

	Economic growth factors	Literature sources
1	Favourable geography (location, climate)	Gallup et al. (1999), Hall and Jones (1999), Rodrik et al. (2002), Easterly and Levine (2003)
2	Rich natural resources	Sachs and Warner (1997), Bloom and Sachs (1998), Masters and McMillan (2001), Armstrong and Read (2004), Rodrik et al. (2002), Easterly and Levine (2003)
3	Robust macro-economic management	Kormendi and Meguire (1985), Grier and Tullock (1989), Barro (1991, 1997), Fischer (1993), Easterly and Rebelo (1993), Barro and Sala-i-Martin (1995)
4	High degree of openness	Dollar (1992), Sachs and Warner (1995), Edwards (1998), Dollar and Kraay (2000), Levine and Renelt (1992), Rodriguez and Rodrik (1999), Vamvakidis (2002)
5	Specialization in knowledge and capital intensive sectors	Romer (1990), Grossman and Helpman (1991)
6	Free market economy (low state intervention)	Sachs and Warner (1995)
7	Low levels of public bureaucracy	Knack and Keefer (1995)
8	Stable political environment	Kormendi and Meguire (1985), Scully (1988), Grier and Tullock (1989), Lensink et al. (1999), Lensink (2001), Alesina et al. (1994), Brunetti (1997)
9	Capacity for collective action (political pluralism and participation, decentralization)	
10	High quality of human capital	Barro (1991), Mankiw et al. (1992), Barro and Sala-i-Martin (1995), Brunetti et al. (1998), Hanushek and Kimko (2000), Levine and Renelt (1992), Benhabib and Spiegel (1994), Topel (1999), Krueger and Lindahl (2001), Pritchett (2001)
11	Good infrastructure	
12	Significant Foreign Direct Investment	Borensztein et al. (1998), Hermes and Lensink (2000), Lensink and Morrissey (2006). See for investment more generally: Kormendi and Meguire (1985), De Long and Summers (1991), Levine and Renelt (1992), Mankiw et al. (1992), Auerbach et al. (1994), Barro and Sala-i-Martin (1995), Sala-i-Martin (1997), Easterly (1997), Bond et al. (2001), Podrecca and Carmeci (2001)
13	Secure formal institutions (legal system, property rights, tax system, finance system)	See for institutional framework: Lewis (1955), Ayres (1962), Knack and Keefer (1995), Mauro (1995), Hall and Jones (1999), Rodrik (1999, 2000), Acemoglu et al. 2002, Easterly (2001)
14	Strong informal institutions (culture, social relations, ethics, religion)	Granato et al. (1996), Huntington (1996), Temple and Johnson (1998), Landes (2000), Inglehart and Baker (2000), Zak and Knack

(*continued*)

Table 4.1 (continued)

	Economic growth factors	Literature sources
		(2001), Barro and McCleary (2003), Knack and Keefer (1997), Easterly and Levine (1997)
15	Capacity for adjustment (flexibility)	
16	Significant urban agglomerations (population and economic activities)	
17	Favourable demographic conditions (population size, synthesis and growth)	Kormendi and Meguire (1985), Dowrick (1994), Kelley and Schmidt (1995), Barro (1997), Bloom and Williamson (1998), Grier and Tullock (1989), Pritchett (2001)
18	High technology, innovation, R&D	Acs (2002), Aghion and Howitt (1992), Fagerberg (1987), Lichtenberg (1992), Ulku (2004)
19	Random factors (unpredictable shocks)	

Source: Petrakos et al. (2007)

with higher precision and confidence. An interesting comparison of these empirical growth studies is given by Temple (1999). He mentions in his study that, although certain, mainly technical, problems have become evident in the development of these techniques, it seems that as yet there are no better alternative analysis frameworks available, at least for comparative growth analysis. Because of the lack of a unifying theory on economic growth, however, different studies tend to draw on different theoretical frameworks and examine different factors that are taken from different sources. As a result, findings often tend to be contradictory, which makes drawing conclusions far from safe. A unifying theoretical model would be an ideal solution, but as times change often so does economic insight. Also, economic growth views often appear to be closely related to the political situation of a given moment, something that we will look into more detail at a later stage.

Thirdly, a gradual evolution is taking place in the way the main theories of economic growth view the process of growth, which is related to the discussion of "proximate" and "fundamental" sources of growth. Apparently, this has a large influence on how theories determine contextual long-term factors, i.e. the factors that do not necessarily determine growth as such, but that do influence the level and pace of growth. The starting point of conventional economic growth theorization is Solow's (1956) model. Here, savings or investment ratio are the most important determinants of economic growth, and technical progress is also important but exogenous to the economic system. Other important elements remain unexplored. As such, this model is rather static with convergence being absolute, moving towards a common steady-state when economies are homogeneous or conditional, or towards different steady-state positions in the case of heterogeneous economies. The endogenous growth theories, with Romer (1986) and Lucas (1988) as their main representatives, have taken another approach by proposing that the introduction of new accumulation factors, such as knowledge, innovation, etc., will induce self-maintained economic growth. As a result, and in contrast to their neoclassical counterparts, in endogenous growth theories policies are deemed to play a substantial role in advancing growth on a long-run basis. Here, convergence does not occur at all. This idea is shared by the growth theory of cumulative causation. “Cumulative causation”, in which initial conditions determine the economic growth of places in a self-sustained and incremental way, does not leave room for unconditional convergence as a result of the emergence of economic inequalities among economies. Eventually then, economic policy has to come into play to correct those imbalances. The new economic geography (NEG) also shares the idea of economic growth as an unbalanced process favouring the initially advantaged economies. Here, however, emphasis is not placed on the economic system per se, but rather on the economic actors within the economies. It is the actors who decide, and, consequently, NEG is mainly concerned with the location of economic activity, agglomeration, and specialization rather than with economic growth as such, which in the NEG context would be too abstract as an object of choice. Growth, however, is here the outcome of making the right choices and can be inferred from its models.

To date, knowledge diffusion from a geographical perspective is far from having reached general conclusions. The theory of localized knowledge spillovers (LKS), for example, originates from the analytical models in the new economic geography tradition, and focuses more closely on the regional clustering of innovative activities. In particular, it investigates the extent to which spillovers are local, rather than national or international in scope. The main results from this type of econometric study on LKS is that innovation inputs (from private R&D or university research) lead to a greater innovation output when they originate from local sources, i.e. from firms or public institutes that are located in the same region (Castellacci 2007). These ideas appear to be in sharp contrast with the emphasis on the international scope of spillovers that other econometric studies suggest, and again underline the evolutionary path of theoretical growth studies. We therefore believe that it is worth examining the scope for constructing an evolutionary economic geography. In the next section, we will discuss the distinguishing features of an evolutionary approach to economic geography.

An Evolutionary Perspective of Economic Dynamics

According to Boschma and Martin (2007), theories on economic evolution have to satisfy three basic requirements: they must be dynamic; they must deal with irreversible processes; and they must cover the generation and impact of novelty as the ultimate source of self-transformation. The third criterion is particularly crucial to any theory of economic evolution, dealing in particular with innovation and knowledge, whilst the first rules out any kind of statistical analysis, and the second all dynamic theories that describe stationary states or equilibrium movements, hereby distancing itself from mainstream economic theories. Evolutionary economics is also applied to the investigation of uneven geographical development. Here, its basic concern is the process of the dynamic transformation of the economic landscape, where it aims to demonstrate how place matters in determining the trajectory of evolution of the economic system (Rafiqui 2008). For this demonstration, concepts and metaphors from Darwinian evolutionary biology or complexity theory are employed, and innovation and knowledge in the spirit of Schumpeter are emphasized (Boschma and Lambooy 1999; Essletzbichler and Winther 1999; Boschma and Frenken 2006; Martin and Sunley 2006; Frenken 2007). In the light of our research, of special interest is the aim, central to evolutionary thinking, of linking the micro-economic behaviour of agents (firms, individuals) to the macro-outcomes of the economic landscape (as embodied in networks, clusters, agglomerations, etc.). Such a construction has the ability to combine individual growth factors that are seemingly unrelated into a coherent and organic whole, something that relates to the central aim of the DYNREG study. Let us now look at the link in more detail.

According to Maskell and Malmberg (2007), when investigating evolutionary processes of knowledge creation in a spatial setting, micro-level action provides particularly interesting insights. Particularly useful is the idea that learning from experience, by trial and error or repetition (Arrow 1962; Scribner 1986), which is now well-established in economic thinking, can lead to path-dependence and eventually stagnation or even lock-in (van Hayek 1960; Arthur 1994; Young 1993). In this respect, cognitive psychologists often speak of “bounded rationality”, which makes individuals concentrate their search on a restricted range of potential alternatives (March 1991; Ocasio 1997). Looking for answers close to already existing solutions while utilizing existing routines, is preferred. Local search is conditioned even in those situations where the costs of searching different paths or pursuing a more global strategy is more than balanced by the potential benefits of acquiring a broad variety of knowledge inputs (Tversky 1972; Jensen and Meckling 1976; Simon 1987). Maskell and Malmberg (2007) label this “functionally myopic behavior”, which also has an interesting corresponding spatial aspect (Levinthal and March 1993). Incorporating functional and/or spatial myopia as a basic behavioural assumption implies departing from mainstream economic conjectures of rationalization, global maximization and equilibria, because, overall, myopia implies disequilibrium and heterogeneity caused by the primarily local character of processes of interactive knowledge creation. In a local setting, each place is thus characterized by a certain information and communication ecology created by numerous face-to-face contacts among people and firms who congregate there (Grabher 2002). Gradually, these learning processes lead to spatial myopia, in the sense that they contribute to direct search processes into local, isomorphic paths (Levitt and March 1988).

On a macro-level, the economic system evolves as the decisions made in one period of time generate systematic alterations in the corresponding decisions for the succeeding period (Kirzner 1973), even without changes in the basic data of the market. Decisions are the product of knowledge here, and, consequently, the economic landscape is the product of knowledge, and the evolution of that landscape is shaped by changes in knowledge (Boschma 2004). Places, however, condition and constrain how knowledge and rules develop. Institutions, for example, provide incentives and constraints for new knowledge creation at the regional level, resulting in the selection and retention of regional development paths. In this way, institutions constitute the selection environment of localities or regions (Essletzbichler and Rigby 2007). Maskell and Malmberg (2007) believe that it is especially this interplay between processes of knowledge development and institutional dynamics that constitutes the core of evolutionary economic geography. What is still unclear, however, is how micro-level individuals who are constrained by durable institutions can initiate change and transformation, and why, on a macro-level, some regional economies are capable of adapting themselves despite firm-specific routines and region-specific institutional inertia, while other regions seem to lack such adaptability (Maskell and Malmberg 2007; Essletzbichler and Rigby 2007). According to evolutionary economic geography, this is where the performance of national systems, in the form of specialization patterns, productivity dynamics and trade performance, and a broad range of other country-specific factors, of a social, cultural and environmental nature come into play (Castellacci 2008).

In evolutionary economics the economic landscape is seen as the product and the source of knowledge. This is a relatively new conception that has hardly been articulated (Boschma 2004). This articulation is a complicated task, not least because evolutionary economics views spatial structures as the outcomes of historical processes, and as conditioning and constraining micro-economic behaviour. Historical time series data on individuals, firms, industries, technologies, sectors, networks, cities, regions, and so on, are not always easy to obtain or construct. A specific focus on cluster formation can in this respect be helpful. Clustering is considered a particularly important aspect for technologically advanced industries, and in many cases constitutes a major engine of growth and a competitive branch of the system of innovation (Breschi and Malerba 1997). Here, the sector-specific nature of the cluster determines the regional design: firms in science-based sectors generally have a preference for the availability of public sources of technological opportunities and close university–industry links, while specialized suppliers and scale-intensive firms require geographical proximity because of the highly tacit nature of the knowledge base (Asheim and Coenen 2005). Clusters are further considered to follow an evolutionary path, where stages of infancy are succeeded by a growth phase, followed in turn by increasing maturity and subsequent stages of stagnation or decline. A recent body of literature within evolutionary economics emphasizes the relevance of clustering in space and investigates the factors that may explain these spatial patterns. According to Asheim and Gertler (2005), three main factors are considered to determine clustering: *the tacitness of the knowledge base*, i.e. the localized and embedded nature of learning and innovation; *public sources of technological opportunities* in the form of the availability of public facilities and infrastructure (e.g. R&D labs, universities, technical schools); and *a mechanism of regional cumulativeness*, i.e. the fact that successful regions are better able to attract advanced resources leading to further technological and economic success in the future.

The aim of our paper is to investigate whether and how evolutionary economics analyses – with a clear actor-orientation –shape the economic landscape, and are shaped by the emergence and diffusion of knowledge and new economic activities, and to what extent these ideas correspond with the prevailing experts' views in Europe and the Netherlands. By means of the interview results of the DYNREG project, we gain insight into European experts' views on economic dynamism and the factors which influence growth. Overall, the results of the different partner countries largely correspond with those of the Netherlands. In this respect, particularly interesting is the highest score for the new geography models as theoretical framework that best explains economic dynamism, and this leads us to believe that the question of economic dynamism is also worth pursuing from an evolutionary perspective. To recognize underlying theoretical constructs between the variables, a factor analysis of the Dutch results is applied here. With the help of these constructs we aim to determine the similarities between the theoretical notions of evolutionary economics.

Dutch Expert Views on Knowledge Drivers

The goal of the questionnaire was to explore experts' views on the factors underlying economic dynamism in countries at different levels of economic development. Economic dynamism, in this research, refers to the potential an area has for generating and maintaining high rates of economic performance. In the Netherlands, during the second half of 2006, a group of 30 experts filled in an on-line questionnaire, which, in its complete form, consists of five parts. The first part of the questionnaire provides instructions and definitions. The second part aims to make experts verify five wider regions in the world, from the 20 specified, that are expected to exhibit economic dynamism in the next 15 years. The third part assesses which factors are regarded as important for economic dynamism utilizing Likert-type questions. The fourth part evaluates the available theoretical backgrounds and research methods in terms of their ability to adequately explain economic dynamism at a given spatial level. The final part of the questionnaire then gathers socio-economic information about the respondents, such as age, gender, education and country of residence.

Besides some general information from the final part of the questionnaire, in this paper only the results of two questions (dealing with "growth variables at different stages of development" and "opposite characteristics promoting economic dynamism") of the third part of the questionnaire were used for further analytical research, since because of their Likert-type form, these were the questions that were suitable for further statistical economic analysis. Furthermore, although the DYNREG project has yielded 313 properly completed responses in nine different countries, in this paper only the results of the questionnaires conducted in the Netherlands have been analysed. A factor analysis is used because, in the first question on "growth variables at different stages of development", various experts were asked their opinion on the extent to which 19 variables influence economic dynamism in countries, while, in the second question on "opposite characteristics promoting economic dynamism", 11 variables or characteristics were used to explore which combination of opposite characteristics promotes economic dynamism. Since factor analysis is exploratory by nature, used by researchers with different disciplinary backgrounds and used as a tool to reduce a large set of mutually correlated variables to a more meaningful, smaller set of independent variables, this method is especially suited for our study. Factors generated in this statistical tool are thought to be representative of the underlying mechanisms that have created the correlations among variables. In this particular case, factor analysis was used to give further insight into what variables that influence economic dynamism will correlate with factors that may actually provide insight into the ways experts in the Netherlands think about economic dynamism in their own country as compared with countries that have other levels of development, and whether and how this may explain something about the Netherlands' economic situation in general.

It is appropriate to be more specific about the term "experts" used in this research. According to Petrakos et al. (2007), experts should be "knowledgeable" individuals, i.e. academics, high ranked officials of local authorities, and high-ranking business people, who, because of their position, should have an "informed perspective or represent different viewpoints concerning regional economic dynamism". Before we turn to the results and interpretation of our factor analysis, we will give some information about the composition of the respondents of our questionnaire. Half of the respondents in our sample (i.e. 15 respondents) were working in the private sector, the other half consisted mainly of experts from the public sector (i.e. 13 respondents), and only two respondents came from academia. When we look at the results of the overall DYNREG interviews, a majority of the respondents opted for the new economic geography model as the theoretical framework that best explains economic dynamism, followed by neoclassical theory, and institutional economics (see Table 4.2). However, the overall results for all DYNREG partner countries show different outcomes when responses are analysed according to the occupation of the person who replied. People in the public sector highlighted the importance of endogenous growth theories, followed by the new economic geography models and the supply-side models, while private sector experts preferred the demand management models, downrating the new economic

Table 4.2 Theoretical backgrounds explaining economic dynamism at any spatial level – overall score DYNREG

Rank	Theoretical backgrounds	Average score	1st choice (%)
1	New trade theories/New Economic Geography	3.14	23.39
2	Rational expectations/neoclassical	3.22	22.71
3	Institutional economics	4.00	16.10
4	Demand management models	4.03	9.36
5	Supply-side models	4.20	12.66
6	Endogenous growth	4.33	12.99
7	Path dependence/cumulative causation	4.66	9.58

Source: Petrakos et al. (2007)

geography models. Academics, further, opted for cumulative causation theories, followed by the endogenous growth and the new economic geography theories (Petrakos et al. 2007). As a result, the degree of differentiation is quite high, indicating that there is a different understanding of the main functions of the economy among the three groups. Theoretical paradigms which are highly popular in academia appear of less interest for people working in the private sector. In addition, pro-active models tend to be appreciated more than market-driven models.

The results for the Netherlands show a similar picture. Overall, the new economic geography model is preferred, followed by the neoclassical model (see Table 4.3). Although generalizations are difficult to make because of a lack of understanding of the background of the different perceptions of the main functions of the economy among the three groups, overall, pro-active models tend to be appreciated more than market-driven models (Tables 4.4 and 4.5) (the two academics chose the supply-side model and the endogenous growth model). Further, the Dutch experts from the private sector tend to rate pro-active models slightly higher than do experts from the public sector. Nevertheless, the responses analysed according to the occupation of the person who replied show more or less the same pattern for the Netherlands. Experts from both the public and the private sector prefer the new trade theories and new economic geography model. Economic dynamism, according to these experts, is explained by increasing returns to scale and the network effect, rather than by international free trade. In particular, competitiveness is related to the location of industries and economies of agglomeration (i.e. linkages), whereby social, cultural and institutional factors in the spatial

Table 4.3 Theoretical backgrounds explaining economic dynamism at any spatial level – overall score for the Netherlands

Rank	Theoretical backgrounds	Average score	1st choice (%)
1	New trade theories/New Economic Geography	3.13	39.1
2	Rational expectations/neoclassical	3.75	16.7
3	Demand management models	3.68	16.0
4	Path dependence/cumulative causation	4.17	12.5
5	Institutional economics	4.16	8.3
6	Supply-side models	4.71	8.0
7	Endogenous growth	4.28	4.0

Source: Petrakos et al. (2007)

Table 4.4 Theoretical backgrounds explaining economic dynamism at any spatial level – Public sector

Theoretical backgrounds	1st choice (%)
New trade theories/New Economic Geography	33.3
Rational expectations/neoclassical	22.2
Demand management models	22.2
Supply-side models	11.1
Path dependence/cumulative causation	11.1
Institutional economics	0
Endogenous growth	0

Source: Petrakos et al. (2007)

Table 4.5 Theoretical backgrounds explaining economic dynamism at any spatial level – Private sector

Theoretical backgrounds	1st choice (%)
New trade theories/New Economic Geography	46.2
Rational expectations/neoclassical	15.4
Institutional economics	15.4
Path dependence/cumulative causation	15.4
Supply-side models	7.1
Demand management models	7.1
Endogenous growth	0

Source: Petrakos et al. (2007)

economy are also taken into account. We find this an interesting conclusion, not least because it implies the need for a more holistic approach of the economic problem. According to Coe and Wai-Chung Yeung (2007), the economists' approach has four main drawbacks that economic geographers try to avoid: universalism; economic rationality; competition and equilibrium; and economic process-thinking. Universalism represents the economic concept that one set of financial remedies will work in every situation without taking factors such as space, place, and scale into consideration. Secondly, economic rationality stands for the thought that the most probable cause of a problem is in fact the source of the problem. The third drawback is economists assuming that competition and equilibrium (i.e. capitalism) are the best economic approach for any economic problem or economic phenomena that may be analysed. Fourthly, economists think in terms of processes based on certain laws and principles in the field of economics. Economic geographers, in contrast, use expertise from many fields in order to determine the underlying causes of an economic problem holistically. Furthermore, an evolutionary perspective opens up a new way of thinking about what is arguably the central concern of economic geographers, i.e. uneven geographical development, but additionally it also offers the opportunity to engage with a range of novel concepts and theoretical ideas drawn from a different body of economics than economic geographers have used so far. Taking into account the experts' interest in this line of economic thinking leads us to believe that the ideas of evolutionary economics on uneven geographical development are certainly worth investigating.

In this paper, we therefore focus especially on evolutionary economic geography, which seeks to apply the core concepts from evolutionary economics to explain uneven geographical development (see, for example, Boschma and van der Knaap 1997; Rigby and Essletzbichler 1997; Storper 1997; Cooke and Morgan 1998; Boschma and Lambooy 1999; Essletzbichler and Winther 1999; Martin 2000; Essletzbichler and Rigby 2004; Hassink 2005; Boschma and Frenken 2006; Iammarino and McCann 2006; Martin and Sunley 2006; Frenken 2007). At the moment, there is no single, coherent body of theory that defines evolutionary economics. In this paper, therefore, we focus especially on four mechanisms derived from the literature with which evolutionary economic geography is broadly considered to be concerned: the spatialities of economic novelty (innovations, new firms, new industries); how the spatial structures of the economy emerge from the micro-behaviour of economic agents (individuals, firms, institutions); how in the absence of central coordination or direction, the economic landscape exhibits self-organization; and with how the processes of path creation and path dependence interact to shape geographies of economic development and transformation, and why and how such processes are themselves place dependent (Martin and Sunley 2006, in Boschma and Martin 2007). In the next section, we will conduct a factor analysis to gain insight into exactly what set of factors are considered important at different stages of economic development according to the Dutch experts. These sets are then analysed on the basis of the four evolutionary mechanisms. In this way, we hope to find support for the added value of the inclusion of an evolutionary approach in the dynamic growth discussion, and, at the same time, set some boundaries for further research in this direction.

An Empirical Analysis by Means of Factor Analysis

Growth Variables at Different Stages of Development

As mentioned before, two questions of the questionnaire have been used for our factor analysis. The first of these questions is formulated as follows:

> Please evaluate on a scale of 0 to 10 the degree of influence of the following factors on the economic dynamism of countries. Please give a zero (0) when a factor has no influence and a ten (10) when there is a very strong influence. Please fill in all columns for each factor.

The respondents were asked to evaluate a set of 19 factors represented in Table 4.6 for countries in three distinctive stages of development (i.e. developed countries, countries of intermediate development, and developing countries), as well as for their own country, i.e. in this case, the Netherlands. The idea here was to find out whether the existence of three distinct stages of growth was supported by

Table 4.6 The top five degree of influence of specific factors on the economic dynamism of countries for all partner countries in the DYNREG project

	Developed countries		Countries of intermediate development		Developing countries	
1	High technology, innovation, R&D	7.9	Stable political environment	6.8	Stable political environment	7.0
2	High quality of human capital	7.8	Secure formal institutions	6.8	Significant FDI	6.9
3	Specialization in knowledge and capital intensive sectors	7.4	High quality of human capital	6.7	Secure formal institutions	6.7
4	Good infrastructure	7.1	High degree of openness	6.7	Rich natural resources	6.5
5	High degree of openness (networks, links)	7.1	Good infrastructure	6.7	High degree of openness	6.3

Source: Petrakos et al. (2007)

the experts interviewed, by looking at the kind of variables they would consider of importance for countries at different stages of economic growth. In our study, the focus will be on the results of the Netherlands and developed countries.

Before we turn to the results of the factor analysis, it might be interesting to look at the overall results of the above question for all the partner countries together (Table 4.6), and for the Netherlands (Table 4.7) in more detail. According to Petrakos et al. (2007), the five variables that are regarded as overall most influential for the developed countries are ranked as follows (the numbers in the parentheses indicate their score out of 10): high technology, innovation and R&D (7.9); high quality of human capital (7.8); specialization in knowledge and capital intensive sectors (7.4); good infrastructure (7.1); and high degree of openness (7.1). For intermediate countries, Petrakos et al. (2007) found the following average score for the first five variables: stable political environment (6.8); secure formal institutions (6.8); high quality of human capital (6.7); high degree of openness (6.7); and good infrastructure (6.7) (see Table 4.6). The variables that are regarded as the most influential for the developing countries are then ranked as follows: stable political environment (7.0), significant FDI (6.9), secure formal institutions (6.7), rich natural resources (6.5), and high degree of openness (6.3).

The Dutch respondents (see Table 4.7) marked high quality of human capital (8.5) and stable political environment (8.5) as most important for economic growth in developed countries, followed by good infrastructure (8.2), secure formal institutions (7.9), specialization in knowledge and capital intensive sectors (7.9), and high degree of openness (7.9). When we compare this outcome with the results of

Table 4.7 Overview of the top five of highest growth variables recognized by Dutch respondents in the different developmental stages of growth

	Developed countries		Countries of intermediate development		Developing countries		The Netherlands	
1	High quality of human capital; and stable political environment	8.5	Secure formal institutions	8.0	Significant FDI	7.7	High degree of openness	8.5
2	Good infrastructure	8.2	Stable political environment	7.8	Rich natural resources	7.6	Good infrastructure	8.4
3	Secure formal institutions	7.9	Good infrastructure	7.4	Stable political environment	7.5	High quality of human capital	8.4
4	Specialization in knowledge and capital intensive sectors	7.9	Robust macroeconomic management	7.3	Secure formal institutions	7.5	Secure formal institutions	8.1
5	High degree of openness	7.9	High degree of openness	7.2	Low levels of public bureaucracy	7.3	High technology, innovation, R&D; spec. in knowledge and capital intensive sectors	8.0

Petrakos et al. (Table 4.6), surprisingly the variable "high technology, innovation and R&D" is missing in the Dutch top-five list. Instead, the variables "stable political environment" and "secure formal institutions" score very highly. Only for the Netherlands does the variable "high technology, innovation and R&D" appear in the top-five list. For countries of intermediate development, in the Netherlands, "robust macroeconomic management" further scores higher than "high quality of human capital" in the overall results, and developing countries need "low levels of public bureaucracy" more according to the Dutch respondents than "high degree of openness".

Factor Analysis Results

It should be noted that correlation coefficients tend to be less reliable when estimated from small sample sizes. In this case, the sample size was 30, which is not very large. In general, it is a minimum requirement to have at least five cases for each observed variable. However, normality and linearity is ensured, so that correlation coefficients are generated from appropriate data, meeting the assumptions necessary for the use of the general linear model. Univariate and multivariate outliers have been screened out because of their heavy influence on the calculation of correlation coefficients, which in turn has a strong influence on the calculation of factors. In factor analysis, singularity and multicollinearity are a problem. Accidental singular or multicollinear variables have therefore also been deleted. As such, our results may be assumed to be valid. The goal of the factor analysis is to find out whether there are significant correlations between the variables and if there are clearly recognizable underlying theoretical constructs coming to the surface that show resemblance to the constructs of evolutionary economic geography. Our factor analysis based on 19 variables (see Table 4.8) for the Netherlands shows that 37% of the common variance shared by the 19 variables can be explained by the first factor (see Table 4.8, "proportion" column). A further 14% of the common variance is explained by the second factor, bringing the cumulative proportion of the common variance explained to 51%.

Only one variable that is considered to be influencing the economic dynamism of countries loads onto Factor 1 with a cut-off value for the correlation between the indicator and this factor of 0.55 (see Table 4.9, the variables that scored $>$ 0.50 in the Factor 1 column). Considering the nature of this variable, Factor 1 reflects

Table 4.8 Factor analysis results: the Netherlands

Factor	Eigenvalue[a]	Proportion	Cumulative proportions
1	4.40	0.37	0.37
2	1.68	0.14	0.51

[a]Eigenvalue: an eigenvalue is the variance of the factor. In the initial factor solution, the first factor will account for the most variance, the second will account for the next highest amount of variance, and so on

Table 4.9 Factor Loadings: the Netherlands

Items		Factor 1	Factor 2
4	High degree of openness (networks, links)	0.85	−0.07
5	Specialization in knowledge and capital intensive sectors	0.37	−0.08
7	Low levels of public bureaucracy	−0.09	0.71
9	Capacity for collective action (political pluralism and participation, decentralization)	0.22	−0.10
10	High quality of human capital	0.50	0.29
12	Significant Foreign Direct Investment	−0.11	0.08
13	Secure formal institutions (legal system, property rights, tax system, finance system)	0.04	−0.00
14	Strong informal institutions (culture, social relations, ethics, religion)	0.32	0.05
15	Capacity for adjustment (flexibility)	0.35	0.56
16	Significant urban agglomerations (population and economic activities)	0.46	0.25
17	Favourable demographic conditions (population size, synthesis and growth)	0.16	0.87
18	High technology, innovation, R&D	−0.21	0.72

Extraction method: principal axis factoring
Rotation method: Oblimin with Kaiser normalization

Table 4.10 Factor analysis results: developed countries

Factor	Eigenvalue[a]	Proportion	Cumulative proportions
1	5.53	0.43	0.43
2	1.67	0.13	0.55

[a]Eigenvalue: an eigenvalue is the variance of the factor. In the initial factor solution, the first factor will account for the most variance, the second will account for the next highest amount of variance, and so on

"spatial structures of the economy", especially when one considers the variables "high quality of human capital (0.50)" and "significant urban agglomerations (0.46)" that come closest to the cut-off value of 0.55. "High degree of openness" has a value of 0.85, which is relatively high. Further, there are four variables that load onto Factor 2 (see Table 4.9, the variables that scored > 0.50 in the Factor 2 column). Factor 2 mostly appear to reflect "institutional flexibility": besides "low levels of public bureaucracy", "capacity for adjustment" and "favourable demographic conditions", the variable "high technology, innovation, and R&D" comes to the surface, with a value of 0.72. However, as part of Factor 2 "high technology, innovation and R&D" only has a shared value of 14% (see Table 4.8), which is not particularly influential for the explanation of the common variance.

Table 4.10 shows that also for developed countries two factors stand out, of which 43% of the common variance can be explained by the first factor and 13% by the second one, bringing the cumulative proportion of the common variance explained to 55%.

Looking at Factors 1 and 2 in more detail we see that three of the variables load onto Factor 1, using again a cut-off value of 0.55 (see Table 4.11, the variables that scored > 0.50 in the Factor 1 column). Considering the nature of these variables, here too they appear to reflect “spatial structures of the economy”, which is similar to Factor 1 of the Netherlands. Both factors imply a kind of micro-behaviour of economic agents (individuals, firms, institutions), either by means of networking and links in the case of the Netherlands or rather through collective action (0.81), FDI (0.66) or informal institutions (0.69) for developed countries. In Table 4.11, we further see that two variables load onto Factor 2 for developed countries, reflecting “stable political environment” and “secure formal institutions”. In this case, similar to the Factor 2 outcomes for the Netherlands, a form of institutional quality is required.

It should be noted here that in the case of developed countries, several variables, such as “high technology, innovation, and R&D”, were already screened out via “measure of sampling adequacy (MSA)”, because they did not correlate sufficiently with the other variables. In order for factor analysis to have a good outcome, the MSA is supposed to be >0.6, but it was only 0.4.

For developing countries and countries of intermediate development, robust macroeconomic management and infrastructure are regarded as important building blocks, together with a stable political environment, secure formal institutions, high quality of human capital, specialization in knowledge and capital intensive sectors, and capacity for collective action for developing countries, and a high degree of openness and a favourable geography for countries of intermediate development (see Tables 4.12 and 4.13). Factor 1 of both developing countries and countries of intermediate development, then, represents “specialization of economic novelty”, because they focus on the development of knowledge, solid institutions, and new industries in order to stimulate innovations.

Table 4.11 Factor Loadings: Developed Countries

Items		Factor 1	Factor 2
2	Rich natural resources	−0.05	0.14
6	Free market economy (low state intervention)	−0.07	−0.01
7	Low levels of public bureaucracy	0.15	0.11
8	Stable political environment	0.29	0.58
9	Capacity for collective action (political pluralism and participation, decentralization)	0.81	−0.07
10	High quality of human capital	0.37	−0.08
11	Good infrastructure	−0.08	0.20
12	Significant Foreign Direct Investment	0.66	0.18
13	Secure formal institutions (legal system, property rights, tax system, finance system)	0.18	0.78
14	Strong informal institutions (culture, social relations, ethics, religion)	0.69	0.14
15	Capacity for adjustment (flexibility)	0.51	−0.11
16	Significant urban agglomerations (population and economic activities)	0.40	−0.37
17	Favourable demographic conditions (population size, synthesis and growth)	0.27	−0.33

Extraction method: principal axis factoring
Rotation method: Oblimin with Kaiser normalization

Table 4.12 Factor Loadings: Countries of Intermediate Development

Items		Factor 1	Factor 2
1	Favourable geography (location, climate)	0.65	0.18
	Rich natural resources	0.19	0.67
3	Robust macroeconomic management	0.60	0.08
4	High degree of openness	0.77	−0.45
6	Free-market economy	0.05	0.10
11	Good infrastructure	0.64	0.12

Extraction method: principal axis factoring
Rotation method: Oblimin with Kaiser normalization

Table 4.13 Factor loadings: developing countries

Items		Factor 1	Factor 2
3	Robust macroeconomic management	0.72	0.23
4	High degree of openness	0.12	0.18
5	Specialization in knowledge and capital intensive sectors	0.63	−0.11
6	Free-market economy (low state intervention)	0.34	0.36
7	Low levels of public bureaucracy	0.11	0.15
8	Stable political environment	0.76	0.27
9	Capacity for collective action (political pluralism and participation, decentralization)	0.65	0.37
10	High quality of human capital	0.86	−0.30
11	Good infrastructure	0.57	−0.08
12	Significant Foreign Direct Investment	0.04	0.67
13	Secure formal institutions (legal system, property rights, tax system, finance system)	0.64	0.34
15	Capacity for adjustment (flexibility)	−0.06	0.75
18	High technology, innovation, R&D	0.41	0.14

Extraction method: principal axis factoring
Rotation method: Oblimin with Kaiser normalization

Opposite Characteristics Promoting Economic Dynamism

The second issue in the questionnaire used for our comparative analysis is the question on "opposite characteristics", which is formulated in the following manner:

> Please indicate which combination of opposite characteristics promotes economic dynamism. Please put a mark in the appropriate box (see below). For example, the following answer indicates that economic dynamism is promoted with a mix of 30% variable A and 70% of variable B.

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%	
A				x								B

The Dutch respondents overall had a preference for the 50–50% option. Further, they chose market forces over public policies with 70–30%, an open economy was preferred over a closed economy with 90–10%, and social cohesion was considered more important than social inequality with 70–30% (see Table 4.15 for combinations of opposite characteristics that were used). In the light of the results of the factor analyses in Sect. 5.5, especially the 70–30% score of market forces over public policies is interesting, because it further explains the preferences of the experts for an institutional role in dynamic growth. In the above results, the institutional aspect is highlighted, but its role in the economic process should rather be diminished than enlarged.

Here again, the goal of the factor analysis is to find out whether there are significant correlations between the variables, and if there are clearly recognizable underlying theoretical constructs coming to the surface. With regard to the "opposite characteristics promoting economic growth", we are especially curious to find whether or not there are indeed significant combinations of opposite characteristics that promote economic dynamism that correlate, and if they support the theoretical constructs found in the factor analysis of "growth variables". The factor analysis based on 11 variables, each consisting of two opposite characteristics/variables shows that 56% of the common variance shared by the 11 variables can be explained by the first factor (see Table 4.14, "proportion" column). A further 26% of the common variance is explained by the second factor, bringing the cumulative proportion of the common variance explained to 82%, which is considerable.

Two of the variables that are considered to be influencing the economic dynamism of countries load onto Factor 1 with a cut-off value for the correlation between the indicator and this factor of 0.55 (see Table 4.15, the variables that scored > 0.50 in the Factor 1 column). Considering the nature of these variables, Factor 1 reflects "coordinated self-organization". "Closed economy versus open economy", is the variable with the highest score in Factor 1, with a value of 0.90. One variable loads onto Factor 2: namely, the variable "metropolitan dominance versus polycentric urban system" (see Table 4.15, variables that scored > 0.50 in the Factor 2 column). Factor 2, then, reflects "path creation and dependence", with value of 0.87. Although, the factor analysis cannot say much about which exact combination of opposite characteristics promotes economic dynamism, the results do show a clear pattern.

Table 4.14 Factor analysis results: combination of opposite characteristics promoting economic dynamism

Factor	Eigenvalue[a]	Proportion	Cumulative proportions
1	2.26	0.56	0.56
2	1.03	0.26	0.82

[a]Eigenvalue: an eigenvalue is the variance of the factor. In the initial factor solution, the first factor will account for the most variance, the second will account for the next highest amount of variance, and so on

Table 4.15 Factor loadings: combination of opposite characteristics promoting economic dynamism

Items		Factor 1	Factor 2
1	Public policies vs. market forces	0.67	−0.51
2	Discretionary policies vs. persistent policies		
3	Closed economy vs. open economy	0.64	−0.29
4	Endogenous qualities vs. exogenous forces		
5	Competition vs. Cooperation		
6	Flexibility vs. stability	−0.72	−0.20
7	Informal arrangements vs. formal institutions		
8	Sectoral diversity vs. specialization		
9	Public sector decentralization vs. public sector centralization		
10	Metropolitan dominance vs. polycentric urban system	0.03	0.71
11	Social inequality vs. social cohesion		

Extraction method: principal axis factoring
Rotation method: Oblimin with Kaiser normalization

Overall, respondents seem supportive of the mechanisms of evolutionary economic geography, i.e. the “spatialities of economic novelty”, the spatial structures of the economy, the (coordinated) self-organization of the economic landscape, and path creation and dependence. In this respect, institutions are an important contribution, because they provide incentives and constraints at the regional level. Their role, especially for developed countries, should, however, be limited and, above all, flexible. This is in line with the ideas of Setterfield (1993, 1995, 1997) that institutions and the economy co-evolve in an interdependent way, with different short-run and long-run consequences. In the short-run, in this study represented by developing countries, institutions can be assumed to be “exogenous” to the economic system, in the sense of displaying some degree of stability, thus providing an environment that frames current economic activity. In the longer run, i.e. the intermediate and especially the developed stage, the institutional structure itself must be considered to be “endogenous”, and open to feedback effects from the changes in the economy, changes that are in part influenced by the institutional framework. In this respect, Martin and Sunley (2006) speak of the path-dependence of institutional changes, which are not necessarily efficient and may even cause “lock-in” for a considerable time. Lock-in, then, does not necessarily have to be negative. Positive lock-in, i.e. the phase of growth and success, may last for decades, but overall will eventually lose its former growth dynamic and enter a phase of negative lock-in and decline. When we further take into account the three types of lock-in as identified by Grabher (1993): namely, functional (based on firm relations); cognitive (consisting of a common world-view); and political (the institutional structure), we cannot escape the notion put forward by Best (2001) that the ongoing, self-organizing activities of inhabitants for a large part revitalize or hamper the region’s technological capability. Our results support such a view, in the sense that experts put relatively great stress on factors such as: high quality of human capital; networks, links, collective action and informal institutions; high technology, innovation and R&D; and political and institutional environment.

Implications

Pavitt (2005) has already highlighted that technological innovation is increasingly based on specialized and complex knowledge specific to particular sectors, resulting in generic capability that lies predominantly in the coordination and integration of specialized knowledge and learning under conditions of uncertainty. Our results show that, in line with the ideas of evolutionary economic geography, experts, in general, believe that learning, agglomeration, and interrelatedness are key to the development of the economy in general and to the economic development of specific places and regions more particularly, and can invoke positive or negative lock-in. This puts considerable emphasis on the importance of research institutions and human capital, and the ability of regions to retain skilled and educated labour. Glaeser (2005), for example, connects the city of Boston's long-run ability to reinvent itself economically to the presence of residents who were attracted to work in Boston for reasons other than high wages. Together with the results of several influential accounts that have argued that regional economies with network-based production systems possess greater adaptability (Grabher 1993; Saxenian 1996), in particular human capital and learning are considered key for greater economic dynamism. In this respect, formal and informal institutions, social arrangements and cultural forms are considered to be self-reproducing over time, in part through the very system of socio-economic action they engender and serve to support and stabilize. Institutions inherit a legacy from their past, and, as a result, institutions and the economy co-evolve. Institutions have a role in shaping paths, and the way paths are shaped depends on their past. This also has its effect on knowledge creation in a region, because knowledge creation is improved by learning, in which process knowledge institutions like universities play an important role. When we further consider that institutions, both formal and informal (such as routines, conventions and traditions) change slowly over time, then also for such institutions, path dependence can lead to negative lock-in. North (1990) and Setterfield (1993, 1995, 1997) underline that some institutional structures that emerge may not be the most efficient.

According to Martin and Sunley (2006) the focus on the role of localized learning and knowledge spillovers in the development of regional innovation systems has been a major spur to the importation of path dependence ideas into economic geography in the past decade or so. The associated emphasis on the local socio-cultural embeddedness of economic activity, and, in line with this, the emergence and development of local institutional forms has further contributed to this trend. Our factor analysis shows that Dutch experts largely support the idea of regional agglomerations with absorptive capacity that can be enhanced by learning processes. Further, our factor analysis also points to the undeniable presence of institutions that provide incentives and constraints for new knowledge creation at the regional level. In this respect, the experts seem to underline the core of evolutionary economic geography according to Maskell and Malmberg (2007), i.e. the interplay between processes of knowledge development and institutional dynamics. However, learning does not necessarily have to be growth-enhancing. In our Introduction, we already highlighted the strong path-dependency of learning activity, leading to myopic behaviour and lock-in. This implies that there are different types of learning with some types being more reflective (see Visser and Boschma 2004). We believe that research into different types of learning and the conditions for their existence will be particularly useful for explaining regional economic dynamism. In this connection, Martin and Sunley (2006) already mentioned that actor's involvement in different forms of regional and extra-regional social networks may clearly shape the nature of the learning process and hence their capability to initiate new paths. Further, the distinctive impact of new scientific knowledge on regional economies is still largely unclear. Much of the current path-dependent literature emphasizes the classic evolutionary view that learning and knowledge accumulation are heavily path-dependent, as they rely on both formal and informal or tacit knowledge such as learning-by-doing and learning-to-practice. Local institutions and human resources that have developed as a result of one industry's development in a region often appear to act as critical causes of, and inputs to, the creation of other industries.

Conclusions

On the basis of the results of the interviews, we find that Dutch experts seem especially interested in new trade theories/new economic geography – something they have in common with experts from other European countries. These results are in themselves not necessarily surprising, but do seem to show that experts are well-informed about economic theorizing, because these theories deal with uneven geographical development which is in line with the focus of the study: namely, economic dynamism. For the Netherlands, this is also interesting because the majority of the respondents are experts from the private and public sectors, ruling out a large academic input that is generally considered better-informed on such issues. When we take a closer look at the outcomes of the interviews by conducting a factor analysis, we find that experts overall believe that especially knowledge development (i.e. by means of learning) and knowledge transfer (i.e. by means of networks and links) can create spatialities of economic novelty (innovations, new firms, new industries). We argue in this study that these ideas are closely related to the ideas of evolutionary economic geography, because, in this approach, the economic landscape is considered the product of knowledge, and the evolution of that landscape is shaped by changes in knowledge. The economic landscape is both the product and the source of knowledge, and populations of economic agents play a key role in determining the landscape. This is similar to the ideas of new trade theories/new economic geography. However, whereas new trade theories/new economic geography are mainly concerned with the location of economic activity, agglomeration, and specialization evolutionary economic geography actually studies the behaviour of the agents themselves and how they interact. We are aware that such a conception is hardly articulated as of yet, but we believe that for a thorough understanding of economic dynamism, it is important that such a perspective is taken into account.

Even more so because the results of the factor analysis already seem to show the experts' interest in the way the spatial structures of the economy emerge from the micro-behaviour of economic agents. On a micro-level, the object of study is localized learning, represented in our study by factors such as high quality of human capital; high technology, innovation and R&D; and specialization in knowledge and capital intensive sectors. At the macro-level, it is institutions, in the form of political environment; good infrastructure; and secure formal institutions that contribute even further. Networks and links connect these economic agents (individuals, firms, institutions) and, in this respect, create some form of coordinated self-organization. Finally, the historical setting influences how this self-organization takes place. Our factor analysis underlines the notion that the coordinated self-organization of the economic landscape, by means of the interaction of processes of path creation and path dependence, shape geographies of economic development and transformation that are in turn place-dependent. Economic agents can influence these processes of path-creation and path dependence particularly through knowledge and learning processes and in this way create spatialities of economic novelty (innovations, new firms, new industries). However, evolutionary processes of social and technical innovation, selection and retention lead to the gradual build-up of routines that allow actors to economize on fact-finding and information processing (Maskell and Malmberg 2007). This, in turn, may lead to negative lock-in and eventually decline. Limited cognitive abilities make individuals prefer local, exploitive search in the form of solutions close to already existing routines, and a concentration of their search in their spatial vicinity. Learning improves fact-finding, information processing, and decision making. In this respect, learning can lead to both path creation and path dependence. Further insight into the exact processes of learning and their effect on economic agents, networks of agents in a firm, networks between clusters of firms, and networks between firms and (knowledge) institutions can, we believe, greatly benefit the discussion on dynamic growth and convergence patterns, least, because such a conclusion implies a much larger impact of individual and group behaviour on economic dynamism. Experts should be aware of the impact of their own behaviour on the economy, and evolutionary economics can prove useful for unravelling behavioural patterns. In conclusion, even though we are aware that, strictly speaking, an evolutionary perspective also implies that individuals cannot actually influence economic dynamism, we nevertheless believe that this is a challenge worth pursuing.

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Chapter 5
Knowledge Spillover Agents and Regional Development

Michaela Trippl and Gunther Maier

Abstract It is widely recognised that knowledge and highly-skilled individuals as "carriers" of knowledge (i.e. knowledge spillover agents) play a key role in impelling the development and growth of cities and regions. In this chapter we discuss the relation between the mobility of talent and knowledge flows. In this context, several issues are examined, including the role of highly-skilled labour for regional development and innovation, the essential features that characterise knowledge spillovers through labour mobility, the key factors for attracting and retaining talent as well as the rise of "brain gain" policies. Although this chapter deals with highly-skilled mobility and migration in general, particular attention will be paid to flows of (star) scientists.

Introduction

In the past years, there has been a growing recognition that knowledge and highly-skilled individuals as "carriers" of knowledge are a key driving force for regional development, growth and innovation (Lucas 1988; Romer 1990; Glaeser and Saiz 2004; Florida 2002a, 2005). Given the importance of well-educated people for regional dynamism, the geography of talent and the mobility patterns of the highly-skilled class are increasingly attracting the attention of both academic scholars and policy agents. The central purpose of this chapter is to shed some light on the relation between the mobility of talent and knowledge flows. We refer to talented individuals who transfer knowledge from one place to another by means of their mobility as "knowledge spillover agents". Although this chapter deals with highly-skilled mobility and migration in general, special attention will be given to international movements of top scientists and outstanding researchers, because these key

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individuals are acknowledged to be highly important in the knowledge-driven economy, influencing the rise and dynamic evolution of science-based sectors. Understanding the precise character, spatiality, and temporality of the international mobility of highly-skilled people is essential for explaining regional growth patterns and uneven development.

Based on a review of different strands of literature and recent insights from regional economics, concepts about innovation and knowledge interactions, and migration studies we will investigate the following questions:

- What is the role of highly-skilled labour for regional development and growth and to what extent and in which ways do star scientists contribute to the innovation performance and dynamic development of cities and regions?
- Which features characterise the geography of knowledge spillovers through labour mobility in general and movements of star scientists in particular?
- Which factors are essential for attracting and retaining the highly-skilled class and which determinants shape the migration and location decisions of talented scientists?
- Finally, what are the policy implications which result from the rise in importance of knowledge spillover agents for the development and growth of cities and regions?

In the remainder of this chapter we will review the most important findings from the literature concerning the issues raised above and we will map out an agenda for further research.

The Role of Highly-Skilled Labour for Regional Development and Growth

In the past two decades a considerable body of work has enhanced our understanding of the critical role played by human capital and talent in spurring regional development, innovation and growth. Highly-qualified people and human talent are acknowledged to be an essential economic asset and a source of creative power in science, technology and business (Straubhaar 2001; Solimano 2008). The new growth theory (Romer 1990) formally highlights the connection between knowledge, human capital, and economic growth. Drawing on the insights of this conceptual work, Lucas (1988) has put forward the argument that the spatial concentration of (skilled) labour generates strong external economies (or in his words "external human capital"), and that these externalities increase productivity and growth. In the meantime there exists a large number of empirical studies providing evidence for the strong relationship between well-educated people and the performance and growth of cities and regions (Eaton and Eckstein 1997; Black and Henderson 1999; Glaeser and Saiz 2004; Rodriguez-Pose and Vilalta-Bufi 2005).

Looking specifically at high-technology and knowledge-based sectors, it has been shown that a flexible labour market and highly-qualified personnel play a central role for the emergence and dynamics of high-technology industries (see, for instance, Saxenian 1994; Keeble and Wilkinson 2000). Florida's recent work on the creative class (Florida 2002a, b, 2005, 2007) supports the above raised issues, as it also identifies human capital as the driving force behind regional development. His research indicates that the economic geography of talent exerts considerable effects on the location of high-technology industries and regional incomes. Although Florida's creative class approach has been criticised sharply for a variety of reasons (see, for example, Glaeser 2005; Lang and Danielsen 2005; Peck 2005; Boyle 2006; Markusen 2006; Scott 2006; Asheim 2009; Asheim and Hansen 2009), his basic ideas on the significant role played by skilled labour for regional economic dynamism continue to be highly influential, both in the scientific and policy community.

What are the contributions of highly-qualified scientists to the innovation performance and dynamics of cities and regions? There is a growing awareness in the literature that outstanding researchers can potentially be a key source of regional innovation and dynamism (Zucker et al. 2002; Furukawa and Goto 2006; Zucker and Darby 2007; Thorn and Holm-Nielsen 2008). Indeed, in the emerging knowledge-based economy scientists are by no means detached inhabitants of the academic ivory tower. University scientists increasingly participate in technology transfer and commercialisation activities, whilst at the same time often preserving their academic role identity (Jain et al. 2009). Recent empirical work suggests a complementary relation between scientists' high quality academic research and their engagement in the development of industrial innovations (see, for example, Calderini et al. 2007). Already 40 years ago, Horowitz (1966) analysed the economic effects of the regional distribution of scientific talent and concluded that areas which are rich in scientific talent can derive subsequent economic benefit while those which are poorly endowed with scientists suffer economic loss. More recently, Baba et al. (2009) demonstrated that collaborations with top researchers have a positive effect on the innovative performance of firms operating in the fields of advanced materials. Zucker and her colleagues showed for the rapidly advancing science and technology area of biotechnology that star scientists making major discoveries play an important role, influencing the use of the new technology by firms (Zucker et al. 1998, 2002). Zucker et al. (1998) introduced the concept of biotechnology stars based upon productivity measured by the number of articles written through the 1990s which reported a genetic-sequence discovery. Direct involvement of these stars proved to be a major factor in determining which firms were ultimately major winners in biotechnology (Zucker et al. 1998, 2002). In a recent paper Zucker and Darby (2006) extend the concept of star scientists to all areas of science and technology. They demonstrate that the number of stars in a U.S. region or in one of the top-25 science and technology countries has a consistently significant and quantitatively large positive effect on the probability of firm entry in the same area of science and technology. These findings lead them to conclude that the stars themselves rather than their potentially disembodied discoveries play a crucial role in the formation or transformation of high-tech industries, emphasising their embodied knowledge, insight, taste and energy. This view is also confirmed by Trippl and Maier (Chap. 6 in this volume) who found evidence that star scientists tend to be strongly embedded in their current location by exhibiting various kinds of knowledge linkages to research institutes, companies, and policy actors (see also Trippl 2009a). The physical presence of star scientists, thus, seems to matter fundamentally. The evidence presented above strengthens the case for the importance of the work of these extraordinary individuals for the economic development of regions and nations. Given the crucial role played by scientific and other talent in fuelling regional dynamics, their mobility patters and location decisions are issues which deserve closer attention.

Labour Mobility as a Key Mechanism of Knowledge Spillovers and Knowledge Transfer

The main aim of this section is to unravel the linkages between the mobility of highly-skilled labour and knowledge transfer. In order to capture the relevance of that issue, it seems to be useful to "embed" the reflections on it within the more general academic discussion about knowledge flows. In the last years, the nature and geography of knowledge flows have become an important research topic in regional studies (see, for example, Bathelt et al. 2004; Gertler and Levitte 2005; Gertler and Wolfe 2006; Maskell et al. 2006; Tödtling et al. 2006; Cooke et al. 2007; Trippl et al. 2009). A key argument which has been raised in the recent literature on the mechanisms of knowledge flows and knowledge circulation is that it is not only market transactions and networking which matter for the exchange of ideas and expertise. There seems to be a widespread consensus that also spillovers constitute an important type of and specific channel for knowledge transfer and that these externalities have a positive impact on innovation and growth (Breschi and Lissoni 2001a, b; Bottazi and Peri 2003; Greunz 2005; Maier and Sedlacek 2005; Eckey et al. 2005; Abdelmoula and Bresson 2006). Knowledge externalities are complex in nature as they can take very different forms (Tödtling et al. 2006; Trippl et al. 2009). There are, for example, spillovers through the reading of scientific literature and patent specifications (Jaffe 1989; Jaffe et al. 1993), through informal contacts (Feldman 2000), through observation and monitoring of competitors (Malmberg and Maskell 2002) or through spin-offs (Keeble and Wilkinson 2000). The mobility of highly-skilled personnel represents another core mechanism for the spilling over of (embodied) knowledge (Arrow 1959; Matusik and Hill 1998; Argote and Ingram 2000; Rosenkopf and Almeida 2003; Audretsch and Keilbach 2005; Moen 2005; Döring and Schnellenbach 2006; OECD 2008; Breschi and Lenzi 2010). In the following our focus is exclusively on the mobility of highly-qualified workers as a specific type and manifestation of knowledge spillovers. We refer to talented individuals who transfer knowledge from one place to another by means of their mobility as "knowledge spillover agents". To get a better understanding of the geographical dimension of this phenomenon is essential for explaining the foundations of regional growth and innovation.

The Geography of Knowledge Spillovers Through Mobile Labour

The movement of highly-skilled workers between local firms, universities and other organisations is regarded to constitute a central mechanism of regional collective learning and localised knowledge transfer (Saxenian 1994; Henry and Pinch 2000; Lawton Smith and Waters 2005; Breschi and Lenzi 2010), underpinning the dynamic development of high-technology clusters and innovative regions. Mobile highly-skilled researchers, scientists, engineers and managers are important "carriers of knowledge" (Keeble and Wilkinson 2000) on the local labour market, leading to an enhanced transfer of embodied expertise and a deepening and broadening of the regional pool of knowledge.

Labour mobility, however, is not restricted to the local or regional levels. On the contrary, the international migration of labour has become an important form of globalisation in recent years (Beaverstock 2002; Willis et al. 2002, Global Commission on International Migration 2005; Freeman 2006; Zaiceva and Zimmermann 2008; OECD 2008). Particularly interesting for the purpose of this chapter is the increase of the global mobility of highly-skilled people (Iredale 2001; OECD 2005; Skeldon 2009). There is a growing global competition for talent and highly-qualified people (Mahroum 2001; Cervantes and Goldstein 2008; OECD 2008). Over the last two decades a global "migration market for skills" (Salt 2005) has emerged. The main driving forces of this trend are a growing demand in advanced countries for IT and other skills in science and technology as well as the emergence of more selective immigration policies that favour highly-skilled migrants (Cervantes 2004; Salt 2005).

International migration and mobility of people are powerful mechanisms for the global diffusion of cutting-edge scientific, technical and managerial knowledge (Coe and Bunnell 2003; Williams 2007; OECD 2008), underpinning innovation in "traditional high-tech centres" such as the USA (see, for example, Alarcon 1999; Saxenian 1999; Stephan and Levin 2001) and impelling the emergence of new dynamic agglomerations of knowledge-based industries. Several Asian regions represent interesting examples in this respect (Sternberg and Müller 2005; Wadhwa et al. 2009). Saxenian (2002, 2005) shows that the development of IT industries in Taiwan, India and China has been considerably accelerated by highly-skilled engineers, who retuned to their home countries after having studied and worked in the United States. This talent, she argues, is increasingly reversing the "brain drain" phenomenon, by working or creating new companies in (and, thus, transferring technology entrepreneurship to) formerly peripheral regions. Another important issue raised by Saxenian is that foreign-educated venture capitalists increasingly invest in their home countries, thus, transferring first-hand knowledge of the financial institutions of the new economy to peripheral regions. This leads us to examine in more detail the character of knowledge flows through mobile talent.

Directions of Knowledge Flows and Spillovers Through Movements of Highly-Skilled Workers

Several authors have argued that knowledge spillovers through mobile talent are far from being one way flows but tend to be more multi-directional in nature (Meyer et al. 2001; Ackers 2005a), leading to a sharing of the benefits of skilled migration between sending and receiving countries and regions (see, e.g. Fromhold-Eisebith 2002; Wickramasekara 2002; Regets 2007; Kerr 2008; Trippl 2009a). These insights stress the need to go beyond a strict dichotomy between "brain drain" and "brain gain" when assessing the consequences of international migration of highly-skilled workers. Several terms such as "international brain exchanges" (Salt 2005) or "brain circulation" (Saxenian 2005) can be found in the literature as denominations for this phenomenon. The trend towards circulation is strongly linked to the changing temporality of skilled labour migration, which is reflected in a shift from longer-term to shorter term mobility (Koser and Salt 1997; King 2002). As Williams et al. (2004, p. 28) put it: "Longer-term migration has increasingly been replaced by more diverse, shorter-term flows, so that it is more apposite to refer to circulation and mobility than to migration". The return of highly-qualified people to their home countries represents an important example in this context (see, for example, Wadhwa et al. 2009). The cases of India, China, Taiwan, Israel and Eastern Europe clearly show that such return flows of talent can even constitute an economic development strategy in its own right (Saxenian 2002, 2005; Cervantes and Goldstein 2008). Recent academic work has demonstrated that the sending countries or regions might also benefit from their "knowledge migrants" (Ackers 2005a) even if they do not return. Highly relevant in this context is the rise of diaspora networks which connect skilled expatriates with their country of origin, alleviating the negative effects of the loss of highly-qualified persons for the sending area (Meyer 2001; Ackers 2005b; Gill 2005). Kerr (2008) highlighted potential benefits from high-skilled migration for sending countries by demonstrating that ethnic scientific and entrepreneurial communities in the United States play an important role for international technology transfer to their home countries. A study carried out by Agrawal et al. (2006) identified the existence of knowledge spillovers from the receiving region to the sending one. Agrawal and his colleagues have developed a model of knowledge spillovers that rests on social relationships between inventors. In this model, geographical proximity is crucial for the emergence of social ties, but the authors allow for the possibility that social ties endure even after individuals have become separated. Based on an analysis of patent data, Agrawal et al. (2006) found strong evidence in support of the enduring social capital hypothesis: social ties that promote knowledge transfer persist even after formerly co-located individuals are separated (see also Oettl and Agrawal 2008). Thus, at the regional level, there is a spillover from the region that receives the employee to the region that lost the employee. Similar findings have been presented by Corredoira and Rosenkopf (2005), who analysed the mobility of technical employees among firms in the U.S. semiconductor industry between 1980 and 1995.

They show that a firm experiencing a loss of an employee is more likely to cite the firm receiving the mobile employee. Interestingly, the authors found that this effect is stronger for firms that are geographically distant than for firms that are spatially proximate.

Jöns (2009) focussed on international scientific mobility and explored the long-term effects of research stays spent by foreign academics in Germany. She demonstrated that this kind of scientific movements triggered a process of subsequent academic movements and collaboration, linking Germany to the visiting researchers' home countries. In a similar vein, Trippl (2009a) provided evidence that mobile star scientists tend to maintain their connections to the scientific community and to companies at their previous location, thus, giving rise to a large variety of international knowledge linkages. To summarise, the "circulation phenomenon" manifests itself in a variety of ways and seems to be to some extent "decoupled" from the physical presence of talent.

In the meantime there is a considerable body of literature on the causes and effects of international migration of skilled labour on the sending and receiving countries and regions (Ottaviani and Peri 2005, 2006; Peri 2006; Kuhn and McAusalnd 2008; Agrawal et al. 2008; OECD 2008; Ortega and Peri 2009). Nevertheless, its economic and other effects are under-researched and remain poorly understood (Coleman and Rowthorn 2004). Regets (2007) has compiled a list of likely outcomes of skilled migration, differentiating between sending and receiving countries (see Table 5.1). However, only few of these factors are – as he admits – well established empirically.

Understanding Scientific Mobility

Highly-skilled migrants are far from being a homogeneous group. On the contrary, there are marked differences between professions regarding, for example, their propensity and motivations to move abroad (Mahroum 2000a; Iredale 2001, see also below). Scientists and academics tend to be more mobile than talent belonging to other highly-skilled categories (Meyer et al. 2001), indicating the significance of an increasingly global research labour market (Ackers and Gill 2005). Looking specifically at star scientists, recent empirical work pointed to outstandingly high levels of international movements and migration (Showkat et al. 2007; Hunter et al. 2009; Trippl 2009b).

The enormous imbalances in the geography of flows of scientists and researchers and the resulting uneven distribution of scientific capabilities have become a key issue of policy debates in many countries and regions (Gill 2005). In Europe, for example, the ongoing loss of scientists to the United States is a matter of constant concern (see, e.g. Morano-Foadi 2005; Tritad 2008). Generally, scientific mobility, or – as Meyer et al. (2001) put it – "scientific nomadism" is regarded to be a normal phenomenon in the academic world and often a precondition for progression in science careers, entailing international flows of scientific knowledge. Laudel (2003,

Table 5.1 Possible global and national effects of high skilled international migration

Sending countries	Receiving countries
Possible positives • Increased incentives for natives to seek higher skills • Possibility of exporting skills reduces risk/raises expected return of personal education investments • Increase in domestic economic return to skills • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology and other products and services • Return of natives with foreign education and human capital • Remittances and other support from diaspora networks	Possible positives • Increased research and development and economic activity due to availability of additional high skilled workers • Knowledge flows and collaboration • Increased ties to foreign research institutions • Export opportunities for technology • Increased enrollment in graduate programs, with the possible result of keeping smaller programs alive and maintaining quality in larger programs
Possible negatives • "Brain drain": lost productive capacity due to at least temporary absence of workers and students with higher skills • Less support for public funding of higher education • Training and research areas may not reflect local priorities (e.g. cancer, not malaria)	Possible negatives • Decreased incentives of natives to seek higher skills • Possibility of displacement of native students from best schools • Language and cultural barriers between native and immigrant highly-skilled workers • Technology transfers to competitors and to possibly hostile countries

Source: Regets (2007, p. 3)

p. 215) noted that "the interorganisational mobility of scientists has always been an important functional requirement for science. Scientists 'on the move' bring their knowledge to other places, acquire new knowledge in the new place and thus promote new combinations of knowledge. This is especially important if knowledge is not communicated through other channels like publications ... Since some kinds of knowledge are circulated in science by scientists who travel around, scientists' inter-organisational mobility constitutes one of the most important knowledge flows in science".

Scientific migration and mobility, however, are a highly complex phenomenon. A sound understanding of its impact requires more than simply enumerating emigrants, immigrants and returnees. The effects of scientific mobility critically depend on factors such as the skill levels involved and the temporal character of such movements (see also Ackers and Gill 2005). Recent research also indicates that mobility patterns differ enormously within the academic or scientific sector between disciplines, scientific specialities and countries (Ackers 2005a; Laudel 2005). A key finding of recent studies and analyses concerns the significance of the "qualitative dimension" of scientific migration. In other words: It is not only the quantity but also the quality of flows that matters (see, for example, Ackers 2005a). In terms of regional and national development, it seems to be obvious that movements of the most brilliant and brightest scientists have the greatest impact. Salt (1997, p. 22) noted that “the departure of a few top-level specialists in certain sectors of basic research could lead to the collapse of national scientific schools”. In this context Mahroum (2003) points to the attraction of global centres of excellence. These centres have a “magnetic” and multiplying effect drawing star scientists who play an essential role in subsequent recruitment: “They tend to go where the best facilities are, and their reputation attracts the best young talents” (Mahroum 2003, p. 2). Laudel (2005) points explicitly to the role of the “scientific elite” in recruiting the next generation of star scientists, emphasising the autocatalytic character of “elite production”. The elite, she argues, is spatially concentrated in a few places “where young scientists are selected and guided into fruitful research areas. This increases the likelihood that those scientists will later become members of the elite themselves” (Laudel 2005, p. 380). Using bibliometric methods she also found that elite migration is partly field-specific and, even more interestingly, that migration occurs more among potential elites rather than among established elites. Recent work by Trippl (2009b) provided further evidence for a highly uneven distribution of outstanding researchers and world-class scientists across space. Analysing the location pattern and international movements of highly cited scientists Trippl (2009b) showed that these individuals are geographically concentrated in a few regional “islands of innovation” in the United States and Europe.

Star Scientists, Knowledge Flows and Regional Development

The issues raised above enable us to be more specific about the nature of knowledge flows which result from the mobility of highly-skilled people and to reflect upon their impact on regional development. Focusing on movements of talented scientists we propose a model of knowledge circulation that goes far beyond a simple and unidirectional transfer of knowledge (see Fig. 5.1).

The model suggested in this chapter recognises that mobile star scientists can give rise to a large variety of interregional and local knowledge flows and it explicates important types in this respect. In the following we intend to discuss in a more comprehensive way the issue of interregional knowledge interactions induced by the movement of talented scientists and to draw first conclusions about their impact on regional development and innovation.

Interregional Knowledge Interactions Due to the Mobility of Star Scientists

In order to unravel the multitude of interregional and international knowledge interactions which can be related to mobile star scientists, our model draws a distinction between “initial knowledge flows” and “subsequent knowledge flows”. The model is, therefore, dynamic, and this allows for capturing the complexity of the phenomenon dealt with here.

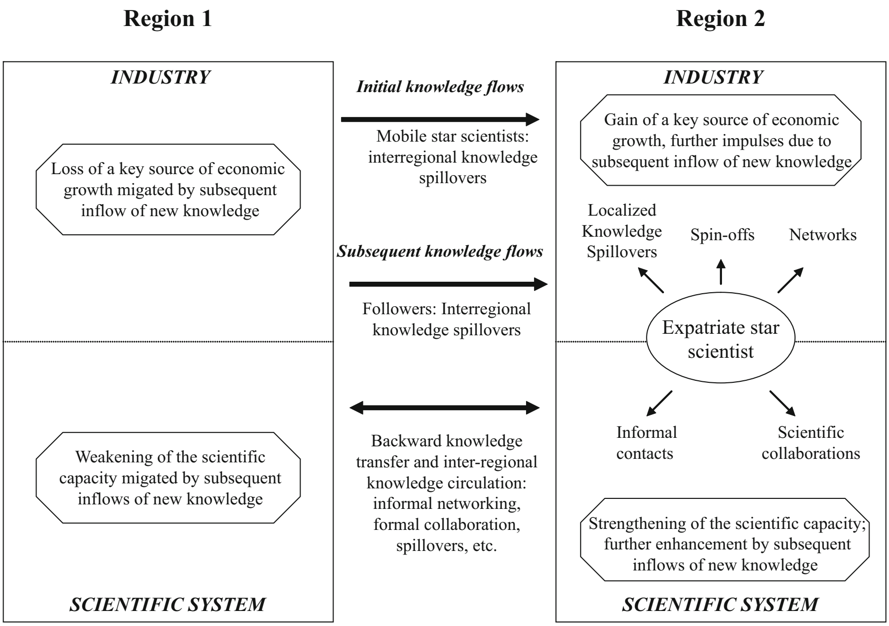

Fig. 5.1 Knowledge link model
Source: Own compilation

- The movement of a star scientist from Region 1 (sending region) to Region 2 (receiving region) is inextricably linked to an interregional spilling over of knowledge. To take into consideration only this first effect, however, is oversimplified and would imply to ignore the large variety of knowledge flows that is potentially set off by the mobile scientist. To put it differently, the initial interregional knowledge spillover effect that is due to the movement of a star scientist could entail a range of further knowledge interactions between the sending and the receiving region.
- These subsequent knowledge flows emphasised above can take different forms. Other talent from Region 1 might follow the star to Region 2, thus, generating a further series of knowledge spillovers from the sending to the receiving area. These "followers" can include, for example, members of the former research team of the star scientist or also talented students.
- Furthermore, there are strong reasons to assume that the star maintains his or her relationships to the academic and industrial world of the sending region, releasing a backward transfer of knowledge or the establishment of linkages promoting the interregional circulation of expertise. There are various manifestations which can make their appearance in this context, such as scientific or R&D co-operations, or more informal contacts promoting the exchange of expertise and ideas.

Mobile star scientists, therefore, can pave the way for an intense interregional and international exchange of knowledge and competences. They play an important role for the establishment of "knowledge infrastructures" which are pivotal for gaining a competitive edge in the contemporary economy. Mobile stars could be regarded as important "creators of knowledge roads" between regions, along which other talent can drive and knowledge can move easily, tying distant areas together.

Scientific and Economic Impacts of the Mobility of Star Scientists

In our model we differentiate between effects on the economy and effects on the scientific system in both the sending and receiving region. Before doing so, it should be alerted that the strength of the effects is dependent on the scientific and economic specialisation and the knowledge bases of the respective areas as well as the duration of time the star stays in a particular region.

- Arguably, there is a strengthening of the science base in the receiving region and correspondingly a weakening of scientific capabilities in the sending region due to the movement of the star scientist. This initial effect is reinforced if the "follower phenomenon" is quantitatively and qualitatively strong. The existence of mechanisms for backward knowledge transfer and interregional knowledge circulation, however, can mitigate the problem, leading to "scientific gains" for both the sending and the receiving region. The latter will in particular benefit from the immigration of the star scientist, if his or her knowledge diffuses locally. This requires an embedding of the star into the local or national scientific community, brought about by the formation of research co-operations, informal relationships and other types of scientific collaboration with local colleagues.
- Dealing with the economic impact of the mobility of star scientists, it seems to be reasonable to argue that the sending region looses a key source of innovative dynamism, whereas in the receiving region the arrival of the star might imply positive impulses for the local industry. Provided that the star scientist does not cut all ties to his or her former home region, an interregional circulation of knowledge can set in, stimulating creativity and economic development in both the sending and the receiving area. Examining in more detail the potential effects for Region 2 leads us to note that their emergence hinges on the successful creation of efficient mechanisms for the economic exploitation of scientific knowledge. These can comprise academic entrepreneurship, i.e. the foundation of a new firm by the star, formal and informal networks between the star and the local industry, membership in advisory boards of science-based firms, various forms of localised knowledge spillovers (e.g. citations of publications and patent specifications), etc. Consequently, only "embedded stars" who establish a range of contacts to actors in the host region will potentially act as an engine of growth, whereas "isolated stars", who lack such essential linkages will probably set off only a few economic effects.

In the following section we will discuss those factors which attract and retain highly-skilled migrants and the scientific elite.

Attraction and Mobilisation of Talent: Which Factors Do Really Matter?

Which factors attract highly-skilled labour and, consequently, shape the economic geography of talent? This question is of outstanding importance, given the importance of knowledge spillover agents for regional innovation, growth and development. Among academic scholars, however, there is little consensus on this crucial issue. According to the empirical findings of Florida (2002b) the location of talent is strongly influenced by high levels of "diversity" (low entry barriers for human capital). To put it differently: talented people are attracted to locations that display a high degree of demographic diversity, i.e. places, where anyone from any background, race, ethnicity, gender, or sexual orientation can easily plug in. Other factors such as climate, cultural, and recreational amenities, in contrast, seem to play only a minor role. The experiences of Korea and Taiwan are also interesting for the question dealt with here. Wickramasekara (2002) argues that active government programmes combined with special incentives were essential in attracting (back) skilled persons. Moreover, the rapid growth of the local economy, the high priority given to R&D, and the establishment of industrial parks (e.g. the Hsinchu Industrial Park in Taipei), and initiatives by private sector industry which went "head-hunting" for talent in developed countries promoted the inflow of (returning) skilled people. Cervantes (2004) – however without any reference to empirical work – lists a multitude of factors including amongst others job opportunities, quality of working conditions, wage differentials, etc. Furthermore, he notes that for researchers and academics the conditions in the host country regarding support for research and demand for R&D staff and professors can be an important determinant in the migration decision and destination.

General claims such as those summarised above, however, conceal that the phenomenon of skilled migration is complex and diverse in nature, as it comprises very distinct groups of mobile professionals. This accentuates the need of a more differentiated approach for identifying and evaluating those factors which attract highly-qualified talent. Mahroum (2000a) developed a typology of skilled migration and argued convincingly that each group of mobile professionals is driven by different push and pull factors (see Table 5.2).

As shown in Table 5.2, the group of academics and scientists, which is of special relevance for the aim of this chapter, is mainly lured by bottom-up developments in academia and science, favourable working conditions, and the prestige of the host institution (Mahroum 2000a). In particular the latter aspect seems to be significant. Drawing on empirical results, Mahroum (2000b) demonstrates that a high reputation of an academic or scientific institution can serve as important magnet for

Table 5.2 A classification of highly-skilled mobility and types of influencing factors

Group	Type of push and pull factors
Managers and executives	Benefits and remuneration
Engineers and technicians	Economic factors (supply and demand mechanisms)
	The state of the national economy
Academics and scientists	Bottom-up developments in science
	Nature of conditions of work
	Institutional Prestige
Entrepreneurs	Governmental (visa, taxation, protection etc.) policies
	Financial facilities
	Bureaucratic efficiency
Students	Recognition of a global workplace
	Accessibility problems at home
	Intercultural experience

Source: Mahroum (2000a)

mobile talented scientists. This underscores the essential role of global centers of scientific gravity as a key location factor.

Looking specifically on the location preferences of star scientists, Zucker and Darby (2006) show that stars are attracted by places which host other stars. Star scientists tend to move from areas with relatively few peers to those with many in their scientific field. This implies a concentration of stars over time. Millard (2005) examines the mobility of scientific researchers in the EU within the context of the clustering of science and R&D in particular geographical areas. Reporting on a case study of Italian researchers who moved to the UK, the location decisions of this group of researchers based on the clustering of R&D in Europe and in the UK are analysed. The results point to the importance of prestige and networks in determining location decisions and these factors give established research centres an important advantage over smaller, developing ones. Other empirical work supports the view that non-economic determinants play a crucial role in shaping international movements of academics. A study of the migration motivations of highly-skilled migrants in the United Kingdom identified three groups of factors which influence scientific mobility. These comprise (1) aspects of employment (career advancement opportunities, the existence of global centres of excellence, wage differentials, and quality of research facilities); (2) economic and quality of life factors (i.e. living conditions) and (3) personal development associated with travel and experiencing another culture (DTI 2002). A European Science Foundation report also stresses the significance of issues of status and autonomy which are not directly related to economic rewards. Martin-Rovet (2003, p. 1) noted that “researchers want centres of scientific excellence and access to the best and latest scientific equipment. They want increased research funding and better salaries. They look for a society where science is respected and where their social status is esteemed”. Finally, also Williams et al. (2004) stress that systemic features (greater openness in research agendas, career structures etc.) and reputations for excellence serve as main factors for attracting academics and scientists. Flows of highly-skilled scientists, they add, tend to be highly localised in knowledge-intensive clusters. These inflows exhibit a cumulative character, as the presence of talent enhances the attractions of the key destination spaces for subsequent inflows.

The literature review of empirical studies has revealed that we still have a poor knowledge about those factors that attract and retain skilled workers and star scientists. Based on the work mentioned above, we might argue tentatively, that the results which have been found for the often broadly defined group of “talent” or “skilled personnel” do not necessarily hold true for the star scientists. There seems to be a widespread agreement in the literature that for the latter group, the presence of centres of scientific excellence constitutes the main factor of attraction. To examine the locational preferences of this type of knowledge spillover agents in more detail and to analyse which locational factors act as “magnets” for these experts and “knowledge carriers” is, thus, a key challenge for future research activities.

Towards a New Approach for Regional Policy?

The prominent role of human capital in general and knowledge spillover agents in particular for economic growth and dynamism has far reaching implications for regional policy. They suggest the need for policies which put more emphasis on human capital building (Markusen 2008) and on attracting and keeping talent. Florida (2002b), for example, proposed a shift from traditional approaches that focus on the attraction of firms and the formation of industrial clusters to policies and programmes to attract and retain talent. Straubhaar (2001, p. 222) noted that “locations will specialise in producing ‘attractivity’ that can be sold to mobile brains. What began with off-shore locations for financial capital will continue for human capital as well”.

Indeed, in recent years, the (international) mobility of highly-qualified workers and the issue of an effective utilisation of their skills have captured the attention of policymakers in both advanced and developing nations and regions (Lowell 2001; Auriol and Sexton 2002; Wickramasekara 2002; Reitz 2005). Many countries have implemented policies and programmes to facilitate the international recruitment of highly-qualified people (OECD 2005, 2008). For an overview of various initiatives and a discussion of particular examples see Iredale (1999), Lowell (2001), Mahroum (2001, 2005), Wickramasekara (2002), Cervantes (2004), Davenport (2004), Fikkers (2005), OECD (2008) and Giannoccolo (2009). Important measures and instruments to promote the inflow of talent include, for example, tax discounts and salaries, connecting with the diaspora, grants and scholarships, changes in legislation to allow the immigration of brilliant scientists, etc. In many cases the attempts by public authorities to attract foreign talent and key workers reflect shortages of specific skills in areas such as ICT or medicine (Auriol and Sexton 2002; Commission on International Migration 2005; Salt 2005).

One reason for the growing international movement of skilled labour is the emergence of more selective immigration policies that favour well educated and talented people (Cervantes and Guellec 2002; Cervantes 2004; Salt 2005; Cervantes and Goldstein 2008). Mahroum (2001, p. 27) states that "immigration, particularly of the highly-skilled, is becoming increasingly an inseparable segment of national technology and economic development policies". As skilled labour is key for innovation and growth, a reorientation of regional policies towards a stronger focus on promoting the attraction, absorption and "anchoring" of highly-qualified and mobile talent is, indeed, important.

Agenda for Further Research

In this chapter an attempt has been made to discuss the relation between international labour mobility and inter-regional knowledge flows. The movement of highly-qualified workers has been identified to constitute a core mechanism of knowledge transfer. We have proposed the term "knowledge spillover agents" to capture the crucial role of talented people who transfer knowledge from one place to another by means of their mobility. In spite an ever growing literature on this phenomenon there are still major research gaps which deserve due attention in future work. In the following we will single out in a crude way some of the most important ones:

- There is still a poor understanding of the specific contribution of skilled labour mobility to the international transfer and exchange of knowledge and expertise. More conceptual and empirical research is necessary to disentangle the relative importance of migration as a mechanism for knowledge flows compared to other channels such as global firm networks, market linkages and informal contacts.
- Furthermore, the mobility strategies of "knowledge spillover agents" remain unclear and need further investigation. Little is known about the conditions and factors that promote or hamper international and interregional labour migration. Empirical evidence in particular about movements of elites and their reasons is still scarce (see also Laudel 2005; Hunter et al. 2009).
- There is a lack of clarity regarding the influence of knowledge spillover agents on regional development. How can the impact of skilled migration in general and knowledge spillovers through mobile star scientists be conceptualised and measured? What are the outcomes for the source region? Which types of knowledge spillover agents can be ascribed to contribute in an essential way to the growth of cities and regions?
- A final set of open questions concerns the role of policy agents in promoting the inflow of internationally mobile top researchers and other "knowledge spillover agents". Should policy makers promote the inflow of these experts and should they design initiatives to retain those who are already there? How can we justify such actions in theoretical terms? What are adequate measures? How should they combined with other programmes to stimulate high-technology development, i.e. what is the right policy mix to promote economic

dynamism and growth? Which strategies should talent-losing regions and countries adopt?

Exploring these issues is a worthy subject and would enhance our understanding of the interweavement of labour mobility and knowledge transfer and its contribution to innovation, growth and prosperity of cities and regions.

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Chapter 6
Star Scientists as Drivers of the Development of Regions

Michaela Trippl and Gunther Maier

Abstract This chapter investigates the location pattern (at the NUTS 2 level) of European-based star scientists (identified by the number of citations they generated in journals in the ISI database) as well as the degree and intensity of knowledge sharing activities performed by the scientific elite in their regions of choice. Using a unique dataset of 197 star scientists, we demonstrate that Europe's world-class researchers are strongly concentrated in a few major places and tend to embed themselves in these regions by creating multiple knowledge linkages to actors from the academic, industrial and policy world. Our empirical research clearly suggests that star scientists located in Europe are far from being isolated inhabitants of the ivory tower. By adopting various mechanisms of knowledge transfer and promoting a circulation of advanced expertise, star scientists have the potential to drive the development of Europe's regions.

Introduction

In the emerging knowledge-based economy scientists and researchers are increasingly acknowledged to be an engine of economic growth and a key asset for regional innovation (Horowitz 1966; Thorn and Holm-Nielsen 2008). It is particularly science-based sectors (Pavitt 1984) and industries relying on an analytical knowledge base (Asheim and Gertler 2005) where knowledge inputs provided by researchers and scientists are regarded to be of crucial significance for successful innovation processes and international competitiveness.

In the meantime there is an extensive literature on the growing importance of university–industry interactions and the role of "ordinary" scientists in regional economic development (see, for instance, Mowery and Sampat 2005; Gunasekara 2006). Only a few studies, however, have drawn attention to top researchers and

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leading scientists and have explored their knowledge transfer activities and participation in the commercialisation of research (Zucker et al. 1998a, b, 2002; Schiller and Revilla Diez 2010). This work has without doubt enhanced our understanding of the positive role played by the scientific elite in promoting regional knowledge-based innovation and high-tech development. Nevertheless, empirical evidence about the degree to which world-class scientists are embedded in their regions remains scarce and little is still known about the relative importance of different forms and combinations of knowledge transfer activities that matter in this context. Furthermore, hardly any attempts have been made so far to identify those regions where the scientific elite can be met (for a notable exception see Zucker and Darby 2007) and to examine whether top researchers located in major concentrations of high-level scientific talent are more engaged in regional development than those working outside these areas.

In this chapter we focus on Europe's best and brightest scientific minds, i.e. on "star scientists" who belong to the very top in their respective disciplines worldwide. We identify star scientists by the number of citations they generated in journals in the ISI database. Drawing on the results of a web-based survey of 197 European-based top researchers we detect regional concentrations of "star power". The main purpose of this chapter, however, is to examine the extent and nature of knowledge sharing activities performed by the surveyed members of Europe's scientific elite and to investigate how they combine different mechanisms to transfer knowledge to regional actors. More specifically, we address the following research questions.

- What is the location pattern of star scientists in Europe? To what extent are they spatially concentrated in particular regions?
- To what extent do European-based star scientists embed themselves in their regions of choice? What is the relative importance of different types of regional knowledge sharing activities performed by stars in this context?
- Do star scientists combine specific channels of knowledge transfer to share their advanced knowledge and expertise with regional actors and organisations?
- Are star scientists located in areas which host many other stars more involved in knowledge sharing activities than stars located elsewhere?

This chapter is organised as follows. In the next section we provide a short literature review on the role of scientists and researchers in regional development and we briefly recapitulate the scarce empirical evidence that exists on knowledge sharing activities performed by star scientists. Then we elaborate on a typology of knowledge transfer channels which – if adopted – might contribute to regional innovation and growth. In this context we differentiate between three worlds (academic, industrial, and policy) and we identify in a conceptual way nine mechanisms by which star scientists might embed themselves in their regions. Then we discuss the methodology and the data of our research. The following section contains the empirical part of the chapter. We present the key findings of our empirical analysis on the location pattern and the extent, intensity and nature of knowledge sharing activities performed by the sampled European-based star scientists in different European regions. The last section summarises the most important results and draws some conclusions.

Conceptual Considerations and Literature Review

It is commonly accepted that in the emerging globalised knowledge economy (Cooke 2002; David and Foray 2003; Cooke et al. 2007) outstanding academics and top researchers are a crucial asset for regional development and growth (Horowitz 1966; Furukawa and Goto 2006; Thorn and Holm-Nielsen 2008; Baba et al. 2009). Especially for innovation processes in science-based industries (Pavitt 1984) and sectors relying on an analytical knowledge base (Laestadius 1998; Asheim and Gertler 2005; Tödtling et al. 2006) scientific knowledge inputs are considered to be of pivotal importance. Most scholars would agree with Thorn and Holm-Nielsen (2008, p. 145) who note that "building and maintaining a stock of researchers and scientists able to generate knowledge and innovate are key elements in increasing productivity and global competitiveness".

This view is also increasingly shared within the policy community. In many parts of the world we can observe policy attempts to attract and retain scientific talent and to stimulate flows of knowledge between researchers and economic actors (Mahroum 2005; OECD 2005, 2008, see also Chap. 5 in this volume). Around the world there is increasing pressure on universities and researchers to contribute to industrial innovation and economic development and many countries and regions are experimenting with new knowledge transfer mechanisms to promote the commercialisation of scientific research (Etzkowitz and Leydesdorff 2000; Etzkowitz et al. 2000; Vincent-Lancrin 2006; Feldman and Owens 2007; Feldman and Schipper 2007; Jain et al. 2009). Particularly relevant for the purpose of this chapter are recent empirical findings which suggest that top-level research, involvement in co-operations with companies and entrepreneurial activities do not exclude each other. Several authors have provided evidence for a complementary rather than a substitutive relationship between scientists' high quality academic research and their involvement in processes of industrial innovation, patenting and new firm formation (Agrawal and Henderson 2002; Van Looy et al. 2004; Breschi et al. 2007; Calderini et al. 2007; Lowe and Golzales-Brambila 2007; Stephan et al. 2007; Azoulay et al. 2009). There is, thus, some evidence on the existence of a virtuous cycle between academic productivity of top researchers and their involvement in commercialisation activities.

For European regions the availability of scientific talent, the embedding of scientific brain-power and its conversion into local economic power are of particular importance. In Europe the knowledge economy emerged later and more slowly compared to its main competitor, the United States. Europe's relative backwardness in terms of developing knowledge-intensive industries might be strongly related to the outflow of world-class researchers and top scientists – often to North America – (Tritad 2008; Trippl 2009a, see also Chap. 5 in this volume), a weaker tradition of university–industry links and difficulties in converting high-quality scientific findings into commercial success (see, for instance, Cooke et al. 2007; Trippl and Tödtling 2008; Bergman 2010). Attraction and retention of scarce scientific brainpower and embedding top researchers by promoting a translation of their research into economic development through various forms of knowledge transfer might be key ingredients for creating highly-competitive regional knowledge economies in Europe.

The specific focus of this chapter is on European-based star scientists, i.e. on highly-cited top researchers and their location pattern and knowledge sharing activities at the regional level. Although these stars constitute only a very small segment of the scientific community, they can be expected to play an outstandingly important role in driving regional development. Generally, star scientists are possessors and carriers of unique cutting-edge knowledge and they make major and exceptional contributions to the advancement of science and technology in their respective disciplines. Only a few attempts have been made so far to explore the location pattern of star scientists (see, for instance, Zucker and Darby 2007; Trippl 2009a) and the nature of regional knowledge circulation induced by these stars. Indeed, whilst there is a considerable body of literature on the expansion of university–industry linkages and the role of "ordinary" scientists in regional development (see, for instance, Goldstein and Renault 2004; Mowery and Sampat 2005; Gunasekara 2006; Perkmann and Walsh 2007; Bergman 2010), empirical evidence about the activities of star scientists and their potential contributions to regional innovation and growth remains limited.

Only a few studies have explicitly dealt with top researchers and scientific geniuses. The seminal work done by Lynne Zucker and her colleagues (Zucker et al. 1998a, b, 2002; Zucker and Darby 2006, 2007) demonstrated that the physical presence of star scientists is a critical element of regional high-tech development. More specifically, it is shown that stars play an important role for the creation and transformation of knowledge-intensive sectors such as biotechnology (for a more detailed discussion of this work see Chap. 5 in this volume). Schiller and Revilla Diez (2010) analysed star scientists located in Germany and showed that these top researchers are rather strongly engaged in knowledge sharing activities, thus, acting as, what might be termed "knowledge spillover agents". Interestingly, many activities performed by Germany's best scientists are strongly localised in nature. It was particularly scientific collaborations, new firm formation and recruitment of staff and PhD students that proved to have a strong local dimension. Less evidence, however, was found for local industrial collaborations involving star scientists. Trippl (2009b) focused attention upon star scientists with an international mobility background and highlighted that these stars do not only create multiple knowledge links to actors in their host region but also tend to maintain their connections to their previous location. Thus, they promote an inflow of knowledge from distant sources into their current region of choice. The few analyses of star scientists reported above have provided interesting insights into the nature of knowledge flows that link stars to regional actors. However, gaining a deeper understanding of the role of star scientists in regional development requires closer scrutiny of the relative importance of different forms of knowledge sharing activities performed by star scientists. Furthermore, it is intriguing to explore how stars combine different modes of knowledge transfer and whether or not stars working in major concentrations of high-level scientific talent are more engaged in knowledge sharing than stars located outside these regions.

In the following an attempt is made to lay the conceptual foundations for such an analysis. Drawing on the work done by Keeble (2000), Tödtling et al. (2006), Schiller and Revilla Diez (2010) and others we elaborate on a typology of knowledge transfer mechanisms which – if employed by star scientists – might have a positive impact on regional development and innovation. In our conceptual model of regional knowledge circulation set off by top scientists we do not take into account unintended spillovers (i.e. externalities) which may result from the mere presence of star scientists in a particular region. Such spillovers do not require any form of engagement or activities by the top researchers and might, thus, be observable even for "isolated star scientists", i.e. for stars who lack any connections at the regional level. We do not argue that such unintended spillovers cannot play an important role for regional development and innovation. Nevertheless, in this chapter we only focus on potential contributions by star scientists to regional dynamics which call for – at least to some extent – deliberate efforts and actions, and, therefore, a certain degree of regional "embeddedness" of top researchers and star scientists. As shown in Fig. 6.1, star scientists may embed themselves in their

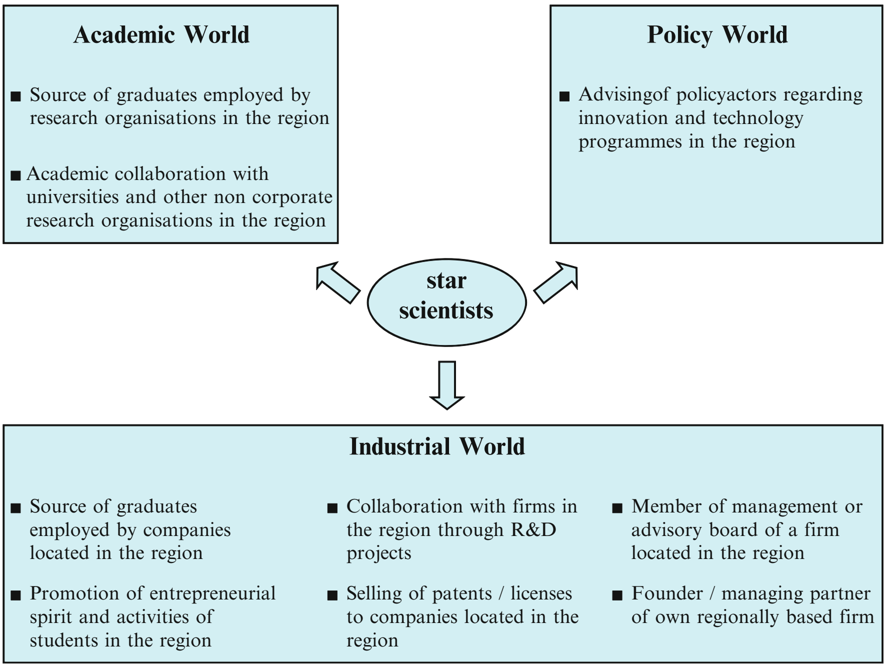

Fig. 6.1 Regional engagement by star scientists: a typology

regions by exchanging knowledge with actors from the academic, industrial and policy world. For knowledge transfer activities to each of these worlds we can identify a set of different channels discussed below.

Academic World

Star scientists can be assumed to be a key asset of regional development and growth by enhancing knowledge generation and diffusion within the regional science system. We differentiate between two main mechanisms in this context. The first channel of knowledge transfer within academia reflects the classic educational function of academics and takes into account their contributions to the dynamic evolution of the regional scientific labour market. Top researchers and star scientists are acknowledged to play a crucial role in this context, by attracting the best young talents (Mulkay 1976; Zuckerman 1977; Mahroum 2003; Laudel 2005) and guiding them into fruitful research areas. Elite members, thus, generate the new elites, leading to a further strengthening of the regional science base. If these young scientific talents do not move away after having finished their studies but continue to stay in the region to work for other research organisations we might observe a positive impact on the regional academic world. The second crucial channel of regional knowledge exchange considered in our model is related to academic scientific collaborations. Arguably, the more cooperative linkages star scientists maintain with other researchers and scientists present in their current location, the more vividly will the advanced knowledge possessed by stars circulate at the regional level.

Industrial World

The role of top-level researchers as drivers of the development of regions might go beyond strengthening the scientific base. As noted above, there are strong reasons to assume that star scientists also influence the innovation capacity of the regional economy by employing various channels for transferring their knowledge to the industrial world. Knowledge transfer from universities to industry takes a variety of forms. Several authors (Keeble 2000; Schartinger et al. 2001; Tödtling et al. 2006) have developed useful typologies in this context. Drawing on this work, we suggest distinguishing between the following six mechanisms of knowledge exchange between star scientists and the industrial world. First, star scientists might have a positive influence on the innovation capacity of their regions of choice by acting as a provider of highly qualified workers for regional firms. The mobility of highly skilled graduates from research institutes to companies is seen to represent a crucial knowledge transfer channel, enhancing the regional diffusion and commercial application of new scientific expertise derived from university research. Second, star scientists might also contribute to regional innovation and growth by promoting the entrepreneurial spirit and activities of their students in their current location. Third, regional knowledge sharing activities by star scientists can also take the form of both informal and formal collaborations and networks such as R&D projects and university–industry partnerships. Fourth, selling patents to regional firms represents another key channel of knowledge transfer for star scientists. Fifth, stars might also engage in knowledge sharing by working part of their time for regional companies as a member of the management or advisory board. Sixth, our model also considers new firm formation by star scientists as a specific mechanism for transferring scientific knowledge to the industrial sector. Arguably, the latter three mechanisms of knowledge transfer represent most direct forms of commercialising scientific knowledge embodied in researchers.

Policy World

The role of star scientists in providing growth impulses to their region of choice might not be confined to academia and the industrial sector. Also the policy world can potentially benefit from the knowledge, insights and energy of stars. A key mechanism of knowledge transfer to the policy world is the involvement of top researchers and outstanding scientists in territorial policy processes. Stars can have a positive impact on the innovation dynamics of their regions by advising public authorities, governments and policy actors regarding the design of innovation and technology programmes, thus contributing to the creation of favourable institutional framework conditions for knowledge-driven development and science-based innovation.

We will adopt the typology of different modes of knowledge transmission proposed above to investigate empirically regional knowledge sharing activities performed by European-based star scientists.

Data and Methodology

The empirical findings discussed in this chapter on the location and regional embeddedness of European star scientists stem from a web-based survey of these outstanding researchers carried out in the year 2008. "Star scientists" are referred to here as the world's top and most renowned scientists and research professionals. More precisely, making use of the database "ISI Highly Cited", we define star scientists as authors of highly cited research papers. ISI Highly Cited is an online information service provided by the Institute for Scientific Information (ISI), a subsidiary of Thomson Incorporated. ISI Highly Cited contains information about individuals, departments, and laboratories that made important contributions to the advancement of science and technology in recent decades. The importance of contributions is identified by the number of citations a researcher generated in journals in the ISI databases.

ISI Highly Cited draws a distinction between 21 different research areas such as clinical medicine, engineering, physics or social sciences and it identifies approximately the 250 most cited individuals in each category. The information in ISI Highly Cited is based on publications and citations from the period 1981–2002.

The database ISI Highly Cited contains approximately 5,600 star scientists, representing less than 0.5% of all publishing researchers worldwide. Two thousand eight hundred and forty-one star scientists provided valid contact information (i.e. a valid email address). These stars have been invited to participate in our study. We have received 720 completed and usable questionnaires. This corresponds to a response rate of 25.3%. One hundred and ninety-seven respondents could be classified as European-based stars, i.e. star scientists who are currently living and working in a European region.

An overview on important characteristics of the sampled European star scientists is given in Table 6.1. A striking feature of the stars included in our sample concerns the gender distribution. As revealed in Table 6.1, nearly 95% of the responding star scientists are male. Analysing the age structure of responding stars we found that more than 50% of them are older than 60 years, indicating that a sizeable fraction of the sampled stars is at a mature stage of their professional careers.

Furthermore, there is a clear pattern regarding the affiliation of European-based stars investigated here. A large majority of them (67%) is employed by universities. About 23% are working for non-university research institutions, whilst the share of star scientists from corporate research units is very small, amounting to only 2%. Almost 6% of the respondents have indicated that they are retired, have founded their own firm, work for the government, or do non-profit research or consulting. These answers have been summarised under the category “other”. Table 6.1 also provides information about the type of research conducted by the sampled star scientists in Europe, revealing a strong orientation towards basis research. More than 50% of star scientists stated that they exclusively (22%) or mostly (31%) carry out fundamental research. Another 24% do both fundamental and applied research. Looking at the research areas of European-based top scientists we can see that 57% of the respondents are working in the field of natural science, and another 26% in medical and health sciences. Other categories (engineering, social science, agricultural science) play a minor role in comparison.

Finally, we also collected data on the mobility background of the surveyed star scientists. Not fewer than 35% of them can be classified as “non-movers”, i.e. scientists who have, so far, not relocated internationally for professional purposes, but have stayed in their home countries. Another 65% have an international mobility background. We can draw a distinction between expatriates on the one hand and returnees on the other hand. Expatriates are defined here as researchers, who have left their home countries and now live and work at a foreign location. Their share in the sample is 20%. On average they have already spent 23 years away from home. Returnees (i.e. scientists, who have returned to their home countries after living abroad for a substantial period of time) represent 45% of all sampled stars. They have spent on average 6 years abroad, before relocating back home.

Table 6.1 Sample characteristics (% of star scientists)

		Percentages
Gender (N = 197)	Female	5.6
	Male	93.9
	Missing	0.5
Year of Birth: Mean: 1947 (N = 197)		
Type of Institution (N = 197)	University	67.0
	Non-university research entity	23.4
	Corporate research unit	2.0
	Other	5.6
	Missing	2.0
Type of Research (N = 197)	Exclusively or mostly fundamental research	52.8
	Rather fundamental research	12.2
	Fundamental and applied research	24.4
	Rather applied research	3.0
	Exclusively or mostly applied research	7.1
	Missing	0.5
Research Discipline (N = 197)	Natural Sciences	56.4
	Agriculture Science	4.6
	Engineering and Technology	8.6
	Medical and Health Sciences	25.9
	Social Sciences	2.5
	Missing	1.0
Mobility Background (N = 197)	Non-movers	35.0
	Expatriates	20.3
	Returnees	44.7
Expatriates: Years spent abroad; Mean (min. 1.0, max. 50): 23.0 (N = 40)	1–10 years	26.5
	11–20 years	10.0
	21–30 years	30.0
	More than 30 years	32.5
Returnees: Years spent abroad; Mean (min 1.0, max. 30): 6.2 (N = 88)	1–3 years	50.0
	4–10 years	33.0
	More than 10 years	17.0

Empirical Results: Location and Regional Embeddedness of European-Based Star Scientists

In this section we investigate the location pattern of the surveyed European star scientists. Furthermore, we examine the relative importance of different types of knowledge transfer activities and we analyse how stars combine different mechanisms to share their knowledge with regional actors. Finally, we also explore whether star scientists who are located in regions which host a relatively large number of stars are more engaged in regional knowledge transfer than star scientists working in regions which are poorly endowed with top researchers.

Location Pattern of Star Scientists in Europe

The European-based star scientists included in our sample are strongly concentrated in a few regions and countries. Analysing in a first step the distribution of stars across European nation states we found a highly uneven spatial distribution of the scientific elite. Only three countries were found to host more than 55% of all stars located in Europe. The UK is by far the leading nation, covering one third of all sampled top researchers, followed by Germany (15%) and France (8%). These findings underscore the role of these nations as scientific powerhouses in the European context. However, it is not only large countries which show a good performance in providing employment opportunities for stars. Also smaller nations such as Switzerland (7%), Sweden (5%) and the Netherlands (5%) seem to have some capacity to attract and retain successfully world-class researchers. If we look at the location of European star scientists at the regional level (NUTS 2 level), we can also observe an outstanding high concentration (Table 6.2). In sum we could identify 71 NUTS 2 regions hosting a total number of 178 stars.[1] Major places are the UK regions London, Berkshire, Buckinghamshire and Oxfordshire, and East Anglia, Upper Bavaria in Germany, Copenhagen, Ile de France, and Vlaams-Brabant. The top nine ranked regions account for more than 40% of all star scientists working in the European Union. The strong concentration of star scientists in particular places is no specific feature of Europe. Recent work by Trippl (2009a) for instance has shown that US stars also tend to agglomerate in only a few regions.

Regional Embeddedness of Star Scientists in Europe

In the following it will be explored to what extent and in which ways European star scientists are engaged in knowledge sharing activities that may contribute to the innovation dynamics and development of their regions of choice. The first question we are dealing with targets the star scientists' perception and general attitude toward regional development oriented activities. We asked them to what extent they agree or disagree with the statement: "Scientists and research professionals should play an active economic role in the regions where they are located". Nearly 60% strongly or at least rather agreed with this statement, while only 14% had a rather or strong sceptical view on that issue. Our results, thus, suggest that European star scientists have a positive attitude towards contributing to regional economic development. Even more importantly, we found evidence that this positive view

[1]A number of 192 European-based star scientists provide information about their current location at the regional level. As indicated above, 178 stars reside in EU regions. The remaining 14 stars are located in regions and countries not belonging to the European Union. These include Zurich (six stars), Lausanne (three stars), Geneva (two stars) and Basel (one star) in Switzerland, as well as Oslo (one star) and Trondheim (one star) in Norway.

Table 6.2 Location of star scientists in European Regions (NUTS 2 level)

NUTS 2 code	Region	Number stars	in %
UKI1	Inner London	13	7.3
UKJ1	Berkshire, Buckinghamshire and Oxfordshire	13	7.3
UKH1	East Anglia	12	6.7
DE21	Oberbayern	8	4.5
DK00[a]	Denmark	7	3.9
FR10	Ile de France	6	3.4
BE24	Prov. Vlaams-Brabant	5	2.8
UKM2	Eastern Scotland	5	2.8
DEB3	Rheinessen-Pfalz	4	2.2
DE12	Karlsruhe	3	1.7
DE26	Unterfranken	3	1.7
ES30	Comunidad de Madrid	3	1.7
FI18	Etelä-Suomi	3	1.7
ITC4	Lombardia	3	1.7
ITD5	Emilia-Romagna	3	1.7
ITE1	Toscana	3	1.7
NL33	Zuid-Holland	3	1.7
SE12	Östra Mellansverige	3	1.7
SE22	Sydsverige	3	1.7
UKF1	Derbyshire and Nottinghamshire	3	1.7
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	3	1.7
UKM5	North Eastern Scottland	3	1.7
	17 regions each hosting 2 stars	34	19.1
	32 regions each hosting 1 star	32	18.0
	Total	178	100.0

[a]*Note*: all Danish stars included in our sample are located in the capital city of Copenhagen

concerning the engagement of scientists in regional development and innovation also becomes manifested in real actions performed by the sampled European stars. Our empirical findings highlight that European-based top researchers tend to be "embedded" stars, exhibiting close connections to other actors and organisations at the regional level. Table 6.3 provides an overview on the extent and intensity of regional knowledge sharing activities reported by the surveyed star scientists and on the relative importance of different mechanisms in this respect.

Linkages Between Europe's Star Scientists and the Regional Academic World

European star scientists are a source of creative power in science and key agents of knowledge circulation within the regional academic world. Indeed, our empirical findings demonstrate that they maintain close linkages to other members of the scientific community in their region of choice. Nearly all (98%) European-based top researchers included in our sample collaborate with scientific organisations at the regional level and not less than 67% do so in a quite strong way, i.e. on a regular or frequent basis. Thus, there is convincing evidence of regional academic knowledge

Table 6.3 Types and intensity of regional engagement (% of star scientists)

	Total (N = 197)	Strong	Weak
Academic World			
Academic Collaboration	97.9	66.2[a]	30.7[b]
Source of talent for scientific labour market	89.7	21.0[c]	68.7[d]
Industrial World			
Source of talent for firm labour market	77.7	19.7[c]	58.0[d]
Fostering entrepreneurial spirit of students	76.6	16.7[a]	59.9[b]
R&D projects with firms	79.5	29.2[a]	50.3[b]
Selling patents to firms	31.8	5.7[a]	23.1[b]
Entrepreneur	14.5	–	–
Member of firm board	25.3	–	–
Policy World			
Advice of policy-makers	75.4	16.9[a]	58.5[b]

[a]Strong: regular or frequent
[b]Weak: seldom or occasional
[c]Strong: a lot or almost all
[d]Weak: a few or some

exchange involving the best and brightest scientific minds in Europe. The collaborations reported above might entail a transfer and diffusion of the cutting-edge scientific knowledge possessed by stars and can even lead to new knowledge generation at the regional level. Furthermore, a sizeable fraction of star scientists (90%) also indicated that some of their former students are employed by research organisations in the region. Consequently, there is a knowledge transfer via the mobility of students educated and monitored by the surveyed stars. European-based top researchers play a crucial role in providing talented graduates for the regional scientific labour market. This holds in particular true for those 21%, who state that many or almost all of their former students have moved to other research organisations in the region. Both modes of scientific knowledge sharing activities examined here point to a rather high degree of embeddedness of Europe's star scientists in the regional academic system of their current location. Given their strong involvement in new knowledge generation and diffusion, the surveyed European top researchers can, thus, be acknowledged to be critical elements of the science base of their regions.

Linkages Between Europe's Star Scientists and the Regional Industrial World

It is not only regional science systems in Europe which seem to benefit from the physical presence of top researchers and outstanding scientists. Our empirical research results show that European-based star scientists also contribute to economic development and growth by adopting various mechanisms to transfer their advanced knowledge and expertise to regional companies. Knowledge sharing activities related to the industrial world proved to take a variety of forms. There is evidence for knowledge transfer via R&D projects between academic stars and regional firms. Not less than 80% of the sampled European stars reported being involved in such co-operations and almost 30% seem to have even very close connections to the regional industrial world, collaborating regularly or frequently with companies. Other central modes of knowledge transfer comprise the provision of highly skilled graduates (78%), and the promotion of the entrepreneurial spirit and activities of their students in their respective regions (77%). However, it is also worth mentioning that more than 50% of all investigated stars in Europe make use of these three modes in quite sporadic and weak ways. Finally, we found evidence that Europe's top researchers are involved in very direct forms of commercialising their scientific knowledge and discoveries. Almost two thirds of star scientists in Europe reported selling patents to regional companies. However, only 6% carry out this activity regularly or frequently. Furthermore, a sizeable fraction of European-based star scientists (25%) act as member of the management or advisory board of regional firms and not less than 15% of the stars included in our sample indicated to run their own regionally based business. Consequently, there is a large variety of mechanisms by which star scientists supply their knowledge to the regional industrial world. By doing so, they potentially provide essential impulses to the growth and transformation of regional economies.

Linkages Between Europe's Star Scientists and the Regional Policy World

Regional knowledge sharing activities by star scientists are not confined to the academic and industrial world. Our findings clearly suggest that the sampled European-based star scientists tend to have good connections to the regional policy world. We found evidence that their advanced knowledge and insights are incorporated in public programmes geared towards enhancing regional innovation and improving framework conditions and public incentives for technological development. A considerable fraction (75%) of the surveyed researchers provides advice to public authorities and policy-makers and not less than 17% seem to be strongly engaged in such activities.

Relative Importance of Regional Knowledge Sharing Mechanisms

Europe's highly cited top researchers are in close touch with regional actors. There is a large variety of mechanisms by which star scientists can potentially influence regional growth and innovation. It is not only the science system which seems to benefit from the physical presence of top researchers. Apparently, some of them also maintain different kinds of linkages to regional firms or even have established their own firms, thus supplying their expertise to the industrial world. Looking at the relative importance of different types of knowledge sharing (or modes of regional engagement) we found that academic collaboration within the region is almost ubiquitous, closely followed in level by providing talent for the scientific labour market. That these classic academic activities are widely performed could have been expected. However, also interactive activities in relation to regional firms and policy makers are rather common. The more general activities of providing highly-qualified graduates for companies and fostering students' entrepreneurial spirit are performed by almost 80% of star scientists. Similar shares also engage in more specific activities like performing R&D projects with firms and providing policy advice. But even activities related to direct commercialisation of scientific research which require high levels of engagement and considerable efforts (selling patents to firms, establishing academic spin-off companies or being a board member in regional companies) are reported by a substantial share of these highly qualified scientists. A look at the column "strong" in Table 6.3 confirms the conclusion that Europe's star scientists are important knowledge-sharers and well embedded in their regional economies. They engage strongly in activities that may contribute to regional innovation and development.

Number and Combinations of Regional Knowledge Sharing Mechanisms

Looking at the number of different mechanisms of knowledge sharing which are adopted by the surveyed top scientists in Europe provides additional insights into the degree of their potential contributions to regional development (Table 6.4). A very small share uses only one transfer channel (1.6%) and 22% reported adopting less than five channels. Almost 80% employ five or more channels and even 7% reported using all mechanisms investigated here. However, more than 50% adopt only one or two channels in strong ways and 19% of the sampled European stars use none of the knowledge transfer channels considered here in strong ways.

These findings, thus, provide further evidence that the surveyed European-based star scientists tend to employ a large variety of different channels to transfer their knowledge to regional actors and organisations. In a next step of our empirical analysis we explore whether specific combinations of knowledge sharing

Table 6.4 Number of different knowledge transfer channels used by stars (% of stars)

	Total (N = 184)	Strong
None	–	19.3
One	1.6	30.5
Two	4.9	23.5
Three	6.5	15.0
Four	9.2	7.5
Five	20.1	1.6
Six	26.6	1.6
Seven	12.5	1.1
Eight	12.0	–
Nine	6.5	–
Total	100.0	100.0

mechanisms play a more important role than others. In sum we could identify not fewer than 52 different combinations. Indeed, our results suggest that some of them are by far more relevant than others. As revealed in Table 6.5 it is one single combination that clearly stands out. Not less than one fifth of the European-based highly cited stars included in our sample transfer their knowledge to regional actors, by combining academic and industrial collaborations with provision of talent to research organisations and firms, promotion of the entrepreneurial spirit of their students and supply of policy advice. Another 30% also use this set of core channels, but complement it by engaging additionally in even more direct forms of commercialising scientific expertise (i.e. selling patents, acting as a member of firm boards, and most importantly, academic entrepreneurship). The combinations listed in Table 6.5 explain the knowledge sharing activities of not less than 50% of all sampled star scientists located in Europe.

Looking at strongly used knowledge transfer mechanisms, we could identify 49 different constellations. As revealed in Table 6.6 there is a clear dominance of academic collaborations, used either solely or in combination with other mechanisms. The majority (46 European-based stars or 30.5%) is strongly involved in academic collaborations only, and another 52% reported strongly adopting this channel in combination with others, particularly with industrial collaborations and provision of talent for the scientific labour market.

Not less than 75% or 138 European-based star scientists indicated to transfer their advanced knowledge to all three worlds considered here. Another 21% (38 stars) are engaged in knowledge sharing activities with actors and organisations from the academic and industrial world, but do not have connections to the policy world. Only 3.3% transfer knowledge exclusively to the academic world, whilst

Table 6.5 Combinations of knowledge transfer channels

Combinations of knowledge transfer channels (values in brackets: number of different channels used)	Number of stars (N = 184)	%
ACO + SLM + FLM + SPI+ ICO + POL (6)	37	20.1
ACO + SLM + FLM + SPI + ICO + PAT + POL (7)	15	8.2
ACO + SLM + FLM + SPI + ICO + PAT + MEM + POL (8)	14	7.6
ACO + SLM + FLM + SPI + ICO + PAT +ENT +MEM + POL (9)	12	6.5
ACO + SLM + FLM + SPI + ICO+ ENT + MEM + POL (8)	6	3.3
ACO + SLM + FLM + SPI+ ICO + MEM + POL (7)	6	3.3
ACO + SLM + FLM + SPI+ ICO + PAT + ENT + POL (8)	2	1.1
ACO + SLM + FLM + SPI+ ICO + ENT + POL (7)	1	0.5
Total	93	50.5

ACO Academic collaborations
SLM Source of talent for scientific labour market
FLM Source of talent for firm labour market
SPI Fostering entrepreneurial spirit of students
ICO Industrial collaborations
PAT Selling patents to firms
ENT Entrepreneur
MEM Member of firm board
POL Advice of policy-makers

Table 6.6 Combinations of strongly used knowledge transfer channels

Combinations of knowledge transfer channels used in strong ways (values in brackets: number of different channels used strongly)	Number of stars (N = 151)	%
ACO only (1)	46	30.5
ACO + ICO (2)	12	8.0
ACO + SLM (2)	10	6.6
ACO + FLM + ICO (3)	7	4.6
ACO + FLM (2)	6	4.0
ACO + POL (2)	5	3.3
25 further combinations involving ACO	39	25.8
Total	125	82.8

ACO Academic collaborations
SLM Source of talent for scientific labour market
FLM Source of talent for firm labour market
SPI Fostering entrepreneurial spirit of students
ICO Industrial collaborations
PAT Selling patents to firms
POL Advice of policy-makers

1.1% exchange knowledge with actors from the academic and policy world, but not with the industrial world.

Analysing combinations of only strongly used mechanisms of knowledge transfer, we find a different result. A sizeable fraction of European stars (40%) is involved in strong knowledge transfer to the academic world only, whilst 32% transfer knowledge in strong ways to both the academic and industrial world. Remarkably, 13% of Europe's world-class researchers included in our sample share their advanced knowledge with actors and organisations from all three worlds in strong ways. However, it should also be noted that 72 stars located in Europe strongly adopt mechanisms to transfer their advanced knowledge to one world only.

Comparing Top Regions with Other Regions in Europe

In a final step of our empirical analysis we explored whether or not the degree of "star power" in a region has an influence on top researchers' engagement in regional development. In other words: Do star scientists who are located in regions which host many other stars differ in their knowledge sharing activities from star scientists located in areas with relatively few stars? There are good reasons to assume that such differences do exist. Arguably, the presence of a relatively large number of stars who engage heavily in regional development and act as role models in this respect might incite other stars located in the same region to also engage in regional knowledge sharing activities. In order to explore this issue, in the following we draw on the findings about the location pattern of stars presented above and distinguish between two categories of regions. We classify the leading nine areas listed in Table 6.2 as "top regions" and the remaining areas as "other regions".

Our investigations of the importance of different forms of regional engagement and the number of different channels used by star scientist show some surprising results which do not corroborate our assumptions. We found some differences between stars residing in top regions and those located in other regions, but not always in the expected ways, and none of these differences proved to be statistically significant at 5% level.

Looking at the shares of stars who reported adopting different modes of knowledge transmission, we found that stars working outside the top regions are more engaged in knowledge sharing activities than stars located within the centres of star power (Table 6.7). The only exceptions in this context are the mechanisms "academic collaboration" and "member of firm board". Furthermore, to some extent stars residing outside the top regions seem to share their knowledge more strongly than their counterparts in the leading regions. This holds true for the provision of talent for the scientific and firm labour markets, promotion of entrepreneurial spirit of students and industrial collaboration. However, as illustrated in Table 6.7, stars in the top regions engage more strongly in academic collaboration, selling patents, and policy advice.

Finally, we examined whether star scientists working in the top regions employ a larger set of different knowledge transfer channels than those located in other regions. As illustrated in Table 6.8, similar shares (about 30%) make use of a rather large number of channels (i.e. more than six mechanisms) and around 11% of both groups use more than three channels in even strong ways. However, a higher

Table 6.7 Knowledge sharing activities by stars in different types of regions (% of stars)

	Top 9 regions (total)	Other regions (total)	Pearson Chi-square prob.	Top 9 regions (strong)	Other regions (strong)	Pearson Chi-square prob.
Academic collaboration	98.6	96.2	0.516	71.2	65.1	0.388
Source of talent for scientific labour market	89.0	89.6	0.901	19.2	22.6	0.578
Source of talent for firm labour market	72.6	80.8	0.201	17.8	18.3	0.937
Fostering entrepreneurial spirit of students	69.4	80.8	0.083	13.9	16.3	0.657
Industrial collaboration	74.0	82.1	0.193	23.3	32.1	0.201
Selling patents to firms	27.8	34.6	0.338	8.3	2.9	0.107
Entrepreneur	13.9	15.1	0.823	–	–	–
Member of firm board	26.0	25.7	0.963	–	–	–
Advice of policy-makers	74.0	74.5	0.933	17.8	15.1	0.628

Table 6.8 Number of channels used by stars in different types of regions (% of stars)

	Top 9 Regions	Other Regions
Number of channels used		
1 to 3	16.1	10.1
4 to 6	52.9	58.6
7 to 9	30.0	31.3
Pearson Chi-Square Prob.: 0.402		
Number of strongly used channels		
None	16.9	22.0
Only one	38.0	26.0
2 to 3	33.8	41.0
4 to 7	11.3	11.0
Pearson Chi-Square Prob.: 0.384		

fraction of stars outside the top regions use none of the channels investigated here rather strongly, whilst a higher share of those located within these leading regions adopt only one mechanism in strong ways. However, these differences are not statistically significant (at 5% level).

Obviously, the degree of "star power" in a region is not a decisive factor for explaining the nature and intensity of knowledge sharing activities performed by the sampled European-based star scientists. Stars located in top regions (i.e. areas which are well endowed with stars) do not engage more in regional development than stars located in regions which host only a low number of leading researchers.

Summary and Conclusions

In the knowledge-driven economy top scientists and highly qualified researchers are claimed to be essential drivers of regional high-technology development and growth. In this chapter we sought to contribute to the growing literature on this topic by shedding some light on European-based star scientists. Star scientists were defined here as the world's top and most renowned researchers, identified by the number of citations they generated in journals in the ISI database. In spite of some recent analyses which focused on star scientists, empirical evidence about these geniuses remains scarce. This concerns in particular the location pattern of star scientists and the relative importance of different knowledge transfer channels adopted by world-class researchers. Furthermore, little is known about how stars combine different mechanisms of knowledge sharing to embed themselves in their regions of choice. Finally, it remains unclear whether stars located in regions which are well endowed with star scientists are more engaged in regional knowledge circulation than stars located elsewhere.

We identified in a conceptual way a set of mechanisms by which star scientists may influence the innovation dynamics of their regions. These included connections to the regional academic world (academic collaborations and provision of talent for the scientific labour market) and to the policy world (advice of policy makers) as well as a differentiated typology of modes of knowledge sharing with the regional industrial world. In the latter case we did not only consider more general activities such as provision of highly qualified graduates to regional firms and fostering the entrepreneurial spirit of students but also more specific activities, i.e. R&D collaborations with firms, selling patents to companies, and being an entrepreneur or member of a firm board.

Empirically, we employed a unique dataset, drawn from a web-based survey of 197 European-based star scientists in five different research areas. We provided evidence that Europe's best scientists are rather strongly concentrated in a few major areas, showing that the top nine NUTS 2 regions host more than 40% of all sampled stars. We also found that a large majority of star scientists exhibit various knowledge connections to actors and organisations at their current location. Europe's world-class researchers are, thus, strongly embedded in their regions of choice. The sampled stars strongly acknowledge that researchers should play an important role in regional economic development, and even more important, this positive view also becomes manifested in real actions. We found evidence that they strongly engage in knowledge sharing activities that may contribute to regional innovation and growth. Analysing processes of knowledge circulation triggered by star scientists within the regional academic world we observed a profound importance of scientific collaborations. Furthermore, the provision of talent for the scientific labour market proved to be a key mechanism by which the surveyed top researchers potentially contribute to regional development and dynamism. However, the role of European-based top scientists is by no means restricted to these classic academic activities. They bring science to life by transferring cutting-edge knowledge to the regional industrial world. We found evidence of manifold forms of knowledge sharing activities between the sampled star scientists and regional firms. Almost 80% supply their advanced knowledge and expertise to the regional industrial world by providing highly qualified graduates, fostering the entrepreneurial spirit of students and carrying out R&D projects with regional companies. Moreover, even rather direct forms of commercialising scientific knowledge such as selling patents to regional firms and acting as an entrepreneur or member of a firm board were reported by a substantial share of Europe's highly cited top researchers. Finally, we could also observe that linkages to regional policy-makers and public authorities are rather common, reflecting a rather strong role of stars as providers of policy advice. Our analysis of the intensity by which the surveyed star scientists employ different modes of knowledge sharing confirms our conclusion that Europe's best and brightest scientific minds are by no means isolated inhabitants of the academic ivory tower. This view was confirmed by looking at the number of different knowledge transfer channels used by the surveyed stars. Nearly 80% reported adopting more than four different channels to share their knowledge with regional actors. However, about 50% of the surveyed stars use only one or two channels rather strongly. Investigating combinations of knowledge sharing activities we found that there is one single set of mechanisms that is used by a large majority of Europe's stars. Not less than 20% engage in regional development by combining academic and industrial collaborations with provision of talent to research organisations and firms, promotion of entrepreneurial spirit of students and supply of policy advice. Another 30% also reported using these channels in combination with mechanisms related to more direct forms of commercialisation of scientific findings (i.e. selling patents, acting as a member of firm boards, and most importantly, academic entrepreneurship). Looking at strongly used mechanisms, we found a prevalence of academic collaboration, which is adopted solely (31%) or in combination with other channels (52%).

Finally, we investigated whether or not star scientists who are working in regions which host many other stars ("top regions") differ in their knowledge sharing activities from those stars who are located elsewhere ("other regions"). Interestingly, we found that the degree of "star power" in a region has no impact on star scientists' engagement in regional development.

Taking all findings from our empirical analyses together, we can conclude that Europe hosts world-class researchers who are a source of creative power in science and an important economic asset, driving regional development. Europe's highly cited star scientists are strongly embedded in their respective regions and by no means detached inhabitants of the academic ivory tower. We found convincing evidence that top researchers located in European regions do not only generate new knowledge but also engage in knowledge sharing activities that may benefit regional economic development and contribute to regional innovation and growth. They adopt a large variety of different mechanisms and combine them in specific ways to supply their expertise to the academic, industrial and policy world. Europe's world-class researchers are, indeed, key agents of knowledge generation, transmission and circulation, providing many growth impulses to their home regions. They are of pivotal importance for the strength and vitality of Europe's high-tech regions and processes of science-based innovation.

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Chapter 7
The Determinants of Regional Educational Inequality in Western Europe

Andrés Rodríguez-Pose and Vassilis Tselios

Abstract This chapter provides an empirical study of the determinants of educational inequality across regions of the EU. Using the European Community Household Panel dataset for 102 regions over the period 1995–2000, it analyses how microeconomic changes in income distribution as well as in educational attainment affect educational inequality. The different static and dynamic panel data analyses conducted reveal the complexity of the interaction between income and education. Educational attainment seems to curb the increase in educational inequality. While the impact of income per capita is unclear, the relationship between income inequality and educational inequality is positive and robust to the model specification. Other results indicate that women's access to work has a negative impact on inequality and that there is an EU North–South and urban–rural divide. Educational inequality is lower in social-democratic welfare states, in mainly Orthodox areas, and in regions with North/Central family structures. All the results are robust to changes in the definition of income distribution.

Introduction

Who gets educated, to what level, and what accounts for educational inequality are recurrent questions. The answers to these questions are not simple and have been a

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major source of concern for social scientists and decision-makers alike. Yet, despite this interest, little is known about the determinants of educational inequality from a regional perspective in Western Europe. This chapter aims to address this gap in the literature by examining the impact of educational attainment as well as of income per capita and income inequality on educational inequality.

We pursue our objective by resorting to microeconomic data from the European Community Household Panel (ECHP), as well as macroeconomic data from the Eurostat's Regio databases for 102 regions over the period 1995–2000. We use the education level completed as proxy for measuring education. By means of econometric analyses of static and dynamic panel data models, the chapter examines both the short-run and the long-run impact of the determinants of educational inequality and correct the inconsistency of the models introduced by using lagged endogenous variables.

The remainder of this chapter is organised as follows. In the next section, we discuss the theoretical underpinnings of educational inequality. Due to the complexity of the issue and the multidimensional concept of education, this section is divided into two parts. The first part focuses explicitly on the impact of educational attainment, income per capita, and income inequality on educational inequality, as well as on its dynamic structure, while the second part deals with some additional variables such as population ageing, work access, unemployment, inactivity, urbanisation, geography, and institutions. The third section presents the variables and the model used in the analysis. The fourth section depicts the regression results of the determinants of educational inequality. In the final section, we summarise the main points of our inquiry, synthesise our empirical results, and discuss the implications and limits of the analysis.

Theoretical Considerations: The Causes of Educational Distribution

How educational inequality is generated and how it reproduces over time have been major concerns for social scientists. Given the vast body of literature on the determinants of educational inequality, the aim of this section is mainly to consider the dynamic structure of educational inequalities and then to review the link between educational attainment and inequality, before going on to analyse the impact of income per capita and income inequality on educational inequality.

The Determinants of Educational Inequality

There are multiple factors that affect educational inequality. The intergenerational transmission of educational achievement is probably the most important one.

People's educational opportunities are linked not only to their own human capital, but also to those of their communities and families. The value of an individual's own educational credentials depends in part on how they compare to the credentials of their family and, more generally, those of the local population (Hannum and Buchmann 2005: 339). For example, students in higher education usually tend to come from relatively favoured backgrounds (Blöndal et al. 2002: 7). Becker and Tomes (1986) and Galor and Tsiddon (1997) point out that the individual's level of human capital is an increasing function of the parental level of human capital. This is known as the home environment externality. Industrialisation is another important factor (i.e. Treiman 1970). It brings about educational expansion which, in turn, affects educational inequality. The more industrialised a society, the greater the educational expansion. This implies more educational opportunities for the lower strata, greater overall educational attainment, and thus, a lowering of educational inequality (Blau and Duncan 1967).

Yet, economic theory and empirical studies are ambiguous about the likely effects of educational attainment on educational inequalities. On the one hand, it has been mentioned that with respect to the general theory of industrialisation, the stock of education negatively affects educational inequality as result of educational expansion (Ram 1990: 266). Educational expansion narrows human capital inequalities within regions by promoting a meritocratic basis for status attainment in which the talented can achieve appropriate positions in the economy, regardless of their social background (Hannum and Buchmann 2005).[1] However, one critical factor underlying the negative relationship between educational attainment and inequality is the cost of education. Low cost, which could be achieved through higher grants, subsidised loans, subsidised "work-study" jobs, and other financial devices or through lower tuition fees and a lower interest rate on borrowing for educational purposes, enhances the opportunity for those at the bottom of the scale to improve their education. Empirical studies by Lam and Levison (1991) and Thomas et al. (2001) illustrate that educational inequality is negatively associated with the average years of schooling in a country. Ram (1990) shows that the Kuznets curve in education exists only when the standard deviation is used as an inequality measure. He argues that as the human capital stock increases, educational inequality first increases and, after reaching a peak, starts to decline in later phases of educational expansion. Most empirical studies show that countries with higher levels of human capital stock are more likely to achieve equality in human capital than those with a lower stock. These studies illustrate that the "maximum inequality threshold" in education is likely to rise with economic development, as it is with the adoption of skill-intensive technologies.

On the other hand, Ceroni (2001) stresses the positive effects of educational attainment on educational inequality. She argues that if education is privately

[1]Walters (2000: 254), however, argues that educational expansion alone does not change the relative position of social groups in the "education queue", and elites manage to maintain their status by getting more education than the masses.

financed, the poor require relatively higher returns to increased expenditure on education in order to increase the human capital stock. For this reason the poor invest a smaller share of their income in education than the rich do. Moreover, occupations that require high levels of investment in human capital are beyond the reach of poor people, who choose instead to work for others (Banerjee and Newman 1993).

Wealth is another factor that affects educational inequality. On the whole, the overall impact of personal wealth and income per capita on educational inequality seems to be negative. The higher the individual income, the higher the expenditure on education for all strata. This identifies education as a key instrument for securing equal opportunities for people and for helping to improve their life chances (Wolf 2002). An increase in regional economic development is likely to increase the income levels of the poor. This raises the educational opportunities for the lowest strata, which implies a lower level of educational inequality. Moreover, the higher the income levels of the rich, the higher the rate of taxation, and thus the greater the expenditure on public education programmes (Saint-Paul and Verdier 1993), which usually constitute the major portion of the European educational programmes. This will mean more public investment in human capital, and, therefore, increased educational opportunities for the lowest strata, leading to a decline in educational inequalities.

Conversely, lower levels of income per capita limit the opportunities open to the poor and their economic well-being. For example, credit constraints may prevent the poor from undertaking the efficient amount of human capital investment, perpetuating educational inequalities (Loury 1981; Bénabou 1996; Graham 2002). More explicitly, Graham (2002: 67) argues that due to credit market imperfections, access to capital depends on the wealth that may be offered as collateral, which means that an individual's initial assets (i.e. land, credits, education) may be an important determinant of his/her ability to finance educational investments. This may cause a particular problem for human capital investments, because future earnings cannot be used as collateral and, since education plays a central role in determining opportunity investments, this market failure has a particularly negative impact in terms of the opportunities for the poor to move out of poverty. Akin to market failure, government failure contributes to the perpetuation of educational inequality. The behaviour of governments and the allocation of public goods reflect the distribution of political power and the organisational capacity of different societal groups (Birdsall and Estelle 1993; Graham 2002). Thus, government failure is likely to generate an unequal distribution of political power that can lead to a perpetuation or concentration of income and educational inequality.

The effect of income inequality on educational inequality is also not unambiguous. On the one hand, Saint-Paul and Verdier (1993) have supported the idea that income inequality has a negative effect on human capital inequality. More explicitly, they argue that the greater the income inequality, the higher the rate of taxation, and the larger the expenditure on public education programmes. This yields higher public investment in human capital, which in turn leads to a decline in educational inequality. On the other, Checchi (2000) argues that an increase in income inequality may involve a self-perpetuating poverty trap that may increase educational inequality. The more skewed the income distribution, the larger the share of the population that are excluded from schooling and the greater the inequality in educational achievement. From this perspective, European citizens who live under poverty can only escape that condition by increasing their educational attainment. A positive relationship between income and educational inequality is also likely to indicate the responsiveness of the European labour market to differences in qualifications and skills (Tselios 2008; Rodríguez-Pose and Tselios 2009).

Empirically, Jensen and Nielsen (1997) have found some support for the notion that poverty and inequality force households to keep their children out of school. Mayer (2001) examined the effect of growing income inequality on the educational attainment of low-income and high-income children. Her results indicate that inequality has not led to an increase in high school graduation, but may have brought a slight decrease, especially for low-income people, whereas the growth in inequality appears to have led to an increase in college graduation, but only among young people from the top half of the income distribution. Mayer also considers two contrasting economic theories about how income inequality may affect children's educational attainment: effects due to the parents' income and effects due to the consequences of other people's income. Finally, Acemoglu and Pischke (2000) analysed the patterns of college enrolments across the United States. They did not find any evidence to support the idea that college enrolments increase more in states where wage inequality and returns to schooling are higher (Thorbecke and Charumilind 2002: 1488).

Control Variables

According to the literature, numerous other factors may also affect inequality in education. Some of the most prominent factors are (1) population ageing, (2) work access, (3) unemployment and inactivity, (4) urbanisation, (5) geography and (6) institutions.

1. *Population ageing*: As with previous factors, the impact of population ageing on inequality is controversial. For some, as people get older, their lack of educational opportunities stretches the human capital distribution (Motonishi 2006). Their low probability of increasing their educational stock leaves them with little opportunity to improve economic circumstances. For others, regions with a very young population will tend to have a lower rate of participation in the labour force and high human capital inequalities. Young people in work will earn less in a labour market that rewards seniority, increasing inequality within a society (Higgins and Williamson 1999). Finally, regions with a mature working age cohort tend to have lower inequality, because these people do not face credit constraints that prevent them from increasing their level of education (Dur et al. 2004).

2. *Access to work*: Greater access to work is likely to lead to lower educational inequality. Both theoretical and empirical evidence has been presented in support of this direction in the relationship (i.e. Borooah 1999; Rodríguez-Pose 2002). A trade-off between inequalities and work access (either full-time work or atypical employment) is expected. In addition, men and women generally do not have equal opportunities to engage in paid work. The causes of gender inequality in the EU labour market are quite complex, with a variety of political, administrative, and legislative responses involved (Barnes et al. 2005). Women have traditionally had more responsibilities for care-giving and household tasks than their male partners. Many women, particularly those who are heads of households with young children, are either unemployed or limited in their employment opportunities for reasons that include inflexible working conditions and arrangements, inadequate sharing of family responsibility, and a lack of sufficient services such as child care. Many women stop working altogether after having their first child, while others only return to the labour market as part-time workers when their child or children reach school age (Rodríguez-Pose 2002: 80). The cultural barriers, including the persistence of informal networks from which women are excluded, also prevent them from achieving equal participation in the labour market (Court 1995). Moreover, the effect of women's individual characteristics which shape their access to labour market may depend on the socio-political structure, such as the male dominated hierarchy of the political economy and existing ideologies on gender (Coleman 1991). It is therefore important to distinguish the women's work access effect from the total population's work access effect.
3. *Unemployment and inactivity*: Unemployment and inactivity are fundamentally considered to be positively associated with educational inequality. Increases in unemployment and inactivity aggravate the relative position of low-income and low-educated groups, as marginal workers with relatively low skills are at the bottom of the income and educational distribution and their jobs are at greater risk during an economic downturn (Mocan 1999). The effect of unemployment and inactivity on inequality also might reflect the inflexibility of European labour markets. European labour conditions, such as the differences among the European countries concerning unemployment benefit, job-creation policies, and vocational training programmes among others (Ayala et al. 2002) are all important factors in accounting for the differences observed in educational inequality across European regions. From a broader perspective, the relatively higher level of structural unemployment which characterises many European societies is likely to cause a loss of current output and fiscal burden, social exclusion, skill loss and long-run damage, psychological harm, ill health, loss of motivation and organisational inflexibility, among other effects, which, in turn, increase inequality (Sen and Foster 1997). Individuals will tend to choose the optimal level of educational attainment by means of a marginal benefit–cost calculus, comparing the benefits derived from additional schooling to the costs incurred (Becker 1964). Students from poorer backgrounds might not be able to choose the optimal level of educational attainment because of a lack of

resources, low budget, and low labour market information. First, students whose parents are unemployed or inactive (and thus have a low budget) are less likely to maximise their economic welfare by investing enough in human capital. Second, students may not be well informed about the nature and the prospects of the different education levels. In a market system, decisions are left to parents, at least for early education (Barr 2004). However, parents with little education may have less information than better-educated parents about school choice and they may be less able to make use of the information they have (Ludwig 1999; Barr 2004). Therefore, children and teenagers from more affluent families have more accurate labour market information than children from unemployed and poor families. Less-educated people have limited access to the labour market and are unlikely to find work even if there is an increase in labour demand, because they either do not possess the skills, or their skills are in some way unsuitable for the jobs on offer (European Commission 1999).

4. *Urbanisation*: There is less empirical evidence on the relationship between urbanisation and educational inequality. Glaeser (1999), for instance, has suggested that urbanisation influences the wages of different workers in different ways as a result of learning, knowledge, and skills. He points out that urban density may be negatively associated with wage dispersion, because low-skilled workers may have more to gain through learning than high-skilled workers. Wheeler (2004) has also offered some evidence on this relationship. Information about labour markets has an impact on urban–rural differences in educational inequality. People who live in low-income rural areas have usually less accurate information about labour market institutions than people in high-income urban areas. There is no horizontal equity in education between urban and rural citizens, because the problem of lacking information is greater for individuals in lower socioeconomic and rural groups as information is costly to acquire (i.e. due to distance). Since information has a positive influence on educational attainment (Ludwig 1999), and educational attainment and educational inequality are negatively correlated, low-income rural areas are likely to have not only low educational attainment, but also high educational inequality.
5. *Geography*: Physical geography has recently re-emerged as a factor explaining socioeconomic phenomena (Gallup et al. 1999; Sachs et al. 2001). We examine whether latitude, which is regarded as an essential element of "first" nature of geography (physical geography) (Brakman et al. 2001), accounts for a proportion of variation in educational inequality. Past studies of the relationships between regional economic activity and geography have been hampered by the use of dummies in order to classify the location of each region (i.e. Baumont et al. 2003; Fischer and Stirbock 2006). However, the allocation of some regions to the North–South regime is arbitrary and should be tested according to alternative definitions of "North" and "South". In order to avoid this problem and partly as a result of the identified limitations of the existing literature in examining the impact of latitude on inequalities and on economic activity in general (Gallup et al. 1999; Mitchener and McLean 2003; Woods 2004), the analysis performed here is an attempt to fill this gap. But why should latitude

matter for educational inequalities? Mitchener and McLean (2003) have found that latitude accounts for a low proportion of the differences in productivity levels in the United States. Woods (2004), in contrast, shows that latitude is a key analytical concept in understanding the spatial aspects that affect economic development. Latitude can also be considered as a good proxy for the effects of a region's climate on its level of productive efficiency (Mitchener and McLean 2003). Climatic variation affects productivity for three reasons. First, disease ecology, agronomic processes, and soil fertility can be influenced by climate and may, in turn, alter productivity (Mitchener and McLean 2003). Second, good weather is an amenity. For example, cities with better weather than the average of their countries have systematically higher rates of urban population growth (Cheshire and Magrini 2006). Third, changes in the occupational and wage structure are not independent of weather. For instance, inequality is higher in the Mediterranean countries which have many tourist resorts (i.e. the Greek islands) that offer part-time jobs, especially in the summer and for women and young people. Finally, classifying regions according to the North–South regime may lead to theoretical considerations based on the "second" nature of geography (the geography of distance between economic agents) (Brakman et al. 2001). Thus, while latitude is a variable of physical geography, the analytical concepts that are crucial in understanding the relationship between latitude and inequalities may not be a matter of the "first" nature of geography. The analysis performed here goes beyond the distinction between the "first" and the "second" nature of geography.

6. *Institutions*: The variables explored here organise regions into categories that are hypothesised to have some underlying similarity with regard to institutions, such as welfare regimes, religion, and family structure. The goal is to investigate the effects of more general institutional and cultural arrangements (DiPrete and McManus 2000; Stier et al. 2001). This approach is more concise than using country-dummies.

The Welfare State: The mechanisms through which human capital inequalities are reproduced vary across the welfare states because they comprise not only cash benefits (i.e. income) but also benefits in kind (i.e. education) (Barr 2004). Following the work of Esping-Andersen (1990), Ferrera (1996), and Berthoud and Iacovou (2004), four categories of welfare state are used: social-democratic (Sweden, Denmark), liberal (United Kingdom, Ireland), corporatist or conservatism (Luxembourg, Belgium, France, Germany, Austria), and "residual" or "southern" (Portugal, Spain, Italy, Greece).[2] This now classical categorisation focuses on the relationship between the state and the market with respect to the provision of income and services and considers the effects of welfare states on social stratification and socioeconomic inequalities (Geist 2005: 25). The hypothesis here is that a country's welfare policy

[2]Although the boundaries of the welfare states are not well defined, the classification assumes that a country belongs to only one welfare state regime. In reality, there is no single pure case (Esping-Andersen 1990).

as measured through its social expenditures has a significant effect on educational redistribution. For instance, educational inequality is low in the social-democratic regimes because they encourage women's participation in the labour market. The availability of public care services to families has an influence on women's life choices by enabling them to combine having children with careers (Esping-Andersen 2002). In conservative regimes, by contrast, women are encouraged to stay at home while the children are young.

Religion: Going back to Weber (1922), religion, as an aspect of social life and culture, distributes social rewards and shapes life chances. It concerns "non-market" activities and institutions (Iannaccone 1992) and affects the economic attitudes and activities of individuals, groups (i.e. the members of a household), and societies (i.e. regions). Religion may influence the rate of return on human capital as has already been examined by many scholars (i.e. Tomes 1985; Iannaccone 1998). We classify European regions on the basis of the main or more traditional religion in every territory into four groups: mainly Protestant (Sweden, Denmark, Northern Germany, Scotland); mainly Catholic (France, Ireland, Luxembourg, Portugal, Spain, Italy, Austria, southern Germany, Belgium); mainly Anglican (England); and mainly Orthodox (Greece).[3] Although the relationship between religion and inequality is tremendously complex, it is hypothesised that regions with the same religion have close social links, leading to similar educational inequality levels within-groups of religion, but different inequality levels between-groups of religion. Various channels through which religion may influence the level of education have already been considered, such as marriage, divorce, fertility, and childrearing (Iannaccone 1998). Religion also leads to differences in earnings, in education, and in female employment (Lehrer 1999). According to Keister (2003), religion affects wealth ownership by shaping demographic behaviours, identifying which goals should be valued and contributing to social contacts that provide information and opportunities. Additionally, religion influences the processes that create educational inequalities through attitudes towards work (Heath et al. 1995), family traditions and cultures (Swidler 1986), the creation and implementation of public institutions, such as blue laws and prohibition (Fairbanks 1977), and party competition (Hutcheson and Taylor 1973). In addition, religion may be an important determinant of how people think about inequalities (Feagin 1975). Some Protestants groups hold the strongest individualistic beliefs, which locate the causes of low income and human capital stock in the people themselves (i.e. lack of ability, lack of effort), but are weakest in terms of structuralist beliefs, which locate the causes of low income in the social and economic system (i.e. lack of jobs, discrimination) (Hunt 2002).

Family Structure: The concept of family structure that is used in this analysis refers to the household size. Following the work of Berthoud and Iacovou (2004), three groups of countries in the study of living arrangements are used: Nordic

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[3] *Sources*: http://www.cia.gov/cia/publications/factbook;
http://commons.wikimidia.org/wiki/Image:Europe_religion_map_de.png;
http://csi-int.org/world_map_europa_religion.php

(Sweden, Denmark), North/Central (UK, Belgium, Luxembourg, France, Germany, Austria), and Southern/Catholic (Ireland, Portugal, Spain, Italy, Greece). The hypothesis is that a country's family structure plays a significant role in educational inequality. According to Berthoud and Iacovou (2004) there are, broadly speaking, three different living arrangements (1) Living with unrelated individuals. This type of household means sharing living quarters with unrelated persons (i.e. students) and does not imply sexual relations between housemates. In this case, householders tend to choose housemates with the same educational level (Leppel 1987). This implies that the intra-household educational inequality is very low. (2) Living alone (i.e. unmarried, widowed and divorced). In this case, individual inequalities coincide with household inequalities. (3) Living with related individuals. In societies where the husband is expected to support the wife who usually serves as full-time homemaker, the husband's wage and his educational attainment must be large enough to support two adults (Leppel 1987). In this case, the intra-household inequality is high and it is even higher when the husband must support children. Fertility is also one of the most significant determinants of family structure. In some societies, marriage is usually delayed until the man is in a sufficiently strong financial position (Leppel 1987). In contrast, where women are labour force participants, the spouse shares the living expenses and the intra-household educational inequality is low. In addition, the larger the household size, the higher the intra-household educational inequality as rich people have usually less children than poor people. A particular case in this type of household is the single-parent family. Scholars such as Sandefur and Wells (1999) have pointed out that individuals who grow up in a single-parent family are less likely to graduate from high school than those who grow up in a family with both original parents.

Econometric Specification, Data, Variables, and Methodology

The question that arises at this point is how different contributions of these factors affect educational inequalities across regions in Western Europe. We use the following econometric specification.

$$EducIneq_{it} = \beta_1{}'EducAtt_{it} + \beta_2{}'Incpc_{it} + \beta_3{}'IncIneq_{it} + \beta_4{}'x_{it} + u_{it}$$

With i denoting regions ($i = 1, \ldots, N$) and t time ($t = 1, \ldots, 6$) [4] $EducIneq_{it}$ is educational inequality, $EducAtt_{it}$ is educational attainment, $Incpc_{it}$ is income per capita, $IncIneq_{it}$ is income inequality, x_{it} is a vector of control variables, $\beta_{1,\ldots,4}$ are coefficients and u_{it} is the composite error.

Table 7.1 shows the definition, description and sources of the main and control variables. Microeconomic variables are extracted from the ECHP data survey,

[4] $t = 1$ denotes 1995, ..., $t = 6$ denotes 2000.

Table 7.1 Variables

Definition	Description	Sources
Educational attainment	Average in education level completed	ECHP
Educational inequality	Inequality in education level completed (Theil index)	ECHP
Income per capita (a) income per capita for the whole of the population (b) income per capita for normally working (15+ h per week) people	Income per capita (/1,000)	ECHP
Income inequality (a) income inequality for the whole of the population (b) income inequality for normally working people	Income inequality (Theil index)	ECHP
Population ageing	The average age of respondents	ECHP
Work access	(a) The percentage of normally working (15+ h per week) respondents	ECHP
	(b) The percentage of economic activity rate of total population	EUROSTAT
Unemployment	The percentage of unemployed respondents	ECHP
Inactivity	The percentage of inactive respondents	ECHP
Female's work access	The percentage of female's economic activity rate	EUROSTAT
Urbanisation (*time-invariant*)	The percentage of respondents who live in a densely populated area (1999–2000)	ECHP
Latitude (*time-invariant*)	Latitude	GIS
Welfare state (*dummies*)		Esping-Andersen (1990), Ferrera (1996), Berthoud and Iacovou (2004)
Social-democratic	Sweden, Denmark	
Liberal	United Kingdom, Ireland	
Corporatist (conservatism)	Luxembourg, Belgium, France, Germany, Austria	
Residual ("Southern")	Portugal, Spain, Italy, Greece	
Religion (*dummies*)		http://www.cia.gov; http://csi-int.org; http://www.wikipedia.org/
Mainly Protestant	Sweden, Denmark, Northern Germany, Scotland	
Mainly Catholic	France, Ireland, Luxembourg, Portugal, Spain, Italy, Austria, Southern Germany, Belgium	
Mainly Orthodox	Greece	
Mainly Anglicans	England	
Family structure (*dummies*)		Berthoud and Iacovou (2004)
Nordic (Scandinavian)	Sweden, Denmark	
North/Central	UK, Belgium, Luxembourg, France, Germany, Austria	
Southern/Catholic	Ireland, Portugal, Spain, Italy, Greece	

which covers from 104,953 to 124,663 individuals during the period 1994–2001. These variables are complemented with macroeconomic variables from the Eurostat's Regio dataset. The ECHP dataset is based on NUTS regions' version 1995 and the Eurostat's Regio one on NUTS regions' version 2002. The elaboration process of both datasets is coordinated by Eurostat, making comparisons reliable. However, some adjustment of regions in order to match different datasets is required.

This study uses static and dynamic methods of panel data regression analysis. The static models are characterised by one source of persistence over time due to the presence of unobserved regional-specific effects. They concern ordinary least squares (OLS), fixed effects (FEs), and random effects (REs) estimators. To evaluate which technique is optimal we use the diagnostic tests of Breusch and Pagan's (1980) Lagrange multiplier (LM) statistic and Hausman's (1978) chi-squared statistic. The robust estimation of the covariance matrix is also presented following the White estimator for unspecified heteroskedasticity (White 1980). The dynamic models are characterised by two sources of persistence over time: autocorrelation due to the presence of a lagged dependent variable among the regressors and unobserved regional-specific effects (Baltagi 2005). Pooled OLS, FEs, and REs estimators are now biased and inconsistent, because the econometric model contains a lagged endogenous variable (Baltagi 2005). The dynamic panel structure of our data is exploited by a generalised method of moments (GMM) estimation suggested by Arellano and Bond (1991) (Arellano-Bond estimation). We assume that the explanatory variables might be: strictly exogenous, predetermined, or endogenous. The GMM methodology is based on a set of diagnostics. It assumes that there is no second-order autocorrelation in the first-differenced idiosyncratic errors. Additionally, Arellano and Bond (1991) developed Sargan's test (1958) of over-identifying restrictions. The Sargan test has an asymptotic chi-squared distribution in the case of homoskedastic error term only. Both the homoskedastic one-step and the robust one-step GMM estimators are presented. In these models we obtain both short-run and long-run parameters. Comparing the two models, the main advantage of dynamic over static models is that the former corrects the inconsistency introduced by lagged endogenous variables and, also, permits a certain degree of endogeneity in the regressors. Overall, in order to examine the determinants of educational inequality and to evaluate the robustness of the results, we experiment with a number of alternative specifications and also include additional determinants to our equations.

Regression Results

Estimations of the Static Model

The statistical evidence of the OLS, FEs, and REs models of inequality in the education level completed when explanatory variables are income per capita of the population as a whole and income inequality among the whole of the population is

Table 7.2 FEs

	(1)	(2)	(3)
Educational attainment	−1.0761	−1.0985	−1.1385
	(0.0251)***	(0.0325)***	(0.0371)***
	*(0.0225)****	*(0.0376)****	*(0.0445)****
Income per capita		0.0038	0.0055
		(0.0027)	(0.0037)
		(0.0024)	*(0.0030)**
Income inequality		0.2725	0.1674
		(0.0867)***	(0.1106)
		*(0.0786)****	*(0.0868)**
Population ageing			0.0047
			(0.0049)
			(0.0048)
Unemployment			0.1448
			(0.3222)
			(0.2614)
Female's work access			−0.0058
			(0.0028)**
			*(0.0028)***
R-squared	0.7888	0.7940	0.7596
Observations	596	596	513
LM test	1134.37	1047.57	784.54
(p-value)	(0.0000)	(0.0000)	(0.0000)
Hausman test	23.91	79.28	69.25
(p-value)	(0.0000)	(0.0000)	(0.0000)

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*), (**)* and *(***)* denote the significance of the White (1980) estimator. LM TEST is the Lagrange Multiplier test for the random effects model based on the OLS residuals (Breusch and Pagan 1980). HAUSMAN TEST is the Hausman (1978) test for fixed or random effects. A constant is included

in favour of the FEs models, which are presented in Table 7.2. Table 7.3, which includes time-invariant variables (urbanisation, latitude, and institutional variables), displays the OLS models.[5]

Regression 1 (Table 7.2) examines the pure educational attainment effect on educational inequality. There is a strong negative relationship between the average level of educational attainment and the inequality in the education level completed. The coefficient on educational attainment is statistically significant at the 1% level. The R-squared is 0.7888. It shows that educational attainment explains a large variation in educational inequality in the sample. In terms of the goodness-of-fit, it is likely to indicate a good unconditioned model. Including the other variables of the model does not change this result (Regressions 2–3). Educational attainment plays a prominent role and appears robust to the inclusion of additional influences. Taking into account the standardised coefficients (Table A1 in Appendix), it

[5]The REs results are not reported because of space constraints, but may be obtained upon request.

Table 7.3 OLS

	(1)	(2)	(3)	(4)	(5)
Educational attainment	−1.0990	−1.1127	−1.3622	−1.2859	−1.1899
	(0.0765)***	(0.0529)***	(0.0501)***	(0.0510)***	(0.0529)***
	_(0.0800)***_	_(0.0580)***_	_(0.0516)***_	_(0.0497)***_	_(0.0571)***_
Income per capita	−0.0355	−0.0214	−0.0075	−0.0207	−0.0256
	(0.0061)***	(0.0038)***	(0.0044)*	(0.0033)***	(0.0046)***
	_(0.0056)***_	_(0.0034)***_	_(0.0047)_	_(0.0038)***_	_(0.0048)***_
Income inequality	0.4926	0.4398	0.4814	0.7405	0.6511
	(0.1528)***	(0.1208)***	(0.1016)***	(0.0940)***	(0.1139)***
	_(0.1372)***_	_(0.1004)***_	_(0.0923)***_	_(0.0732)***_	_(0.1008)***_
Population ageing	0.0052	−0.0014	0.0111	0.0163	0.0047
	(0.0061)	(0.0045)	(0.0041)***	(0.0041)***	(0.0045)
	_(0.0076)_	_(0.0050)_	_(0.0052)**_	_(0.0049)***_	_(0.0052)_
Unemployment	−0.3464	−2.0025	0.1922	−0.3720	−1.5483
	(0.5673)	(0.3048)***	(0.3317)	(0.3104)	(0.3323)***
	_(0.7354)_	_(0.2980)***_	_(0.4129)_	_(0.3817)_	_(0.3708)***_
Female's work access	0.0212	0.0147	0.0166	0.0142	0.0186
	(0.0026)***	(0.0017)***	(0.0018)***	(0.0015)***	(0.0019)***
	_(0.0022)***_	_(0.0016)***_	_(0.0018)***_	_(0.0015)***_	_(0.0018)***_
Urbanisation (fixed)	0.2642				
	(0.0561)***				
	_(0.0440)***_				
Latitude (fixed)		−0.0087			
		(0.0026)***			
		_(0.0023)***_			
Liberal			0.3650		
			(0.0401)***		
			_(0.0348)***_		
Corporatist (conservatism)			0.1249		
			(0.0391)***		
			_(0.0326)***_		
Residual ("Southern")			0.2557		
			(0.0626)***		
			_(0.0636)***_		
Mainly Catholic				0.0126	
				(0.0246)	
				_(0.0216)_	
Mainly Orthodox				−0.1580	
				(0.0461)***	
				_(0.0407)***_	
Mainly Anglicans				0.2663	
				(0.0246)***	
				_(0.0211)***_	
North/Central					−0.2059
					(0.0423)***
					_(0.0334)***_
Southern/Catholic					−0.0158
					(0.0429)
					_(0.0451)_
Adj R-sq	0.7963	0.8063	0.8480	0.8569	0.8123
Observations	299	513	513	513	513

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. _(*), (**)_ and _(***)_ denote the significance of the White (1980) estimator. A constant is included accounts for the majority of the variation in educational inequality. Educational attainment is thus one of the most powerful instruments known for reducing educational inequality. One reason for this may be that the increased chances to acquire higher education enable more people to improve their socioeconomic circumstances. Educational expansion and free primary and secondary education have offered educational opportunities and numerous favourable chances to both advantaged and disadvantaged groups.

The income per capita and income inequality for the whole of the population, which are both indicators of income distribution, are added to the model in Regressions 2–3 (Table 7.2). The impact of income per capita on educational inequality on the one hand is positive and statistically significant at the 10% level only in Regression 3 and for the heteroskedastic error term. The positive coefficient could indicate that an increase in the income per capita of a region may raise the educational opportunities of the highest strata implying under certain circumstances greater educational inequality. This positive inequality relationship goes against Saint-Paul and Verdier's (1993) hypothesis that the higher the income per capita, the higher the rate of taxation, the greater the expenditure on public education programmes, the higher the public investment in human capital, and, therefore, the greater the educational opportunities of the lowest strata. Although public education programmes constitute the major portion of the European education system, they do not seem to be sufficiently effective to reduce the inequality in education level completed. The coefficients on income inequality, on the other hand, are significant and have the expected sign. The greater the income inequality, the greater the human capital inequality. The most likely explanation is that rich people have higher educational opportunities than the poor. Rich people have also better job chances and greater opportunities to take their education to an otherwise more profitable level, should it be necessary. Additionally, a further increase in income inequality may lead to a self-perpetuating poverty trap that may in turn increase the population share excluded from certain levels of schooling. Due to the causality effects, the positive impact of income inequality on educational inequality is likely to be reflected in the responsiveness of the EU labour market to differences in qualifications and skills (Tselios 2008; Rodríguez-Pose and Tselios 2009).

In Regression 3 (Table 7.2) we add some time-variant control variables. We also test for the influence of population ageing, unemployment, and female's work access. The impact of population ageing and unemployment on human capital inequality seems to be ambiguous. The findings also show, as expected, a negative connection between women's access to work and educational inequality. It supports the view that increasing women's access to the labour market – through more adequate childcare services, more flexible working conditions, and more sharing of family responsibilities – contributes to reduce educational inequalities.[6] Due to the

[6]We also controlled for work access of the population – measured as the percentage of normally working respondents (source: ECHP) and as the percentage of economic activity rate of the total population (source: EUROSTAT) – and inactivity. The economic activity rate of the total population is negatively associated with educational inequality, while the remaining two variables

high value of the R-squared in all the specification FEs models, a significant proportion of cross-regional and over time variations in inequality in the education level completed have already been explained.

We now resort to the OLS models (Table 7.3) in order to explain the association of urbanisation, latitude and institutions (time-variant variables) to educational inequalities. The coefficient on urbanisation is positive, but the coefficient on latitude is negative. Both coefficients are statistically significant at the 1% level. Educational inequality is higher in liberal welfare states and in Anglican areas such as the United Kingdom, but lower in social democratic regions and in mainly Orthodox areas. Additionally, educational inequality is lower for North/Central family structures than for Nordic family structures.

Considering income per capita and inequality for normally working people as explanatory variables, the FEs and OLS regression results of educational inequality models are similar to the results when the explanatory variables are income per capita and inequality for the whole of the population (see Tables A.2 and A.3 in Appendix).

Estimations of the Dynamic Model

Table 7.4 displays the long-run results for the GMM estimation of the dynamic educational inequality model. The short-run evolution of the determinants of educational inequality in the EU and the test statistics for serial correlation and overidentifying restriction are presented in Table A.4 in Appendix.

The coefficient on the lagged dependent variable lies in the interval between 0.2338 (equation 3c) and 0.5335 (equation 1a) (Table A.4 in Appendix). It is higher when the explanatory variables are assumed to be exogenous. Additionally, the coefficients on the lagged educational inequality are statistically significant at least at the 5% level. One would expect to find that educational inequality in the current period depends on educational inequality in the lagged 1-year period. However, most people in the ECHP data survey have already completed their formal studies and thus their time-series variation in education level completed is zero. People who have not completed their studies (i.e. the young) change education level at least every 3 years (i.e. from the first stage to the second stage of secondary education level completed).

Table 7.4 shows that the long-run effect of educational attainment, which is obtained after full adjustment of educational inequality, is negative, robust, and

are not statistically significant. Greater regional access to work implies higher regional earnings which, in turn, increase the possibility of entering higher education. Conversely, the presence of pools of people with low skills would contribute to social exclusion and to the perpetuation of educational inequality (Rodríguez-Pose 2002). The coefficients of educational attainment, income per capita, and income inequality are robust to the introduction of control variables.

Table 7.4 Long run GMM

	Regression (1)			Regression (2)			Regression (3)		
	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous
Educational attainment	−1.1667	−1.3155	−1.7170	−1.3328	−1.3964	−1.4555	−1.3239	−1.3340	−1.3343
	(0.0982)***	(0.1363)***	(0.2330)***	(0.1201)***	(0.1207)***	(0.1397)***	(0.1104)***	(0.1268)***	(0.1285)***
	*(0.1254)****	*(0.2353)****	*(0.4263)****	*(0.1691)****	*(0.1632)****	*(0.1831)****	*(0.1439)****	*(0.1594)****	*(0.1428)****
Income per capita				0.0050	−0.0292	−0.0346	−0.0024	0.0080	−0.0025
				(0.0127)	(0.0141)**	(0.0195)*	(0.0146)	(0.0171)	(0.0166)
				(0.0099)	*(0.0133)***	*(0.0235)*	*(0.0087)*	*(0.0131)*	*(0.0121)*
Income inequality				1.0584	1.9193	2.5936	0.8870	0.8276	1.3005
				(0.2947)***	(0.3111)***	(0.3726)***	(0.2879)***	(0.3777)**	(0.4709)***
				*(0.3557)****	*(0.6291)****	*(0.8933)****	*(0.3653)***	*(0.4036)***	*(0.4774)****
Population ageing							0.0295	0.0383	0.0184
							(0.0168)*	(0.0170)**	(0.0170)
							(0.0187)	*(0.0252)*	*(0.0229)*
Unemployment							−0.5645	−1.3964	0.5442
							(0.9049)	(1.2954)	(1.5256)
							(0.7823)	*(1.8041)*	*(1.6406)*
Female's work access							−0.0164	−0.0243	−0.0311
							(0.0075)**	(0.0106)**	(0.0121)***
							(0.0108)	*(0.0183)*	*(0.0206)*
Observations	392			392			325		

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*)*, *(**)* and *(***)* denote the significance of the White (1980) estimator statistically significant at the 1% level. The higher the educational attainment, the lower the educational inequality. This finding is consistent with the static results. Regression 2 displays the introduction of income distribution as measured by income per capita and income inequality. This regression indicates that regional economic development has a negative influence on human capital inequality which is not consistent with the static results. We therefore find some evidence that both educational attainment and income per capita alleviate the inequality in human capital. As in the static models, the results also show that a more unequal distribution of income is associated with higher educational inequality. The coefficient on income inequality is significant and does not disappear when other background factors are held constant.

The long-run impact of population ageing on educational inequality is positive, while the impact of unemployment on educational inequality is ambiguous (Regression 3), as in the respective FEs model. The findings once more show a negative connection between women's access to work and educational inequality.[7] Finally, no matter what income distribution is considered, the regression results of educational inequality are similar (see Tables A.5 and A.6 in Appendix for the long run and short run results, respectively, for income distribution for normally working people).

Overall, educational attainment and income inequality have been found to be robust, in the sense that their estimated parameters keep the same sign and are statistically significant in both static and dynamic specifications.

Concluding Remarks

Our empirical analysis of the regional determinants of educational inequality in Western Europe revealed a rich set of findings. As a whole, the results are reasonable and there are theories in the literature that confirm the observed relationships. They also provide useful insights for the conduct of future regional educational policy in Europe. Considering that education is a multidimensional concept which accounts knowledge, skills, learning-by-doing, acquisition of information about the economic system, investments in reputation and personal relationships among others, a plethora of factors have an impact on educational inequalities.

[7]Controlling for inactivity, its coefficient is negative and statistically significant. It is likely to show that the higher the percentage of inactive young people, the lower the educational inequality in the long run, because more widespread access to education means that young people are kept out of the labour market, as reflected in the high incidence of youth inactivity (Rodríguez-Pose 2002). Additionally, the impact of the percentage of normally working respondents is not clear, while that of the economic activity rate of total population is negative and statistically significant.

One of the main conclusions of the study is that improving access to education, providing a higher quality of education, and generally increasing educational attainment are likely to curb the increase in educational inequality at a regional level in Europe. While the impact of income per capita on inequality in education is not clear, no matter how income distribution is defined, income and educational inequality are positively connected, highlighting the fact that (1) rich people have greater educational opportunities than the poor, as well as greater chances to take up profitable educational opportunities, should it be necessary, and (2) that the EU labour market responds to differences in qualifications and skills, due to the causality effects. Overall, microeconomic changes in income distribution as measured by levels of inequality seem to be more important than those measured by the average levels.

The use of control variables underlines the robustness of the positive relationship between income and educational inequality. Hence, despite the limitations of the definition and measurements of educational inequality, this relationship is not sensitive for instance to the age of respondents, their participation in the labour market, the city and region they live in, or the religion they belong to. The findings, in addition, indicate that female's work access has negative impact on inequality and that there is an EU North–South and urban–rural divide in terms of educational inequality. Finally, educational inequality is lower in social-democratic welfare states, in mainly Orthodox areas, and in regions with North/Central family structures.

Despite the robust and important findings regarding the association between educational inequality, on the one hand, and educational attainment and income inequality at a regional level in Europe, on the other, the analysis conducted here is not exempt from limitations which fundamentally concern the availability and quality of the data. As the quality of the data improves and longer time series become available, this would allow, first, to refine the estimates by considering longer periods at a more disaggregated level of analysis. Second, the measurement of education could be decomposed in order to shed light into how different factors affect educational inequality using different definitions. This chapter has provided a first analysis of the determinants of regional educational inequality in western Europe and it has raised as many questions as it has answered, questions that could whet our appetite for more in depth research on the specific determinants of educational inequality at a regional level in Europe and elsewhere.

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Appendix A: Standardized Coefficients

Table A1 Independent variables are income per capita and income inequality for the (a) whole of the population (b) normally working people

	Regr. 1	Regr. 2	Regr. 3
(a)			
Educational attainment	−0.8691	−0.7804	−0.7526
Income per capita		−0.1760	−0.2510
Income inequality		−0.0732	0.2424
Population ageing			−0.0004
Unemployment			−0.1654
Female’s work access			0.3214
(b)			
Educational attainment	−0.8691	−0.6651	−0.7903
Income per capita		−0.1849	−0.1964
Income inequality		0.1569	0.1745
Population ageing			−0.0266
Unemployment			−0.1072
Female’s work access			0.1776

Table A.2 FEs: independent variables are income per capita and income inequality for normally working people

	(1)	(2)	(3)
Educational attainment	−1.0761	−1.0932	−1.1260
	(0.0251)***	(0.0315)***	(0.0362)***
	*(0.0225)****	*(0.0338)****	*(0.0407)****
Income per capita		0.0019	0.0019
		(0.0021)	(0.0027)
		(0.0016)	*(0.0019)*
Income inequality		0.2020	0.1559
		(0.0864)**	(0.1105)
		*(0.0665)****	*(0.0788)***
Population ageing			0.0052
			(0.0049)
			(0.0047)
Unemployment			0.1463
			(0.3193)
			(0.2590)
Female’s work access			−0.0059
			(0.0027)**
			*(0.0029)***
R-squared	0.7888	0.7916	0.7581
Observations	596	596	513
LM test	1134.37	1064.72	809.09
(p-value)	(0.0000)	(0.0000)	(0.0000)
Hausman test	23.91	47.16	61.08
(p-value)	(0.0000)	(0.0000)	(0.0000)

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*), (**)* and *(***)* denote the significance of the White (1980) estimator. LM TEST is the Lagrange Multiplier test for the random effects model, based on the OLS residuals (Breusch and Pagan 1980). HAUSMAN TEST is the Hausman (1978) test for fixed or random effects. A constant is included

Table A.3 OLS: independent variables are income per capita and income inequality for normally working people

	(1)	(2)	(3)	(4)	(5)
Educational attainment	−1.0838	−1.1527	−1.3747	−1.3245	−1.2316
	(0.0754)***	(0.0504)***	(0.0473)***	(0.0483)***	(0.0503)***
	*(0.0736)****	*(0.0544)****	*(0.0520)****	*(0.0502)****	*(0.0567)****
Income per capita	−0.0301	−0.0151	−0.0056	−0.0155	−0.0175
	(0.0047)***	(0.0027)***	(0.0031)*	(0.0024)***	(0.0032)***
	*(0.0042)****	*(0.0025)****	*(0.0036)*	*(0.0030)****	*(0.0035)****
Income inequality	0.5754	0.7519	0.5903	0.9599	0.8194
	(0.1803)***	(0.1383)***	(0.1251)***	(0.1168)***	(0.1403)***
	*(0.1643)****	*(0.1316)****	*(0.1306)****	*(0.1087)****	*(0.1394)****
Population ageing	0.0002	−0.0053	0.0058	0.0096	−0.0023
	(0.0061)	(0.0043)	(0.0040)	(0.0040)**	(0.0044)
	(0.0079)	*(0.0047)*	*(0.0053)*	*(0.0047)***	*(0.0051)*
Unemployment	0.4806	−1.4358	0.4535	0.1802	−1.0256
	(0.5486)	(0.3029)***	(0.3156)	(0.3011)	(0.3181)***
	(0.6450)	*(0.3035)****	*(0.3882)*	*(0.3675)*	*(0.3401)****
Female's work access	0.0150	0.0101	0.0117	0.0069	0.0109
	(0.0023)***	(0.0015)***	(0.0017)***	(0.0013)***	(0.0019)***
	*(0.0021)****	*(0.0015)****	*(0.0019)****	*(0.0012)****	*(0.0019)****
Urbanisation (fixed)	0.2392				
	(0.0551)***				
	*(0.0441)****				
Latitude (fixed)		−0.0081			
		(0.0024)***			
		*(0.0024)****			
Liberal			0.3196		
			(0.0423)***		
			*(0.0404)****		
Corporatist (conservatism)			0.0841		
			(0.0410)**		
			*(0.0371)***		
Residual ("Southern")			0.2229		
			(0.0640)***		
			*(0.0715)****		
Mainly Catholic				0.0123	
				(0.0245)	
				(0.0214)	
Mainly Orthodox				−0.1770	
				(0.0464)***	
				*(0.0418)****	
Mainly Anglicans				0.2454	
				(0.0249)***	
				*(0.0214)****	
North/Central					−0.1508
					(0.0447)***
					*(0.0380)****
Southern/Catholic					0.0046
					(0.0406)
					(0.0453)
Adj R-sq	0.7986	0.8129	0.8481	0.8583	0.8132
Observations	299	513	513	513	513

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*)*, *(**)* and *(***)* denote the significance of the White (1980) estimator. A constant is included

Table A.4 Short run GMM

	Regression 1			Regression 2			Regression 3		
	(a) x_{it} strictly exogenous	(b) x_{it} predetermined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predetermined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predetermined	(c) x_{it} endogenous
Annual lagged	0.5335	0.4642	0.4850	0.4597	0.3207	0.2847	0.3520	0.3291	0.2338
educational	(0.0692)***	(0.0662)***	(0.0690)***	(0.0689)***	(0.0668)***	(0.0737)***	(0.0768)***	(0.0636)***	(0.0723)***
inequality	*(0.1546)****	*(0.1592)****	*(0.1641)****	*(0.1410)****	*(0.1225)****	*(0.1130)***	*(0.1592)***	*(0.0919)****	*(0.0868)****
Educational attainment	−1.0509	−1.0173	−1.1366	−1.2015	−1.3466	−1.2691	−1.2625	−1.2235	−1.2610
Annual lagged	(0.0455)***	(0.0651)***	(0.0803)***	(0.0554)***	(0.0861)***	(0.1208)***	(0.0656)***	(0.0930)***	(0.1147)***
educational	*(0.0777)****	*(0.1005)****	*(0.1448)****	*(0.0941)****	*(0.1468)****	*(0.1537)****	*(0.0931)****	*(0.1148)****	*(0.1208)****
attainment	0.5066	0.3125	0.2524	0.4814	0.3980	0.2280	0.4047	0.3285	0.2387
	(0.0847)***	(0.0928)***	(0.1125)**	(0.0897)***	(0.0967)***	(0.1191)*	(0.1063)***	(0.1046)***	(0.1176)**
	*(0.1786)****	*(0.1642)**	*(0.2146)*	*(0.1564)****	*(0.1254)****	*(0.1502)*	*(0.1898)***	*(0.1160)****	*(0.1080)***
Income per capita				−0.0231	−0.0512	−0.0444	−0.0251	−0.0206	−0.0352
Annual lagged income				(0.0058)***	(0.0109)***	(0.0152)***	(0.0080)***	(0.0125)*	(0.0151)**
per capita				*(0.0069)****	*(0.0158)****	*(0.0187)***	*(0.0090)****	*(0.0136)*	*(0.0145)***
				0.0258	0.0313	0.0197	0.0236	0.0259	0.0333
				(0.0073)***	(0.0131)**	(0.0157)	(0.0082)***	(0.0116)**	(0.0140)**
				*(0.0081)****	*(0.0136)***	*(0.0149)*	*(0.0085)****	*(0.0115)***	*(0.0133)***
Income inequality				0.4930	0.8107	1.4792	0.4672	0.4778	0.9362
Annual lagged income				(0.1224)***	(0.2616)***	(0.3491)***	(0.1396)***	(0.2297)**	(0.3409)***
inequality				*(0.1648)****	*(0.3747)***	*(0.5037)****	*(0.1666)****	*(0.2068)***	*(0.2995)****
				0.0788	0.4931	0.3759	0.1076	0.0774	0.0603
				(0.1298)	(0.2907)*	(0.3820)	(0.1415)	(0.2312)	(0.2970)
				(0.0963)	*(0.4405)*	*(0.5096)*	*(0.0977)*	*(0.1704)*	*(0.3353)*
Population ageing							0.0067	0.0161	0.0053
Annual lagged population							(0.0092)	(0.0100)	(0.0111)
ageing							*(0.0099)*	*(0.0118)*	*(0.0132)*
							0.0124	0.0097	0.0088
							(0.0059)**	(0.0058)*	(0.0062)
							*(0.0072)**	*(0.0082)*	*(0.0081)*
Unemployment							0.2051	0.5696	1.3752
Annual lagged							(0.3987)	(0.7011)	(0.8235)*
unemployment							*(0.3053)*	*(0.8967)*	*(0.8543)*
							−0.5709	−1.5064	−0.9583
							(0.3817)	(0.5138)***	(0.7835)
							(0.3558)	*(0.5788)****	*(0.7173)*

Female's work access							−0.0091	−0.0188	−0.0155
Annual lagged female's							(0.0035)**	(0.0056)***	(0.0069)**
work access							*(0.0050)**	*(0.0093)***	*(0.0107)*
							−0.0015	0.0025	−0.0083
							(0.0038)	(0.0058)	(0.0078)
							(0.0040)	*(0.0045)*	*(0.0074)*
Observations	392			392			325		
SARGAN TEST	70.04	106.35	72.33	74.97	108.10	54.85	54.42	124.77	71.76
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
AR(1) TEST	−7.26	−7.16	−6.58	−6.50	−3.94	−2.18	−4.44	−4.78	−3.32
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0290)	(0.0000)	(0.0000)	(0.0009)
	−3.57	*−3.53*	*−3.28*	*−3.76*	*−2.75*	*−1.70*	*−3. 06*	*−3.86*	*−2.42*
	(0.0004)	*(0.0004)*	*(0.0010)*	*(0.0002)*	*(0.0060)*	*(0.0893)*	*(0.0022)*	*(0.0001)*	*(0.0154)*
AR(2) TEST	−0.47	−0.64	−0.93	0.30	1.03	0.91	0.85	0.40	0.95
(p-value)	(0.6394)	(0.5222)	(0.3548)	(0.7629)	(0.3017)	(0.3614)	(0.3968)	(0.6877)	(0.3396)
	−0.93	*−1.18*	*−1.30*	*0.59*	*1.42*	*1.27*	*1.48*	*0.60*	*1.08*
	(0.3544)	*(0.2395)*	*(0.1926)*	*(0.5541)*	*(0.1553)*	*(0.2046)*	*(0.1394)*	*(0.5464)*	*(0.2815)*

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*)*, *(**)*,and *(***)* denote the significance of the White (1980) estimator. SARGAN TEST is the Sargan test for overidentifying restrictions (Sargan 1958). AR(1) TEST and AR(2) TEST are the Arellano-Bond test for the first and the second-order autocorrelation in the first differenced residuals, respectively. Time dummies and a constant are included

Table A.5 Long run GMM: independent variables are income per capita and income inequality for normally working people

	REGRESSION (1)			REGRESSION (2)			REGRESSION (3)		
	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predetermined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous
Educational attainment	−1.1667	−1.3155	−1.7170	−1.3019	−1.2910	−1.4928	−1.2960	−1.1766	−1.2666
	(0.0982)***	(0.1363)***	(0.2330)***	(0.1289)***	(0.1329)***	(0.1662)***	(0.1149)***	(0.1245)***	(0.1423)***
	*(0.1254)****	*(0.2353)****	*(0.4263)****	*(0.1883)****	*(0.2016)****	*(0.2426)****	*(0.1535)****	*(0.1424)****	*(0.1723)****
Income per capita				0.0062	−0.0146	−0.0299	−0.0039	−0.0004	0.0002
				(0.0098)	(0.0107)	(0.0164)*	(0.0111)	(0.0122)	(0.0132)
				(0.0100)	*(0.0106)*	*(0.0203)*	*(0.0083)*	*(0.0090)*	*(0.0101)*
Income inequality				0.7330	1.6640	3.0082	0.6372	0.8876	1.6243
				(0.3164)**	(0.3670)***	(0.5358)***	(0.3269)*	(0.4090)**	(0.6992)**
				*(0.3056)***	*(0.5793)****	*(1.2096)***	*(0.3203)***	*(0.3694)***	*(0.6970)***
Population ageing							0.0376	0.0506	0.0241
							(0.0190)**	(0.0179)***	(0.0201)
							*(0.0198)**	*(0.0251)***	*(0.0250)*
Unemployment							−1.0489	−1.6125	−0.5911
							(1.0521)	(1.2455)	(1.7971)
							(1.1002)	*(1.5632)*	*(1.9354)*
Female's work access							−0.0204	−0.0267	−0.0328
							(0.0084)**	(0.0104)**	(0.0133)**
							*(0.0122)**	*(0.0167)*	*(0.0229)*
Observations	392			392			325		

Note: (*), (**) and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*)*, *(**)* and *(***)* denote the significance of the White (1980) estimator

Table A.6 Short run GMM: independent variables are income per capita and income inequality for normally working people

	Regression 1			Regression 2			Regression 3		
	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter -mined	(c) x_{it} endogenous
Annual lagged	0.5335	0.4642	0.4850	0.5098	0.3909	0.3244	0.4083	0.3439	0.3124
educational	(0.0692)***	(0.0662)***	(0.0690)***	(0.0697)***	(0.0680)***	(0.0796)***	(0.0793)***	(0.0707)***	(0.0790)***
inequality	*(0.1546)****	*(0.1592)****	*(0.1641)****	*(0.1512)****	*(0.1415)****	*(0.1563)***	*(0.1810)***	*(0.1255)****	*(0.1167)****
Educational attainment	−1.0509	−1.0173	−1.1366	−1.1655	−1.1766	−1.2484	−1.2465	−1.0797	−1.1948
Annual lagged	(0.0455)***	(0.0651)***	(0.0803)***	(0.0551)***	(0.0961)***	(0.1324)***	(0.0657)***	(0.1094)***	(0.1312)***
educational	*(0.0777)****	*(0.1005)****	*(0.1448)****	*(0.0992)****	*(0.1504)****	*(0.1934)****	*(0.0978)****	*(0.1004)****	*(0.1222)****
attainment	0.5066	0.3125	0.2524	0.5273	0.3903	0.2399	0.4796	0.3076	0.3239
	(0.0847)***	(0.0928)***	(0.1125)**	(0.0921)***	(0.1080)***	(0.1450)*	(0.1132)***	(0.1279)**	(0.1428)**
	*(0.1786)****	*(0.1642)**	*(0.2146)*	*(0.1698)****	*(0.1706)***	*(0.2101)*	*(0.2160)***	*(0.1549)***	*(0.1572)***
Income per capita				−0.0114	−0.0214	−0.0185	−0.0162	−0.0063	−0.0165
Annual lagged income				(0.0040)***	(0.0092)**	(0.0132)	(0.0057)***	(0.0107)	(0.0122)
per capita				*(0.0036)****	*(0.0111)**	*(0.0144)*	*(0.0056)****	*(0.0089)*	*(0.0097)**
				0.0144	0.0125	−0.0017	0.0139	0.0061	0.0167
				(0.0050)***	(0.0103)	(0.0126)	(0.0056)**	(0.0094)	(0.0115)
				*(0.0057)***	*(0.0111)*	*(0.0116)*	*(0.0056)***	*(0.0066)*	*(0.0088)**
Income inequality				0.3040	0.8430	1.2627	0.3342	0.2801	0.9536
Annual lagged income				(0.1082)***	(0.2529)***	(0.3344)***	(0.1385)**	(0.2676)	(0.4168)**
inequality				*(0.1239)***	*(0.3465)***	*(0.5372)***	*(0.1201)****	*(0.2033)*	*(0.3963)***
				0.0553	0.1706	0.7696	0.0429	0.3023	0.1633
				(0.1181)	(0.2304)	(0.3204)**	(0.1358)	(0.2171)	(0.2939)
				(0.0799)	*(0.2993)*	*(0.5134)*	*(0.0878)*	*(0.2256)*	*(0.3415)*
Population ageing							0.0079	0.0241	0.0092
Annual lagged							(0.0095)	(0.0110)**	(0.0126)
population ageing							*(0.0095)*	*(0.0116)***	*(0.0128)*
							0.0143	0.0091	0.0073
							(0.0060)**	(0.0058)	(0.0063)
							*(0.0068)***	*(0.0080)*	*(0.0081)*
Unemployment							0.0547	0.5640	0.8371
Annual lagged							(0.4177)	(0.6840)	(0.8381)
unemployment							*(0.3154)*	*(0.7134)*	*(0.8380)*
							−0.6754	−1.6220	−1.2436
							(0.3951)*	(0.5344)***	(0.8448)
							*(0.4051)**	*(0.6010)****	*(0.8154)*

(*continued*)

Table A.6 (continued)

	Regression 1			Regression 2			Regression 3		
	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter - mined	(c) x_{it} endogenous	(a) x_{it} strictly exogenous	(b) x_{it} predeter -mined	(c) x_{it} endogenous
Female's work access							−0.0101	−0.0196	−0.0163
Annual lagged female's							(0.0036)***	(0.0058)***	(0.0068)**
work access							*(0.0053)**	*(0.0089)***	*(0.0104)*
							−0.0019	0.0021	−0.0062
							(0.0039)	(0.0061)	(0.0082)
							(0.0043)	*(0.0044)*	*(0.0073)*
Observations	392			392			325		
SARGAN TEST	70.04	106.35	72.33	70.79	111.11	45.76	51.49	112.41	71.89
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0014)	(0.0000)	(0.0000)	(0.0000)
AR(1) TEST	−7.26	−7.16	−6.58	−6.80	−4.77	−1.58	−4.65	−4.75	−3.44
(p-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.1148)	(0.0000)	(0.0000)	(0.0006)
	−3.57	*−3.53*	*−3.28*	*−3.60*	*−2.71*	*−1.01*	*−3.06*	*−3.59*	*−2.43*
	(0.0004)	*(0.0004)*	*(0.0010)*	*(0.0003)*	*(0.0066)*	*(0.3126)*	*(0.0022)*	*(0.0003)*	*(0.0150)*
AR(2) TEST	−0.47	−0.64	−0.93	−0.72	−1.20	−1.62	−0.03	−0.31	−1.01
(p-value)	(0.6394)	(0.5222)	(0.3548)	(0.4745)	(0.2308)	(0.1053)	(0.9794)	(0.7583)	(0.3148)
	−0.93	*−1.18*	*−1.30*	*−1.19*	*−1.65*	*−1.74*	*−0.05*	*−0.58*	*−1.10*
	(0.3544)	*(0.2395)*	*(0.1926)*	*(0.2345)*	*(0.0980)*	*(0.0825)*	*(0.9634)*	*(0.5634)*	*(0.2729)*

Note: (*), (**), and (***) indicate significance at the 10%, 5% and 1% level, respectively. *(*)*, *(**)* and *(***)* denote the significance of the White (1980) estimator. SARGAN TEST is the Sargan test for overidentifying restrictions (Sargan 1958). AR(1) TEST and AR(2) TEST are the Arellano-Bond test for the first and the second-order autocorrelation in the first differenced residuals, respectively. Time dummies and a constant are included

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Chapter 8
Innovation and Firms' Productivity Growth in Slovenia: Sensitivity of Results to Sectoral Heterogeneity and to Estimation Method

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Abstract The paper examines implications of endogenous growth theory on the relationship between innovation and firm productivity (productivity growth) by combining information on firm-level innovation (CIS) with accounting data for a large sample of Slovenian firms in the period 1996–2002. We employ several different estimation methods in order to control for the endogeneity of innovation and idiosyncratic firm characteristics. We find a significant and robust link between productivity levels and firm propensity to innovate, while the results on the link between innovation activity and productivity growth are not robust to different econometric approaches. Although OLS estimates indicate that successful innovation positively impacts productivity growth, further analysis reveals that these results are mainly driven by the exceptional performance of a specific group of services firms located in the fourth quintile with respect to size, productivity and R&D propensity measure. Estimates based on matching techniques, on the other hand, do not reveal any significant positive effects of innovation on productivity growth, regardless of the sectors, firm size and type of innovation.

Introduction

The primary aim of the paper is to analyze the link between firm-level innovation activity and productivity. Endogenous growth theory suggests, firstly, that technological progress is endogenous and driven by the deliberate investment of resources by profit-seeking firms (Smolny 2000) and, secondly, that a firm's innovation activity is central to its technological progress and productivity growth. The

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direction of causality therefore has to run from higher productivity to higher innovative activity (propensity to innovate) and consequently from higher innovative activity (propensity to innovate) to higher productivity growth.

One of the most influential studies on innovation and productivity growth is that of Crepon, Duguet, and Mairesse (CDM 1998), who combine a knowledge–production function, relating R&D activity to patenting or innovative activities, with economic performance as measured by labor productivity. The paper by Crépon et al. (1998) has influenced a new and burgeoning literature on the relationship between innovation output and firm performance. The main finding of these studies is that, regardless of how performance is measured, innovation output positively and significantly affects firm performance. The exception to this is the study by Klomp and van Leeuwen (2001) that finds a negative but insignificant effect of innovation output on employment growth. Studies have been done on developing countries as well. Two of these, Benavente (2006) on Chile and Mohnen (2006) on Tanzania, show that innovation output (or R&D activity) does not influence firm performance. The findings of Jefferson et al. (2006) for China are more optimistic.

Some of the studies distinguish between product and process innovations. The findings of Harrison et al. (2005), Griffith et al. (2006), Parisi et al. (2006), and Hall et al. (2007) demonstrate that process innovations have labor displacement effects and are therefore expected to result in significant productivity growth, while, due to the demand effect, product innovations may likely cause employment growth and, thus, may not result in significant productivity growth.

So far, with some notable exceptions (Parisi et al. 2006; Hall et al. 2007[1]), the vast majority of the relevant empirical work focuses on the first part of the causality equation only, i.e. on the link between innovation and firm productivity levels. Our paper, instead, takes into account both aspects of productivity–innovation nexus. We first empirically establish the causal relationship from productivity level to propensity to innovate, while in the second step we focus on the impact of successful innovation on firm productivity growth.

Our empirical strategy is as follows. In order to examine the productivity (productivity growth)–innovation nexus, we combine firm-level innovation data taken from Community Innovation Survey (CIS) with accounting data for a large sample of Slovenian firms in the period 1996–2002. We apply the CDM approach to establish the knowledge–production function of Slovenian firms by simultaneously linking the research capital equation with both the innovation equation and the productivity equation. In the second step, we then study the impact of innovation on firms' productivity growth. We apply two different econometric methods. First, we apply ordinary least squares (OLS) on first-differenced data by taking as our main measure of innovation variable either the innovation variable

[1]Harrison et al. (2005) and Hall et al. (2007) do not focus on the link between innovation and productivity growth, but the relationship is included in their decomposition of the effects of innovation on employment.

from the CIS or the probabilities to innovate estimated by using the CDM approach in the first step. In addition, as a robustness check, we use nearest neighbor matching in order to match innovating and non-innovating firms with similar characteristics and then perform average treatment tests of the impact of innovation on performance of innovating firms as compared to the performance of non-innovating firms. We also distinguish between product and process innovations and control for sectoral differences and within sector heterogeneity.

We find robust evidence of a positive link between firm productivity levels and their propensity to innovate, while support for a positive correlation between innovation activity and productivity growth was less conclusive as it depended on different econometric approaches employed. OLS estimates seem to provide some empirical support for a positive impact of innovation on productivity growth. Further empirical tests, however, reveal that these results are mainly due to the exceptional performance of a specific group of services firms in the fourth quintile with respect to size, productivity and R&D propensity measure. Estimates based on the matching techniques do not reveal any significant positive effects of innovation on labor productivity growth, regardless of the period after the innovation was made. Results do not differ neither between subsamples of manufacturing and services firms nor between samples of firms classified by size. In addition, results do not reveal any difference in the effects of product or process innovations. Both types of innovations bring about a reduction of employment, however, little evidence is found in favor of innovations – be it product or process – positively affecting productivity growth.

The remainder of the paper is structured as follows. Section 8.2 provides the theoretical background on R&D, innovation, and firm performance. Section 8.3 briefly discusses the extent and determinants of the innovation activity of Slovenian firms. Section 8.4 applies the CDM approach to Slovenian data in order to estimate consistently the probabilities to innovate, while Sect. 8.5 provides estimations of the effect of innovation activity on firms' productivity growth by using two different empirical methods. The last section presents the conclusions.

Theoretical Background: R&D, Innovation Activity, and Firm Performance

Griliches (1979) was the first to introduce R&D capital stock as a factor of production into the residual computation framework pioneered by Solow (1957). In this approach, R&D activities add to the existing stock of accumulated knowledge of firms, leading to productivity growth through product and process innovation. Romer's (1990) model predicts a link between R&D activity and productivity growth, and Cohen and Levinthal (1989) point to the importance that R&D activity can have in absorbing technology used by other firms. Studies of the relationship between knowledge creation and productivity appear at different levels of aggregation (economy, sector, firm) depending on the objective of the analysis.[2]

Early models incorporating what Griliches (1979) termed 'knowledge capital' focused mainly on the relationship between R&D activity and productivity growth within a production function framework (Wieser 2005). It is the elasticities of output with respect to each of the inputs into the production function that will matter most for the analysis. Studies of the direct relation between R&D and firm performance give mixed results.[3] These include Griliches (1980, 1986) and Schankerman (1981) on the value-added of U.S. firms in selected industries in 1963 and 1972, respectively, Griliches and Mairesse (1984) on sales of U.S firms from 1966 to 1977, Cunéo and Mairesse (1984) on French scientific firms from 1972 to 1977, Hall and Mairesse (1995) and Mairesse and Hall (1996) on sales and value-added in U.S. and French firms in the 1980s, Bartelsman, et al. (1998) on value-added in Dutch firms in the late 1980s, Cincera (1998) with regard to the world from 1987 to 1994, O'Mahoney and Vecchi (2000) on sales of U.S., European, and Japanese firms in the mid-1990s. Wieser (2005) carries out a meta-analysis of these studies and provides five conclusions:

1. Despite considerable variation across studies, the analysis suggests a strong and positive relationship between R&D expenditures and growth of output or total factor productivity.
2. Studies confirm that firms accrue spillover benefits from R&D activity in other firms. They also suggest that spillovers between industries are more important than those within industries.
3. There is considerable variation in the rates of return on R&D activity within firms, but no apparent trend across industries.
4. It is not clear whether the relationship between R&D activity and firm performance is strengthening or weakening over time.
5. The rates of return on R&D activity are similar across countries.

Pakes and Griliches (1984) developed a variant of this framework in which changes in knowledge capital, defined as the level of economically valuable technological knowledge, are unobservable, which allows for the inclusion of several interrelated innovation inputs. Crépon et al. (1998) extended this approach to explore the channels through which R&D activity influenced innovation and productivity growth for a cross-section of firms in the French manufacturing sector for 1992. The model combines a knowledge–production function, relating R&D activity to patenting or innovative activities, with economic performance as measured by labor productivity. It contains a system of three simultaneous

[2]Relevant reviews of the literature include Nadiri (1991), Griliches (1992), Mairesse and Mohnen (1995), Cincera (1998), and Wieser (2005).

[3]There is also group of studies that focus on the rate of return on R&D activity at the firm level. These include Mansfield (1980) and Link (1981, 1983) on the United States, Griliches and Mairesse (1983, 1984, 1990) on the United States, France, and Japan, Hall and Mairesse (1995) on France, and Cincera (1998) on the world.

equations where R&D activity and other factors generate new knowledge, which then propels innovation (output) and finally productivity growth. Other supply and demand factors as well as sectoral differences and unobserved heterogeneity are also included in the model to improve its explanatory power. One novel aspect of the model is that the authors incorporated indicators derived from a French innovation survey into the framework. They found evidence in support of a positive effect on R&D activity and innovation output measured by patent numbers, as well as a positive and significant effect on value-added per employee of French firms.

The paper by Crépon et al. (1998) has influenced a growing literature on the relationship between innovation output and firm performance. Firm performance variables may include value-added, sales or exports per worker, sales per worker, and the growth rate of value-added, sales, profitability, or employment, and sales margin, profit before and after depreciation (in level and growth rates). The main finding of these studies is that, regardless of how performance is measured, innovation output positively and significantly affects firm performance, with the exception of the study by Klomp and van Leeuwen (2001), which found a negative but insignificant effect of innovation output on employment growth (Hall and Mairesse 2006; Raymond et al. 2006). Lööf and Heshmati (2006) performed a sensitivity analysis of the different measures of firm performance and found the same pattern of positive and significant effect of innovation output on firm performance.

Similar results are found in other papers. Mohnen et al. (2006) estimated the relationship between innovation output and firm performance by using micro-aggregated data from seven countries (Belgium, Denmark, Ireland, Germany, the Netherlands, Norway, and Italy) for 1992. They also observed that firm productivity correlates positively with higher innovation output, even when correcting for the skill composition of labor and capital intensity, but they also note that simultaneity tends to interact with selectivity, and that both sources of biases must be taken into account together.[4] Griffith et al. (2006) estimated a variation of the model for four European countries (France, Germany, Spain, and the UK), using firm-level data from CIS3 carried out in 2000. They found that job loss due to process innovation is partly compensated for by the displacement effect and that there is no evidence of a displacement effect when there is product innovation, even when old products are no longer produced. Similarly, Parisi et al. (2006) found that process innovations significantly impacted the productivity growth of Italian firms in the late 1990s, while product innovations had a much less significant effect. A common explanation for this may be the different displacement and compensation effects of product and process innovations. As shown by Harrison et al (2005) and Hall et al. (2007), due to demand effect, product innovation may likely result in employment growth, while process innovation is likely to have labor saving effects.

[4]Mohnen et al. (2006) use a generalized tobit model together with a variation of the production accounting framework and include size, industry, ownership type, continuous R&D, cooperative R&D, R&D intensity, proximity to basic research, and perceived competition as independent variables.

Other papers, including Lööf et al. (2003), showed that there was considerable variation between Finland, Norway, and Sweden in the early 1990s. They argue that this variation may be due to data errors, the econometric model (3SLS), model specifications, or unobservable country effects. Using CIS data from France in 1993, Duguet (2000) shows that strongly innovative firms are much more likely to improve their TFP than weaker firms, and that the return on innovation increases with the degree of innovation opportunities that firms have. The model also shows that the Solow residual at the industry level is linked to radical innovations at the firm level. Janz et al. (2004) pooled observations from Germany and Sweden to show that there is a strong link between innovation output and sales per employee in knowledge intensive manufacturing firms independent of the country. Criscuolo and Haskel (2002) used a matched innovation survey and Census data to investigate the link between innovation and productivity growth in the UK. They found a statistically significant association between (process) innovations and TFP growth.

Lately, there have also been studies looking at the impact of innovative activity in less developed countries. Benavente (2006) applied the Crépon et al. (1998) model and estimating procedures to Chile during the period 1995–1998. He found that R&D and innovative activities are related to firm size and market power, but that innovation output (or R&D activity) does not influence firm performance. By contrast, Jefferson et al. (2006) showed that there is a strong relationship between R&D intensity and new product sales and returns on R&D expenditure after correcting for size, industry, profitability, and market concentration. Using data from the World Bank Investment Climate Survey covering the years 2000–2002, Mohnen (2006) showed that innovation output (or R&D activity) did not influence firm performance in Tanzania, but that the institutional arrangements had an important impact.

The Extent and Determinants of Firms' Innovation Activity in Slovenia

Firms' innovation activity in the European Union member states is measured in a standard manner by the so called Community Innovation Surveys (CIS). In Slovenia, CIS surveys are conducted by the Slovenian statistical office every even year, starting in 1996. We have at our disposal four waves of innovation surveys, covering the periods 1994–1996, 1996–1998, 1998–2000, and 2000–2002. These innovation surveys are carried out among a wide sample of manufacturing and non-manufacturing firms with no restrictions put on the actual R&D activity by these firms. The number of firms covered by the innovation survey increased constantly during the 1996–2002 period (stratified random sampling, see Table 8.1). Hence, these surveys allow for a broad picture of determinants of innovation activity and its impact on the performance of Slovenian firms.

Table 8.1 reveals that the rate of innovation activity, which captures both product innovation and process innovation, is comparatively low in Slovenia.

Table 8.1 R&D expenditures and innovation activity of Slovenian firms by type of ownership, 1996–2002 (%)

	N	R&D/sales (Innovative firms)	R&D/sales (Non-Innovative firms)	Fraction of innovative firms
All firms				
1996	1,454	1.5	0.026	21.7
1998	1,777	1.6	0.003	23.0
2000	2,518	6.0	0.021	21.2
2002	2,564	6.5	0.015	20.6
Domestic				
1996	1,148	1.4	0.027	18.6
1998	1,371	1.5	0.003	19.5
2000	1,923	7.1	0.023	17.5
2002	1,935	6.4	0.004	17.3
Foreign				
1996	306	1.8	0.023	33.3
1998	406	1.9	0.003	34.7
2000	595	4.1	0.012	32.9
2002	629	6.6	0.055	30.5

Source: Statistical office of Slovenia; own calculations

Only about 20% of Slovenian firms innovate, i.e. claimed to have conducted at least one innovation with respect to products and services or regarding the innovation of processes in the respective 2-year period. What is striking is the negative trend of innovation activity of Slovenian firms, as the share of innovative Slovenian firms shrunk from 1998 to 2002.[5] This is predominantly due to the low innovation activity of domestic firms (only 17% of domestically owned firms are innovative). Among foreign owned firms (firms with 10% or higher foreign equity share) the share of innovative firms is twice as high as that of domestic firms. This indicates a more competitive and innovation conducive environment in foreign owned firms. Still, higher innovation activity by foreign owned firms is not necessarily backed by their higher own R&D expenditures (relative to total sales). The fact is that in the 2000 innovation survey foreign owned firms show proportionally less R&D expenditures compared to domestically owned firms, and in the 2002 survey approximately the same. Hence, their higher propensity to innovate must be driven by other factors, such as a constant transfer of technology and other knowledge spillovers from their parent companies.

Determinants of innovation activity by Slovenian firms were extensively studied by Damijan et al. (2006) using a very similar dataset. Table 8.2 reveals the basic descriptive statistics of the innovation activity of Slovenian firms, showing that innovative firms are on average larger in terms of employment, have higher R&D expenditures, receive more R&D subsidies, are more export oriented, and are more

[5]The share of innovative firms is shrinking in spite of the fact that total R&D expenditure is increasing.

Table 8.2 Determinants of firms' innovation in Slovenia, 1996–2002 (in %)

	No.	INOV_t-2[a]	rVA/Emp[b]	Employment	R&D/sales[c]	R&D/VA[d]	Total sub./R&D[e]	Public sub./R&D[f]	Foreign sub./R&D[g]	Exports/ sales	IFDI[h]
Innovative firms											
1996	316	–	1.26	346.7	1.55	5.39	5.39	3.12	0.27	43.9	0.388
1998	409	0.643	0.84	312.9	1.62	5.96	4.07	2.42	0.85	43.1	0.397
2000	533	0.554	1.11	278.5	6.02	19.22	4.33	3.42	0.59	38.1	0.368
2002	527	0.694	1.09	283.6	6.47	18.42	4.98	3.14	1.08	43.7	0.364
Non-innovative firms											
1996	1138	–	1.19	122.8	0.026	0.101	0.180	0.066	0.054	25.7	0.254
1998	1368	0.095	1.11	96.5	0.003	0.006	0.004	0.004	0.000	27.3	0.237
2000	1985	0.122	1.01	68.5	0.021	0.047	0.013	0.013	0.000	21.6	0.201
2002	2037	0.113	0.99	67.5	0.015	0.038	0.016	0.000	0.001	22.8	0.215

Source: Damijan et al. (2006)

Notes: [a]Past innovation activity, lagged one period, that is 2 years; [b]Relative productivity; firm value added per employee relative to the average productivity of particular sector; [c]R&D expenditures as a share of sales; [d]R&D expenditures as a share of value added; [e]The share of total R&D subsidies in R&D expenditures; [f]The share of public R&D subsidies in R&D expenditures; [g]The share of foreign R&D subsidies in R&D expenditures; [h]Foreign ownership likely to be foreign owned. At the same time, Table 8.2 shows also that the innovation activity of firms is persistent over time.

Based on these data, Damijan et al. (2006) estimated the impact of firms' internal R&D capital, external R&D spillovers, firms' absorption capacity, and other structural indicators (such as firm size and productivity) on firms' innovation activity within an integrated dynamic model. They find that the probability of a firm innovating depends on the following factors:

1. A firm's own R&D expenditures have a highly significant and positive impact on the probability of innovating
2. A firm's current innovation activity is heavily dependent on its previous innovation activity
3. A firm's size positively affects its ability to innovate
4. Public R&D subsidies as well as R&D subsidies received from abroad significantly improve a firm's ability to innovate
5. Foreign ownership stimulates firms to innovate, while exporting is not shown to have a significant impact on a firm's innovation activity
6. Horizontal knowledge spillovers seem to drive firm innovation activity, while vertical knowledge spillovers are shown to not be important
7. Contrary to expectations, relative labor productivity (i.e. relative to the sector average) and technological intensity of sectors in which a firm operates do not determine its innovation activity[6]

Research Capital Production Function by Using the Crépon–Duguet–Mairesse Approach

In order to explain the extent of innovation activity of Slovenian firms, we examine the links between firm's research and development, productivity, and innovation by applying the research capital production function introduced by Crépon et al. (1998) (hereafter CDM). Given that our dataset differs in certain aspects from the one originally used by CDM, we adapted their estimation approach to the available data.

The three stage estimation approach proposed by CDM is based on a structural model that explains productivity by innovation output and innovation output by research investment. The applied econometric methods take into account several key statistical features of the available data: the fact that only a portion of the of firms engage in research and development activities, the endogeneity of productivity, innovation, and research activity, as well as the fact that research investment and

[6]In addition to the above estimations, Damijan et al. (2006) also ran a separate estimation for product and process innovations. Results are almost identical for both types of innovation activity. There are only minor differences in estimation results in the sense that process innovations require a slightly larger firm size, while product innovations seem to be more pronounced in foreign owned firms and seem to give slightly higher return on public subsidies.

(research) capital are truncated variables, while innovative activity is binomial data. The availability of innovation survey data in addition to the usual firm-level accounting information allows us to separate different aspects of the innovation process and directly measure the effects this process has on productivity. Following CDM, we model three simultaneous relationships: the research equation, which links research to its determinants, the innovation equation relating research to innovation output measures, and, finally, the productivity equation relating innovation output to productivity.

Estimation Approach

Following CDM, we present our version of the estimation algorithm to estimate the effects of R&D activity and expenditures on innovation and productivity. The system of equations is split into three sets: the research equation, innovation equation, and productivity equation.

Research equation. Firm research activities are depicted by two equations accounting separately for a firm's decision to engage in research and the magnitude or intensity of these activities. For the research decision, CDM assume that there exists a latent dependent variable g_i^* for firm i given by the following equation:

$$g_i^* = x_{0i} b_0 + u_{0i} \tag{8.1}$$

where g_i^* represents the decision criterion (such as the expected present value of firm profit accruing to research investment), x_{0i} is a vector of explanatory variables, b_0 the associated coefficient vector, and u_{0i} an error term. Firms with g_i^* above some threshold value (overall or industry specific) choose to invest in research. As was the case for French firms studied by CDM, only a portion of Slovene firms actually invest in R&D.

The intensity of research k_i^* is determined by the second "research" equation:

$$k_i^* = x_{1i} b_1 + u_{1i} \tag{8.2}$$

where k_i^* is the research capital per employee of firm i when this firm carries out research, x_{1i} is, again, a vector of explanatory variables, b_1 is the associated coefficient vector, and u_{1i} denotes the error term.[7] Even though it needs not be the case,[8] we follow CDM and assume that both equations have the same explanatory variables ($x_0 = x_1$). The explanatory variables we employ in the estimation

[7]We use both logarithm of research capital per employee and logarithm research investment per employee in the estimation. Construction of the research capital variable follows the approach suggested by CDM.

[8]There do not seem to be many theoretically convincing choices of variables that could serve to explain the choice to invest in R&D but not the magnitude of the investment, and vice versa.

of (8.2) and (8.3) differ somewhat from those employed by CDM. Partly due to the restrictions of the dataset, and partly due to our belief that firm's engagement in research depends also on firm's ownership and sources of external knowledge spillovers – such as trade and intra- and inter-sectoral knowledge spillovers. The regressors we use are:

$$x_{0i} = x_{1i} = (l_i, s_i, \exp_i, fdi_i, HS\_inov_i, VS\_inov_i, T_i, S_i)$$

where l_i is number of employees, s_i is firm's i market share (based on NACE 3-digit markets), $\exp_i$ is the share or export sales in total revenue, fdi_i represents an indicator variable, taking on value 1 if a firm is in foreign ownership (at least 10% of the capital has to be foreign owned) and 0 if it is domestically owned. Horizontal (HS_inov_i) and vertical spillovers (VS_inov_i) from innovation activity of other firms are also included. Horizontal spillovers are measured by the number of innovations done in the same sector. Vertical spillovers are calculated as the number of innovations conducted in the related sectors multiplied by the respective input–output coefficients, where the latter reflect the strength of input – output relationship between the sectors. Finally, T and S are time and industry dummies. Unfortunately, the innovation survey does not include information on demand pull and technology push factors, nor do we have access to product-level sales information.

Innovation equation. We proxy innovation output with an indicator variable of innovation, which takes the value 1 if a firm has innovated in the past year and 0 if it has not. Furthermore, we are able to differentiate between product and process innovations.[9] On the other hand, we do not observe patent data nor do we have information on the share of sales coming from newly launched products. The innovation equation we estimate is:

$$p_i^* = \alpha_k k_i^* + x_{2i} b_2 + u_{2i} \tag{8.3}$$

where p_i^* is the latent probability to innovate, k_i^* is the latent research variable, x_{2i} is a vector of other explanatory variables, and u_{2i} is the heterogeneous error term. We assume that the error term is normally distributed with zero mean and constant variance. In contrast to CDM, in two innovation equations, where the regressants are patents and share of innovative sales, respectively, we estimate (8.3) using a probit model.[10] The exogenous variables x_{2i} used in the actual estimation are:

$$x_{2i} = (l_i, a_i, T_i, S_i)$$

[9] In the regressions presented here we do not discriminate between product and process innovations, but include both forms in the indicator variable. As a robustness check, we ran regressions on product and process innovation dummies individually and found no appreciable difference in the results.

[10] CDM estimate their two innovation equations with pseudo maximum likelihood and ordered probit, respectively.

where notation is the same as above. As suggested by CDM, the market share variable is not included directly into the innovation equation, but only indirectly through research capital. This also helps impose structure on the model and allows us to use market share as an instrument.

Productivity equation. Lastly, we use the results of the previous two stages to augment the standard Cobb–Douglas production function with innovation output. Given the specification of the innovation equation, innovation output will be measured by the probability that firm i will innovate in the current period. The productivity equation to be estimated is:

$$q_i = \alpha_I p_i^* + x_{3i} b_3 + u_{3i} \tag{8.4}$$

where q_i is the logarithm of labor productivity (log value added per employee), while the factors of productivity (other than innovation output) captured in x_{3i} are:

$$x_{3i} = (l_i, c_i, T_i, S_i)$$

where c_i is the logarithm of physical capital per employee. Again, our choice for the regressors in the productivity equation differs somewhat from the one suggested by CDM as we do not have data on the shares of engineers and administrators in the total number of employees.

Estimation Issues

In estimating the above system of equations (8.1)–(8.4), we first have to take into account the nature of available data: research investment and hence research capital are truncated variables, while innovative outcome is binomial. Furthermore, there are possible selectivity and simultaneity biases stemming from the endogeneity of research capital in the innovation equation, while innovation output is endogenous in the productivity equations.

The setup of the model and the endogeneity issues dictate the use of a simultaneous equations system estimator. CDM find that the joint distribution of observable variables does not have a closed form, while numerical integration seems intractable due to the number of integrals involved and the size of the sample. Although a generalized method of moments estimator (GMM) could have been used, CDM propose using an asymptotic least squares (ALS) estimator.[11] ALS has been shown (Lee 1982), firstly, to be more efficient than GMM in large samples. Secondly, there is a smaller computational cost (in terms of lost observations) of the estimator. Thirdly, ALS can be easily generalized to more complicated systems,

[11] For more on asymptotic least squares, see CDM and Gourieroux and Monfort (1989).

which helps provide a unified and tractable framework for estimating limited dependent variables systems.

Results

We estimate the CDM approach on the Slovenian dataset by estimating the above system of equations (8.1)–(8.4) for a single year of observation as well as for the whole period in question. As results are fairly similar both for all single periods as well as for the whole period 1996–2002, we only present the latter in Table 8.3. In the presentation of results, first two columns of the table show estimates of the two research equations, followed by estimates of the innovation equation and, in the last column, the productivity equation. Although a direct comparison between these results and the findings of CDM is not possible as different specifications were

Table 8.3 Impact of R&D spending and innovation on productivity in Slovenia for the whole sample 1996–2002 (asymptotic least squares estimations)

Model	Research equations		Innov. and prod. equations	
	Probit[a]	Tobit[b]	Innovation[c]	Productivity[d]
R&D investment per emp. (k_i)			0.168***	
			(0.018)	
Probability to innovate (p_i)				0.930***
				(0.337)
Market share (s_i)	1.844	4.352***		
	(1.283)	(2.728)		
Number of employees (l_i)	0.299***	1.829***	0.028***	−0.219***
	(0.030)	(0.106)	(0.005)	(0.039)
Export share (exp_i)	0.489***	3.777***	−0.049	0.039
	(0.091)	(0.395)	(0.027)	(0.089)
Foreign direct investment (fdi_i)	0.196***	1.183***	0.005	0.231***
	(0.061)	(0.314)	(0.018)	(0.052)
Horizontal spillovers (HS_inov_i)	0.034***	0.061***	0.0002	−0.001
	(0.010)	(0.009)	(0.0004)	(0.001)
Vertical spillovers (VS_inov_i)	0.143***	0.013	−0.001	0.007***
	(0.016)	(0.020)	(0.001)	(0.002)
Physical capital per emp. (c_i)				0.231***
				(0.008)
Sectoral dummies (S_i)	Yes	Yes	Yes	Yes
Time dummies (T_i)	Yes	Yes	Yes	Yes
Number of observations (N)	4,947	4,947	4,947	4,947

Notes: [a]Dependent variable is an indicator variable taking on value 1 if firm *i* invests in research and 0 if it does not

[b]Dependent variable is the logarithm of investment in research and development per employee

[c]Dependent variable is an indicator variable taking on value 1 if firm *i* has innovated and 0 if it has not (we include both product and process innovation)

[d]Dependent variable is logarithm of value added per employee

Robust standard errors in parentheses. *,** and *** denote statistical significance at 10%, 5% and 1% level employed, we find that our results are broadly consistent with those in French manufacturing firms. Our results for the whole period are also consistent with those for individual years. While we find no statistically significant effect of market share on the probability to engage in research, the remaining regressors (with the exception of vertical spillovers in the tobit equation) all positively affect both the probability to engage in research and development as well as the actual investment into R&D. The innovation equation reveals that firms with larger R&D investment per employee tend to be more successful at innovating, which is line with the conclusions of CDM. On the other hand, we find that firm size also has a beneficial effect on innovative activity, which contradicts the CDM finding that size has no impact on innovation intensity (which they measure by patents or share of innovative sales). The effect of innovation on productivity is again positive and significant. The novelty of our approach is the inclusion of export share, foreign ownership indicator and spillover variables in the analysis. While the added variables, by and large, positively affect the probability of R&D and its size, they do not have any additional significant effect on either the probability to innovate or productivity itself. The only exception is the foreign ownership indicator which is positively correlated with firm productivity.

In the next section, we use the probabilities of innovation estimated using the CDM approach as our major explanatory variable of firm performance. We use this variable interchangeably with the CIS variable of innovation activity in order to check for the robustness of results.

The Impact of Innovation Activity on Firms' Productivity Growth

With some notable exceptions (see for instance Parisi et al. 2006; Hall et al. 2007) most of the relevant empirical work focuses on the link between innovation and firm productivity levels. While this is only one aspect of the causal relationship between productivity and innovative activity, we believe that it is of particular interest to explore the other aspect of the relationship as well – the consequent impact of successful innovation on firm-level productivity growth.

This section is therefore aimed at exploring the efficiency of innovations regarding firms' total factor productivity (TFP) growth. We apply several empirical specifications and econometric approaches in order to verify the robustness of the link between firms' innovation and productivity growth. First, we estimate the growth accounting model by applying ordinary least squares (OLS) approach to the data in first differences. We estimate several specifications of the empirical model, by including either R&D capital, innovation variable from the CIS or the estimated probability to innovate as obtained from the CDM approach in the previous section. Second, we refine our empirical model by splitting the sample of firms into manufacturing and services firm, and continue with splitting both samples into the quintiles of firms by the productivity measure (value added per employee), size (employment) and propensity to research (R&D expenditures relative to sales). We then estimate the impact of innovation on TFP growth for each subsample in order to check the robustness of results to sample of data. Finally, in the third approach we check the robustness of results to the econometric method by using propensity score to discriminate between innovating and non-innovating firms in order to explore whether innovation activity is the decisive factor driving firm productivity growth.

The Effect of Innovation on Productivity Growth Using OLS Estimations

In the OLS estimations we follow a great body of literature on the contribution of R&D to firms' TFP growth. Typically, a growth accounting approach in the form of a standard Cobb–Douglas production function is used in this type of analysis. We start from the following production function:

$$Y_{it} = Ae^{\lambda t} K_{it}^{\alpha} L_{it}^{\beta} R_{it}^{\gamma} e^{\varepsilon_{it}} \tag{8.5}$$

where Y_{it} is value added in firm i at time t, and K, L, and R represent the capital stock, employment, and research capital used in production, respectively. A is a constant and λ represents the rate of disembodied technical change; e is the error term capturing all firm specific disturbances as well as measurement errors, etc. The production function is homogenous of degree r in K, L, and R, such that $g = \alpha + \beta + \gamma \neq 1$, which implies that Y may have non-constant returns to scale. α, β, and γ are the elasticities of production with respect to capital, labor, and R&D capital. Our main focus is placed on the estimated elasticity γ, which reflects the marginal productivity or rate of return of output to R&D capital.

By log-linearizing we can rewrite (8.5) in the form of first differences:

$$\Delta y_{it} = \lambda + \alpha \Delta k_{it} + \beta \Delta l_{it} + \gamma \Delta r_{it} + \Delta \varepsilon_{it} \tag{8.6}$$

Note that after controlling for standard inputs (labor and capital), the estimate of γ returns the contribution of R&D capital to total factor productivity (TFP) growth. We assume that R&D capital contains a set of factors that enhance innovation activity and are either internal or external to the firm. Hence, one can write R as a function of a firm's internal R&D capital $\mathbf{F}_{it}$ and of various spillover effects $\mathbf{Z}_{it}$:

$$R_{it} = f^{i}(F_{it}, Z_{it}) \tag{8.7}$$

where $\mathbf{F}_{it}$ contains firm's own R&D expenditures, measured as a share of R&D expenditures relative to the firm's total sales. $\mathbf{Z}_{it}$ captures spillover effects that enhance a firm's ability to innovate, such as foreign ownership (*IFDI*), learning by exporting (exports to sales ratio, *exp*) as well as innovation spillovers received from other firms within the same sector (*HS_inov*) or from other sectors (*VS_inov*). We basically employ the same formulation of the research capital function (8.7), i.e. elements of F_{it} and Z_{it}, the same determinants of firms' innovation activity as in the CDM model in the previous section. A dummy variable for services firms is included in our model specification in order to control for differences in TFP growth pattern between manufacturing and services firms. The model also includes time dummies and dummy variables for technology intensity sectors (low tech, medium-low tech, medium-high tech and high tech).

Note that in a panel data framework, (8.5) is typically subject to firm-specific time invariant disturbances, which one can control for by using one of the standard panel data estimation techniques (within or between estimators). Alternatively, one can get rid of firm-specific effects by estimating the equation as in (8.6), where, by first-differencing the time invariant, firm-specific effects are simply eliminated. Another problem with the time-series cross-section specification of (8.5) is a potential endogeneity between the inputs and the output, which may lead to a biased estimation of input coefficients. However, in such a short and unbalanced panel dataset with mostly two to three observations per firm, there is little one can do about it. Correcting for this endogeneity, by using either the Olley-Pakes method or general method of moments (GMM) requires longer time series.

In our first specification (see column 1) we estimate the impact of innovations, which is the effective result of R&D, on firm TFP growth. This specification returns a significant estimate of the rate of return on innovation (γ) of 0.083. It demonstrates that in an average Slovenian firm innovation results in a bi-annual TFP growth of 8.3%. In addition to this, foreign ownership enhances a firm's TFP growth by an additional 8.8%, but our results also demonstrate that innovations have the same impact on TFP growth both in foreign owned and domestic firms (no significant difference found for the interaction term *INOV*IFDI*). Nevertheless, foreign ownership has a dual impact on a firm's TFP growth. As shown by the CDM model in previous section, it first enhances firm's ability to innovate, while also contributing additionally to a firm's TFP growth via superior organizational techniques, etc. Export propensity is also shown to contribute significantly to TFP growth.

From other external spillover variables included in our model, horizontal innovation spillovers seem to have a slightly negative impact on firm TFP growth, while vertical spillovers do not seem to have any direct impact. It is likely that innovation spillovers enhance firm's R&D activity and its ability to innovate but do not affect a firm's TFP growth per se. Test of the CDM specification of the research capital creation (see research equation in Table 8.3) confirms this only partly showing that both horizontal (intra-industry) and vertical (inter-industry) knowledge spillovers do enhance firm's research capital creation, but do not contribute separately to firm's ability to innovate.

Innovation, as well as export propensity and foreign ownership are, thus, shown to have a positive and significant impact on firm productivity growth. However, it is important to see, first, whether these results are uniform across sectors and, second, whether product and process innovation have a different impact on TFP growth.

In the second specification (see column 2) we introduce a dummy for services sectors, which produces two interesting results. First, after including a dummy for the services sector the general impact of innovation (γ) drops considerably (to 0.053) and becomes insignificant. And second, while services firms are shown to increase TFP at a slower pace (by some 10% points) than manufacturing firms, this changes dramatically when interacting the services dummy with the innovation variable (*INOV*Services*). Results show that innovating services firms do increase TFP at some 18% points faster than non-innovating services firms. Similar results are obtained when controlling for product or process innovation (see columns 3 and 4). We find that both product as well as process innovations are shown to boost the productivity growth of services firms (by 17.8% and 15.5%, respectively), while neither of the two seems to have a significant impact on TFP growth of manufacturing firms.

As a robustness check we replicate the above estimation by using the estimated probabilities to innovate from the CDM model (instead of innovation indicators from the CIS) where the research capital equation and innovation equation are estimated simultaneously. Note that explanatory variables in this system of equations are the same as those used as additional covariates in the above OLS estimations of the impact of innovation on TFP growth. Results including the estimated probabilities to innovate from the CDM model (see columns 5–7 in Table 8.4) show a statistically significant and larger estimate of the return on innovation (the estimate of γ increases to 0.077) as compared to 0.053 in the specification 8.3. Separate estimations for impact of product and process innovation on firm TFP growth gives (both marginally insignificant) slightly higher coefficients of γ (0.079 and 0.083 for product and process innovations, respectively). Again, product and process innovations in the services firms are found to have substantial impact on individual firm's TFP growth. Innovating services firms increase their TFP by 23% (process innovations) to 25% (product innovations) as compared to non-innovating services firms. Innovations apparently pay off considerably for services firms.

Robustness Check 1: OLS Estimations on Sub-Samples of Firms

The results presented so far do not provide conclusive evidence on the general impact of innovation on firm TFP growth. The evidence seems to point towards a significant impact for services firms, but no significant impact for manufacturing firms. We explore the issue further by splitting both samples of manufacturing and services firms into smaller sub samples of more homogenous firms. Estimating the above empirical model on larger samples of quite heterogeneous firms – although controlling for their broader sectoral classification and technological intensity – hides most of the variation within the sample. Therefore, we split our samples of manufacturing and services firms into the quintiles of firms by the productivity

Table 8.4 Impact of R&D and innovation on TFP growth of Slovenian firms, 1996–2002 [OLS on first differences]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Type of innovation	All Inov	All Inov	Product Inov	Process Inov	All Inov	Product Inov	Process Inov
ΔCapital	0.112	0.144	0.144	0.145	0.154	0.152	0.153
	[8.68]***	[8.26]***	[8.25]***	[8.30]***	[8.89]***	[8.70]***	[8.71]***
ΔLabor	0.65	0.475	0.474	0.477	0.489	0.482	0.482
	[22.24]***	[14.13]***	[14.09]***	[14.19]***	[14.64]***	[14.26]***	[14.26]***
ΔR&D/Sales							
Serv. dummy		−0.105	−0.102	−0.094	−0.144	−0.132	−0.123
		[3.11]***	[3.05]***	[2.84]***	[5.18]***	[4.49]***	[4.25]***
INOV [a]	0.083	0.053	0.049	0.058			
	[3.34]***	[1.39]	[1.24]	[1.40]			
INOV * Serv.[a]		0.184	0.178	0.155			
		[2.77]***	[2.54]**	[1.93]*			
p[INOV][b]					0.077	0.079	0.083
					[2.00]**	[1.64]	[1.53]
p[INOV][b] * Serv. [c]					0.214	0.249	0.227
					[2.48]**	[2.25]**	[1.65]*
IFDI	0.088	0.090	0.081	0.094			
	[3.73]***	[2.80]***	[2.58]**	[3.08]***			
INOV * IFDI	−0.055	−0.051	−0.024	−0.070			
	[1.32]	[0.90]	[0.41]	[1.13]			
EX/Sales	0.139	0.081	0.080	0.086			
	[5.31]***	[2.07]**	[2.05]**	[2.22]**			
HS_INOV	−0.002	−0.002	−0.002	−0.002			
	[2.85]***	[2.17]**	[2.19]**	[2.21]**			
VS_INOV	0.002	0.001	0.001	0.001			
	[1.21]	[0.58]	[0.57]	[0.52]			
Med. low tech	0.025	0.065	0.067	0.064			
	[0.82]	[1.42]	[1.46]	[1.41]			
Med. high tech	0.102	0.136	0.137	0.140			
	[3.20]***	[3.04]***	[3.05]***	[3.13]***			
High tech	−0.069	−0.015	−0.014	−0.009			
	[1.92]*	[0.27]	[0.26]	[0.17]			
Const.	−0.016	0.011	0.012	0.016	0.075	0.075	0.077
	[0.55]	[0.27]	[0.29]	[0.39]	[3.86]***	[3.64]***	[3.78]***
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs	4,146	4,171	4,171	4,171	4,171	4,171	4,171
Adj R-sq.	0.19	0.10	0.10	0.10	0.09	0.08	0.08

Dep.var: ΔValue added

[a]Innovation variable taken from CIS

[b]Probabilities to innovate obtained by the CDM approach

[c]NACE codes 38-74. t- statistics in brackets *, ** and *** denote significance of coefficients at the 10%, 5% and 1%, respectively

measure (value added per employee), size (employment) and propensity to research (R&D expenditures relative to sales) and then estimate impact of innovation on TFP growth for each subsample. By doing so we try to uncover a relationship between innovation and TFP growth for smaller and larger firms, for less productive and more productive firms, and for firms which have a different propensity to engage in R&D.

Table 8.5 reports the results obtained by estimating our empirical model on quintiles of firms by their key characteristics – productivity, size and R&D

Table 8.5 Impact of innovation on TFP growth of Slovenian firms, by sub samples of firms according to quintiles of productivity, size and R&D propensity, 1996–2002 [OLS on first differences]. Manufacturing firms (NACE 15-37)

	Productivity quintiles					
Innovation type[a]	All	Q1	Q2	Q3	Q4	Q5
Product or process	0.034	−0.039	−0.031	−0.020	−0.008	0.043
	[1.25]	[0.35]	[0.64]	[0.39]	[0.20]	[0.74]
Product	0.031	−0.053	−0.023	−0.034	0.008	0.061
	[1.09]	[0.47]	[0.46]	[0.63]	[0.19]	[1.02]
Process	0.024	−0.091	−0.082	0.015	−0.010	0.048
	[0.82]	[0.76]	[1.54]	[0.28]	[0.24]	[0.80]
	Size quintiles					
Innovation type	All	Q1	Q2	Q3	Q4	Q5
Product or process	0.034	0.049	0.005	0.050	0.059	−0.023
	[1.25]	[0.31]	[0.05]	[0.89]	[1.30]	[0.45]
Product	0.031	0.004	0.026	0.044	0.053	−0.019
	[1.09]	[0.02]	[0.26]	[0.75]	[1.14]	[0.37]
Process	0.024	0.155	−0.046	0.051	0.053	−0.043
	[0.82]	[0.74]	[0.41]	[0.83]	[1.10]	[0.84]
	R&D/Sales quintiles					
Innovation type	All	Q1	Q2	Q3	Q4	Q5
Product or process	0.041	0.275	0.157	−0.323	−0.473	0.344
	[0.28]	[1.05]	[0.57]	[0.89]	[1.12]	[0.74]
Product	0.023	0.028	0.336	−0.228	−0.001	0.063
	[0.35]	[0.21]	[2.15]**	[1.50]	[0.01]	[0.34]
Process	−0.002	0.191	−0.080	0.012	−0.043	0.205
	[0.04]	[1.19]	[0.71]	[0.11]	[0.45]	[1.60]
Services firms (NACE 38-74)	Productivity quintiles					
Innovation type[a]	All	Q1	Q2	Q3	Q4	Q5
Product or process	0.161	0.102	0.033	−0.130	0.340	−0.027
	[2.96]***	[0.45]	[0.27]	[1.32]	[3.89]***	[0.27]
Product	0.140	0.168	0.062	−0.130	0.313	−0.102
	[2.40]**	[0.69]	[0.47]	[1.32]	[3.28]***	[0.96]
Process	0.206	−0.025	0.120	−0.118	0.363	0.081
	[3.06]***	[0.09]	[0.72]	[0.99]	[3.35]***	[0.69]
	Size quintiles					
Innovation type	All	Q1	Q2	Q3	Q4	Q5
Product or process	0.161	0.078	0.087	0.052	0.214	0.113
	[2.96]***	[0.45]	[0.39]	[0.55]	[2.15]**	[1.29]
Product	0.140	−0.068	0.084	0.011	0.268	0.103
	[2.40]**	[0.34]	[0.37]	[0.11]	[2.64]***	[1.06]
Process	0.206	0.046	0.220	0.077	0.224	0.141
	[3.06]***	[0.21]	[0.72]	[0.72]	[1.66]*	[1.28]
	RD/S quintiles					
Innovation type	All	Q1	Q2	Q3	Q4	Q5
Product or process	0.176	0.294	0.122	−0.236	0.901	
	[0.80]	[0.56]	[0.44]	[0.32]	[1.87]*	
Product	−0.064	0.111	−0.02	−0.314	0.059	−0.586
	[0.49]	[0.25]	[0.09]	[1.03]	[0.22]	[0.72]
Process	0.093	−0.711	0.208	−0.110	0.059	−0.048
	[0.82]	[0.44]	[1.12]	[0.33]	[0.32]	[0.17]

Dep.var.: ΔValue added

[a]Innovation variable taken from CIS. T-statistics based on robust standard errors in parenthesis. *, ** and *** denote significance of coefficients at the 10%, 5% and 1%, respectively

propensity. Note that we estimate the fully specified model (specification 8.3) with the CIS reported innovation (product or process) as our main explanatory variable. The results demonstrate, that – even after allowing for variation within the sample in terms of productivity, size and R&D propensity – neither product nor process innovations are shown to impact TFP growth of Slovenian manufacturing firms. The second quintile of R&D propensity is the only sub sample where manufacturing firms with product innovations are found to grow faster in terms of TFP relative to their non-innovating counterparts.

Results in Table 8.5 indicate that the overall positive impact of innovation of Slovenian firms is driven by a very specific group of services firms. More specifically, we find that it is the services firms in the fourth quintile – measured either by the size, productivity or R&D propensity – that reveal higher TFP growth due to innovation activity. This is somehow at odds with our expectations, as we would expect this to be a more general case in the sense that medium or large sized firms, most productive firms or firms with the highest R&D expenditures to sales would be the front runners in innovation and would experience the highest impact on productivity growth. It seems that firms just below the top have the highest potential in increasing productivity and are capable of using innovations most efficiently.

Robustness Check 2: The Effect of Innovation on Productivity Growth Using the Nearest Neighbor Matching and Average Treatment Effects

In the remainder of the paper we apply another robustness check of the above results using a different econometric approach. The results presented so far indicate that innovation and R&D expenditure may be of crucial importance as determinants of firm productivity dynamics. However, our approach so far did not control strictly enough for the inherent differences between innovative and non-innovative firms. In order to determine the actual effect innovative activity has on firm productivity growth the effect of innovative activity on firm performance must be estimated by comparing otherwise similar firms. A way of doing this is to employ matching techniques to construct something akin to a controlled experiment. We use firm propensity to innovate to match innovating firms with otherwise similar non-innovating firms in order to evaluate the importance of innovation on productivity growth. Firms' probability to innovate is calculated by running the following probit regression:

$$\Pr(INOV_{it} = 1) = \alpha + \beta_1 INOV_{it-2} + \beta_2 Size_{it} + \beta_3 \frac{rVA}{Emp_{it}} + \beta_4 \frac{RD}{Sales_{it}} + \beta_5 \frac{EX}{Sales_{it}} + \beta_6 IFDI_{it} + \varepsilon_{it} \tag{8.8}$$

where variables employed are the same as those used in both in the CDM approach as well as in the OLS. Probability to innovate is determined by firm's previous innovation experience, its size, relative productivity (relative to the NACE 3-digit sector), R&D propensity, export propensity and foreign ownership.

Conditional on satisfying the balancing property of the propensity score, the fitted values obtained from estimating the above equation (the probit estimation) are used to pair up innovators with non-innovators and those matched pairs are subsequently used to estimate the average treatment effect of innovation on firm productivity growth. The balancing property ensures that once the observations have been stratified into blocks according to the propensity score, the right hand side variables of (8.8) do not differ significantly between the groups of treated and non-treated observations within a block. The more closely the firms are matched with respect to regressors in (8.8), the more likely it is that the observed productivity differences result purely from the fact that some firms managed to innovate while others did not. We match innovating firms with their non-innovating counterparts using nearest neighbor matching (with random draws) which pairs up the treated with the closest, with respect to the propensity score, non-treated observations. Given that our sample size is very small in some instances, all the standard errors reported were generated by bootstrapping with 100 repetitions.

Tables 8.6–8.8 present the results of average treatment effects estimates of innovation on different specifications of growth in value added per employee. In each of the tables we differentiate between manufacturing and service firms, and as well taking explicit account of firm size classes. The top panel of Table 8.6 presents

Table 8.6 Average treatment effects estimates of innovation on growth in *VA*/*Emp* (difference in logs)

Firm size	Productivity growth in first two periods after innovation $(t + 2) - t$					
	Manufacturing (NACE 15-37)			Services (NACE 45-74)		
	ATT	SE	No. of obs. treat. (control)	ATT	SE	No. of obs. treat. (control)
Emp $\leq$ 10	−0.106	0.079	87 (68)	0.037	0.056	131 (116)
10 < Emp $\leq$ 50	−0.121*	0.072	172 (126)	0.024	0.066	69 (57)
50 < Emp $\leq$ 250	−0.029	0.027	545 (311)	−0.102	0.083	47 (41)
Emp > 250	−0.035	0.038	380 (137)	−0.050	0.067	31 (21)
	Productivity growth between periods 4 and 2 after innovation $(t + 4) - (t + 2)$					
Firm size	Manufacturing (NACE 15-37)			Services (NACE 45-74)		
	ATT	SE	No. of obs. treat. (control)	ATT	SE	No. of obs. treat. (control)
Emp $\leq$ 10	−0.168	0.146	87 (55)	−0.090	0.080	131 (92)
10 < Emp $\leq$ 50	0.033	0.084	172 (86)	−0.120	0.109	69 (44)
50 < Emp $\leq$ 250	−0.047	0.044	545 (215)	−0.013	0.179	47 (32)
Emp > 250	−0.054	0.060	380 (94)	−0.144	0.099	31 (18)

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% level. The number of observations is given in terms of both the number of treatment and control observations (the latter in parentheses). SE- bootstrapped standard errors

Table 8.7 Average treatment effects estimates of innovation on growth in VA/Emp (difference in logs) two periods after innovation (*t+2*) – *t*

Firm size	Process innovation					
	Manufacturing (NACE 15-37)			Services (NACE 45-74)		
	ATT	SE	No. of obs. treat. (control)	ATT	SE	No. of obs. treat. (control)
Emp ≤ 10	−0.041	0.064	51 (47)	0.005	0.081	65 (62)
10 < Emp ≤ 50	−0.151***	0.059	114 (99)	0.111	0.073	39 (35)
50 < Emp ≤ 250	0.000	0.024	404 (285)	−0.129	0.087	22 (19)
Emp > 250	−0.054	0.044	318 (142)	−0.031	0.062	12 (10)
	Product innovation					
Firm size	Manufacturing (NACE 15-37)			Services (NACE 45-74)		
	ATT	SE	No. of obs. treat. (control)	ATT	SE	No. of obs. treat. (control)
Emp ≤ 10	−0.190	0.112	77 (53)	−0.053	0.078	121 (87)
10 < Emp ≤ 50	0.153	0.111	153 (83)	0.049	0.111	64 (35)
50 < Emp ≤ 250	0.005	0.063	502 (193)	−0.319***	0.114	42 (28)
Emp > 250	0.019	0.079	357 (98)	−0.075	0.101	30 (15)

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% level. The number of observations is given in terms of both the number of treatment and control observations (the latter is in parentheses). SE- bootstrapped standard errors

Table 8.8 Average treatment effects estimates of innovation on growth in Levinsohn–Petrin specification TFP/Emp (difference in logs)

Productivity growth in the first two periods after innovation (*t+2*) − *t*			
Firm size	Manufacturing (NACE 15-37)		
	ATT	SE	No. of obs. treat. (control)
Emp ≤ 10	−0.188	0.122	87 (33)
10 < Emp ≤ 50	−0.110	0.085	172 (74)
50 < Emp ≤ 250	0.193	0.170	545 (200)
Emp > 250	−0.012	0.039	380 (98)
Productivity growth between second and fourth period after innovation (*t+4*) − (*t+2*)			
Firm size	Manufacturing (NACE 15-37)		
	ATT	SE	No. of obs. treatm. (control)
Emp ≤ 10	−1.792***	0.616	87 (3)
10 < Emp ≤ 50	−0.192	0.158	172 (32)
50 < Emp ≤ 250	0.021	0.052	545 (114)
Emp > 250	−0.083	0.110	380 (63)

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% level. The number of observations is given in terms of both the number of treatment and control observations (the latter is in parentheses). SE- bootstrapped standard errors

the average treatment effects of innovation on labor productivity growth in the first two years after the innovation has been introduced, where productivity growth is accounted for as:

$$growth[(t+2)-t] = \ln\left(\frac{VA}{Emp}\right)_{t+2} - \ln\left(\frac{VA}{Emp}\right)_{t} \tag{8.9}$$

where *VA* is value added and *Emp* is employment. In contrast to the subsequent results, here we do not discriminate between product and process innovation and consider any form of determinant of productivity growth.

Contrary to our expectations, no significant positive effects of innovation on labor productivity growth are revealed in the top panel of Table 8.6. Moreover, small manufacturing firms (between 10 and 50 employees) even experienced a significant negative "treatment" effect of innovation on labor productivity growth (significant at 10% only). It remains to be seen in the later specification whether this result is robust.

One possible explanation for failure to find more conclusive results may be that we are not capturing the relevant growth period. It may take longer than 2 years after the initial innovation for firms to internalize all the benefits of it. To control for this we redefined productivity growth so that we explore the growth in labor productivity between the second and fourth year after the innovation:

$$growth[(t+4)-(t+2)] = \ln\left(\frac{VA}{Emp}\right)_{t+4} - \ln\left(\frac{VA}{Emp}\right)_{t+2} \quad (8.10)$$

The bottom panel of Table 8.6 presents estimates of the average treatment effect of innovation on labor productivity growth between the second and fourth years after the innovation was initially made. By changing the period of observation we hope to capture the effects of innovation on productivity that were not apparent in the first 2 years after the time of innovation. As before, we find that innovating firms did not grow significantly faster (in terms of productivity) than comparable non-innovating firms. We no longer find negative impacts of innovation on productivity growth in small manufacturing firms. Interestingly, while a non-significant impact of innovation on productivity growth of manufacturing firms has been expected with respect to our previous OLS results, finding non-significant results for services firms is a little more surprising. Matching innovating and non-innovating services firms and comparing their relative performance fails to uncover significant differences in post-treatment (i.e. post-innovation) performance between both groups.

To further disentangle the cause of this lack of evidence on the effects of innovation on productivity growth, we opt for a more specific definition of innovation by explicitly discriminating between product and process innovations in Table 8.7. This is based on the findings that process innovations have labor displacement effects and are expected to result in significant productivity growth, while, due to the demand effect, product innovations may likely cause employment growth and, thus, may not result in significant productivity growth (Harrison et al 2005; Parisi et al 2006; Hall et al 2007).

Evidence on changes in employment after a firm has conducted some innovation, however, do not confirm these differentiated expectations (see Table B1 in Appendix B). Notwithstanding what kind of innovation a firm has conducted, both process and product innovating firms seem on average to decrease their employment levels. This is true for virtually all size classes with only a few exceptions.

Decreases in employment levels should therefore result in positive changes in productivity growth in both groups of innovating firms.

Table 8.7 presents estimates of the average treatment effect separately for process and product innovation on labor productivity growth.[12] In line with the evidence on employment changes, results for separate sets of process and product innovating firms do not differ substantially from those presented for aggregate innovations. Again, little evidence is found in favor of innovations positively affecting productivity growth. As was the case before, most of the estimates are not significantly different than zero, whereby small manufacturing firms (between 10 and 50 employees) in the case of process innovations and medium sized services firms (between 50 and 250 employees) in the case of product innovations, are found to experience a significant negative "treatment" effect of innovation on labor productivity growth. These negative effects disappear when taking into account productivity growth between the second and fourth years after the innovation (see Tables A1 and A2 in the Appendix A).

Possibly, the reason for the insignificance of the results may be that the effects of innovation are not adequately captured by labor productivity and that total factor productivity should have been used instead. Additionally, our productivity proxy may fail to control for contemporaneous growth in inputs, which may conceal the actual productivity dynamics. In order to control for this we use a TFP measure of productivity estimated by the Levinsohn and Petrin (2003) method. For obvious reasons this is done for manufacturing firms only. The results shown in Table 8.8 again indicate that there is no significant relationship between innovation activity and subsequent increases in productivity after 2 or 4 years. The only exception are micro firms (less than 10 employees) in the period of 4 years after innovation, where a negative relationship is found, but this result is not repeated in any other alternative specification.

Conclusions

The paper examines the implications of endogenous growth theory on the relationship between firm productivity, innovation and productivity growth using firm-level innovation (CIS) and accounting data for a large sample of Slovenian firms in the period 1996–2002. Two different approaches – simple OLS after the Crépon–Duguet–Mairesse (CDM) approach, and matching techniques – are used to check the robustness of the results. We also distinguish between product and process innovations.

[12]Note that we only show results for the first two years after the innovation has been introduced, while the results for productivity growth between the second and fourth years after the innovation was initially introduced are shown in the Appendix (Tables B1 and B2).

OLS estimates seem to provide some empirical support to theoretical proposition of a positive impact of innovation on productivity growth. Both the actual innovation variables from CIS as well as probabilities to innovate estimated using the system of the research capital equation and innovation equation indicate that innovating firms increase their productivity at a faster rate than non-innovating firms. Refinements of the empirical tests allowing for sectoral differences and within sector heterogeneity, however, reveal that the above results rely mainly on the exceptional performance of a specific group of services firms. It is shown that it is medium sized, more (but not the most) productive firms and firms with high (but not the highest) R&D expenditures to sales in the services sectors that are the frontrunners in innovation. They demonstrate the highest potential to increase productivity and are capable of using innovations the most efficiently. Separate estimation results for product and process innovations show no significant differences.

As a robustness check we use nearest neighbor matching approach in order to match innovating and non-innovating firms with similar characteristics and then perform average treatment tests of the impact of innovation on performance of innovating firms as compared to the performance of non-innovating firms. Estimates arrived at by the matching techniques do not reveal any significant positive effects of innovation on labor productivity growth, regardless of the length of the period after the innovation was made. Results do not differ for the samples of manufacturing versus services firms or the samples of firms classified by their size. The results also do not show any different effects for product and process innovations. Both types of innovations bring about a reduction in employment, however, little evidence is found in favor of innovations – be it product or process – positively affecting productivity growth. The result is not sensitive to the use of a TFP or of a VA/emp as a measure of productivity.

The overall conclusion is that the results of the exercise are not robust to different econometric approaches. There are several possible reasons why our analysis has not yielded the expected positive relationship between innovative activity and productivity growth. In our opinion, the primary reason for these results lies in the quality of the survey data, primarily with regard to the definition of innovation. A simple indicator of conducting at least one (product or process) innovation in the past 2 years may not indicate firm's true innovativeness in a satisfactory way. An indicator pointing out the number of innovations conducted would be more informative. Similarly, a longer series of information about the share of sales obtained through innovated products and services would be of extreme importance. Secondly, we do not have the information on the exact time of innovation, as innovative activity could happen in either of the 2 years between surveys. Finally, it may be the case that a longer time series is required to capture the full effects of innovation.

Appendix A

Table A1 Average treatment effects estimates of innovation on growth in VA/Emp (difference in logs) between two and four periods after innovation $(t + 4) - (t + 2)$ [Process innovation]

Firm size	Manufacturing (NACE 15–37)			Services (NACE 45–90)		
	ATT	SE	No. of obs. treat. (control)	ATT	SE	No. of obs. treat. (control)
Emp $\leq$ 10	−0.084	0.140	52 (43)	−0.019	0.103	65 (47)
10 $<$ Emp $\leq$ 50	0.003	0.083	114 (70)	−0.062	0.133	39 (28)
50 $<$ Emp $\leq$ 250	−0.044	0.040	404 (194)	0.027	0.096	22 (16)
Emp $>$ 250	0.042	0.066	318 (106)	0.027	0.136	13 (9)

Note: ***,**,* denote statistical significance at 10%, 5% and 1% level. The number of observations is given in terms of both the number of treatment and control observations (the latter is in parentheses). SE- bootstrapped standard errors

Table A2 Average treatment effects estimates of innovation on growth in VA/Emp (difference in logs) between two and four periods after innovation $(t + 4) - (t + 2)$ [Product innovation]

Firm size	Manufacturing (NACE 15–37)			Services (NACE 45–90)		
	ATT	SE	No. of obs. treatm. (control)	ATT	SE	No. of obs. treatm. (control)
Emp $\leq$ 10	−0.084	0.140	52 (43)	−0.019	0.103	65 (47)
10 $<$ Emp $\leq$ 50	0.003	0.083	114 (70)	−0.062	0.133	39 (28)
50 $<$ Emp $\leq$ 250	−0.044	0.040	404 (194)	0.027	0.096	22 (16)
Emp $>$ 250	0.042	0.066	318 (106)	0.027	0.136	13 (9)

Note: ***,**,* denote statistical significance at 10%, 5% and 1% level. The number of observations is given in terms of both the number of treatment and control observations (the latter is in parentheses). SE- bootstrapped standard errors

Appendix B

Table B1 Changes in employment in firms conducting product and process innovations in 1996–2002, by size classes[a]

		Product and process innov.				Process innovators only				Product innovators only			
		−1	0	1	2	−1	0	1	2	−1	0	1	2
0 < x < 10	Change in employ.	1.0	0.4	0.1	−27.0	1.0	0.7	−10.4	−1.2	0.9	−4.1	−0.6	−8.5
	Number of firms	38	82	7	10	5	3	5	5	41	23	12	16
10 < x < 50	Change in employ.	2.5	2.0	−2.9	−6.3	1.4	0.3	1.7	−6.2	1.2	1.4	−2.4	0.2
	Number of firms	216	204	99	121	45	43	22	28	176	173	105	126
50 < x < 250	Change in employ.	2.8	1.1	−8.0	−0.8	−0.3	0.7	−25.0	−1.8	0.3	−1.9	0.9	−2.2
	Number of firms	401	264	148	278	52	78	31	36	185	162	119	148
x > 250	Change in employ.	−8.5	−10.8	−12.9	−13.2	−5.4	−34.0	−6.2	−9.2	−1.3	−11.8	−1.2	−9.5
	Number of firms	302	171	70	215	30	25	16	21	94	81	57	68

Notes: [a]Change in number of employees calculated as mean of changes at the firm level in respective size class.
Source: SURS, own calculations

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Chapter 9
Social Capital and Growth in Brazilian Municipalities

Luca Corazzini, Matteo Grazzi, and Marcella Nicolini

Abstract Several authors (Coleman (1990) Foundations of social theory. Harvard University Press, Cambridge MA; Putnam RD (1993); Fukuyama (1995) Trust: the social virtues and the creation of prosperity. Free Press, New York) highlight that social capital could affect the economic performance of a country through a number of channels. Empirical evidence backs these theories, finding a positive relationship between growth, efficiency and the level of trust. Nonetheless, previous analyses focus on a single country or develop a cross-country dimension: we contribute to this literature by investigating the role of social capital at a sub national level. We focus on a country characterized by large disparities, Brazil, and we investigate the relationship between economic growth and social capital over the period 2000–2003, at the municipal level. We derive a number of social capital indicators from official data, and analyse them by means of factor component analysis. Overall, we find evidence of a positive relationship between social capital and income per capita growth.

Introduction

There is widespread empirical evidence showing the positive relationship between the level of social capital present in a society, growth and efficiency (Putnam

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"The advantage to mankind of being able to trust one another, penetrates into every crevice and cranny of human life: the economical is perhaps the smallest part of it, yet even this is incalculable"(J.S. Mill (1848/2004))

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1993; Fukuyama 1995; Heliwell and Putnam 1995; Knack and Keefer 1997; Knack and Zak 2001; La Porta et al. 1997). In fact, according to the modern theory of social capital (Coleman 1990; Putnam et al. 1993; Fukuyama 1995), it may influence economic performance via several channels. First, by reducing transaction costs and legal disputes, social capital gives the opportunity to firms and entrepreneurs to invest a higher quantity of resources in new products or processes. Second, social capital implies a higher reliability of formal institutions, such as the government and the central bank. Finally, a stronger social cohesion due to the sharing of social and ethical norms enhances cooperative behaviours.

In this perspective, social capital is able to account for differentials in economic performances among countries that are similar in terms of other sources of capital (Cole et al. 1992; Temple and Johnson 1998; Temple 1998; Guiso et al. 2004). Nevertheless, while many scholars have performed cross-country analyses, few studies have evaluated the role played by social capital in explaining differences within a country. This work aims at contributing to this line of the literature by analyzing the relationship between social capital and growth rates across Brazilian municipalities.

Brazil is a continent-sized country, ranked eight by world GDP in 2008 (World Bank 2009) and the largest in Latin America in terms of population. In the last years its economy has been one of the World's most dynamic and the country has gained a growing importance in the international political and economic scene. However, despite the recent steady economic growth, Brazil has failed to reduce inequality significantly and remains a country characterized by deep contrasts and diversities. Known as one of the most unequal countries in the world, living conditions for Brazil's 190 million people vary dramatically depending on their location, gender and race. Income inequality is very high and persistent over time, and it has deep historic and regional roots. In 2007, the Gini Coefficient for the distribution of household incomes per capita was 0.59 and the income share of the richest 10% of the population was equal to 43 times the corresponding share of the poorest 10% (ECLAC 2009).

Focusing on spatial variations, differences across regions are extremely marked. For example, life expectancy at birth ranges from 63.2 years in Alagoas to 71.6 years in Rio Grande do Sul and poverty incidence rates range from 3.1% in metropolitan São Paulo to more than 50% in the rural northeast (World Bank 2004). However, income disparities are significant not only across the country's regions and states but also within them, at municipal level. The existence of such heterogeneity suggests that an analysis at municipal level is the most adequate to correctly evaluate the actual contribution of social capital to economic growth in the country.

Thus, we develop our investigation at this geographical level, by considering all 5,507 Brazilian municipalities. In order to obtain good measures of social capital, we start from a large set of social indicators, mainly provided by the Brazilian Institute for Geography and Statistics (IBGE) and by Instituto de Pesquisa

Econômica Aplicada (IPEA). These data come from official sources; therefore they are fully representative, even at this very detailed level.[1] This is a strong advantage with respect to survey data, which could lack representativeness at municipal level. We analyse these social indicators by means of factor component analysis. This methodology allows to combine several indicators into one synthetic variable, by finding the linear combination of the variables that produces the maximum possible variance.

Following a standard approach in growth literature, we regress income per capita growth on the initial level of income per capita, investment and human capital endowment, and a number of city characteristics, in order to account for heterogeneity. We enrich this specification by adding a number of controls for social capital. Overall, we find that social capital is positively correlated with economic growth, thus confirming previous results in the literature. Interestingly, we find that this relationship holds also if considering narrow geographical units within a country characterized by large disparities.

The paper is structured as follows: Sect. 9.2 presents the review of the literature, and Sect. 9.3 the data, the empirical specification, and the methodology. Section 9.4 shows the results and robustness checks, and finally Sect. 9.5 concludes.

Review of the Literature

There is a large number of empirical contributions that state the existence of a positive relationship between growth, economic and institutional performances and the level of social capital. Given its social and cultural connotations, social capital is able to explain differences in economic performances between countries that appear similar in terms of resources and productive processes.

Although focused on a different institutional context, the most related work to ours is Putnam et al. (1993). They study the role of social capital in explaining different institutional performances between Italian regions. Social capital is measured indirectly through four different indicators: the number of voluntary institutions operating at the local level, the diffusion of newspapers within each region, voter turnout at referenda and the distribution of preference votes in political elections. As a result, the authors observe a positive and significant relationship between the social capital indicators and local institutions' performance. As a follow up to this research, Heliwell and Putnam (1995) investigate the economic impact of social capital in the Italian regions, finding that regions characterized by higher levels of social capital are associated with better economic performances. Thus, social capital has been found to account for differences in economic growth between Italian regions.

[1]Municipalities are the smallest administrative units in the Brazilian political system. Each one is governed by a mayor and has a chamber of representatives.

Moving from Putnam et al. (1993), a large amount of empirical studies have been carried out to identify the determinants of social capital and to purify the relationship between social capital and economic performances from spurious effects by using different sources of micro-level data.

La Porta et al. (1997) analyse the effect of social capital on the performance of large organisations measured by government effectiveness, participation in civic organisations, size of the largest firms relative to GNP, and the performance of a society more generally. As a proxy of social capital, the authors draw data from the third wave of the World Value Survey. In particular, they use the percentage of respondents who answered that most of the people can be trusted when asked: "Generally speaking, would you say that most people can be trusted or that you cannot be too careful in dealing with people?". They find that the effects of trust on economic performances are both statistically significant and quantitatively large. Trust is also associated with lower inflation and weakly associated with higher per capita GNP growth.

Knack and Keefer (1997) use data from 29 market economies to investigate the relationship between growth, civic participation and trust. Both the level of trust (TRUST) and the strength of norms of civic cooperation (CIVIC)[2] were assessed drawing data from the World Value Survey. Authors find that social capital variables are positively and significantly correlated with the average annual growth in income per capita over the 1980–1992 period and the ratio between investment per capita and GDP, averaged over the 1980–1992 period. Furthermore, TRUST remains significant after being instrumented with cultural and sociological instruments, such as education and respondents' belonging to specific "ethno-linguistic" groups.

Finally, Knack and Keefer analyse the relationship between TRUST and the levels of output per worker, physical and human capital per worker, and total factor productivity (TFP). They find that TRUST is positively and significantly correlated with output, capital and schooling, while the correlation with TFP is positive but insignificant. Zak and Knack (2001) extend the analysis of Knack and Keefer (1997) by adding eight countries to the original sample. They show that there exists a positive relationship between social capital and effectiveness of formal institutions in enforcing contracts and reducing corruption, while social capital is negatively associated with inhabitants' polarization measured by income inequality, ethnic heterogeneity, and economic discrimination.

As mentioned above, all these studies use as a proxy of the level of social capital in a country data from the World Value Survey. However, given the scope of our

[2]In particular, civic attitude was inferred from responses to questions on whether the following behaviours "could always be justified, never be justified or something in between: claiming government benefits which you are not entitled to; avoiding a fare on public transport; cheating on taxes if you have the chance; keeping money that you have found; failing to report damage you have done accidentally to a parked vehicle."

Respondents chose a number from 1 (never justifiable) to 10 (always justifiable). Authors reversed the scales, so that larger values indicated greater cooperation, and summed values over the five items to create CIVIC.

study, issues of population representativeness raise serious doubts about the reliability of this source of data at narrow level, and drive us to look for more reliable proxies at the municipality level.

Notice that other several recent contributions turn back to the original methodology introduced by Putnam et al. (1993), trying to measure social capital with some objective measures, rather than relying on survey data. For instance, Guiso et al. (2004) analyse the relationship between social capital and development of the financial market by using data on blood donations and electoral participation as a proxy of social capital and strength of social norms. Indeed, they find a positive and significant relationship between social capital and financial development.

Data Description and Empirical Specification

We want to investigate whether, and to what extent, social capital is related to economic growth. In order to implement this analysis, we start with a standard test of absolute convergence of income per capita, and we enrich it with several indicators for social capital. Following a standard approach, in line with Mankiw et al. (1992), we estimate the following reduced form equation, where GDP per capita growth is determined by the initial level of GDP per capita and by the level of investment, human and social capital, and a number of city characteristics to control for geographical and economic heterogeneity:

$$\begin{aligned}\Delta GDPpc_i = \alpha + \beta_1 GDPpc_{\mathrm{t_0 i}} + \beta_2 investment_s + \beta_3 human\_capital_i \\ + \beta_4 city\_characteristics_i + \beta_5 social\_capital_i + \varepsilon_i\end{aligned} \tag{9.1}$$

The dependent variable is defined as the change over time in the logarithm of municipal income per capita in the period 2000–2003. Although we have information for all the years ranging from 1999 to 2003, we consider a safer choice to implement our analysis starting from year 2000 given that Brazil faced a currency crisis in 1999. Nonetheless, the main results on the role of social capital are robust using 1999 as starting year, as shown in the robustness analysis.

As for explanatory variables, $GDPpc_{t_0 i}$ is the logarithm of the initial level of income per capita, which allows us to control if absolute convergence is taking place. As regards data on GDP per capita, we have information at municipality level for all the years ranging from 1999 to 2003. These data come from the Pequisa de Informaçoes Basicas Municapais, which is an annual survey sent to all municipalities by IBGE, the Brasilian Institute for Geography and Statistics.

The variable $investment_s$ is the logarithm of state private investment in 1996, while we use the municipal adult literacy rate as a proxy for human capital.[3]

[3]Data for private investment come from Haddad et al. (2002) and refer to 1996, while data regarding adult literacy rate come from IBGE and refer to 2000.

In order to take into account the large heterogeneity present within Brazil, we introduce in the baseline specification some city-specific characteristics. We include size, measured by the logarithm of population in 2000, distance from the country capital, Brasilia, and a dummy variable taking the value of 1 if the city is a state capital. See Table A.1 for a description of the variables.

Then, we add a set of different indicators of social capital, to control if these measures affect income per capita growth. Social capital variables are derived from a number of indicators retrieved from the 2000 Census by IBGE, on 169,799,170 individuals. [4] We build our measures of social capital using factor analysis.

This methodology is able to extract from a large number of variables just few factors, which linearly reconstruct the original variables. It starts with the search of the linear combination of the variables that produces the maximum possible variance: this is the first principal component; the second component is the linear combination of the same variables having a maximum variance, subject to its being uncorrelated with the first component. The aim of this methodology is to have the first few components explaining a large portion of the total variance.

This technique presents many advantages. First, it helps reducing a large set of variables to a manageable size. Second, it is useful to understand the structure underlying a set of variables, via the interpretation of the factor loadings. Third, it is appropriate to measure a complex concept, or a concept that cannot be measured directly, which is exactly the case of social capital.

The variables used to extract the different factors are listed in Table A.2 in the Appendix, while Table 9.1 presents the correlation matrix between social capital variables. We observe that the correlations between social factors are generally highly significant,[5] while the coefficients are not large in size, thus suggesting that they are capturing different aspects of social capital, and are not simply replicating the same underlying phenomena. Therefore, we feel confident while using these regressors together in the same estimating equation.

Results and Robustness

Growth Patterns

In the empirical analysis we focus on the role of social capital on the economic performance of Brazilian municipalities. Table 9.2 presents some descriptive statistics on growth rates at municipal level: mean, standard deviation and the coefficient of variation, computed for each state. Large differences in mean growth rates

[4]As these variables lack a time dimension, we are forced to implement a cross section regression.

[5]With the exception of the correlation between the measure of social division and the indicator of religiousness, which are not significantly correlated.

Table 9.1 Correlation between proxies for social capital

	Social cohesion	Social division	No religion	Public expenditure in education	Public expenditure in social assistance	Political participation
Social cohesion	1					
Social division	0.519*	1				
No religion	−0.255*	−0.016	1			
Public expenditure in education	0.498*	0.289*	−0.205*	1		
Public expenditure in social assistance	0.447*	0.328*	−0.175*	0.664*	1	
Political participation	0.615*	0.429*	−0.221*	0.385*	0.358*	1

*Significant at 1% level

Table 9.2 Income per capita growth (2000–2003): descriptive statistics by states

GDP p.c. growth (2000–2003), Municipality level			
	Mean	Std. dev.	Coefficient of variation
Acre	0.483	0.226	0.467
Alagoas	0.027	0.236	8.622
Amapá	0.393	0.195	0.497
Amazonas	0.343	0.241	0.703
Bahia	0.367	0.243	0.661
Ceará	0.309	0.172	0.559
Distrito Federal	0.174	–	–
Espírito Santo	0.043	0.270	6.266
Goiás	0.563	0.207	0.368
Maranhão	0.406	0.314	0.775
Mato Grosso	0.488	0.242	0.495
Mato Grosso do Sul	0.519	0.168	0.323
Minas Gerais	0.240	0.192	0.802
Paraná	0.549	0.215	0.392
Paraíba	0.286	0.229	0.803
Pará	0.384	0.189	0.491
Pernambuco	0.361	0.154	0.426
Piauí	0.271	0.165	0.610
Rio Grande do Norte	0.249	0.206	0.828
Rio Grande do Sul	0.545	0.279	0.512
Rio de Janeiro	−0.084	0.523	−6.205
Rondônia	0.375	0.260	0.693
Roraima	0.325	0.081	0.251
Santa Catarina	0.446	0.220	0.494
Sergipe	0.513	0.499	0.973
São Paulo	0.431	0.287	0.666
Tocantins	0.435	0.254	0.582
Total	0.376	0.282	0.750

suggest that different growth patterns exist among states. The coefficient of variation, which normalises the standard deviation by the mean, shows that differences in terms of growth rates are present also within states.

This result is confirmed in Fig. 9.1, which shows kernel densities for the growth rate of GDP per capita over the period 2000–2003, plotted by state. We clearly notice that states are largely heterogeneous as regards growth rates of their municipalities.

We start our empirical analysis by performing an exploratory analysis on patterns of growth in Brazil. Figure 9.2 presents a scatterplot of GDP per capita growth over the 2000–2003 period at municipal level against the initial level of income per capita. We observe a slight tendency toward divergence.

If we regress income per capita growth on the initial level of GDP per capita we find a tendency to divergence while pooling together all observations, when considering 2000 as starting year. If we estimate the same specification over the 1999–2003 period, we find no significant coefficient for the initial level of GDP. As expected, the inclusion of year 1999 seems to change significantly the results

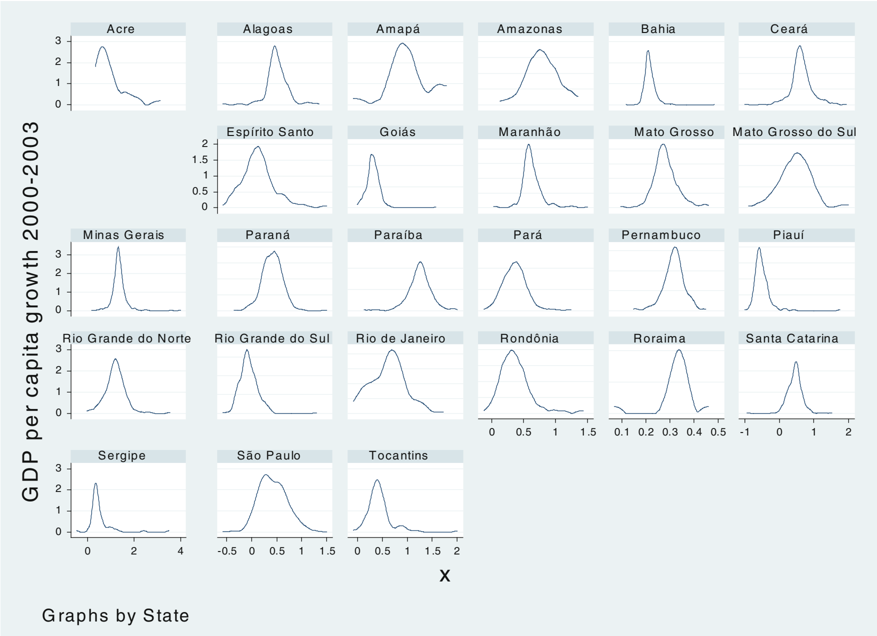

Fig. 9.1 Kernel densities of GDP per capita over the period 2000–2003, by state

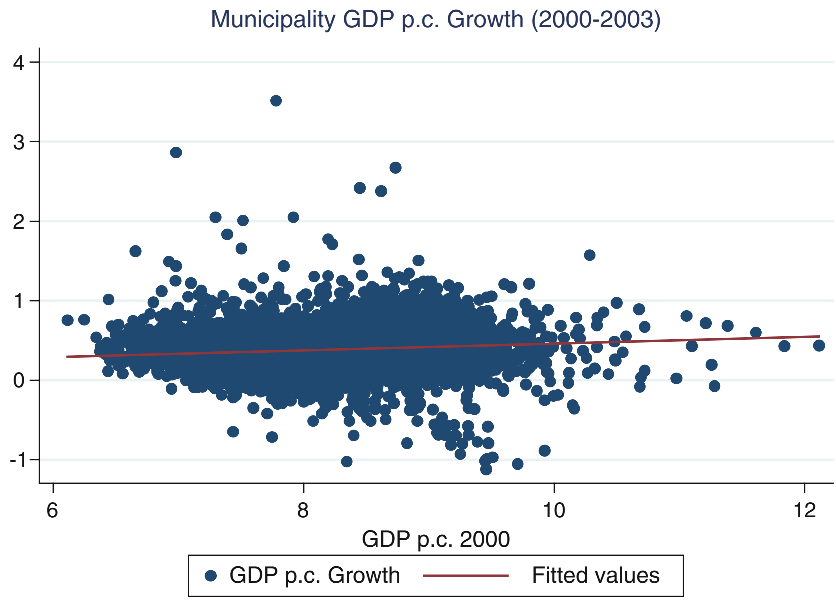

Fig. 9.2 Municipality GDP per capita growth (2000–2003)

Table 9.3 Convergence at country level

Dep. Var: GDP p.c.		Dep. Var: GDP p.c.	
Growth (1999–2003)		Growth (2000–2003)	
GDP p.c.1999	0.000388	GDP p.c.2000	0.0426***
	(0.0055)		(0.0050)
Constant	0.467***	Constant	0.0317
	(0.044)		(0.040)
Observations	5,507	Observations	5,507
R-squared	0.00	R-squared	0.01

***Significant at 1% level

concerning patterns of growth. This supports the intuition that 1999 is a peculiar year.[6] Results are reported in Table 9.3

To better understand growth dynamics, we estimate the same equation over the period 2000–2003 at state level. In this way, we are able to understand growth dynamics within states. Results are shown in Table 9.4. We observe that states may be grouped into three categories. We have a majority of states which show no significant pattern of convergence or divergence between their municipalities. Some states present instead a pattern of convergence among municipalities, while a few others present divergence within themselves. Notably, among the states that show divergence we have the state of Rio de Janeiro. The coefficient for the initial level of income is positive, although not significant, also in Sao Paulo state. Thus, we seem to find some evidence of different patterns of growth between large metropolitan areas and their surroundings located in the same state.

Interestingly, if we shift the focus of our analysis, and look at the pattern between states, we observe a tendency to convergence between states. This can be clearly observed in the scatterplot presented in Fig. 9.3. The figure reports income per capita growth at state level against the initial level of income per capita.

The corresponding regression is presented in Table 9.5. Indeed, we observe that the slope coefficient is negative and statistically significant at 1% level.

Overall, we observe a general divergence between Brazilian municipalities. This pattern is stronger within some states, while in others there is not any clear tendency and in some others there is a tendency to convergence between municipalities located in the same state. Analysis at state level suggests instead that income levels of states are converging. This apparent contradiction can be explained in the light of the ecological fallacy (Robinson 1950) and the modifiable areal unit problem (MAUP) (Openshaw 1984). The first suggests that inference on characteristics of the individuals, based on aggregate statistics may lead to errors of interpretation, while the MAUP underlines that referring to aggregate zones which may be arbitrary in nature could be a source of error in spatial studies.

[6]Performing the same type of regression over shorter time periods always produces a positive and significant coefficient for the initial level of GDP per capita. This coefficient is not significant only when considering 1999 as a starting year.

Table 9.4 Convergence within states

State		
Acre	−0.026	(0.248)
Alagoas	−0.167	(0.070)**
Amapá	−0.473	(0.147)***
Amazonas	−0.215	(0.059)***
Bahia	0.014	(0.022)
Ceará	−0.156	(0.033)***
Espírito Santo	0.166	(0.073)**
Goiás	0.060	(0.026)**
Maranhão	−0.031	(0.059)
Mato Grosso	0.114	(0.043)**
Mato Grosso do Sul	−0.003	(0.042)
Minas Gerais	0.001	(0.012)
Paraná	−0.038	(0.028)
Paraíba	−0.194	(0.039)***
Pará	−0.003	(0.025)
Pernambuco	−0.042	(0.026)
Piauí	−0.013	(0.052)
Rio Grande do Norte	−0.056	(0.028)*
Rio Grande do Sul	−0.070	(0.031)**
Rio de Janeiro	0.174	(0.077)**
Rondônia	−0.383	(0.125)***
Roraima	−0.191	(0.121)
Santa Catarina	−0.062	(0.029)**
Sergipe	0.265	(0.109)**
São Paulo	0.018	(0.022)
Tocantins	−0.090	(0.056)

*Significant at 10%, ** significant at 5%, *** significant at 1%

Table 9.5 Convergence between states

Dep. var: state GDP p.c.	
Growth (2000–2003)	
GDP p.c.2000	–0.0640**
	(0.030)
Constant	0.447***
	(0.046)
Observations	27
R-squared	0.16

**Significant at 5%, ***Significant at 1%

The Role of Social Capital

In order to investigate how social capital is related to growth dynamics in Brazilian municipalities, we estimate (9.1). Results are reported in column 1 of Table 9.6.

As expected, investment and human capital are positively correlated with income per capita growth. The size of the city, measured by the logarithm of the

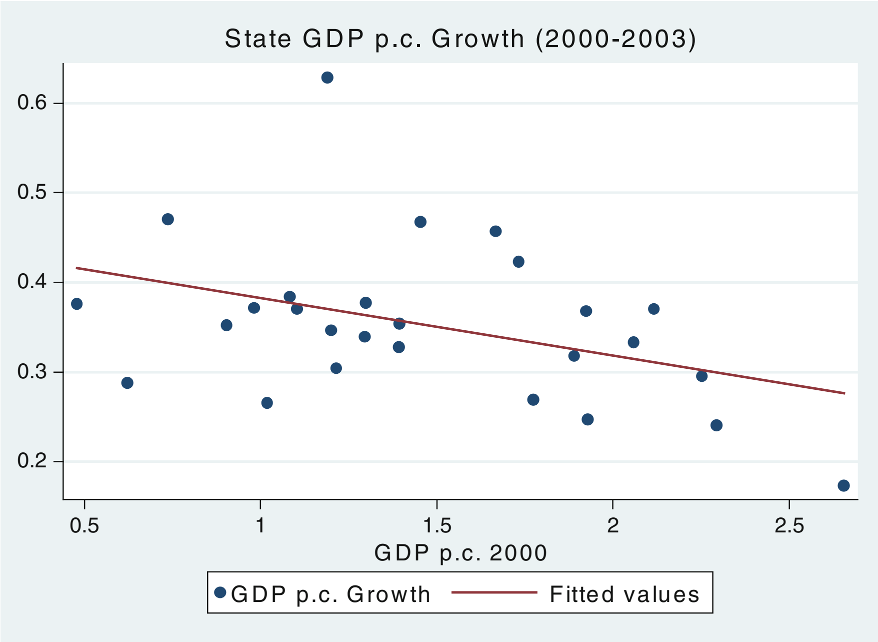

Fig. 9.3 State GDP per capita growth (2000–2003)

population, shows a negative and significant sign: larger cities are growing relatively less in comparison with smaller ones, thus suggesting some process of convergence.[7] Interestingly, we observe that the distance from the country capital presents a positive and significant coefficient, thus suggesting that more peripheral cities are showing higher growth rates. Finally, we find that the dummy for state capitals does not seem to be significant across specifications. Nonetheless, this is not surprising, since there is a large heterogeneity between state capitals, and there could exist cities which share common characteristics with them, without being a capital.

Moving to the analysis of the role of social capital, we enrich our baseline specification by adding a number of indicators. First, in column (2), we include proxies for social capital obtained through factor component analysis. The variables present the expected signs: social cohesion has a positive and significant impact on growth rates of income per capita across all different specifications. If we include a factor that summarises division within the society, or in other terms, lack of social capital, we observe that it has a negative impact on growth

[7]Note that we obtain the same result when considering population density instead of population. However, given the strong correlation between population density and population, we were unable to include both variables in the regression.

Table. 9.6 The role of social capital

Dep. var.: GDP per capita growth (2000–2003)						
	(1)	(2)	(3)	(4)	(5)	(6)
gdp p.c. 2000	−0.00922	−0.000519	−0.00532	−0.00121	−0.00173	−0.000444
	(0.00764)	(0.00822)	(0.00892)	(0.00886)	(0.00869)	(0.00887)
Population 2000	−0.0438***	−0.0271***	−0.0220***	−0.0234***	−0.0231***	−0.0237***
	(0.00362)	(0.00434)	(0.00485)	(0.00481)	(0.00469)	(0.00479)
Human capital	0.00502***	0.00508***	0.00534***	0.00591***	0.00620***	0.00495***
	(0.000529)	(0.000602)	(0.000611)	(0.000609)	(0.000594)	(0.000628)
Investment	0.0105***	0.0145***	0.0150***	0.0175***	0.00555**	0.0154***
	(0.00248)	(0.00252)	(0.00256)	(0.00255)	(0.00262)	(0.00257)
Distance from Brasilia	0.100***	0.0791***	0.0854***	0.102***	0.0903***	0.0893***
	(0.0102)	(0.0106)	(0.0108)	(0.0109)	(0.0106)	(0.0111)
State capital	0.0275	0.0185	−0.00206	0.0122	0.0321	0.0237
	(0.0594)	(0.0591)	(0.0591)	(0.0586)	(0.0572)	(0.0584)
Social cohesion		0.0144**	0.0118*	0.0310***	0.0409***	0.00816
		(0.00611)	(0.00622)	(0.00649)	(0.00644)	(0.00736)
Social disgregation		−0.0397***	−0.0422***	−0.0368***	−0.0253***	−0.0227***
		(0.00587)	(0.00595)	(0.00593)	(0.00589)	(0.00710)
No religion		−0.0261***	−0.0238***	−0.0283***	−0.0165**	−0.0355***
		(0.00721)	(0.00728)	(0.00723)	(0.00719)	(0.00878)
Education expenditure			0.0167**	0.0188**	0.0186**	0.0170**
			(0.00801)	(0.00794)	(0.00774)	(0.00793)
Soc. ass. expenditure			0.00242	0.00477	0.00486	0.00646
			(0.00503)	(0.00499)	(0.00486)	(0.00498)
Political participation				−0.601***	−0.675***	−0.584***
				(0.0628)	(0.0614)	(0.0630)
Social cohesion*div					−0.242***	
					(0.0232)	
Social disgregation*div					−0.108***	
					(0.0178)	

(*continued*)

Table. 9.6 (continued)

Dep. var.: GDP per capita growth (2000–2003)						
No religion*div					−0.0619	
					(0.0395)	
Social cohesion*conv						0.0701***
						(0.0102)
Social disgregation*conv						0.0153
						(0.00995)
No religion*conv						0.0360**
						(0.0149)
Constant	−0.282***	−0.377***	−0.522***	−0.248**	−0.0982	−0.0935
	(0.0934)	(0.101)	(0.107)	(0.109)	(0.108)	(0.113)
Observations	5,061	5,061	4,959	4,958	4,958	4,958
R^2	0.066	0.078	0.084	0.101	0.147	0.110

*Significant at 10%, **Significant at 5%, ***Significant at 1%

rates. The lack of religiousness has a negative impact, and this is coherent with the idea that religious institutions are one of the channels through which social capital develops.

Then, in column (3) we include the average value over the 1991–1999 period of per capita expenditure in education and social assistance at municipal level.[8] Indeed, we expect that per capita expenditure in these two areas could contribute to the rise of social capital. We find that public expenditure in education is positively correlated with growth rates, while there does not seem to exists a relationship between expenditure in social assistance and growth rates. Intuitively, per capita expenditure in social assistance will be higher in cities with older populations, which may be expected to grow less than cities showing a younger population.

Finally, following Putnam et al. (1993), we include a control for political participation, as a proxy for social capital. This variable presents a negative and significant coefficient, as shown in column (4). We would have expected a positive impact of participation on growth rates, as Putnam et al. (1993) find in Italy. Nonetheless, an increase in political participation may take place in an emerging economy also when the economic situation is unstable. Therefore, as the relationship between political participation per se and economic growth is unclear in such a country, our result is not surprising.

Since we observe that states have different patterns of growth within themselves, (see Table 9.4) we use this information in order to investigate whether social capital variables act differently in these types of states. Results are shown in columns (5) and (6). In those states showing divergence patterns, social capital variables act negatively. When we consider states showing convergence dynamics instead, the signs are almost preserved. Overall, the last two columns suggest that social capital may act differently in different states, being more or less supportive to growth.

In order to investigate more in depth the role of spatial heterogeneity, we include in our analysis a set of state dummies. Results are reported in Table 9.7.

As expected, we observe that the F test for the joint significance of state dummies is always positive and strongly significant, thus suggesting that the heterogeneity between states is relevant, and has to be taken into account in the estimates. Moreover, the goodness of fit of our estimates is improved. Controls for human capital and investment remain overall significant. The initial level of income per capita loses significance: its role may be captured by the regional controls. We observe that the inclusion of state dummies changes the results obtained with respect to the geographical characteristics. While population is still negative and significant, the distance from Brasilia now shows a negative and significant coefficient: once we take into account the location in a given state, those cities who are closer to the capital are going to grow more.

[8]We are aware of possible endogeneity issues related with the public expenditure variables, therefore we chose to consider the average value of public expenditure in the ten previous years.

Table. 9.7 The role of social capital, controlling for spatial heterogeneity

Dep. Var.: GDP per capita growth (2000–2003)						
	(1)	(2)	(3)	(4)	(5)	(6)
gdp p.c. 2000	−0.0124	−0.00950	−0.00641	−0.00466	−0.00596	−0.00751
	(0.00821)	(0.00823)	(0.00876)	(0.00878)	(0.00872)	(0.00877)
Population 2000	−0.0318***	−0.0222***	−0.0232***	−0.0234***	−0.0221***	−0.0221***
	(0.00366)	(0.00415)	(0.00461)	(0.00461)	(0.00458)	(0.00460)
Human capital	0.000523	0.00110	0.00127*	0.00200***	0.00160**	0.00180**
	(0.000655)	(0.000691)	(0.000708)	(0.000753)	(0.000748)	(0.000755)
Investment	0.0697***	0.0704***	0.0699***	0.0656***	0.0353***	0.0619***
	(0.0127)	(0.00844)	(0.00850)	(0.00863)	(0.00862)	(0.00865)
Distance from Brasilia	−0.115***	−0.119***	−0.121***	−0.112***	−0.111***	−0.117***
	(0.0192)	(0.0194)	(0.0195)	(0.0198)	(0.0196)	(0.0198)
State capital	0.0960*	0.0938*	0.0963*	0.0960*	0.0761	0.102*
	(0.0539)	(0.0537)	(0.0550)	(0.0550)	(0.0547)	(0.0548)
Social cohesion		0.00423	0.00390	0.00805	0.0172**	0.00450
		(0.00679)	(0.00683)	(0.00699)	(0.00703)	(0.00813)
Social disgregation		−0.0296***	−0.0308***	−0.0307***	−0.0360***	−0.0114
		(0.00593)	(0.00596)	(0.00595)	(0.00602)	(0.00745)
No religion		−0.0174**	−0.0160**	−0.0183**	−0.0206***	−0.0354***
		(0.00717)	(0.00722)	(0.00726)	(0.00734)	(0.00862)
Education expenditure			−0.000436	0.000531	0.000639	0.00166
			(0.00751)	(0.00751)	(0.00745)	(0.00749)
Soc. ass. expenditure			−0.00180	-0.00206	-0.00209	−0.00257
			(0.00480)	(0.00480)	(0.00477)	(0.00479)
Political participation				−0.203***	−0.175**	−0.219***
				(0.0721)	(0.0716)	(0.0720)
Social cohesion*div					−0.260***	
					(0.0356)	
Social disgregation*div					0.137***	
					(0.0247)	
No religion*div					0.0429	
					(0.0374)	

Social cohesion*conv						0.00188
						(0.0143)
Social disgregation*conv						−0.0562***
						(0.0109)
No religion*conv						0.0709***
						(0.0160)
Constant	1.218***	0.996***	0.988***	1.013***	1.115***	1.086***
	(0.158)	(0.158)	(0.161)	(0.161)	(0.164)	(0.161)
Dummy state	Yes	Yes	Yes	Yes	Yes	Yes
F test dummies	59.32***	57.41***	55.38***	50.53***	40.49***	49.79***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	5,061	5,061	4,959	4,958	4,958	4,958
R^2	0.251	0.256	0.259	0.260	0.272	0.266

*Significant at 10%, **Significant at 5%, ***Significant at 1%

Additionally, also the dummy for state capitals becomes significant. As regards proxies for social capital, we observe the expected signs and the significance levels of the estimated coefficients are rather robust to the inclusion of state dummies.

Robustness

In this section we show that our results, as far as the role of social capital is concerned, do not depend on the time period considered. We decide to implement our analysis starting from 2000, due to the financial crisis of 1999. Table 9.8 shows the results considering the growth in income per capita over the period 1999–2003. Many controls change sign and significance, as expected while including a financial turmoil year into the time period considered. Nonetheless, social capital proxies maintain the expected signs, and are statistically significant. This result is interesting, since it confirms that social capital builds its influence over time, and is not immediately affected by the economic situation.

A further robustness check concerns the factor component analysis methodology. One could think that using the single variables that constitute a factor, instead of the factor itself, would produce the same results, with a more direct interpretation of the coefficient estimates.[9] Nonetheless, we show that this is not true, using as an example the factor that summarizes the lack of religiousness, and its four components. The first two enter in the factor with a negative factor loading, while the second two with a positive. If we regress income per capita on this factor, we obtain a negative and statistically significant coefficient, as shown in Table 9.9. If we use the variables constituting the factor as explanatory variables, we would expect a positive sign for the coefficient estimate when considering the first two variables, and a negative sign for the second two.

Nonetheless, Table 9.9 shows that this is not true, when considering civil weddings and couples which cohabit without getting married. This suggests that factor analysis is relevant in the sense that it does not simply "merge" different variables, but it captures underlying characteristics that these variables share.

Conclusions and Policy Implications

In this paper we study growth dynamics in Brazil over the 2000–2003 period. We observe a large heterogeneity not only among states, but also within them. Therefore, we choose to implement our econometric analysis at the smallest administrative unit level: the municipality.

[9]We thank our discussant at II DYNREG Workshop for highlighting this point.

Table 9.8 Robustness: different time period

Dep. var.: GDP per capita growth (1999–2003)						
	(1)	(2)	(3)	(4)	(5)	(6)
gdp p.c. 2000	−0.0649***	−0.0508***	−0.0485***	−0.0470***	−0.0550***	−0.0480***
	(0.00831)	(0.00898)	(0.00992)	(0.00989)	(0.00978)	(0.00993)
Population 2000	−0.0356***	−0.00851*	−0.00616	−0.00694	−0.00723	−0.00834
	(0.00403)	(0.00476)	(0.00537)	(0.00535)	(0.00528)	(0.00537)
Human capital	0.00726***	0.00687***	0.00682***	0.00726***	0.00767***	0.00720***
	(0.000586)	(0.000662)	(0.000676)	(0.000677)	(0.000669)	(0.000680)
Investment	−0.00361	0.00242	0.00241	0.00423	−0.00686**	0.00257
	(0.00277)	(0.00279)	(0.00283)	(0.00284)	(0.00295)	(0.00291)
Distance from Brasilia	0.123***	0.0958***	0.0966***	0.108***	0.0948***	0.101***
	(0.0114)	(0.0117)	(0.0120)	(0.0121)	(0.0120)	(0.0125)
State capital	0.00479	−0.00601	−0.0149	−0.00513	0.00380	0.00138
	(0.0660)	(0.0653)	(0.0655)	(0.0652)	(0.0644)	(0.0653)
Social cohesion		0.0338***	0.0319***	0.0457***	0.0594***	0.00224
		(0.00670)	(0.00684)	(0.00718)	(0.00721)	(0.0153)
Social disgregation		−0.0628***	−0.0645***	−0.0606***	−0.0565***	−0.0352***
		(0.00654)	(0.00662)	(0.00663)	(0.00668)	(0.0109)
No religion		−0.0280***	−0.0282***	−0.0314***	−0.0249***	−0.0162
		(0.00797)	(0.00805)	(0.00804)	(0.00809)	(0.0192)
Education expenditure			0.00515	0.00701	0.00660	0.00500
			(0.00902)	(0.00900)	(0.00888)	(0.00902)
Soc. ass. expenditure			0.00243	0.00413	0.00499	0.00456
			(0.00556)	(0.00555)	(0.00548)	(0.00555)
Political participation				−0.424***	−0.489***	−0.439***
				(0.0699)	(0.0691)	(0.0703)
Social cohesion*div					−0.283***	
					(0.0261)	
Social disgregation*div					−3.46e-05	
					(0.0200)	
No religion*div					−0.00403	

(*continued*)

Table 9.8 (continued)

Dep. var.: GDP per capita growth (1999–2003)						
					(0.0445)	
Social cohesion*conv						0.0509***
						(0.0156)
Social disgregation*conv						−0.0318***
						(0.0121)
No religion*conv						−0.0181
						(0.0215)
Constant	−0.133	−0.293***	−0.360***	−0.163	0.0411	−0.0638
	(0.104)	(0.113)	(0.118)	(0.122)	(0.122)	(0.127)
Observations	5,061	5,061	4,959	4,958	4,958	4,958
R^2	0.055	0.077	0.078	0.085	0.111	0.087

*Significant at 10%, **Significant at 5%, ***Significant at 1%

Table 9.9 Robustness: decomposition of factors

Dep. var: GDP p.c. Growth (2000–2003)					
GDP p.c.2000	0.0318***	0.0226***	0.0498***	0.0423***	0.0428***
	(0.0051)	(0.0059)	(0.0061)	(0.0050)	(0.0050)
No religion	−0.0531***				
	(0.0067)				
Civil and church weddings	0.269***				
		(0.043)			
Church weddings			0.304**		
			(0.15)		
Civil weddings				−0.0832	
				(0.12)	
Cohabiting not married					0.0982
					(0.082)
Constant	0.119***	0.133***	−0.0351	0.0388	0.0204
	(0.041)	(0.043)	(0.052)	(0.042)	(0.041)
State dummies	No	No	No	No	No
Observations	5,507	5,507	5,507	5,507	5,507
R-squared	0.02	0.02	0.01	0.01	0.01

*Significant at 10%, **significant at 5%, ***significant at 1%

We aim to investigate the relationship between social capital and economic growth of Brazilian municipalities. In order to proxy for social capital, we retrieve a number of social variables at municipal level, and we combine them using factor component analysis. Moreover, we include additional proxies for social capital, such as public expenditure per capita in education and social assistance, and political participation.

Overall, we find evidence of a positive relationship between social capital and economic performance. This result is robust to the inclusion of state dummies, and to the time period considered. We focus our analysis on the period 2000–2003, but we show that extending the analysis to year 1999, which was characterised by financial turmoil, does not change the results concerning social capital. This is interesting as it allows us to affirm that social capital has a positive effect on growth rates, independently from the economic cycle: the financial crisis of 1999 does not alter the role of social capital in our growth estimates.

This works suggests that governments should aim at promoting social capital, as it is positively related to economic growth. Policies that promote social cohesion and increase associationism (which in our work is proxied by the relevance of the religiousness, and the membership of a religious community) are beneficial to the economic performance of a country.

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Appendix

Table A.1 Data summary

Variable	Description	Year	Source	Mean	Std. deviation
Δ GDP pc (2000–2003)	Log of average GDP per capita growth	2000–2003	IBGE	0.38	0.04
GDP pc 2000	Log of GDP per capita level in 2000	2000	IBGE	8.07	0.01
Human capital	Literacy rate (individuals over 10)	2000	IBGE	80.71	0.16
Physical capital	Log of state private investment	1996	Haddad et al. (2002)	2.46	0.02
Distance from Brasilia	Log of distance from Brasilia (Km)	1998	IPEA	6.87	0.07
State capital	Dummy variable: 1 if the municipality is a state capital; 0 otherwise.	1998	IPEA	0.05	0.01
Education expenditure	Log of average municipal expenditure per capita in education (R$)	1991–1999	IPEA	3.95	0.77
Soc. ass. expenditure	Log of average municipal expenditure in social assistance and social security (R$)	1991–1999	IPEA	2.26	1.06
Political participation	Average electoral turn-out in local elections	1994–1998	IBGE	0.79	0.08

Table A.2 Factors' description

Factor	Variable description	Year	Source
Social Cohesion	Number of cohabiting individuals over total population	2000	IBGE
	Number of married individuals over total population	2000	IBGE
	Number of married cohabiting individuals over total population	2000	IBGE
	Number of divorced cohabiting individuals over total population	2000	IBGE
	Number of widow cohabiting individuals over total population	2000	IBGE
	Number of single cohabiting individuals over total population	2000	IBGE
Social Division	Number of separated individuals over total population	2000	IBGE
	Number of separated cohabiting individuals over total population	2000	IBGE
	Number of separated not cohabiting individuals over total population	2000	IBGE
	Number of divorced individuals over total population	2000	IBGE
	Number of divorced cohabiting individuals over total population	2000	IBGE
	Number of divorced not cohabiting individuals over total population	2000	IBGE
No religion	Number of civil and church weddings over total population	2000	IBGE
	Number of civil weddings over total population	2000	IBGE
	Number of church weddings over total population	2000	IBGE
	Number of cohabiting individuals over total population	2000	IBGE

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Part II
Globalisation, Competitiveness and Growth

Chapter 10
A Knowledge: Learning-Based Perspective on Foreign Direct Investment and the Multinational Enterprise

Christos N. Pitelis

Abstract We apply insights from Edith Penrose's work to extant theories of Foreign Direct Investment (FDI) and the multinational enterprise (MNE) as developed by John Dunning's Ownership, Location, Internalization (**OLI**) Paradigm, to propose a novel knowledge-learning-based theory of FDI and the MNE. We suggest that the knowledge/learning-based approach has important implications with regard to the nature of, and the interactions between, **O**, **L** and **I**, and that it helps endogenize and integrate the three elements of Dunning's triad in the context of a dynamic, strategic and entrepreneurial perspective of the MNE. The learning-based perspective adds a cognitive dimension to the MNE and **OLI**. It supports a forward looking, synchronic decision making view, that may lead to apparently sub-optimal decisions, taken in view of anticipated changes, alongside strategic behaviour, aiming to effect such change, once decisions have been reached. It also helps explain new strategies of MNEs, which are harder to appreciate within the conventional paradigm.

Introduction

Extant theory on FDI and the MNE seems at times to be at odds with MNE strategies in modern knowledge-based, semi-globalized economies. We claim that a novel knowledge-learning-based theory can help address various limitations of current theory.

In particular, a purpose of this chapter is to follow-up and apply insights from Edith Penrose's work to extant theories of FDI and the MNE, as developed, in particular, by John Dunning's (1977, 1988, 2000, 2003) Ownership, Location, Internalization (**OLI**) perspective. We claim that Penrose's insights can serve as a basis for a novel knowledge-learning-based theory of FDI and the MNE which have

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implications for the nature of **O**, **L** and **I**, and the interactions between the three. They serve as a means of endogenizing and integrating all three elements in the context of the dynamic and strategic perspective of the MNE. In so doing, the learning perspective responds to earlier critiques of the **OLI** as discussed by Dunning (2001). Moreover, it adds a cognitive dimension, leads to a more forward looking entrepreneurial perspective on the **OLI** and the MNE.

In Sect. 10.2 we briefly cover existing contributions to the MNE, focusing on the **OLI** as their envelope. Section III discusses Penrosean insights of relevance to extant theory, proposes a knowledge/learning-based interpretation of **OLI**, and discusses its implications on earlier critiques, and modern accounts of the **OLI**. Section 10.4 contains concluding remarks and implications for managerial practice.

Theory of Foreign Direct Investment (FDI) and the Multinational Enterprise (MNE)

Extant Theory

The theory of FDI and the MNE dates back to Stephen Hymer's PhD dissertation, completed in 1960, and published in 1976. Hymer is arguably the father-figure of the theory of the MNE because he is the first scholar who posed the question why foreign direct investment (FDI), vis-à-vis alternative modalities of what he called 'foreign operations', like licensing, tacit collusion, joint ventures, etc (Dunning and Pitelis 2008).[1] Accordingly, Hymer posed the questions 'why internalize', for the case of the MNE. This was in line with Coase's (1937) similar question for the national firm.[2]

Hymer attributed the benefits of FDI to the advantages of the control it conferred to firms. He proposed three reasons for the choice of FDI. The 'Removal of conflict-Rivalry' between firms in international markets, and the exploitation of the (monopolistic) advantages of firms were the two major reasons. 'Diversification of risk' was the third, less important one for Hymer because it did not involve control. Through FDI firms could both reduce the forces of **R**ivalry in international markets, and exploit their monopolistic **A**dvantages better than through the open market. That was possible for numerous 'market failure' (or intra-firm success)-related reasons, to include the avoidance of bilateral oligopoly, difficulties of finding

[1]Earlier contributions to the literature included both Edith Penrose (1956) and John Dunning (1958), indeed Hymer (1976) cites both Dunning and Penrose in his PhD thesis. However, neither Penrose, nor Dunning had posed the question why FDI (intra-firm) versus inter-firm foreign operations.

[2]Indeed he even used the verb 'internalize' already at the PhD thesis "The firm is a practical devise which substitutes for the market. The firm internalizes or supersedes the market" (Hymer 1976, p. 48).

licensees in foreign countries, honest or dishonest differences in the perceptions of the value of the advantage, etc. All these have predated more recent literatures, as documented in Casson 1990; Horaguchi and Toyne 1990; Pitelis 2002a, b; Dunning and Pitelis 2008.

While the Coasean question 'why internalize', was already present in 1960, Hymer only pursued explicitly Coase's arguments later, in a 1968 article. He also quoted Coase in Hymer 1970 and 1972.[3] Post-Hymer developments of the MNE zeroed in on the 'why internalize the advantages' question. Various important contributions emphasized different reasons. Buckley and Casson (1976) focused on the public good character of 'intangible assets' which are susceptible to 'market failure' if they are not exploited internally, while Williamson (1981) stressed post-contract hold-ups in the case of 'opportunistic' licensees and investments in specific assets.

Post-Hymer 'internalization' theorists did not address the issue of location. Dunning (1958) had done so, and indeed Hymer discussed locational factors under various guises, for example, exploitation of foreign assets, better demand conditions abroad etc., see Dunning and Pitelis 2008. Location is crucial, indeed a sine-qua-non or the theory of the MNE (Dunning 1998). One reason is that, in effect, most questions on the MNE are also applicable for the case of non-MNEs. Penrose (1987) criticized both Hymer-type and Coase-type application to the theory of the MNE, for failing to distinguish between intra-country and international expansion. For inter-country expansion the crucial issue is investment in different countries. This is a locational issue. In addition it is an issue that involves location under different cross-border regulatory jurisdictions (Pitelis and Boddewyn 2009). In this context the whole debate on MNEs can convienently be subdivided to three sub-questions. First, why internationalization. Second, why integration/internalization. Third, which location, which in this case means which country.

In Hymer (1970, 1972, 1976) why internationalization (why foreign operations in his words), is explained in terms of push and pull factors such as external market opportunity, product life cycle considerations and differential demand conditions (e.g. mature domestic markets), (see Pitelis 2002a). Such considerations, especially when viewed in line with other 'locational' considerations by Hymer (see Dunning and Pitelis 2008) also provide an indirect answer to the question 'which country'. The 'internalization school' did not focus on the questions 'why internationalization' and 'which country/location'. It is John Dunning's **OLI** that covers all three aspects. In the **OLI**, **O** stand for Ownership advantages specific to the firm (which need not be monopolistic, but could also be due to efficiency). **L** stands for Locational advantages, and **I** for Internalization advantages. The main idea is that given **O**, **L** will explain the choice of location, and **I** the choice of modality. In terms of our questions, **L** explains 'which country' (and up to a point 'why

[3]Hymer's analysis and, even, terminology in this article incorporates most major contributions of the post-Coase transaction costs literature, see Dunning and Pitelis 2008.

internationalization') and **I**, why internalization. **O** is a necessary (but not sufficient) condition for both 'internationalization' and 'internalization'.

OLI has served and is serving an important role in the literature in part because of its paradigmatic nature, and in part because of the agility and ability of its proponents to incorporate new ideas and developments, as well as to propose new ones (Dunning 2000, 2005; Dunning and Lundan 2009).[4] As Dunning (2001) points out, it is arguable that in its early manifestation the **OLI** paid limited attention to the endogeneity of advantages, in particular the link between intra-firm knowledge generation, **O** advantages and their relation to **L**, and **I** advantages – and thus (up to a point) the **OLI** underplayed the firm as a strategic actor.[5] Moreover, and similar to the internalization theories, the quasi-exogeneity of **O**, **L** and **I** also implied that the framework could benefit from a more dynamic, strategic, entrepreneurial and knowledge-learning-based foundation.[6] We contend that Penrose's contribution to the theory of (the growth of) the firm can serve such a purpose. At the same time, however, a learning-based perspective goes beyond extant theory of the **OLI**, by introducing a cognitive and entrepreneurial agency issues dimension, missing from the **OLI** (Spender 1994).

Modern MNE Strategies

In recent years there emerged significant innovations in MNE strategy that require improved conceptual foundations so as to be better appreciated and integrated within IB scholarship. These concern the simultaneous adoption of strategies by MNEs of internalisation and externalisation and their move from closed to open innovation and/or the combination of the two (Augier and Teece 2007). The 'portfolio and stages approach' to entry modalities; the leveraging of the advantages of others; MNEs also have a role as 'global optimizers' and orchestrators of the global wealth creation process. In this process tensions can arise between global value capture, the sustainability of the global wealth creation process and the challenge of 'global governance' (Pitelis 2009). Some of these topics received

[4]Dunning (2005), for example, proposes institution-seeking FDI, an idea in line with the knowledge-based perspective.

[5]In contrast to some critics, Hymer had examined the historical evolution of **O** advantages in the context of his "'law' of increasing firm size" (Hymer 1972), yet failed to see advantages as a process of endogenous knowledge generation and (thus) firm growth. That task was performed by Penrose (1959) and up to a point by evolutionary models of the MNE, such as Kogut and Zander's (1993). Despite significant progress in dynamising and extending the **OLI** (e.g., Dunning 2001), an application of Penrose's intra-firm knowledge generation dynamic to the **OLI** has not been attempted before.

[6]No detailed explanation of intra-firm advantages generation has been provided in extant Hymer, transaction costs and (thus) early **OLI**-based theories. The intra-firm focus is specific to Penrose (and subsequent resource-based-view (RBV) scholarship, see, for example, Pitelis 2007a, for a recent account).

attention, some others less so. Increasingly we feel they are becoming topical and pressing. We discuss them in turn.

Historically firms grew through integration. That was the world described by Chandler (1962), Penrose (1959), Schumpeter (1942) and Hymer (1976). Hymer predicted externalisation through subcontracting, but externalisation and outsourcing only acquired significance in the past 15 years or so (Teece 2006). There is nothing inherent about growth through integration. Firms can grow by combining integration with dis-integration, internalisation with externalisation, specialisation with diversification (Kay 1997). We need a better appreciation of the role of F in this context. For example, could it be that increased global integration helps engender specialisation alongside the outsourcing of some activities? Which activities do (should) firms externalize and which ones should (do) they keep in-house and on the basis of what criteria?

One major activity that firms, especially MNEs used to internalise was R&D. These days many firms have moved to open innovation, or combine 'closed' with 'open' innovation (Chesbrough 2003). Often this involves keeping sufficient in-house R&D to create the 'absorptive capacity' to identify (or even develop) 'open' innovation opportunities created by others, or in collaboration with others (such as universities), that can be captured by the MNEs (Research Policy 2006; Panagopoulos and Pitelis 2009). Can IB scholarship help us understand this better? In particular, does being an MNE help to better explain the move from closed to open innovation, or their combined use?

Despite Hymer's and much of IB scholarship's focus on the advantages of FDI, many MNEs today, for example Starbucks, adopt a 'portfolio approach', combining simultaneously FDI, franchising and inter-firm cooperation. They also often employ a 'stages' approach, whereby an initial joint venture is eventually followed by FDI. What are the implications of this, for example on the unit of analysis? Would it be more appropriate to move from the firm-level to the activity project or even the capability levels to analyze the choice of modality?

The decisions of many MNEs on the issues of RAD, OLI and their extensions seem to be synchronous, based on learning, anticipatory of change and display proactive behaviour aiming to make these changes come true, to the extent possible (Penrose 1959; Pitelis 2007b). Extant theories of the MNE are not well designed to account for such behaviour, they are rather positivist, rationalist and static. It is challenging to marry the ideas of MNEs as 'global learners' and 'global optimisers' that are prevalent in the literature on the 'transnational solution' (Bartlett and Ghoshal 1993), 'born globals' and 'meta-nationals' (Doz et al. 2001), with the idea of bounded rationality, uncertainty, path dependence, anticipatory, proactive, conflict-ridden behaviour implied by less positivist works such as that of Simon (1995), Cyert and March (1963) and Nelson and Winter (1982). A better understanding of such issues is essential for progress within IB scholarship (Augier and Teece 2007).

In trying to capture value from their value creating advantages, but also those of others, MNEs become increasingly more aware of the systemic benefits of overall value creation. They can help the creation of value by funding universities, collaborating with rivals, encouraging their employees to set-up their own firms (sometimes competitors), helping competitors to innovate and even helping create competitors. Large companies, like Siemens and Microsoft do this. Many others, like IBM and Apple, focus on their complementary integration, design and marketing capabilities, to package extant knowledge in attractive new products. Gradually from 'system-integrators' (Teece 1986, 2006) within the firm, sector, region or nation, MNEs tend to become orchestrators of the wider global value creation process – a role that has traditionally been the prerogative of nation states and international organizations. This can be good and a challenge. Good, because it makes MNEs interested in global value creation, so as to capture as large a part of it as possible. A challenge, because value capture may undermine the sustainability of global wealth creation (Pitelis 2004; Mahoney et al 2009).[7]

It is arguable that extant theory is not well equipped to address the above issues. The next Section suggests that a Penrose-inspired knowledge-learning-based perspective is better aligned to the realities of the modern knowledge-based semi-globalized economy.

Learning, FDI, the MNE and the OLI

A founder of the knowledge-learning-based theory of the firm is Edith Penrose (Penrose 1959; Spender 1994; Pitelis 2000). Penrose was one of the earliest contributors to the MNE, her 1956 article in the *Economic Journal*, appeared prior to Hymer's PhD thesis. As discussed by others, (e.g. Dunning 2003; Pitelis 2000, 2004, 2007b; Kay 1999; Rugman and Verbeke 2002), Penrose dealt extensively with MNEs and MNE-country relationships in general (e.g., the 1956 article), and in particular in the context of the 'international oil industry' and Arab countries. In the context of this work, Penrose was one of the earlier contributors to issues of 'transfer pricing', 'dumping' and 'infant-firm' arguments (in support to some protectionism).[8] All these are also of importance to the issue of economic integration, see below. However, Penrose did not address the question 'why MNEs' vis-à-vis, let's say, licensing or exports, therefore, she did not deal with the 'nature of the MNE'. Similarly, her 1959 classic book on *The Theory of the Growth of The Firm* (TGF thereafter) did not address the issue why (national) firms

[7]A way to visualize this possibility is by considering the world as fully integrated-flat. In such a world any restrictive practices by large firms, would tend to lead to monopolistic imperfections, in terms of reduced consumer surplus and innovation, therefore static and intertemporal efficiency (Baumol 1991, 2002). If large firms are tempted to pursue such practices in order to capture value, and if nation states try to help them through strategic trade policies and protectionism to include non-tariff barriers.

[8]As discussed in Pitelis (2002a).

either.[9] (Moreover, Penrose did not explore in any detail the implications of her TGF contribution for the MNE.[10])

The fundamental insight in TGF was that intra-firm knowledge generation (through learning) generates excess resources. These motivate managers to expand, as 'excess resources' can be put to (profitable) use, at (near) zero marginal cost. This endogenous knowledge/growth dynamic is realized through managerial 'productive opportunity' – the perceived dynamic interaction between internal resources and external/market opportunity (Penrose 1959, Chapter V).

Despite limitations,[11] we claim here that Penrose's insight has implications for the **OLI**, our three related questions, and the need for a more endogenous, dynamic, and strategic theory of FDI and the MNE (Dunning, 2001). In addition, Penrose's knowledge/learning perspective adds cognitive and entrepreneurial elements that are currently missing from the **OLI**, of interest to theory, managerial practice and public policy. We explain these below in the context of Dunning's triad.

O(wnership)

In TGF **O** advantages are not monopolistic, at least as far as their process of derivation goes. They are efficiency advantages by definition, as they are the result of an endogenous knowledge/innovation process. **O** advantages only become monopolistic when firms attempt to capture value by, for example, bases, raising barriers to entry, using restrictive practices, etc. All these are discussed in Penrose (1959, mainly Chapter VII). In addition in Penrose there are also explicit references to both efficiency and monopolistic advantages. For example, Penrose (1959) observes that

> "A firm may attempt to entrench itself by destroying or preventing effective competition by means of predatory competitive practices or restrictive monopolistic devises that relieve it of the necessity of either meeting or anticipating serious competitive threats to its position. In such circumstances a firm may grow for a considerable period depending on the demand for its products, harassed neither by price competition nor by the fear that competitive developments will make its products or processes obsolete. Examples of growth over long periods which can be attributed *exclusively* to such protection are rare, although elements of such protection are to be found in the position of nearly every large firm." (1959, pp. 113).

Monopolistic advantages are in line with Penrose's claim that while the process of expansion is definitionally efficient, the resulting state need not be – as/when MNEs try to capture value through monopolistic practices. This idea introduces the

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[9]Although she explicitly distinguished between the firm and the market and discussed the boundaries issue, she went on to focus on growth, not on the issue of the existence per-se.

[10]For a speculation as to why, see Kay (1999) and Pitelis (2000).

[11]Notably, the observation that the use of managerial time has positive costs (Marris 1999) that TGF fails to deal with issues of intra-firm conflict (Pitelis 2000) and that a number of important assertions by Penrose have yet to be tested (Pitelis 2007a).

important distinction between process and state-type advantages, the latter being potentially monopolistic as originally suggested by Hymer.

L(ocation)

Penrose did not deal with **L** in TGF. In her preface to the third edition (Penrose 1995) she claimed that all the theory of the MNE requires it to suitably adapt her TGF ideas, and account for the existence of different nations. This would require accounting for inter-national differences in regulatory and tax systems, different laws and cultures, etc. (Penrose 1959, xv). Penrose did not pursue this much further, leaving it to other scholars to do so. (We will return to this later, when discussing **I**.) Nevertheless, the Penrosean perspective has important implications for resource/asset/knowledge/innovation seeking and augmenting locational advantages for FDI. As firms are bundles or resources creating knowledge, it is 'natural' for them to locate where existing resources/knowledge are so that it can add value to firms' existing resources, knowledge and technological base and (thus) operations. This implication from Penrose's work is in line with Dunning's discussion of asset and institution seeking **L**ocational advantages (e.g., Dunning 2001, 2005), and more recent attempts to build a theory of the meta-national (e.g., Doz et al. 2001), which consider MNEs as pursuers of global learning, knowledge acquisition and upgrading.

I (nternalization)

Penrose did not deal with **I** – advantages in the specific context of the MNE.[12] However, she dealt extensively with integration, which she considered as an earlier (and more accurate) term for 'internalization'.[13] Accordingly, her views on 'internalization' should be looked at in her analysis of integration. For example, one argument she offers for horizontal integration is the acquisition of valuable managerial resources (partly in response to the 'Penrose effect' – limits to growth due to limited intra-firm managerial resources) (Pitelis 2007b).

Concerning vertical integration, according to Penrose, one reason for it is the superior knowledge, and (thus) ability of firms to cater for their own needs, as they have better knowledge of these (Pitelis and Wahl 1998 and Pitelis 2007b discuss these points in more detail).

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[12]The nearest she comes in the book to discussing the MNE is the following: "Often the large firms organize their various types of business in separate divisions or subsidiaries" (p. 156).

[13]In private discussions. Note also that Richardson (1972) too, pursued this approach. In essence the two terms are synonymous.

Applying such ideas to the case of MNEs, would suggest resource/knowledge-seeking superior firm capability-induced FDI.[14] The last mentioned is similar to Kogut and Zander's (1993) subsequent 'evolutionary' contribution to the MNE (see also Verbeke 2003 for a critical account).[15]

By bringing to centre stage the role of learning, the knowledge/learning-based view of FDI and the MNE has important implications both for interaction effects between **O**, **L** and **I**. Moreover, by incorporating cognition and agency, it calls for a more entrepreneurial, forward-looking approach for FDI, the MNE (and more widely), one that (tries to account for) anticipated change and to act on its basis.

Starting with interaction effects, these have not been given much attention in the early literature (Dunning, 2001). They are crucial. **O**, **L** and **I** are dynamically interrelated. For example, **L** advantages once realized serve as **O** advantages. Similarly, **I** advantages are **O** advantages too (*viz* Hymer's (1972) view that 'multinationality per se' is an advantage, the standard view that vertically integrated firms may possess higher market power, etc., see Pitelis and Sugden (2002) for more on such advantages). In turn, **I** advantages are related to **L** and **O** advantages in that the last two pose the question what and where to be internalized respectively. In addition, in the context of a learning perspective, **L** and **I** advantages are endogenously selected as **O** advantages in the very process of firm growth. Crucially moreover **O**, **L** and **I** can be/are shaped by firms' own decisions. Managers 'productive opportunity' is in part a result of their own efforts to shape the firms' internal and external environment.[16] In this context, 'productive opportunity' both helps endogenize and shape **O**, **L** and **I**. This helps provide a more endogenous, dynamic, entrepreneurial and forward looking strategic theory of FDI and the MNE.

Another aspect of the learning perspective, often missed in the literature, is that it helps explain whether, what, when, where and how to integrate/internalize. This is a crucial limitation of the transaction costs approach, especially Williamson's (e.g. 1981) version. Despite his advocacy of 'bounded rationality', in his story, firms are always able to answer 'make or buy' through the solution of a global optimization process that includes transaction (and production) costs. If anything, solving this problem can be more difficult than the standard neoclassical problem of (production) cost minimization-profit maximization. Penrose's endogenous

[14] Also institution-seeking FDI, a more recent important addition to the **OLI** (Dunning 2005).

[15] Being capabilities-based and very Penrosean in nature, this contribution has acquired prominence. Yet both the Penrosean view of vertical integration and Kogut and Zander's view of the MNE, suffer from a failure to appreciate that differential firm capabilities are tantamount to relative firm superiority on the market (i.e. relative market failure). This also raises the question why - in which context the Hymer/Buckley/Casson/Williamson transaction costs-based explanation is of significance. It is interesting to note that in her case study on the Hercules Powder Company (Penrose 1960) she provides a reason for vertical non-integration of Hercules' customers and of Hercules, in terms of 'oligopolistic interaction' arguments, but also in terms of the superior advantages of specialization of Hercules'.

[16] "Firms not only alter the environmental conditions necessary for the success of their actions, even more important, they know that they can alter them and that the environment is not independent of their own activities" (Penrose 1959, p. 42)

(perceived and imperfect) intra-firm knowledge generation idea provides an answer to the question whether to 'make or buy' (but also what, when, where and how). These issues are beyond the scope of both transaction costs economies and early **OLI**, as they involve learning. They are of importance.

By relying on learning the emergent knowledge-learning-based **OLI** is more concurrent/synchronic and also forward looking yet procedurally (as opposed to globally, or even boundedly) rational than its earlier cousins. It implies that proactive growing firms must at any given point in time rely on their endogenously generated extant 'productive opportunity' to make imperfect **L** and **I** decisions not just on the basis of what reality is perceived to be now, but also on the basis of anticipated change. This may require making apparently 'sub-optimal' decisions now, which are expected to turn out to be superior in the medium or longer terms, if and when conditions have changed in the way managers have expected, hoped for and importantly, aimed for! Such decisions often need to be made simultaneously. A firm contemplating expansion, may have the option of horizontal, vertical or conglomerate expansion, domestically or cross-border. Its decision is based on existing knowledge, resources and advantages and its implementation represents simultaneously a locational, internalization and ownership-related advantage (or dis-advantage as the case may be).

The Penrose inspired learning-based **OLI** is by its very nature more concurrent and at the same time forward looking. By helping explain **O**, **L** and **I** endogenously, paying more attention to firms efforts to shape **O**, **L**, and **I**, and by recognizing the close links and interactions between the three the knowledge-based **OLI** also needs to account for anticipated and aimed for change. It is therefore both more agency-based (thus entrepreneurial) and forward looking.

The learning-based **OLI** is also more in line with concepts such as 'born-global' firms and meta-nationals. Both are phenomena of limited empirical occurrence (see Verbeke and Yuan 2007) yet of high conceptual interest. Born-global firms need more than already established firms to simultaneously consider **O** and **L** (and perhaps also **I**), while meta-nationals can be seen as global Penrosean resource/knowledge seekers/optimizers.

In terms of the three questions posed earlier in this Chapter, the knowledge-learning-based approach explains 'why internationalization' in terms of firms 'productive opportunity', 'why internalization' in terms of 'superior relative intra-firm ability for resource-knowledge transfer as well as resource/knowledge acquisition', and 'which country' in terms of 'perceived relative [dis]advantages of countries as seen from the perspective of firms' productive opportunity', and for exploitation and acquisition of resource/knowledge (and institutional) advantages (see Dunning 2005, for the latter).

The learning-based perspective is more aligned with the new strategies of MNEs discussed above. It explains 'portfolio and stages' approaches, as well as 'closed' versus 'open innovation', in terms of MNE attempts to optimize under shifting conditions, which they have themselves helped shape. For example, a stages approach may involve using a joint venture, learn from it, and then use this learning to proceed to FDI, when this helps implement strategy better. Open innovation could be the outcome of learning how to leverage the advantages of others. A portfolio approach could be the outcome of learning, which in turn is better suited different activities and/or countries.

Three following propositions follow. First; In considering FDI, MNEs attempt to simultaneously optimize the **O**, **L** and **I** advantages. Second; Entrepreneurial managers may consciously take what they perceive to be suboptimal decisions today when/if they expect these decisions to prove superior under perceived changing future conditions. Third; Once imperfect decisions are made, entrepreneurial managers will aim to shape the perceived 'productive opportunity' of their firms to make their decisions succeed.

All three propositions seem to be well in line with the current practice of MNEs. For example, by recently undertaking FDI in the UK, through acquisition of the RMC Group, the Mexican MNE, Cemex, chooses a **location** that confers to it an **ownership** and an **internalization** advantage simultaneously.

> As *The Economist* observes, "The acquisition of the RMC added new expertise in ready-mix which was important, and more large-scale construction projects were beginning to be undertaken in Mexico, and Cemex's international competitors began to muscle in on the company's domestic market." (*The Economist* 2005, p. 88).

This quote also shows that Cemex's choice is not necessarily the optimal one in terms of a pure net present value calculus of today's conditions. Instead, it is based on expectations of change both with regard to impending changes in the sector in Mexico and emerging competition. Clearly, once Cemex has taken its decision it will also have to make the best of it by trying to influence the very changes it expects will take place, in the direction of the decision it has already taken. All this is very consistent with, and follows naturally from, the learning perspective. In contrast, Cemex' approach is more difficult to explain in terms of transaction costs, power/efficiency, and resource-based reasoning alone, and therefore in terms of the constituent element of the **OLI**.[17] Clearly Cemex is only one example, yet possibly representative of the behaviour of other MNEs.

Conclusions

In today's knowledge-based, semi-globalized economy, knowledge-learning-based **OLI**, is in a better position to:

1. Help explain the derivations of **O**, **L** and **I** advantages endogenously
2. Pay more attention to firms' efforts to shape/create the **O**, **L** and **I** advantages (and (through) their 'productive opportunity')

[17]Our support is consistent with Dunning's most recent writings on MNEs as agent of institutional change (see Dunning and Lundan 2009).

3. Help explain whether, what, when and how to internalize (thus create) **I** (and **L**) advantages
4. Emphasize the interaction between **O**, **L** and **I**
5. Emphasize the forward looking nature of decisions on **O**, **L** and **I**
6. Can explain apparently sub-optimal decisions, taken on the basis of entrepreneurial manager's assessment of anticipated change
7. Assert/predict that entrepreneurial managers will try to influence change so as to suit their decisions; once they have taken them

All these help develop a more endogenous dynamic, strategic, cognition-based and entrepreneurial forward looking theory of FDI and the MNE.

Concerning 'managerial practice', the knowledge/learning-based **OLI** is less positivist and more agency-based and entrepreneurial. It points to the following prescription for practice. Use extant dispersed knowledge, while developing new. Use available knowledge and information in order to make concurrent (even if imperfect) decisions on **O**, **L** and **I**, taking into account your perceived current conditions, but also your perception of where things are heading. Try to shape both the internal and external environments to suit your choices, recognize that mistakes are likely, try to correct these or change track, when correcting is too expensive. In all cases learn from your mistakes (as well as your successes). Importantly, learn to unlearn. Current success could be a recipe for future disasters, current failures, an incentive to future success. (Business) life is messy, but all the more exciting for it.

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Chapter 11
Determinants of MNE Subsidiaries Decision to Set up Own R&D Laboratories: The Choice of Region

Constantina Kottaridi, Marina Papanastassiou, and Christos Pitelis

Abstract We test for the determinants of Multinational Enterprise (MNE) headquarters decisions to augment the innovative capabilities of the MNE group by granting mandates to their subsidiaries to set-up own R&D labs in UK regions, using a unique primary data set. Our findings suggest that the best predictor for a subsidiary receiving a mandate, is the strength of its 'productive opportunity' (the interaction between internal competencies and external environment). We employ a measure that augments the external environment to include regional agglomeration characteristics. Our findings highlight the importance of subsidiary, industry and locational characteristics, as well as MNE strategy to leverage subsidiary skills in determining the location of R&D activity in the global economy and in enhancing MNE innovative potential.

Introduction

Leveraging subsidiary skills can be a potent means through which Multinational Enterprises (MNEs) can augment the MNE group's overall innovative capabilities. A way to achieve this is by allocating mandates to subsidiaries to set-up their own R&D laboratories on the basis of subsidiary characteristics that are perceived as being valuable to the overall group. Studies tackling R&D internationalization to-date have been preoccupied with incentives inducing foreign expansion of research

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units at the country level, based on strategic firm decision making and home and host countries' considerations. Nevertheless, related literature on agglomeration, points to the clustering phenomenon of industrial and hence MNE activities in locations within countries, moving the focus of interest to the sub-regional level. Surprisingly little attention has been paid to the strategic interaction between subsidiary characteristics and host environmental competencies in the decision of MNEs to expand their R&D operations. Our objective in this paper is to fill the gap in the literature and test for intra- and extra- firm factors effecting MNE decisions to allocate mandates to their subsidiaries to set-up own R&D labs in UK regions.

Our intended contribution in this paper is threefold: First, to test for the role of the subsidiary internal capabilities and their external environment (Penrose's 1959, concept of 'productive opportunity') in effecting MNEs decisions to locate within regional milieus; Second, in the above context, to explore the importance of the embeddedness of subsidiaries and specifically their links with local research institutions as well as Porter's (1990) and more recently New Economic Geography (NEG) predictions of the agglomeration forces and cluster formation; and third, to help predict the location of innovative activity, based on business strategy, intra-firm, industry and regional agglomeration factors.

The remainder of the paper is organized as follows: in the next section we provide a brief overview of the relevant literature. Section 11.3 poses the hypotheses under investigation and describes the data collection process and associated descriptive statistics. Section 11.4 analyses the econometric methodology and model specification, discusses empirical findings and interprets results. In Sect. 11.5 we conclude with a short discussion of potential implications on managerial practice and limitations as well as suggestions for future research.

Literature Review

The decision to decentralize R&D operations stems from the need of the firm to sustain and augment competitive advantage by tapping into the knowledge base of foreign markets (Florida 1997; Kuemmerle 1999) and thus augment the knowledge base of the MNE group (Pearce 1989; Cantwell 1992; Patel 1996; Cantwell and Janne 1999; Granstrand 1999; Hill 2007). While a firm's unique capabilities and resources can generate competitive advantage Barney (1991) competence development may also rely on relationship building and interaction with local agents. The relevance of both the external and the internal environment of firms has first been emphasized by Penrose (1959), who defined the interaction between the internal and external environments, as perceived by firm managers, as a firm's 'productive opportunity'.

In this respect, the literature on economic geography that focuses on local factors that are important for the creation of linkages domestically (and thus the subsequent positive externalities) is relevant. A long lineage of scholars, including, Marshall (1890, 1916), Hirschman (1958), Myrdal (1957), Krugman (1991), Venables (1999), Markusen and Venables (1995), Markusen (1996), point to the interaction of local characteristics with firm activities that induce agglomeration of interrelated activities in particular regions. In this context, firm decisions are closely linked to the internal (of the MNE network) environment that contributes to the evolution of competitive advantage of the firm but at the same time they are influenced by factors present at the external environments.

One line of research in International Management (IM) literature focuses on the MNE as an organizational structure and recognizes the significance of the MNE subsidiary (Jarillo and Martinez 1990; Birkinshaw 1997). In this context, Birkinshaw and Hood (1998) identify local environment factors, subsidiary choice and headquarters assignment as three key drivers of the subsidiary's role (formally defined by its charter or mandate) with dynamic feedback effects. Cantwell and Mudambi (2005) claim that R&D will tend to be higher in subsidiaries that acquire competence-creating mandates as opposed to those that do not and the award of such a mandate is more likely when the subsidiary is located in a regional center of technological excellence. Thus, the level of competence of a subsidiary has been viewed as highly related to the degree of 'embeddedness' of particular value-added activities in their respective host countries production systems (Kuemmerle 1999; Dunning 1996; Cantwell 1995; Jarillo and Martinez 1990; Zanfei 2000; Benito et al. 2003). Furthermore, Dunning and Robson (1988) suggest that MNEs may evolve from country-centered to regional strategies as economic integration deepens. This can induce changes in international sourcing and consequently in technology sourcing patterns (McCann and Mudambi 2004).

According to the early views on the MNE (Venron 1966), technological activity was centralized and limited to the home country. Since then, the decentralization of R&D in MNEs has preoccupied many scholars (Håkanson and Nobel 1993a, b; Howells 1990; Kuemmerle 1999; Casson 1991; Pearce and Papanastassiou 1999). For Buckley and Casson (1976), *"the search for relevant knowledge in a particular field is also an international operation"* (p. 35) and thus it is not limited to one central location. In this spirit, the term "reverse technology transfer" has been adopted in the literature, to indicate the potential to generate and/or to apply knowledge at any location (Håkanson and Nobel 2001; Yamin 1995, 1999). It is consequently evident that the wide expansion of overseas R&D labs and their activities (Gerybadze and Reger 1999; Pearce and Papanastassiou 1999), point to the multiplicity of their roles based on the particular needs of the whole group and its relationship to the local environment.

Pioneering typologies of R&D laboratories of MNEs are attributed to Cordell (1971, 1973); Ronstandt (1977, 1978), Håkanson (1981), Hood and Young (1982), Haug et al. (1983) and Pearce and Papanastassiou (1999). They extend from R&D laboratories which seem to have solely a supportive role in the overseas production process (Support Laboratories – SLs), to those that are seen to generate new products (Locally Integrated Laboratories – LILs) and to independent to current production labs that carry out basic and/or applied research at a precompetitive stage (Internationally Interdependent Laboratories, IILs) (see Pearce and Papanastassiou 2006).

In this paper, we investigate the decision by MNEs' Headquarters to grant mandates to subsidiaries to set-up own R&D laboratories in selected geographical regions of the UK. On the basis of our discussion above, we hypothesize that this decision may rely on both the internal – subsidiary – factors, (in particular the competences of the subsidiary) and on regional characteristics.[1]

Our paper maintains the focus on both intra-firm and external factors, but focuses on MNE-wide innovation augmentation through the leveraging of subsidiary skills.

Hypotheses Development

Following Buckley and Casson (1976), we incorporate in our hypothesis formulation three levels of factors: subsidiary-level factors (internal environment), location-specific factors and industry-level factors (external environment).

Subsidiary-Level Factors

Embeddedness and Local Linkages

A subsidiary's value adding propensity to the group is likely to be dependent on its degree of embeddedness to the local milieu, its networking and its ties with local partners. A subsidiary may be regarded as a platform for the subsequent R&D expansion (Howells and Wood 1991; Blanc and Sierra 1999; p. 190). In addition, some subsidiaries which may have initially served as market-oriented, or cost-effective units, may have evolved to more autonomous roles. The effort of firms to augment their R&D competence portfolios on a global scale involves relationship building with academic institutions and research centers of the local market. Due to the relative openness of academic environments, knowledge may be readily diffused into the local environment. Forging links with universities broadens the boundaries of knowledge exploration and speeds up innovation by securing access to scientific researchers. Subsidiaries that are closely interconnected with academic institutions from where they may have sourced their technology in the past, are more likely to be given the mandate to set up their own R&D unit in order to collaborate more effectively with their academic partners and absorb, assimilate

[1] In a recent paper, Vega-Jurado et al. (2008) identify three factors as possible determinants of innovation: technological opportunity, appropriability conditions and internal technological competencies. They measure technological opportunity as the importance attributed by the firm to cooperation with external agents for the development of innovative activities, distinguishing between industry agents (customers, suppliers, competitors and firms in the same group) and non-industry agents (consultants, commercial laboratories/R&D firms, universities and public research organizations/technology centers). Regarding technological competencies, they use the R&D intensity, i.e. the R&D spending as a percentage of a firm's sales volume.

and "reverse engineer" innovations and ideas developed in those institutions. Corporate specialists tend to be attracted to areas where other specialists are located enabling them to tap into existing scientific networks (Davis and Meyer 2004). Hence, it can be argued that the greater the local embeddedness of the subsidiary, the higher the likelihood that it will acquire a competence-creating mandate as evidenced by the likelihood of establishing an R&D laboratory (Cantwell and Mudambi 2005). The age of the subsidiary, may then reflect the degree of its embeddedness in the local environment and consequently its better information and access regarding local needs, input supplies and government initiatives. The variable *AGE* thus indicates the number of years that the subsidiary operates in the host economy.

Our discussion leads to the following hypothesis:

Hypothesis 1. The more embedded subsidiaries are (embeddedness being proxied by longevity and linkages with local knowledge creating partners), the more likely it is that they will be given a mandate to establish their own R&D laboratory.

Role of Subsidiaries

Recent subsidiary-level literature has suggested that the greater the extent of subsidiary autonomy, the better the ability of the subsidiary to form favorable external network linkages in its local environment (Andersson and Forsgren 2000) thus, the stronger the engagement in R&D activities (Cantwell and Mudambi 2005). A number of authors have classified subsidiaries according to their development and roles assigning different typologies to each group (see Rugman and Bennett 1982; Poynter and Rugman 1982; White and Poynter 1984; Bartlett and Ghoshal 1986; Birkinshaw and Hood 2000; Taggart 1997; Birkinshaw and Morrison 1996; Crookel and Morrison 1990; Papanastassiou and Pearce 1999; Holm and Pedersen 2000). In this study we distinguish among the following types of subsidiaries: First, Truncated Miniature Replicas (TMRs) which are subsidiaries of low autonomy and tend to produce well-established final products already existing in the MNE group value chain. The literature has also identified "implementers" or "branch factories" as those subsidiaries with relatively low autonomy whose main task is to implement the group's existing and already shaped technological strategy (Bartlett and Ghoshal 1986; Ghoshal and Nohria 1993; Young et al. 1994; Taggart and Hood 1999). Second, World Product Mandates (WPMs) which have a large degree of autonomy and are assigned with the introduction of innovative products, they are the ones in charge of expanding the product line of the MNE group. WPMs are found on the top of "competence ladder" and correspond to "strategic leaders" (Bartlett and Ghoshal 1986) 'centres of excellence' (Andersson and Forsgren 2000); 'global innovators' (Gupta and Govindarajan 1991).[2] Third, the Specialized

[2]See Rugman and Verbeke (2001), for a thorough discussion on the internal patterns of competence creation in MNC groups.

Miniature Replica (SMR) which is a type of subsidiary is attributed to be a more specialized, though narrow product mandate, related to horizontal integration (Papanastassiou and Pearce 1999; Venables 1999). The above lead us to the following hypothesis:

Hypothesis 2. A higher degree of subsidiary autonomy increases the likelihood of it receiving a mandate to establish its own R&D unit.

Other Firm-Level Factors: Control Variables

Other firm characteristics of significance to subsidiaries' sourcing patterns recognized in the empirical literature (UNCTAD 2001), are the following.

Size of subsidiary: Size may be an important determinant of innovative activity (one of the major hypotheses attributed to Joseph Schumpeter) (Veugelers 1997; Kuemmerle 1999). The larger the subsidiary, the easier it is believed to be to exploit economies of scale in R&D and the greater the ability to spread risks over a portfolio of projects. In addition, large subsidiaries are easier to create linkages and get access to local pool of inputs. Importantly, they can find more easily necessary funds to expand. We measure the subsidiary's size by the volume of sales as indicated in questionnaire responses *(SALES)*. This is in line with Penrose's approach too, albeit in Penrose's (and also in Schumpeter's writings) the causality goes from innovation to size (see Cantwell 1991; Pitelis 1991; Cainelli et al. 2005) for evidence.

Export orientation: The more a subsidiary is engaged in exporting part of its production, the higher its underlying competitive strength is likely to be. Such competences will tend to help the affiliate to source its technology inputs from in-house operations rather than from elsewhere in the group or from other local sources. It has been shown that more externally oriented subsidiaries have better capabilities in consolidating competitive advantages (Mudambi and Navarra 2004), and in this respect they are expected to be more prone to advance their own R&D facilities. In addition, Hughes (1986) suggests a positive relation between the two on the grounds of the wider market served by the firm (also Kleinknecht and Poot 1992). In this case we have the generation of technology gap trade (Pearce and Papanastassiou 2006).

Entry mode: The mode of entry of a foreign affiliate into a market can make a difference as to the subsequent decision to engage in R&D functions. In the case of a take-over for example, the existing production facility may already run its own R&D laboratory. Mergers and acquisitions, moreover, are often seen as a means through which MNEs may gain access to technological resources and skills (Grandstand and Sjolander 1990; Pearce 1989). Others point to difficulties of mergers, due to the varying objectives between merged organizations (David and Singh 1993). A third group considers this to be irrelevant (Paoli and Guercini 1997). Mudambi and Navarra (2004) contend that entries through acquisition are likely to be associated with higher levels of knowledge production. Survey evidence has often suggested that most foreign-located R&D in MNEs is the result of acquisitions (Cantwell and Mudambi 2005). The following hypotheses are then formulated:

Hypothesis 3. Larger subsidiaries are more likely to be given a mandate to develop their own R&D operations.

Hypothesis 4. More export-oriented subsidiaries are more likely to be given a mandate to develop their own R&D operations.

Hypothesis 5. Entry through acquisitions is more likely to lead to the subsidiary receiving a mandate to build its own R&D facilities than in the case of entry through greenfield investment.

External Environment

Agglomeration Factors

In line with the NEG predictions on cluster formation of interrelated activities in particular regions we include the following three variables as proxies of agglomeration.[3]

R&D lab concentrations: Spillover effects and mimicking behavior may act positively in the decision to establish an in-house laboratory. Thus, the existence of other R&D laboratories in the region may propel further R&D establishments. Innovative activity is indeed highly agglomerated (Jaffe et al. 1993; Keller 2002), in part because proximity enables the exchange of tacit knowledge (Cantwell and Piscitello 2005). Accordingly the concentration of R&D labs *(AGGLORD)* may be an additional pull factor.

Sectoral concentration: Agglomerations of related and supporting industries or activities within a region are widely acknowledged to be important in the relevant literature (Porter 1990; Braunerhjelm et al. 2000; Paci and Usai 2000). Managers may find it advantageous to establish their own R&D operating units not because they want to source their own technology in the first place, but because locating near related industries (Porter 1990; Maskel and Malmberg 1999) may allow them to benefit from technology spillovers. The included variable is symbolized by *AGGLOSE*.

Sectoral R&D concentrations: Another most relevant concentration is that of subsidiaries belonging to the same sector and running at the same time their own R&D laboratory *(AGGLORDSE)*. MNEs need to be on-site with their innovatory capacity to access benefits from localized knowledge (Cantwell 1989; Almeida 1996; Cantwell and Iammarino 1998). This is a case where interconnected firms

[3]Agglomeration variables that aim to capture regional technological competencies in a business strategy framework that relates to technology strengthening, have not been employed before to the best of our knowledge.

may benefit the most through direct R&D externalities. This leads to the following hypothesis:

Hypothesis 6. Agglomerations of activities belonging to the same sector and in particular concentrations of R&D activities either in the same or other sectors are reinforcing factors in the decision of an MNE to grant its subsidiaries the mandate to set-up own R&D facilities.

Local Competencies

Besides agglomeration variables, the existence of particular local competences may potentially reinforce the decision of a subsidiary to engage in its own R&D operations. According to a study by the French Ministry of Research (Madeuf 1992) of 30 firms under foreign control, over half emphasized the country's scientific and technological tradition, the availability of skilled researchers and the science and technology infrastructure as the three main benefits of locating R&D in France. In their study, Gerybadze and Reger (1999) concluded that research-intensive companies in fields like genetic engineering and advanced solid-state physics emphasized the significance of access to unique areas with strong international reputations. Such resources refer to:

R&D personnel: The existence of a pool of R&D personnel in the host region may be a pull factor in the decision to engage in own R&D, since the lab can recruit local skilled workforce. Kuemmerle (1999) termed the presence of researchers the 'scientific excellence' of a country, while Florida (1997) considers scientific talent a crucial motivating element for an R&D operation.

R&D expenditures: The amount of R&D expenditures relative to the output of a region may be of interest to subsidiaries wishing to source their technology through the establishment of own R&D. Total R&D spending includes both business R&D spending and the commitment of the region to upgrade technological potential. It is therefore considered a measure of knowledge seeking behavior (Chung and Alcácer 2002) or else a source of economic knowledge (Audretsch and Feldman 1996). *RADSHR* thus captures the degree of commitment of a local community to advance its research base.

Technological output: The number of patents registered in a region can be seen as an indication of its innovation potential, and also the effectiveness of local activities to advance technological sophistication. Cantwell and Piscitello (2002) use regional patents to capture the amount of specific knowledge available locally. This may act negatively in cases where subsidiaries are not competitive enough. However, this is likely to apply to the decision to establish a foreign affiliate and not in the subsequent decision to engage in own research once a subsidiary already operates. Maskel (2001) finds that even in the case of protected knowledge by a patent, information often spills over to other firms. The share of innovative output to the regions gross output is hence used *(EPASHR)* to check for possible triggering effects on the decision to engage in own R&D sourcing. There follows

Hypothesis 7: MNE subsidiaries are more likely to be given a mandate to establish their own R&D unit in regions with a science base and highly skilled workforce

Control Variables

Industry-Level Factors

Technology intensity: Broadly speaking, more technologically intensive industries would be expected to be more prone to engage in own R&D research. The source of technology is believed to *"differ substantially by industry and technical field"* Florida (1997, p. 86) while high technology competence industries are assumed to affect positively R&D involvement (Dixon and Seddighi 1996; Rosenberg and Nelson 1994). A dummy of 1 is included if sectors are classified as high -tech[4] and 0 otherwise.

Origin

Region of Origin: The location of research operations may vary according to the country of origin Le Bas and Sierra (2002). To account for this we have categorized foreign affiliates coming from Europe, America and the Pacific Rim. Dummies for Europe and America are thus included in our models to tentatively discern potential differentiation.

Method and Results

The Sample

The current study uses three levels of datasets: location-specific data, subsidiary data and industry-level data. Their sourcing and combination resulted in a unique and non- replicable dataset. More precisely: Industry level data at the 6 digits are used mainly for classification purposes and correspond to the 1992 UK Standard Industrial Classification of Economic Activities code (UK SIC(92)). Given the number of replied questionnaires we decided to group the data to the 2-digit level. The relevant industries at hand are those discussed below in the descriptive

[4]Sectors classified as high-tech are: Aerospace, Electronics, Instruments, Chemicals and Pharmaceuticals, whilst Medium Technology sectors comprise of Automobile, Buildings, Mechanicals, Metals, Rubber, Food and Other industries.

statistics and may be found in the Appendix. Foreign subsidiary-level data were derived from a postal questionnaire survey conducted on foreign subsidiaries operating in the UK. The list of foreign firms operating in the UK were extracted from the Lexis–Nexis database of International Directory of Corporate Affiliations (1992). As a major part of the questionnaire was addressing questions related to the R&D operations of the subsidiaries, and in order to achieve the maximum possible accuracy in the quality of information on foreign (overseas) R&D laboratories data were also acquired from the edition of Longman's Directory of European Research Centers (1993). The sampling process was aimed at subsidiaries with parent – companies enlisted in Global Fortune 500, thus the final version of the questionnaire was posted to 812 subsidiaries.

The survey was conducted in 1994–1995 and the questionnaire was sent via normal post twice within a three months period. Two reminders were faxed to the subsidiaries that had not responded three and six weeks after the survey was first mailed out. The majority of the filled questionnaires were received after the first round. The questionnaires were filled by the subsidiary's CEO, however. When this was not feasible the R&D Manager replied instead. Overall, we collected a data set of 190 replies, which represent a respond rate of 23.3%. This compares favourably with response rates obtained in similar surveys (Harzing 1997). We excluded one reply due to inadequate information, thus we were finally left with 189 valid responses.[5] Non-response bias was investigated with the Armstrong and Overton (1977) method, which involved comparing early and late respondents. The comparisons were carried out with the use of a χ^2 test of independence. In all cases, the responses were found to be virtually identical.

The combination of the above analyzed data sources resulted in this uniquedatabase.[6]

Information from the International Directory of Corporate Affiliations (1992), from where firms were originally extracted, allowed us to identify the specific region of operation of foreign subsidiaries.

The regional breakdown of the UK was based on extant classification of UK National Statistics[7] albeit we chose to merge some neighbouring regions. As the UK National Statistics distinguishes among twelve regions, it would be difficult to obtain reliable results at least for some regions with the existing number of responses. Consequently, we merged some to a total of seven larger regions. These comprise London and Home Counties, Midlands, Northern Ireland, North, Scotland, South and Wales.

[5]In models presented, it appears that the number of observations is less than that. This is due to the fact that some of the firms haven't given a reply on the specific questions used in the analysis. Thus, we end up with a range of 163–179 firms in the econometric analysis.

[6]The element of originality also reinforces the methological sustainability of the dataset (for similar examples see Cantwell and Mudambi (2005) and Davis and Meyer (2004) who used questionnaire surveys conducted in 1994/1995 and 1996/1997 respectively).

[7](http://www.statistics.gov.uk/).

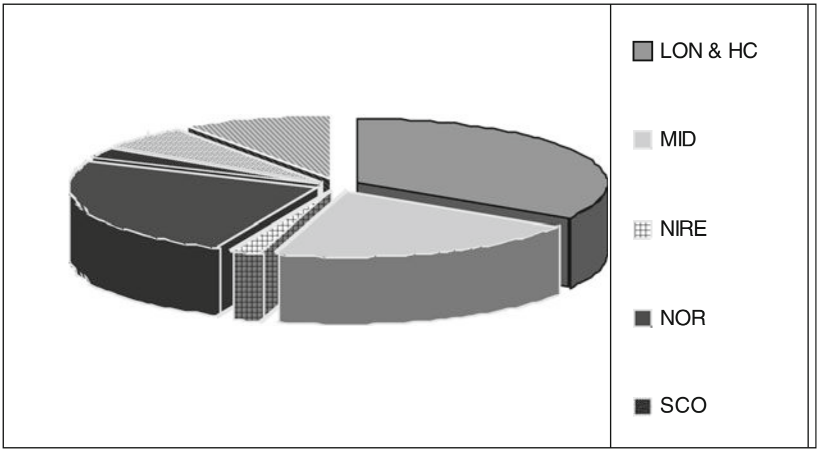

Fig. 11.1 Regional breakdown of R&D laboratories

Data on regional characteristics and particularly local technological competencies were obtained from various issues of the 'Regional Statistical Yearbook' published by Eurostat for the early nineties depending the year of availability.[8] Regional agglomeration variables were constructed from the questionnaires. A representation of the regional characteristics with respect to technology variables is depicted in Table A.1 in the Appendix.

More than half of the respondent firms (54.2%) indicated that they operate their own R&D laboratory.

Figure 11.1 shows schematically the distribution of foreign affiliates operating their own R&D laboratories within the boundaries of seven UK regions.

The majority of R&D labs are in London and the Home Counties (LON&HC) with a share of 33.98%, while North and Midlands are the second and third most populated in terms of R&D labs – regions with 25.2 and 20.4% respectively. Northern Ireland hosts the least number of subsidiaries with R&D labs. It's worthwhile to note that the South does not emerge as an attractive base for R&D operations (with a relevant share of only 5.8%) despite its proximity to London.

A classification of R&D facilities was made according to the sector their subsidiaries belong to. Figure 11.2 presents the distribution of R&D labs based on their operating sector. [9]

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[8]A large number of R&D labs were established in late 80s and early 90s. However, there is a number of subsidiaries that have established much earlier. For comparison purposes we had to stick on a specific time frame. Besides, based on the fact that there is always the possibility of terminating operations if local conditions are not any more favorable, it is logical to assume that R&D labs still operate when the questionnaire took place, it must be due to existing local technological infrastructure.

[9]The respective shares are depicted in Tables 11.3 and 11.4 of the Appendix.

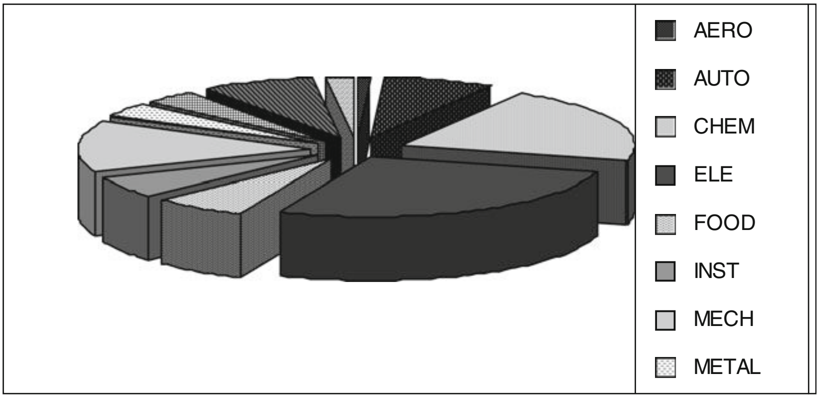

Fig. 11.2 Sectoral breakdown of R&D laboratories

The majority belongs to the Electronics and Electrical Equipment sector followed by Chemicals. From them, the majority of the former is located in the L&HCs and the Midlands, whilst North and L&HC are the most preferred regions for Chemicals.

In total, 65 subsidiaries replied that their primary or major role is WPM. Of these, 49 run their own R&D unit, i.e. a share of 75.4% while 16 do not (Table A.4, Appendix).

Finally, an analytical description of the variables and their sources may be found in Table A.5 in the Appendix.

Econometric Techniques

We examine whether a subsidiary is given a mandate to set-up an R&D laboratory. Thus, we have a discrete choice model where the dependent variable is a binary one taking the value 1 if the answer is 'yes' and 0 if the answer is 'no'. Discrete choice models do not lend themselves readily to regression analysis nevertheless there are models that link the decision or outcome to a set of factors (Greene 2000). The approach is to analyze these kinds of models in the general framework of probability models:

$$\text{Prob(event } j \text{ occurs)} = \text{Prob}(Y{=}j) = F[\text{relevant effects:parameters}] \tag{11.1}$$

Hence,

$$\begin{aligned} \Pr ob(Y = 1) &= F(x, \beta) \\ \Pr ob(Y = 0) &= 1 - F(x, \beta) \end{aligned} \tag{11.2}$$

Where $\boldsymbol{x}$ is a vector of factors that explain the decision and $\boldsymbol{\beta}$ is the set of parameters reflecting the impact of changes in $\boldsymbol{x}$ on the probability. Most widely used in such cases is the logistic distribution partly because of its mathematical convenience:

$$\Pr ob(Y = 1) = \frac{e^{\beta' x}}{1 + e^{\beta' x}} = \Lambda(\beta' x) \tag{11.3}$$

where Λ *(.)* indicates the logistic cumulative distribution function. The logistic distribution is similar to the normal except in the tails, which are considerably heavier (Greene, 2000)

The model then takes the following form:

$$Y_i = \beta_0 + \beta_j X_1 + \beta_k X_2 + \beta_l X_3 + \beta_m X_4 + \beta_n X_5 + \varepsilon_i \tag{11.4}$$

where Y_i is the binary dependent variable, taking the value of 1 if the respective subsidiary owns an R&D laboratory and 0 if it doesn't. X_1 contains our basic variables of interest, X_2 contains the external environment agglomeration forces, X_3 is a vector of variables capturing the internal to the firm characteristics, X_4 is a vector of variables that indicate the technological sophistication of the external environment, and X_5 contains the control variables discussed above. ε_i is an error term, assumed to satisfy the usual requirements.

More specifically, X_1 contains EMBED, LINK and the role of the subsidiary, X_2 contains agglomeration forces, X_3 includes the control variables of SIZE, PROPEXP, ENTRY, X_4 accounts for RDPERSHR, RADSHR and EPASHR, whilst X_5 controls for home origin and sector intensity.

The estimation of binary choice models is based on the method of Maximum Likelihood (ML) where each observation is treated as a single draw from a Bernoulli distribution (Greene 2000).

In order to isolate the preferred model we followed the 'general to specific' method (Hendry 1987, 1995). This involves starting from the most general specification and gradually removing the least significant variables, until we reach our 'preferred' from the data model (using statistical criteria significance tests, regression diagnostics and misspecification tests). The gradual elimination of the non-significant variables led as to the 'preferred equation' (No 1.1).[10]

[10]For comparison and robustness check we also followed another methodology, the one proposed by Sala-i-Martin (1997). Although his work refers primarily to testing for growth, his methodology is arguably applicable in other models. Sala-i-Martin suggests that in order for one to be sure whether her variables of interest are robust and significant, she must follow the following procedure: First, always keep in the model the two or three variables that according to theory and empirical testing affect the dependent variable (first set of variables). Then add other variables of interest in the model that are to be tested (second set of variables). Now, from the pool of variables that have been occasionally found in the literature that influence the dependent variable, choose different combinations of three variables and add these combinations to the above model

A number of econometric tests have been performed in order to test for robustness of our results. To start with, we tested for specification error in our models, none of which turns out to suffer from this problem. Then we proceeded to goodness-of-fit tests.

In order to account for potential multicollinearity problems we calculated the *variance-inflation factor* (VIF) and the *condition number* (C.N.) (Greene 2000; Maddala 1977, 1992). Belsley et al. (1980) argue that *condition numbers* less than 20 are not indicative of a problem. Serious collinearity was detected between the *RDPERSHR* and *RADSHR* variables as well as between *AGGLOSE* and *AGGLORDSE*. To resolve this problem, the respective variables were orthogonalized and used in regressions. Both the *VIFs* and *C.N.s* (for models that we already have encountered orthogonal variables) are reported at the bottom of the tables.[11]

To compare various models and finally answer our research questions, we used the Bayesian Information Criterion (BIC′) rather than the pseudo-R^2s (McFadden's R^2 – likelihood-ratio index can be as low as zero). The pseudo-R^2s provide only limited information as to the comparability of models and can only be used for nested models. In contrast, the BIC′ is advantageous in that it can be used to compare even non-nested models and it uses the likelihood ratio chi-square. The smaller the BIC′, the better it is. Depending on the absolute difference of BIC′s between two models, it is possible to conclude in favor of one model vs. another (UCLA web courses).[12]

The Likelihood Ratio (LR) test shows that the models tested are robust in all cases.

Discussion of Results

Table 11.1 below presents results obtained following the Hendry (1987, 1995) 'general to specific' method. Column 1 illustrates the full model with all variables discussed in the previous section. We gradually take out of our regressions the least significant variables to end up with results shown in column 4. Our results remain basically the same in all estimations hence we may claim that they are robust. Our main hypothesis receives support from the data. Both embeddedness and local linkages which are viewed as existing knowledge and capabilities of the firm turn out to be significant. At the same time, our results also unearthed a higher propensity of competence-creating subsidiaries (WPMs) to establish own R&D laboratory than TMRs and SMRs. In this case the R&D laboratory could be seen as a Locally

(third set of variables). With such a testing, if one's variables of interest turn out to be persistently significant, then it is arguably the case that those variables are robust. In our estimation, there is no particular theory and empirical evidence to provide variables that belong to the first set of variables above.

[11]Analytical tables with the eigenvalues of the variables are available upon request.

[12]http://www.gseis.ucla.edu/courses/ed231c/notes3/fit.html.

Table 11.1 Econometric results: dependent variable: RDLAB (1/0), Logit estimation general-to-specific method

	(1)	(2)	(3)	(4)
EMBED	0.774	0.765	0.727	0.715
	2.30**	(3.17)***	(3.13)***	(3.33)***
LINKS	0.732	0.714	0.652	0.649
	(1.88)**	(1.90)**	(1.78)*	(1.82)*
AGGLOSE	0.087			
	(0.28)			
AGGLORD	0.04	−0.018		
	(0.93)	(−0.62)		
AGGLORDSE	1.197	0.207	0.193	0.182
	(3.66)***	(2.52)***	(2.96)***	(3.00)***
SALES	0.131	0.166	0.158	
	(0.85)	(1.22)	(1.19)	
PROPEXP	0.026	0.023	0.025	0.022
	(2.75)***	(2.95)***	(3.42)***	(3.32)***
NEWCOM	−0.09			
	(−0.12)			
TOVER	0.966	1.033	0.989	0.959
	(1.16)	(1.93)**	(1.88)*	(1.88)*
RDPERSHR	0.324	−0.002		
	(1.21)	(−0.02)		
RADSHR	−0.256)			
	(−0.64)			
EPASHR	86.36	48.471	56.56	
	(1.17)	(0.82)	(1.16)	
WPM	1.476	1.493	1.555	1.5
	(2.73)***	(2.94)****	(3.26)***	(3.35)***
TMR	−0.473	−0.198		
	(−0.99)	(−0.46)		
SMR	0.292			
	(0.58)			
TECHINT	0.845	0.216		
	(1.61)*	(0.47)		
EU	−0.454			
	(−0.64)			
AM	−0.271			
	(−0.43)			
Constant	−7.2	−5.981	−6.296	−5.016
	(−4.15)***	(−3.90)***	(−5.32)***	(−5.41)***
N	163	163	164	170
Pseudo R2	0.3691	0.2908	0.2880	0.2661
LR chi2	82.58	65.07	64.78	61.65
BIC′	9.112	−3.948	−23.985	−30.834
Pearson chi2	186.98	209.31	213.89	218.75
Mean VIF	2.07	1.74	1.16	1.09
C.N.	25.58	30.02	14.69	10.47

Note: The BIC′ uses the likelihood ratio chi-square. The smaller the BIC′, the better it is. Depending on the difference of BIC′s between two models, we conclude in favor of one model vs. another. The scale shown below can assist in interpreting the difference in two models (http://www.gseis.ucla.edu/courses/ed231c/notes3/fit.html)

Integrated Laboratory (LIL) involved in the development of new products. NEG predictions and particularly the agglomeration of R&D activities of the same sector seem to act as a catalyst to this decision. Furthermore, regarding control variables, a firms' propensity to export and mode of entry (if it is a takeover) are factors that influence that decision.[13]

Concerning the region of origin, (whether subsidiaries belong to European, American or a Pacific Rim parent), this seems to make no difference here (although in general there is support in the literature in favor of more research orientation of Japanese firms). Technology intensity of the particular sector is non-significant either.

Overall, the results are in line with the NEG predictions of the cumulative causation mechanisms of knowledge externalities spurring agglomerations of interconnected operations sharing common interests and specialization. Internal factors reflecting subsidiary competencies are placed in the priority list with the embeddedness element and established linkages providing support to the role of firms' 'productive opportunity'.

Concluding Remarks, Limitations and Implications

We empirically examined the decision by MNEs to add value to the group by granting (or not) their subsidiaries a mandate to set-up own overseas R&D laboratory, focusing on MNEs operating in the UK. In particular, we aimed to bridge the dichotomy between the internal environment and the external environment by drawing on Penrose's concept of 'productive opportunity' and new economic geography hypotheses on the impact of agglomeration, as an element of the external environment.

Our findings, are in line with the RBV view that intra-firm factors are important determinants of a firm's decisions, but also lend support to the idea that the external environment matters. The last mentioned included the industry (Porter 1980), but also the regional milieu. In terms of the evolution of GIS our results indicate the following: First, high order regions, with sophisticated local knowledge, tend to be associated with high order subsidiaries - WPMs. In turn, this reflects MNEs' involvement in the product development facet of a *GIS which is carried out* through a product mandate (PM) subsidiary and an associated locally integrated laboratory (LIL). Second, the choice not to establish an R&D laboratory in support of TMRs and SMRs reflects a more centralized facet of a GIS where existing products are produced in the local economy mainly for market-seeking reasons. Concerning managerial practice, our results suggest that MNE top management should grant mandates to subsidiaries to establish own R&D laboratories in cases and locations which satisfy the characteristics discussed above.

[13]The above results are confirmed when using the methodology suggested by Sala-i-Martin.

Our study has a number of limitations. First, our database seems rather dated. While we acknowledge this, it is not uncommon in studies which combine unique and non-replicable data sources. In addition we can think of no obvious reason why the sort of decision we are exploring here, might have changed in the past ten years. Even if it has, knowing the determinants of such decisions in the 1990s could still be interesting, especially if found to differ from MNEs decision to date. A more recent survey would be of great usefulness and would enable comparisons as to the dynamic evolvement of the local-subsidiary-industry framework developed in this study over time. Another limitation of our analysis concerns the issue of causality, notably in the context of the relationship between size and R&D. We were not able to test for bi-causal links, which is a limitation. Also we proxied intra-firm factors with size and export orientation. While in line with the RBV focus, it would be helpful for more fine features of intra-firm resources to be used. This remains a problem for the RBV as a whole. We do hope to address such limitations in future work and motivate others to do so. On the positive side, this is to our knowledge the first empirical test of Penrose's concept of 'productive opportunity' and one of the few studies to apply a general to specific method in a non-time-series context.

To conclude, we tested for the determinants of MNE headquerters decisions to add value to the MNE group by granting mandates to subsidiaries to set up their own R&D laboratories, based on the subsidiaries 'productive opportunity' with the external environment augmented to account for regional agglomeration factors. Our results lend support to the idea that the stronger a subsidiary's 'productive opportunity' is the more likely it will receive a mandate to set-up its own R&D lab.

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Appendix

Table A.1 Regional Characteristics for selected variables

Region	Variable		
	RDPERSHR	RADSHR	EPASHR
London & HC	11.71	3.96	0.35
Midlands	8.6	2.46	0.20
NIRE	2.91	1.23	0
North	8.17	2.83	0.44
Scotland	5.62	2.07	0.25
South	11.22	3.26	0.31
Wales	3.38	1.33	0.25

Table A.2 Distribution of foreign affiliates having an R&D laboratory by host UK region

Region	Total
LON & HC	33.98%
MID	20.39%
NIRE	1.94%
NOR	25.24%
SCO	2.91%
SOU	5.83%
WAL	9.71%
Grand Total	100.00%

Table A.3 Distribution of foreign affiliates having an R&D laboratory by sector

Sector	Total(%)
AERO	0.97
AUTO	7.77
CHEM	20.39
ELE	27.18
FOOD	6.80
INST	5.83
MECH	13.59
METAL	3.88
OTHER	3.88
PHARMA	7.77
RUB	1.94
GRAND TOTAL	100.00

Table A.4 Distribution of WPM foreign affiliates having an R&D laboratory by host UK region

REGION	WPMs with R&D lab (%)
LON & HC	32.65
MID	18.37
NIRE	2.04
NOR	28.57
SCO	4.08
SOU	4.08
WAL	10.20
Grand Total	**100.00**

Note: The sectoral classification is as follows: High technology Sectors include Aerospace, Electronics, Instruments, Chemicals and Pharmaceuticals, whilst Medium Technology sectors comprise of Automobile, Buildings, Mechanicals, Metals, Rubber, Food and Other industries.

Table A.5 Description and source of variables

Variables	Description
Internal ENVIRONMENT-SUBSIDIARY ROLES	
I. Firm characteristics	
SALES	Logarithm of sales of million UK currency, Q.R.
AGE	Number of years the subsidiary has been established in host country, Q.R.
PROPEXP	Share of production exported, Q.R.
NEWCOM	Dummy=1 if it is a greenfield investment, 0 otherwise, Q.R.
TOVER	Dummy=1 if it is a take-over, 0 otherwise, Q.R.
II. Sector	
HIGH-TECH	Dummy=1 if it is a high-tech sector, 0 otherwise, Q.R. and authors' calculations
III. EMBEDDEDNESS & LINKS	
EMBEDDEDNESS	No. of years of establishment in logs, Q.R. and authors' calculations
LOCAL LINKS	Dummy=1 if the subsidiary cooperates with universities and research centers and 0 otherwise, Q.R.
I. Technology	
RDPERSHR	Share of R&D personnel in total employment, Regional Statistical Yearbook, Eurostat and authors' calculations
RADSHR	Share of R&D expenditures in host region GDP, Regional Statistical Yearbook, Eurostat and authors' calculations
EPAGDP	Share of patents registered in the region to GDP, Regional Statistical Yearbook, Eurostat and authors' calculations
II. Agglo	
AGGLORD	Number of affiliates having an R&D lab in the region, Q.R. and authors' calculations
AGGLOSE	Number of affiliates belonging to the same sector in the region, Q.R. and authors' calculations
AGGLORDSE	Number of affiliates belonging to the same sector and having an R&D laboratory, Q.R. and authors' calculations
CONTROL VARIABLES	
II. Origin	
EUROPE	Dummy=1 if parent is European, 0 otherwise, Q.R.
AMERICA	Dummy=1 if parent is American, 0 otherwise, Q.R.

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Chapter 12
Multinational Enterprise and Subsidiaries' Absorptive Capacity and Global Knowledge Sourcing

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Abstract We build on extant theory of the Multinational Enterprise (MNE), MNE subsidiaries and absorptive capacity (AC) to develop a framework that allows us to explore the role of MNE subsidiaries in the global sourcing of knowledge and MNE performance. We develop and test hypotheses using primary questionnaire-collected data. Our results support the idea that subsidiaries' *realized* AC can be improved by the *realized* and *potential* AC of the MNE group and the subsidiary and in turn may improve the performance of the subsidiaries and the MNE group as a whole.

Introduction

In a global environment that is increasingly characterized by technological and market heterogeneity, creative subsidiaries with specific product mandates may constitute an effective way to monitor knowledge flows on behalf of the MNE group. Therefore, headquarters' technology planning should not only screen the diffusion of technology acquired in the home country, but also the technological

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inputs derived from overseas subunits stemming either from their in-house R&D departments or their established localized knowledge (Ivarsson and Jonsson 2003; Håkanson and Nobel 2001; Andersson and Forsgren 2000; Dunning 2000; Kuemmerle 1999; Patel and Vega 1999).

Cohen and Levinthal (1989) developed the notion of "absorptive capacity" (AC) as the "ability of a firm to identify, assimilate, and exploit knowledge from the environment" (p. 569), AC can affect the firm's ability to innovate and adapt to its external environment. While "absorptive capacity" has attracted the attention of strategy researchers, little has been done to put together issues of international business (IB) and AC as well as how the MNE organization reacts, assesses and builds its AC in order to enhance its ability and performance. Zahra and George (2002) have attempted to contribute to a better understanding of this process by suggesting, first, that absorptive capacity is a dynamic capability and second, by pointing out the existence of two subsets or components of absorptive capacity: ***potential absorptive capacity*** (PAC) (knowledge acquisition and assimilation) and ***realized absorptive capacity*** (RAC) (transformation and exploitation of knowledge).

The contribution of this paper is threefold: First, we offer new theoretical insights in the conceptualization of AC tying it to the organization of MNE and their subsidiaries. Second, it develops the AC conceptualization on the *PAC* and *RAC* notions of Zahra and George (2002) to capture better the multidimensional character of AC. Thirdly, it provides empirical evaluation of our models and show how they can be put into operation by defining specific variables relating to firms' *PAC* and *RAC*. With the notable exception of Jansen et al. (2005), the adoption of measures for different dimensions of AC is still lacking.

The rest of the paper is organized as follows: the next section describes the underlying theoretical framework of external knowledge and absorptive capacity. Section 12.3 develops the model and hypotheses to be tested. Section 12.4 provides a brief description of the data and econometric methodology. Section 12.5 discusses the obtained results and finally Sect. 12.6 summarizes and concludes.

Theoretical Framework and Related Literature

Knowledge creation and diffusion in the MNE has been at the heart of the analysis of MNEs' operations since Hymer's (1960/1976) seminal contribution. For Hymer, knowledge was one of the various 'monopolistic advantages' and argued the exploitation of which was most efficient intra rather than inter-firm for a number of reasons, such as the 'tacit' nature of knowledge, the possibility of assessing differently the value of knowledge by different parties, (or at least claiming that they have different perceptions of the value), and even the ability of firms to transfer knowledge intra-firm, more speedily (see Dunning and Pitelis (2008) for an extensive account). Work by Hirsch (1976) discussed the importance of the "*K* factor", which represents "*firm-specific know-how*" and other intangible income-producing proprietary assets (p. 260) such as R&D.

Buckley and Casson's (1976) contribution places emphasis on the internalization of "markets in knowledge" (p. 34) that leads to "the integration of production, marketing and R&D" (pp. 34–35). The argument suggests that knowledge has the characteristics of a public good within a firm: "This means that the exploitation of proprietary knowledge is logically an international operation" (p. 35). For Buckley and Casson "…the firm thus operates an international intelligence system … the international acquisition and exploitation of knowledge will normally involve international production through a world-wide network of basically similar plants" (p. 35).

The acquisition of new knowledge and techniques is nowadays a crucial element in creating core competencies within the MNE group. Nevertheless, acquiring new knowledge is a function of extant dynamic capabilities of the MNE, especially of the MNE's "absorptive capacity". Cohen and Levinthal (1989) defined "absorptive capacity" (AC) as the "ability of a firm to identify, assimilate, and exploit knowledge from the environment" (p. 569). In their work they did not address issues of multinationality, for example how a MNE through its network of subsidiaries can have a portfolio of different ACs and how these ACs can influence a subsidiary's technological performance. Similarly, Hirsch (1976), and Buckley and Casson (1976) did not recognize at that time that R&D itself is a determining factor of differentiation among the foreign operations of MNE subsidiaries. In order to complete the above framework on the evolution of foreign production and multinationals, insights from international management (IM) assert that "As the scope and aims of globally competing firms have evolved and widened, the nature and position of individual subsidiaries within such MNE groups have also undergone important changes. These subsidiary-level developments are crucial in influencing the emergence of significant decentralized technological activity in MNEs, and in determining the forms it can take" (Pearce and Papanastassiou 1996, p. 32, Birkinshaw et al. 1998; Birkinshaw et al. 2002; Håkanson and Nobel 2001). In this regard, multiple activities of subsidiaries as reflected in the roles allotted to them by their headquarters are of particular relevance in the development and enhancement of their overall AC.

An explanation of the emergence of AC is provided in Penrose's classic 1959 book *The Theory of the Growth of the Firm* (TGF thereafter). In TGF firms are bundles of human and non-human resources under administrative coordination and authoritative communication, producing for sale in markets for a profit. The cohesive shell of the organization, called firm, helps engender knowledge and innovation through specialization, learning and teamwork. In this context, a firm's AC can be seen to be endogenously generated through learning in the very process of firm's operations. Intra-firm knowledge generation in particular, allows managers to enhance their 'image' of the firm's 'productive opportunity', which Penrose sees as the dynamic interaction between the internal firm environment (resources) and its external environment (industry, markets, the economy), as perceived by managers. These perceptions by managers in effect define the firm's

AC, and the higher this is the better will tend to be the firm's 'productive opportunity' and ceteris paribus, the firm's performance, Pitelis (2007).

It follows that the Penrosean perspective can usefully complement the Cohen and Levinthal view. This synthesis and our discussion of the MNE literature leads us to the framework depicted in Fig. 12.1.

Despite it being extensively analyzed by researchers both in theoretical and empirical levels, AC remains a complex and fuzzy notion due to multiple definitions and components. In broad terms, researchers have offered different definitions for AC that capture skills to deal with tacit knowledge, Mowery and Oxley (1995), the capacity to learn and solve problems, Kim (1997, 1998), or even receptivity to technological change, Kedia and Bhagat (1988).

Since Cohen and Levinthal's seminal work, many empirical and theoretical studies have explored the concept of AC from the perspective of different analytical units and modeling strategies Newey and Shulman (2004). Of particular interest are those by Van den Bosch et al. (1999) and Zahra and George (2002), which take the firm as the basic unit of analysis and provide new models for the antecedents, components and outcomes of AC. The main contribution of Van den Bosch et al. (1999) was to suggest that the firm's knowledge environment could influence the development of its absorptive capacity. Zahra and George (2002) define AC as a dynamic capability and add another element, that of transforming

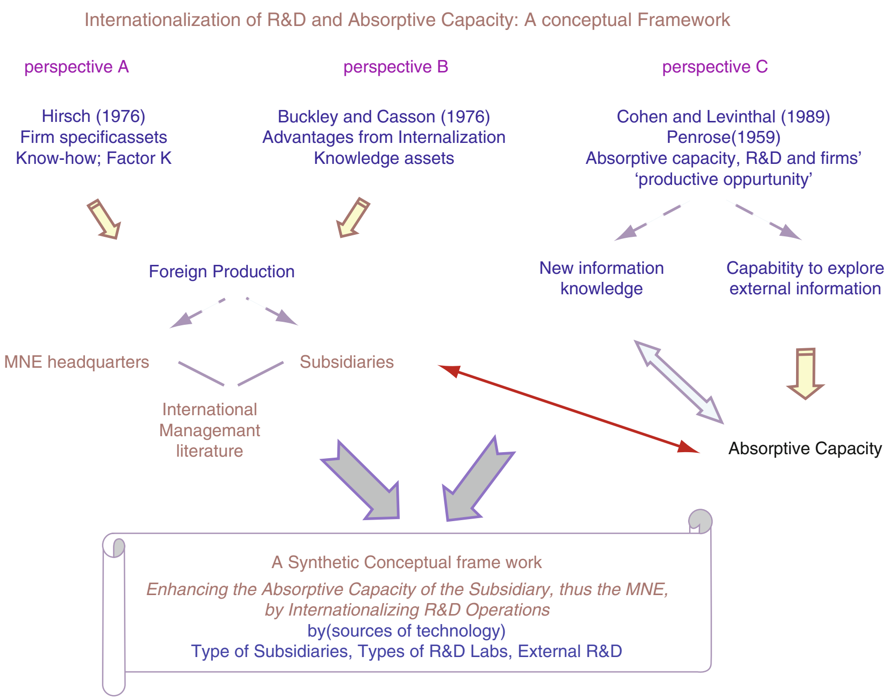

Fig 12.1 Internationalization of R&D and Absorptive Capacity: A Conceptual Framework

the knowledge, i.e. "capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge (p. 190). In their paper they group the four dimensions of AC into two subsets of AC, *potential* and *realized* AC (p. 185). They define these as follows: "Potential capacity comprises knowledge acquisition and assimilation capabilities and realized capacity centers on knowledge transformation and exploitation" (p. 185). The characteristics of acquisition and assimilation relate to the external environment of the firm whilst transformation and exploitation reflect the internal firm capabilities.

On the empirical side, there are numerous studies that examine AC, using alternative measures depending on the author's focus and interest. Lane et al. (2001) test the significance of the three components of AC originally proposed by Cohen and Levinthal (1990) for International Joint Ventures learning and performance. An influential study by Kamien and Zang (2000), developed a three-stage game to show how the R&D approach and the R&D budget of a firm impacts on its ability to realize spillovers from other firms' R&D activities, hence how its R&D efforts enhances its own AC. Most widely used 'proxies' for AC include R&D expenditures, R&D intensity and stock of knowledge, proposed by Cohen and Levinthal (1989). Studies that use such 'proxies' include those of Stock et al. (2001), Leahy and Neary (2004), Oltra and Flore (2003). The stock of knowledge proxied by human capital availability has also been used quite a lot in the relevant literature (Rothwell and Dodgson 1991; Vinding 2000; Frenz et al. 2004). Notable extensions are Veugelers (1997) and Mangematin and Nesta (1999) who capture AC by the existence of an R&D laboratory and the number of R&D labs respectively. Other studies view AC from an organizational point of view, for example, the ability of an entire organization to stimulate knowledge, thus place emphasis on the organizational structure (Van Den Bosch et al. 1999; Welsch et al. 2001; Daghfous 2004). Schimdt (2005) in a recent study extends traditional measures by including human resource and knowledge management proxies drawing information from a questionnaire survey. More recently, Fosfuri and Tribo (2008) assess their *PAC* variable qualitatively through a questionnaire where firms rate the importance of innovation of seven external knowledge sources, on the basis of the premise that they have the ability to identify and assimilate them.

Although AC has been studied in different contexts, for example, in different thematic categories varying from simple knowledge characteristics to AC and corporate scope and alliances Lane et al. (2002), there is paucity in the literature as regards the issue of AC within the boundaries of the MNE organization and particularly the subsidiaries of the MNE group. Recent work by Minbaeva et al. (2003) is an exception. Their paper departs from the tradition of Cohen and Levinthal in the sense that their measure of AC reflects Human Resource Management (HRM) influences and concerns. They analyze a sample of 169 foreign-owned subsidiaries located in three host countries namely, Finland, Russia and USA. In their work they offer a conceptualization of AC as the ability and motivation of employees to constitute the crucial aspects of a firm's ability to "facilitate internal technology transfer" (p. 589). They also estimate the determinants of AC in a three stages least squares model. In their results they show that employees' ability and motivation independently do not constitute a significant indicator of a firm's AC in the sense that none of the two facilitate knowledge flows in the group. However, their interaction appears to enhance knowledge transmission. Whilst their contribution is enlightening and the construct they use meets the arguments developed by Zahra and George (2002), they do not address the R&D issue explicitly.

More recently, Tu et al. (2006) attempt to conceptualize AC in a manufacturing setting and subdivide it into various components, specifically, manager knowledge, worker knowledge, communications network, communications climate and knowledge scanning. Vega-Jurado et al. (2008) suggest that AC is determined not only by R&D activities but also by a set of internal factors, such as organizational knowledge, formalization and social integration mechanisms. Also, Fosfuri and Tribo (2008) concentrate on *PAC* and in particular they explore its antecedents, such as the ability to identify and assimilate external knowledge flows. They find that R&D cooperation, external knowledge acquisition and experience with knowledge search are key antecedents with a firm's *PAC*. Finally, a departure from the above philosophy, is the work of Nieto and Quevedo (2007) who construct a number of AC variables such as staff skills, investment in training, capacity to adapt technologies and a number of several others stemming from a postal questionnaire in order to explore their effect on the firms' innovative activity.

In this paper, we focus on the little researched issues of the AC of MNEs and their subsidiaries. As the MNE group consists of often many subsidiaries which skills it wishes to leverage and given that each subsidiary is likely to have its own AC, it is important to analyze the interrelationship between the overall AC, or the MNE group, or that of its subsidiaries. Following the distinction of Zahra and George (2002) of potential and realized AC (PAC and RAC respectively) and building on their influential work we put forward the following Research Questions (RQ):

RQ 1: *A subsidiary's RAC depends on its degree of autonomy, the existing RAC of the MNE group and on the PAC of the subsidiary.*

RQ 2: *The strength of a subsidiary's own RAC depends on its productive opportunity (the dynamic interaction between its external and its internal environment).*

We further suggest that:

RQ 3: *A subsidiary's performance will be affected positively by the strength of its RAC and PAC.*

To better capture the difference between PAC and RAC it is helpful to keep in mind that PAC enables a firm's receptiveness of the external knowledge, while RAC reflects a firm's capacity to leverage absorbed knowledge and transform it into innovation.

Our key argument is that the total AC (and thus the performance) of an MNE exhibits some form of feedback between potential and realized AC of its subsidiaries. In the event of such a feedback relationship, one can hypothesize that the expected profits of a subsidiary (and by implication the expected profits of the MNE) depend on the decision to further develop its *RAC* by establishing or not a (foreign)

R&D lab; the assumption being that by making this decision and assigning a role to a new R&D lab, the subsidiary moves one step toward transforming and adapting acquired external knowledge to its particular needs. One can envisage that such a binary decision (to establish a new R&D lab or not) may be influenced by a number of factors both internal to the subsidiary and external (relating to environment).

Once a subsidiary has reached its decision on establishing its own R&D laboratory, it enters the second phase of knowledge transformation and exploitation, augmenting its existing *RAC* by its own operations and scientific personnel. By assigning different roles to R&D laboratories the subsidiary separates them into four different levels, as follows. First, R&D laboratories that intend to develop new products for the MNE group. Second, those who plan to provide advice on adaptation or development to other subsidiaries. Third, the ones that aim at adapting processes and products to existing markets and finally, those that carry out basic research. Hence, there is a qualitative ordering of *RAC*. In this sense, we are interested in examining the significance of *RAC* as a source of technology for the subsidiary according to this qualitative classification. At this stage, it is important to assess the significance of the particular laboratory as a source of a subsidiary's technology based on the roles that managers assign to them *ex ante*. To test this, we utilize variables capturing *realized* and *potential* AC as well as the roles of subsidiaries and R&D laboratories as indicated above.

The next interesting question refers to the impact of prior *realized* and *potential* AC on the subsidiary's performance, thus the performance of the entire MNE group.

Data Description, Econometric Methodology and Variables

In order to empirically test the aforementioned hypotheses, data derived from a questionnaire survey will be used. This survey is an updated version of a questionnaire survey designed and tested by Pearce and Singh in 1988–1990 (Pearce and Singh 1992). Both surveys aimed at investigating the positioning of overseas R&D in foreign MNE subsidiaries and contain questions that: (1) define subsidiary roles, (2) define internal and external to the MNE group sources of technology, which can be accessible by overseas subsidiaries and (3) define overseas R&D roles.[1]

The survey was carried out in 1994/1995. The sampling process was aimed at subsidiaries with parent – companies enlisted in Global Fortune 500, thus the final version of the questionnaire was posted to 812 subsidiaries. The questionnaire was sent via normal post twice within a three months period. Two reminders were faxed to the subsidiaries that had not responded 3 and 6 weeks after the survey was first mailed out. The majority of the filled questionnaires were received after the first round. The questionnaires were filled by the subsidiary's CEO, however, when this was not feasible the R&D manager replied instead. Overall, we collected a data set

[1] A brief description of the survey questionnaire may be found in Appendix 2.

of 190 replies, which represent a response rate of 23.3%. This compares well with response rates obtained in similar surveys (Harzing 1997). We excluded one reply due to inadequate information, thus we were finally left with 189 valid responses. Non-response bias was investigated with the Armstrong and Overton (1977) method, which involved comparing early and late respondents. The comparisons were carried out with the use of a χ^2 test of independence. In all cases, the responses were found to be virtually identical.

Based on our modeling directions posed we employ the following econometric methodology: The binary nature of the decision involved in part (a) naturally calls for inference methods of qualitative choice (categorical) models, of the probit and logit variety; in addition, one could employ conditional chi-square tests between the choice variable and other qualitative and quantitative explanatory variables as an additional method for examining which of the explanatory variables appear to be independent of the decision of establishing a lab. For the analysis in part (b) we use inference methods that allow us to examine whether or not the establishment of a lab leads to differentiated performance and changes in absorptive capacity. These methods include (1) standard regressions with a variety of performance and AC measures as dependent variables and a number of control explanatory variables, followed by hypotheses tests on the issue of differentiated performance; (2) a variety of moment and distributional tests on the above dependent variables trying to examine in an alternative way whether the presence of a lab matters – note that the application of distributional tests strengthens the regression and moment tests results, as they look on the entire distribution of the variables for judging differentiated performance and not just a few sample moments; (3) nonparametric regressions, which are extremely suitable for examining whether the response of performance and AC in changes in control variables and/or lab establishment has a particular shape (other than linear) that could have an economic interpretation.

Throughout our analysis, we control for the origin of parent firm, the type of industry, the entry mode of the subsidiary in the local market as well as the period that it operates[2] so as to isolate the effects of *prior potential and realized* AC as well as the type of the subsidiary.

The dependent variable of RQ1 is the existence or not of a R&D laboratory, taking thus the value of 1 (existence) and 0 otherwise. To check for this RQ, we use responses from question 7 of the questionnaire which are categorized as *potential* and *realized* AC. In particular, and based on Zahra and George (2002), those variables that relate to acquisition and assimilation are assigned as potential and those reflecting knowledge transformation and exploitation are depicted as realized. Based on the above, R&D carried out by local scientific institutions for the subsidiary and R&D carried out in collaboration with another firm fall within the potential AC group, since they directly relate to the external environment of the subsidiary, thus pinpoint the subsidiary's efforts to acquire and assimilate knowledge from their surroundings.

[2]All these variables come from the questionnaire.

On the other hand, all other variables that indicate technology stemming from either the MNE group or the subsidiary itself show evidence of the transformation and exploitation of acquired knowledge into particular needs of the MNE and the subsidiary.[3]

The model employed for RQ1 is the following:

$$RDL_i = \beta_0 + \beta_j RAC + \beta_k PAC + \beta_l ROLE + \beta_m CV + \varepsilon_i \tag{12.1}$$

where RDL is the existence of a R&D laboratory, RAC stands for variables measuring realized absorptive capacity, PAC for those measuring potential absorptive capacity, ROLE identifies various subsidiary roles assigned by the MNE group and CV for all control variables taken into consideration. In line with the cited literature, we use industry's technology intensity, mode of entry (new company or joint venture), years of operation and region of origin (whether the MNE originates from the EU, the USA or the Pacific Rim), as control variables.

For RQ2, the dependent variable is the ordered answer (from 4 to 1) of question 7c (R&D carried out by own laboratory), as the source of technology based on the formulation discussed above. In particular, this RQ considers the second stage in the developmental process of a subsidiary's AC, (once it already runs an own R&D laboratory), to check for factors affecting the intensity of its RAC. In this model we also use measures of *potential* and *realized* AC that we used in RQ1. However, the firm has now another element of *RAC*, namely, the scientific personnel hired to equip the laboratory, thus we also include here the number of scientific personnel as an extra variable of *RAC*.

The equation used for RQ2 is the following:

$$OWNRD_i = \beta_0 + \beta_j RAC + \beta_k PAC + \beta_l ROLE + \beta_m SROLE + \beta_n \varepsilon_i \tag{12.2}$$

where the dependent variable is OWNRAD (the importance of sourcing the R&D from own R&D lab as indicated in questionnaire response 7c). Once again, RAC stands for variables measuring realized absorptive capacity, PAC for those measuring potential absorptive capacity, ROLE identifies various subsidiary roles assigned by the MNE group and CV for all control variables taken into consideration. In this RQ we also include as explanatory variables the roles assigned to the existing R&D labs. As control variables, we use industry's technology intensity, the age of the R&D lab (years of operation)[4] and the region of origin.

The dependent variable employed for investigating the impact of *PAC* and *RAC* of the subsidiary is the total turnover.[5] In this stage, the R&D laboratory is in operation,

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[3]For a description of variables falling into either of the two categories, see Appendix 1.

[4]As we examine the intensity of own RAC (own R&D lab), and unlike RQ1, the years of operation of the subsidiary is not relevant, while the age of the R&D lab is.

[5]A number of performance variables are plausible. Our focus on turnover from sales is in line with the focus of the resource-based view (RBV), in particular Penrose's view (see Pitelis 2002, for an extensive discussion).

thus, besides *RAC* belonging primarily to the MNE group, the subsidiary has further enhanced its AC by developing its own research unit hence in addition to variables of *RAC* and *PAC* used above, we hereby include the presence of an R&D laboratory.[6]

The equation used for RQ3 is the following:

$$PERF_i = \beta_0 + \beta_j RAC + \beta_k PAC + \beta_l ROLE + \beta_n \varepsilon_i \quad (10.3)$$

where PERF stands for performance (the subsidiary's total turnover) and the other variables are previously explained.

Results

Each one of the three RQs was estimated by using three independent regression models. The definition of the variables used in the tables below as well as selected sample correlation matrices showing the strength of association between groups of variables may be found in Appendix A. The results of conditional X^2 tests that examine the lack of independence among pairs of variables of interest are also available on request.

RQ1:

Model 1: The impact of AC on the likelihood of establishing an R&D lab – Table 12.1.

Our results show that the likelihood of establishing an R&D lab depends on prior *PAC* of the subsidiary: the higher the dependence of the subsidiary is on R&D carried out for it by local scientific institutions, thus the higher is its *PAC* the higher the likelihood is of establishing an R&D lab (note that other measures of either *PAC* or *RAC* do no enter significantly in the equation although it appears that the higher the dependence of the subsidiary is on existing AC, the lower the likelihood of establishing an R&D lab). It follows that *PAC* measured as the subsidiary's exposure to external knowledge, seems to enhance AC by inducing subsidiaries to develop their own R&D lab in order to be able to transform acquired knowledge to their own procedures and technologies adopted to their own needs, in line with the fourth dimension of Zahra and George (2002).

Our results indicate that subsidiaries aiming at developing and producing new products (WPM) and subsidiaries aiming at producing and exporting already existing products (SMR) are more likely to develop an R&D laboratory, as compared to subsidiaries that target the internal (UK) market only (TMR).

As regards to the control variables, we find that the longer a subsidiary operates in a particular location the more likely it is to create its own R&D unit. We also note

[6]We do not include the number of scientific personnel here, because this belongs to the R&D lab, so by including the existence of the laboratory by definition we account for the scientific personnel engaged in the lab.

Table 12.1 Assessing the impact of AC on the likelihood of establishing an R&D lab

Dependent variable: LAB
Estimation method: ML – Binary logit
Observations used in estimation: 173
Robust std. errors from QML covariance

Variable	Coefficient	Std. error	z-Statistic	Prob.
C	−5.6621***	1.559341	−3.631100	0.0003
EU	2.71805***	0.925917	2.935529	0.0033
AM	2.24389**	0.950761	2.360101	0.01838
PAC	2.68776***	0.968915	2.773986	0.0055
SDH	1.06039***	0.393084	2.697620	0.0070
YO	0.02771***	0.009201	3.012031	0.0026
NC	−0.887073*	0.548129	−1.618367	0.1056
JV	−1.51331*	0.808497	−1.871762	0.0612
TMR	−0.49259**	0.225744	−2.182062	0.0291
SMR	0.59033***	0.231013	2.555379	0.0106
WPM	0.91869***	0.240056	3.826997	0.0001
EXTT	0.83760**	0.416383	2.011615	0.0443
EXST	0.101017	0.292255	0.345646	0.7296
MNET	−0.158813	0.226687	−0.700584	0.4836
MNERD	−0.023550	0.218030	−0.108011	0.9140
COLRD	−0.255565	0.351836	−0.726375	0.4676
Log likelihood	−85.52783	Hannan–Quinn criter.		1.292046
Restr. log likelihood	−118.8690	Avg. log likelihood		−0.494381
LR statistic (15 df)	66.68235	McFadden R-squared		0.280487
Probability(LR stat)	1.73E−08			

In models presented, the number of observations appears less than total replies – this is due to the fact that there might be some non-responses in one or more of the questions

that new companies and joint ventures decrease the likelihood of establishing a lab (if the method of establishing the subsidiary is by taking over an existing company then the corresponding coefficient is positive, thus implying an increase in the likelihood of establishing an R&D lab).

RQ2

Model 2: Assessing the impact of the type of an existing R&D lab on the importance of the lab's research as a source of technology for the subsidiary – Table 12.2.

The importance of an established lab's research as a source of technology for the subsidiary significantly depends on the number of scientific personnel (*RAC*) while the dependence of the subsidiary on internal to the MNE group technology lowers the importance of the established R&D lab as a source of technology.

PAC as captured by the collaborations of the subsidiary with other firms enhances the significance of an R&D lab as a source of technology.

With respect to the role of the subsidiary: the R&D lab appears to be of high importance as a source of technology for subsidiaries that develop and produce new products and the other way around for subsidiaries that produce and export intermediate goods. Note that, as in Model 1, the impact from the role of the subsidiary in developing and producing new products is higher than that of the other roles of the firm (the coefficient of WPM is higher in absolute magnitude).

Table 12.2 Assessing the impact of the type of an existing R&D lab on the importance of the lab's research as a source of technology for the subsidiary

Dependent variable: OWNRD				
Estimation method: ML –Ordered Logit				
Observations used in estimation: 86 (if LAB = 1)				
Robust std. errors from QML covariance				
	Coefficient	Std. error	z-Statistic	Prob.
EU	−2.019458	1.368237	−1.475956	0.1400
AM	−2.480446*	1.471074	−1.686146	0.0918
PAC	−3.20297**	1.550129	−2.066232	0.0388
SDH	−0.188542	0.664942	−0.283547	0.7768
AGE	0.009156	0.010890	0.840768	0.4005
NOPER	0.002468**	0.001102	2.239616	0.0251
RPS	−1.00095**	0.470813	−2.125999	0.0335
WPM	1.37954***	0.390908	3.529072	0.0004
MNET	−1.02546**	0.485460	−2.112338	0.0347
COLRD	1.27781**	0.585120	2.183834	0.0290
IIL	1.00404***	0.337238	2.977232	0.0029
LIL	1.58368***	0.597474	2.650630	0.0080
Log likelihood	−50.51169	Hannan–Quinn criter.		1.695812
Restr. log likelihood	−73.99900	Avg. log likelihood		−0.587345
LR statistic (12 df)	46.97463	LR index (Pseudo-R2)		0.317400
Probability(LR stat)	4.71E−06			

Turning to the type of the R&D unit, if the lab was established to either develop new products for the subsidiary's market or to carry out basic research then it increases the importance of its research as a source of technology for the subsidiary. The lab's importance as a source of technology is higher if it has been established for developing and producing new products for the firm's market than if it has been established to carry out basic research (the coefficient of LIL is higher in absolute magnitude).

RQ3

Model 3: Assessing the impact of establishing an R&D lab on the performance of the subsidiary (as measured by total turnover) – Table 12.3.

It appears that *RAC* plays an important role in the subsidiary's performance. It is noteworthy that among the various measures of *RAC*, operating a R&D laboratory significantly increases the subsidiary's sales. Also, prior *RAC*, i.e. the dependence of the subsidiary on internal technology (from within its MNE group) enhances its performance.

Regarding the roles of the subsidiaries, those established in order to produce and export existing products turn out to have higher sales compared to subsidiaries that were established in order to develop and produce new products.

Concluding Remarks and Policy Implications

The goal of our research is to make progress in terms of modeling AC, where the focal unit of analysis is the MNE subsidiary, by bringing together different conceptual perspectives. Building on Zahra and George (2002) and Veugelers (1997) we

Table 12.3 Assessing the impact of establishing an R&D lab on the performance of the subsidiary as measured by total turnover

Dependent variable: LOG(TS)				
Estimation method: Least squares				
Observations used in estimation: 173				
Robust std. errors from HC covariance				
Variable	Coefficient	Std. error	t-Statistic	Prob.
C	0.223286	0.491904	0.453921	0.6505
LAB	0.78680***	0.255314	3.081696	0.0024
EU	1.05185***	0.339233	3.100665	0.0023
AM	1.16047***	0.351942	3.297321	0.0012
PAC	0.51696*	0.304377	1.698414	0.0913
SDH	0.103364	0.226592	0.456166	0.6489
SMR	0.44107***	0.124627	3.539085	0.0005
WPM	−0.21334*	0.127404	−1.674501	0.0959
MNET	0.42632***	0.121013	3.522895	0.0006
R-squared	0.241091	Mean dependent var		3.123141
Adjusted R-squared	0.204071	S.D. dependent var		1.626555
S.E. of regression	1.451129	Akaike info criterion		3.633182
Sum squared resid	345.3471	Schwarz criterion		3.797226
Log likelihood	−305.2702	F-statistic		6.512446
		Prob(F-statistic)		0.000000

used the existence of an R&D lab as a measure of a subsidiary's *realized* AC and we explored the impact of *potential* and *realized* AC on the performance of a subsidiary by developing and testing three RQs, using primary data collection through a questionnaire survey.

Our results point to the significance of the *PAC* in further enhancing the *RAC* of a subsidiary (as captured by the establishment of an R&D laboratory), whilst other measures of *RAC*, such as the scientific personnel, complement and enhances the importance of an existing R&D unit as the subsidiary's source of technology.

Our study has a number of limitations. First, our database seems rather dated. While we acknowledge this, it is not uncommon in studies which combine unique and non-replicable data sources. Besides, a main focus of this paper was to provide further insights into the modeling of AC in a novel context. We can think of no obvious reason why this should depend on time. A more recent survey would be of great usefulness and would enable comparisons as to the dynamic evolution of *potential* and *realized* AC of MNE subsidiaries over time. We do hope to address this limitation in future work and motivate others to do so.

The clear implication that follows from our results vis-à-vis managerial practice, arise from the finding that the performance of a subsidiary and the MNE group as a whole can benefit from the establishment of an R&D lab, through the enhancement of the subsidiary's AC. An additional research question we intend to pursue refers to the criteria which MNE headquarters can adopt concerning which subsidiaries should be allocated with mandates to set up their own R&D labs, so as to enhance the overall group performance.

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Appendix A

Table A.1 Definitions of variables

EU	Dummy for Europe
AM	Dummy for Americas
PAC	Dummy for Pacific
SDH	Sector dummy for high technology
SDM	Sector dummy for medium technology
YO	Years of operation
TO	Subsidiary established through take over
NC	Subsidiary established through new company
JV	Subsidiary established through joint venture
TS	Total sales
SG	Proportion of sales in MNE group
SE	Proportion of sales that is exported
EG	Proportion of exports to group
IG	Proportion of exports as intermediate goods
TMR1	Question 6a in appendix B
SMR	Question 6b in appendix B
RPS1	Question 6c in appendix B
WPM1	Question 6d in appendix B
EXST	Question 7a in appendix 2
MNET	Question 7b in appendix B
OWNRD	Question 7c in appendix B
MNERD	Question 7d in appendix B
COLRD	Question 7e in appendix B
EXTT	Question 7f in appendix B
LAB	Dummy for existence of an R&D lab
AGE	Age of lab
NOPER	Number of researchers
GROWTH	Growth dummy (subjective)
DECLINE	Decline dummy (subjective)
SL1	Question 9a in appendix B
LIL1	Question 9b in appendix B
SLMNE1	Question 9c in appendix B
IIL1	Question 9d in appendix B

Table A.2 2 Groupings of variables in *realized* and *potential* AC

EXST	Question 7a in questionnaire	Realized AC
MNET	Question 7b in questionnaire	Realized AC
OWNRD	Question 7c in questionnaire	Realized AC
MNERD	Question 7d in questionnaire	Realized AC
COLRD	Question 7e in questionnaire	Potential AC
EXTT	Question 7f in questionnaire	Potential AC
LAB	Dummy for existence of an R&D lab	Realized AC
NOPER	Number of researchers	Realized AC

Table A.3 Establishment of a Lab with Scope of Subsidiary

	LAB	TMR	SMR	RPS	WPM
LAB	1.000000				
TMR	−0.193141	1.000000			
SMR	0.112956	0.290524	1.000000		
RPS	0.007929	0.060247	0.220117	1.000000	
WPM	0.390211	−0.333628	−0.098711	−0.026497	1.000000

Table A.4 Establishment of a lab with sources of knowledge

	LAB	EXST	MNET	MNERD	COLRD	EXTT
LAB	1.000000					
EXST	0.046118	1.000000				
MNET	−0.031362	0.043305	1.000000			
MNERD	−0.077378	0.079981	0.143637	1.000000		
COLRD	0.112507	0.010974	0.108118	0.144122	1.000000	
EXTT	0.248561	−0.000445	0.058629	0.003448	0.462554	1.000000

Table A.5 Importance of own R&D as a source of technology with scope of subsidiary

	OWNRD	TMR	SMR	RPS	WPM
OWNRD	1.000000				
TMR	−0.090670	1.000000			
SMR	−0.159754	0.328076	1.000000		
RPS	−0.115502	0.087797	0.215389	1.000000	
WPM	0.452945	−0.328012	−0.295203	−0.134186	1.000000

Table A.6 Importance of own R&D as a source of technology with other sources of knowledge

	OWNRD	EXST	MNET	MNERD	COLRD	EXTT
OWNRD	1.000000					
EXST	0.017283	1.000000				
MNET	−0.173422	−0.039133	1.000000			
MNERD	−0.121749	0.058517	0.313032	1.000000		
COLRD	0.157028	0.037127	0.059171	0.197637	1.000000	
EXTT	0.171421	−0.044613	−0.058248	−0.096421	0.411263	1.000000

Table A.7 Importance of own R&D as a source of technology with function of an established lab

	OWNRD	SL1	LIL1	SLMNE1	IIL1
OWNRD	1.000000				
SL	−0.084189	1.000000			
LIL	0.193100	0.237736	1.000000		
SLMNE	0.176796	−0.059662	0.030708	1.000000	
IIL	0.223316	−0.419027	−0.196662	0.343903	1.000000

Appendix B

Questionnaire

1. How your company was originally established? (please tick relevant answer)
   (a) By the takeover of an existing UK company
   (b) By the creation of a new company with its own production facilities
   (c) Is a joint venture with an existing UK company
2. What is the current sales/turnover of the subsidiary?
3. What percentage of the sales of the whole MNE group of which the subsidiary is part, does its sales represent?
4. What proportion of your production is exported?
5. What percentage of your exports go to other parts of the MNE group?
6. Please grade each of the following roles in terms of their importance in your operation as:

   (4) our only role
   (3) our major role
   (2) a secondary role
   (1) not a part of our role

   (a) To produce for the UK market products that are already established n our MNE's group product range
   (b) To play a role of the MNE's European supply network by specializing in the production and export of part of the established product range
   (c) To play a role of the MNE's European supply network by producing and exporting component parts for assembly elsewhere
   (d) To develop, produce and market for the UK and/or European or (wider) markets, new products additional to the MNE group's existing range
7. Please grade the following sources of technology for your operation as:

   (4) our only source of technology
   (3) our major source of technology
   (2) a secondary source of technology
   (1) not a source of technology

   (a) Existing technology embodied in established products we produce.
   (b) Technology of our MNE group from which we introduce new products for the UK/European market that differ from other variants introduced in other markets
   (c) R & D carried-out by our own laboratory
   (d) R&D carried out for us by another R&D laboratory of our MNE group
   (e) R & D carried out in collaboration with another firm
   (f) R&D carried out for us by local scientific institutions (e.g., universities, independent laboratories, industry laboratories)

(g) Development and adaptation carried out less formally by members of our engineering unit and production personnel

8. If your subsidiary has its own R&D laboratory to support its operations
   (a) When was it set up?
   (b) How many scientific personnel does it employ?
9. If your subsidiary has its own R&D laboratory to support its operations, please grade as:

(4) its only role
(3) its major role
(2) a secondary role
(1) not a part of its role

(a) Adaptation of existing products and/or processes to make them more suitable to our markets and conditions
(b) To play a role in the development of new products for our distinctive markets
(c) To provide advice on adaptation and/or development to other producing subsidiaries of our MNE group
(d) To carry out basic research (not directly related to our current products) as part of a wider MNE group level research program

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Part III
The Role of Public Policies in Fostering Innovation, Competitiveness and Growth

Chapter 13
The Competitive Advantage and Catching-Up of Nations: A New Framework and the Role of FDI, Clusters and Public Policy

Christos N. Pitelis

Abstract We critically assess extant theory of the competitive advantage and catching-up of nations. We then propose a novel framework and explore the role of FDI, clusters and public policy in its context. We suggest that scholarship in international business and strategy can be usefully leveraged to address these important issues.

Introduction

Our aim is to assess critically extant theory of the competitive advantage and catching-up of nations. Having found the literature lacking in some respects we proceed to proposing a novel framework on national competitiveness that builds on micro (firm-level) foundations and addresses the important issue of "appropriability" (or value capture). We explore the interrelationships between FDI, clusters and public policy, as well as national positioning strategies in helping countries enhance their competitiveness and accelerate their process of catching-up.

We structure the paper as follows. Following this Introduction (Sect. 13.1), in Sect. 13.2 we assess briefly and critically extant perspectives on competitiveness and catching-up theory as well as policy and the role of FDI in this context. Section 13.3 sets off from limitations of extant scholarship identified in the previous Section to develop a novel framework for competitiveness and catching-up and discusses the role of FDI, clusters and government (policy) in its context. Section 13.4 draws on extant literature in International Business (IB) Strategy to propose strategies and vehicles to competitiveness that can be adapted by catching-up countries. The last Sect. 13.5 offers concluding remarks, discusses limitations and the scope for future research.

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Theories of Competitiveness and Catching-Up

The concept of national "competitiveness" is both elusive and controversial. For example, Krugman (1994) lamented the "obsession" of policy makers with the issue of "national competitiveness" claiming that this obsession can be dangerous. One of Krugman's critiques refers to competition between firms and nations. Firms do compete, in his view, for example for market shares and this competition is zero-sum. Instead, nations do not compete in a comparable way and the outcome is positive-sum: when one benefits, the others do too. For Krugman, the best measure of national economic performance is total factor productivity (TFP) – a proposition also supported by Porter (1990).

Krugman's views have been subjected to a battery of criticisms, see Aiginger (2006a, b) for a recent account, albeit not so much on his views on competition. We believe these views are not immune to criticism. Following, for example, Allyn Young's (1928) work on increasing returns, we appreciate that competition between firms is one fundamental way through which markets are created and expanded. This suggests that inter-firm competition need not always be a zero-sum game. On the other hand when nations compete through strategic trade policies, Krugman's own work shows that the outcome need not be positive-sum, (Krugman 1986, 1989). Fundamentally, however, competition and competitiveness are not synonymous. In its more generic sense competitiveness refers to the ability of an economic entity to outperform its own "peer" group, in terms of a shared objective. For example, if the objective is to improve a country's per capita income in terms of purchasing power parity, and if other nations share a similar objective, a country that outperforms the others in terms of this objective can be defined as more "competitive". This competitiveness could be achieved through apparently rivalrous actions (e.g. strategic trade policies), co-operative actions, a combination of the two (co-opetition) or just no interaction whatsoever; a country can outperform another without necessarily engaging in trade with it, or even in trade. In fact such a generic definition of competitiveness can be applicable to individuals, firms, regions, even universities and courses, such as MBAs, as we well know. What changes is the peer group and thus the shared objective, (which for example in the case of MBA courses would be to outperform other universities with a comparable MBA course, ranked on the basis of a widely accepted index). A useful characteristic of this definition is that it has immediate implications for catching-up. For example, if an existing developing country is more competitive than the leading nations this leads to catching-up.

Arguably one can distinguish four major extant approaches-frameworks on competitiveness and catching-up; the neoclassical economic theory-based approach, the Japanese practice-based one, the "systems or innovations" view and Michael Porter's "Diamond". Despite some overlapping (especially between the last three) we aim to show below that there are sufficient differences too between the four models/frameworks to qualify them as separate.

The neoclassical view has a very long and distinguished history; the issue of the nature and determinants of the Wealth of Nations was central in Adam Smith

(1776), while the importance of international trade in this context was a main concern of David Ricardo (1817). In its modern developments (exogenous) growth theory includes the landmark contribution of Solow (1956) while more recently endogenous growth theory includes scholars such as Lucas (1988) and Romer (1986, 1990). The main difference between the two types of views is that "endogenous" growth theory tries to account for the (endogenous) role of "technical change", human capital and "increasing returns" which were previously treated as exogenous variables, see Solow (2000) and Fine (2000) for critical assessments. In international trade neoclassical theory built on the idea of David Ricardo that free trade based on comparative productivity advantages can benefit all nations. The well known Heckscher, Ohlin, Samuelson (HES) model relies on comparative advantage (abundance) in factor endowments and confirms the Ricardian ideas under conditions of non-increasing returns, see for example Samuelson (1962). More recently, however, strategic trade theorists, such as Paul Krugman (1987, 1989) question the predictions of the HES model for the case of imperfect competition, increasing returns, spill-over effects, and first-mover advantages. In such cases, Krugman shows that strategic trade policies (in support of some sectors and firms) could at least theoretically favour a nation that leverages them (see Krugman 1992). On the other hand strategic trade policies can lead to conflicts over the division of benefits and are plagued by the possibility of "government failures" (in identifying the right sectors/firms) and possible retaliations leading to a potential lose–lose situation, Boltho and Allsopp (1987). In the case of high adjustment costs, characterizing the case of inter-industry trade (more common in cases of countries at different levels of economic development), the aforementioned problems could be accentuated (Krugman 1989, 1992). Deraniyagala and Fine (2001) provide a critical assessment of the theory and evidence of trade theory and policy.

Concerning the "competitiveness" of a nation, the implications of exogenous growth and the HES model, on the one hand, and the endogenous growth theory and new trade theory on the other hand can be at odds. Exogenous growth theory and HES assert that perfectly competitive markets alongside free comparative-advantage-based trade can optimize national and global resource allocation and can therefore lead to competitiveness and convergence, see Verspagen (2005). Convergence follows directly from the implied negative relationship between the growth rate of capital stock and the initial level of capital stock. This "absolute convergence" is not empirically confirmed, see Barro and Sala-i-Martin (2004). On the other hand, while "conditional convergence" and/or "club convergence" could be more likely for countries sharing comparable key fundamentals, like saving rates, underlying long-run growth rates and capital stock depreciation, recent evidence does not seem to be in support either of them, Baddeley (2006). The role for government intervention in the context of exogenous growth – HES theory, is rather modest,, to addressing problems of market failure (such as imperfect competition), ensuring no barriers to trade, and aim for temporary increases in the growth rate by increasing investments in plant, equipment, human capital and R&D, see Solow (1997).

The implications and predictions of endogenous growth and new trade theories are more complex and more open to government intervention especially in their interaction. For example, endogenous growth theory views increasing returns and (thus) imperfect competition as a contributor to growth, while the new trade theory regards the same factors as reasons for possible strategic trade policies. In combination one can foresee a situation where governments promote imperfectly competitive markets in order to promote growth at the national level while at the same time protecting their imperfectly competitive sectors and firms, in order to gain advantages from (strategic) trade. The above are not the only policy implications of the two theories, yet such implications are consistent with them while they are inconsistent with the exogenous growth-HES views.[1]

An implication from the above as regards the neoclassical theory of competitiveness is that it consists of two major variants with different assumptions and inconsistent prescriptions. Perhaps more importantly the neoclassical theory is ill-equipped to deal with the creative role of markets (as opposed to their allocative functions, once they exist). This renders it of limited use to analysing issues of competitiveness and catching-up, see Kaldor (1972), Audretsch (1989), North (1994), Amsden (2008), Nelson and Winter (2002). In the words of Nobel laureate Douglass North (1994):

> Neoclassical theory is simply an inappropriate tool to analyze and prescribe policies that will induce development. It is concerned with the operations of markets, not with how markets develop. How can one prescribe theories when one doesn't understand how economies develop? (p. 359).

Concerning "old growth theory", Robert Solow (1997) almost admits as much, but suggests that one should turn "more naturally to Max Weber than to a modern growth theorist" (p. 72), in order to explain the role of institutions, attitudes and "modernisation" (versus "growth" of an already modernised economy). Solow goes on to suggest that the fundamental differences between old (exogenous) and new (endogenous) growth theory are that the former aims to explain trend-lifting growth, not trend-tilting one (growth policies that simply lift the trend as opposed to increasing the rate of growth per-se). The latter is achieved by endogenising technological change, but also at a potentially huge cost of hard to test assumptions, too much importance on the role of investment decisions on growth rates and fragile too powerful and rather dangerous conclusions. In his conclusion "the forces governing the scope of the potential trend – the sustainable rate of growth – are complex, technological, and even a little mysterious. What we do know how to do is

[1]Endogenous growth theories can also predict "divergence", instead of convergence, and that ceteris paribus larger countries will grow faster than smaller ones; see Verspagen (2005), who also distinguishes between "convergence" (refers to the world level) and catching-up (that refers to individual countries) and discusses the similarities and differences between endogenous growth and evolutionary views. Divergence is also implied by contributions in agglomeration and new geography economics, see Henderson (2005) and below. Feenstra (1996) suggests that in the absence of knowledge diffusion divergence is more likely than convergence in open economy models of endogenous growth.

to lift the potential trend by a few percent. Even if the slope remains as before, that is a fine achievement" (Solow 1997, p. 92)

The macroeconomic policy prescriptions deriving from the analytical foundations of the neoclassical perspective have been encapsulated in the various versions of the Washington and post-Washington-type policy advice to developing and transition economics, see Shapiro and Taylor (1990). Their record has been at least questionable, see Stiglitz (2001), Rodrik (2004), Dunning (2006), Serra and Stiglitz (2008).[2]

A second approach to competitiveness and catching-up is that adopted by the Japanese government during the post-second world war reconstruction effort. While more pragmatic than theory-based, the approach has subsequently been "deconstructed" by scholars both Japanese and Western in a way that unearths the theoretical insight of the Japanese policies, see for example Best (1990), Amsden (1989, 2008), Wade (1990), Shapiro and Taylor (1990), Pitelis (1994). In addition, variants of the Japanese approach have been adopted by the various "tiger" economies of the East Asia, justifying, we feel, the term the "Japanese" – East Asian approach (Pitelis 1994, 2001).

An important characteristic of the Japanese approach is an interventionist stance of the government in close contact/partnership with industry, and with the explicit aim to restructure the economy in a way that creates competitive advantages, as opposed to simply accepting existing comparative advantages. In this context, elements of the industrial/competitiveness strategies of the country, devised and implemented in Japan by the Ministry of International Trade and Industry (MITI), included: the targeting and support of specific firms and sectors (which were perceived to be important in terms of high value-added, high income elasticities of demand and oligopolistic with high profit margins). These sectors and firms were at first protected from international competition, through managed-trade policies. Intra-sector competition was managed too, in the sense that in each sector the major players should be not too many, but not too few either (so as to avoid collusive practices, but also to avoid resource dissipation and create critical mass). In effect that was managed locally-based big-business competition. To ensure technology transfer in the absence of foreign direct investment (which was discouraged), MITI encouraged an aggressive policy of buying licenses from foreign firms. To ensure competition from below to big players thus a relatively level playing field, MITI required that firms purchasing licences would make them accessible to smaller players, Hill (2006). In addition, Japanese firms pursued a corporate

[2]For Stiglitz (2001) "The advocates of the neoliberal Washington consensus emphasize that it is government interventions that are the source of the problem; the key to transformation is "getting prices right" and getting the government out of the economy though privatization and liberalization. In this view, development is little more than the accumulation of capital and improvements in the efficiency with which resources are allocated–purely technical matters. This ideology misunderstands the nature of the transformation itself–a transformation of society, not just of the economy" (p. xiv).

strategy of growth and market share acquisition, not short-term profit maximisation, see Best (1990).

In the above context, a number of other characteristics of the Japanese approach included new innovative methods of doing business (for example, just-in-time), human resource management, worker participation, and others such as total quality management. All these have been widely discussed in the literature and were felt by many (e.g. Best 1990; Amsden 1989; Wade 1990; Pitelis 1994; Grabowski 1994, Shapiro and Taylor 1990) to have contributed to the remarkable performance of the Japanese economy, up to the late 1980s when it was leading global markets in sectors such as electronics, semiconductors and automotives, see Hill (2006). Variants of the Japanese approach were adopted by the "tiger" economies, such as South Korea, Taiwan and Singapore (see Pitelis 1994; Chang 1994) and, more recently, by the Chinese government (Nolan 2001; Lin 2004) and other tiger economies, such as Thailand, Malaysia and Indonesia (see Jomo et al. 1997) and Vietnam (Chesier and Penrose 2007). A difference to the Japanese approach, of interest to the current paper, is that smaller economies, like Taiwan, Singapore and Malaysia, did not discourage, but rather encouraged FDI, albeit in a way that was perceived to be aligned to the overall competitiveness strategy (Pitelis 1994; Jomo et al. 1997).[3]

There is extensive and heated debate on the effectiveness, or otherwise, of the Japanese approach, including the possibility that the subsequent decline of Japanese economic performance could be attributed to this original interventionist model, see Pitelis (2001). The simple fact is that it is not easy to tell. Moreover, even if we accept that the Japanese approach was successful other factors might also be in play. These include the effectiveness of the political-bureaucratic structure (less government failure, so to speak) as well as cultural, institutional, and macroeconomic issues, see Shapiro and Taylor (1990) and Pitelis (2001). We do not wish to re-enter this debate here. However, we do wish to point out that many of the fundamental presumptions of the Japanese competitiveness strategy did receive theoretical support from one source or another. For example, the emphasis on big-business competition, the pursuit of market share, the emphasis on innovation of all types (including organisational, managerial and human resources) and the pursuit of long term profit through market share, are all in line with the work of scholars such as Schumpeter (1942), Penrose (1959), Chandler (1962), Baumol (1991) and others, and even more recent endogenous growth theory-based approaches, see Lucas (1988), Romer (1986). A focus on targeting of "strategic" sectors is in line with early development economics thinking on "infant industries" and more recent "new trade theory", see Kaldor (1972), Krugman (1987, 1989), Shapiro and Taylor (1990). The emphasis on domestic competition is in line with arguments by Porter (1990) – see below. The support of SMEs and clusters seems to find accord with almost all economic perspectives, albeit for different reasons (e.g. entrepreneurship,

[3]For a more detailed and nuanced account of similarities and differences between the various East Asian countries, see Shapiro and Taylor (1990), Rodrik (2004), and for differences between older and newer 'tigers' see Jomo et al. (1997).

agglomeration economies, cluster-building, locally-based development, challenge to multinationals, etc), see Krugman (1991a, b), Porter (1990) and Henderson (2005).

It is clear too that mistakes were made, and I believe that the failure of the Japanese to gradually give more space to market forces, could indeed partly explain subsequent difficulties. This is also in line with theoretical prescriptions, concerning the identification of the "optimal" mix between planning and markets and between market, hierarchy and co-operation.[4] Important for our purposes here is that the Japanese-East Asian perspective could be seen as a developmental-competitiveness approach in its own right. It has clear implications on catching-up – indeed the whole philosophy and purpose of the approach is to catch-up through creating and capturing value faster than other countries -as well as implications on FDI and country size, to which we return below.

A third approach to competitiveness involves work under the evolutionary, resource and systems-perspective and varieties of - comparative capitalism banners. Much of this has been encapsulated in the "systems of innovation", agglomeration and clusters and varieties of capitalism-related literature, see Lundvall (1988), Krugman (1991a, b), Nelson (1995), Freeman (1995), de la Mothe and Paquet (1997), Fagerberg et al (2005), Jackson and Deeg (2006) and Lundvall (2007) for a recent summary, assessment and proposed extensions. A main characteristic of the evolutionary and systems-based views is a focus on intertemporal efficiency effected through innovation, combined with the belief that innovation is best promoted not by an exclusive focus to free and competitive markets, but by big-business competition and systems-wide linkages that involve markets, hierarchies (firms, governments), co-operation and competition, NGOs and more wider social capital-promoting institutions and organisations, see Freeman (1995), Jackson and Deeg (2006). The strength or otherwise of the innovation-system depends on the linkages of the whole system, government policies, and institutions that promote innovation. Markets are but a part of the system, albeit an important one (see Stiglitz 1989). They need not be competitive, indeed big business competition may well have innovation-promoting advantages, see Nelson (1995) and/or Nelson and Winter (2002). In addition, the existence and promotion of agglomeration and clusters by small and medium-sized enterprises (SMEs) can be a potent means to promote linkages, diversity, and (thus) innovation, see Fagerberg et al (2005), Metcalfe (2002), Wignarajah (2003).[5]

[4]For example it is arguable that a more hands-on approach by government is required at the catching-up phase, while once a country has reached the "technological frontier" so to speak more focus on market signals may be appropriate.

[5]There is extensive work on "agglomeration" economies, that draws on the work of Krugman (1987) on new trade, see Krugman (1991a, b) and Henderson (2005) for a collection of papers. Martin (1999) provides a critical assessment. Martin and Sunlay (2003) and Pitelis et al (2006) also discuss the historical antecedents of agglomeration and "clusters"-type literatures. For our purposes, agglomeration economies by themselves imply divergence, but also the possibility to catch-up, by diagnosing and upgrading agglomerations. Kottaridi et al (2008) provide an empirical test of the role agglomeration plays in attracting FDI, in the context of UK regions; the results are in

It is arguable that the systems perspective is focused more on value creation through innovation than value capture, (therefore catching-up), albeit not in all cases, see for example the discussion of catching-up in Freeman (1995). It can be argued that the promotion of an innovative economy will help engender superior economic performance, therefore superior competitiveness and (thus) catching-up. This does not fully account however for the possibility that value creation need not always be captured by the innovators (Teece 1986, Research Policy 2006) – we will return to this later. In addition, the "agglomeration" element of "clustering" may well engender inter-regional and inter-national divergence, see Krugman (1991a, b).

It is arguable that dissatisfaction with competitiveness models motivated Michael Porter (1990) to identify a gap to be filled. This is one way to explain why someone should be writing a book in 1990 on a topic that goes as far back as the origins of modern economics (Adam Smith's Wealth of Nations 1776), and so extensively discussed since. Porter's "Diamond" approach suggests that the coexistence of appropriate factor conditions, demand conditions, firm and sectoral structure and strategy and related and supporting industries, engenders a "Diamond" and/or "clusters" of economic success-competitiveness.

Many of the elements of the "Diamond" are present in extant works, for example "factor conditions" in the HOS model; demand conditions in Vernon's (1966) work on the "product-life-cycle", related and supporting industries, in the works of Marshall (1920) and work on clusters (see Best 1990; Edquist 2005), industry structure and rivalry in the works of Industrial Organisation (IO) scholars, see Tirole (1988). However, Porter added new insights and dimensions, notably firm strategy. This draws on strategic management and Porter's earlier works (Porter 1980, 1985), and it is a breakthrough vis-a-vis neoclassical competitiveness models which usually focus on macroeconomic considerations at the expense of firm-level analysis. The last mentioned is critical as it can help shift focus on value capture (a main concern of firms) and (thus) up to a point catching-up.

In addition to the above, interesting in Porter's work is the re-surfacing of agglomeration and "clusters" (in the form of related and supporting industries), and in their interaction with other parts of the "Diamond", an emphasis on specialised, rare and hard to imitate factors (which is very much the theme of the resource-based view of firm strategy – see Wernerfelt (1984), Barney (1991), Peteraf (1993)), his emphasis on the importance of local as opposed to distant (such as international) rivalry, and a focus on demanding and sophisticated consumers (not just undifferentiated aggregate demand as in the Keynes (1936), tradition). All these are quite impressive and help explain Porter's successful journey from IO to strategy to national competitiveness policy scholarship and advice.

Concerning FDI, the four models have different implications and/or recognise different roles for it. In the neoclassical HOS model of international trade FDI can

line with the idea that agglomeration and the location of R&D labs by subsidiaries are positively correlated.

be one of the mechanisms whereby factors and resources are transferred from where they are abundant to where they are scarcer thus contributing to catching-up, see Stiglitz (2001). In the Japanese Far Eastern approach, FDI is a means to an end, it is used to serve the end of catching-up. In some cases, when technology transfer can be effected without FDI, alternatives are chosen; for example licensing in Japan, joint ventures in the earlier phases of Chinese opening-up to international markets, see Nolan (2001). When FDI is deemed to be necessary for industrialisation, it is encouraged, but placed as much as possible within the context of the industrial strategy objectives, as in Singapore, Korea and Taiwan (Shapiro and Taylor 1990; Chang 1994; Pitelis 1994; Jomo et al. 1997). In the systems-perspective, FDI is seen as part of the system – it may help strengthen already extant linkages, but could also be of limited importance if footloose and stand-alone, see Freeman (1995). Finally, in the "Diamond", FDI is seen as a measure of success, indeed outward investment is claimed by Porter (1990) to be no less than a sign of "competitiveness". Others, e.g. Dunning and Pitelis (2008), question this optimism seeing both positive and negative elements. In addition Dunning (1993), as well as Rugman and Verbeke (1993), extended Porter's approach to include the potentially important role of FDI in affecting the determinants of the "Diamond". There has also been extensive work on the potential interrelationship between FDI and clusters, see among others Freeman (1995), Pitelis (2001), Rugman and Verbeke (1993), Cantwell and Iammarino (2000) and Pitelis et al (2006).

There are few direct implications from the above models on the issue of country size, with the possible exception of the endogenous growth theory, where market-size facilitates growth. On the other hand, the ability, for example of Japan and China, to make MNE entry their markets conditional on licensing or joint ventures could well be attributed to the attraction to MNEs of the large size of the market of these economics, alongside the bargaining power that this attraction afforded to them. In contrast, the pursuit of more proactive inward investment strategies by smaller players, (e.g. Taiwan, Malaysia, and Singapore) could be attributed to that their market size was not by itself a sufficiently attractive proposition for MNEs – so more proactive FDI policies were required to foster development.

In the next section where we build on extant theory to develop a novel competitiveness framework that aims to address some problems of existing theories. In particular, none of the competitiveness frameworks or approaches discussed here has an explicit link between competitiveness at the micro (firm), meso (sectoral, regional) and macro levels; there is no explicit discussion of the issue of value capture for catching-up, versus value creation (which may be captured by others), and (thus) the interrelationship between value capture for catching-up strategies and value-wealth creation strategies. Indeed, some models of national competitiveness are ill-equipped to even address such issues, as they tend to rely on macro-categories, at the expense of the micro level (for example IB and strategy), where value capture is far more prominent. In this context, we feel that work on national competitiveness could benefit from insights derived from the IB and strategy literature when applied (suitably modified) to the national level.

Novel Framework for Competitiveness and Catching-up and the Role of FDI, Firm Clusters and Public Policy

The limited discussion of micro-(firm-level)-foundations and the lack of an explicit focus on superior value capture capabilities (which can lead to catching-up) are the two major limitations of extant theory.[6] Both can be addressed by strategic management scholarship which on the other hand, (excepting Porter and some scholars of the systems-approach), is mostly alien to competitiveness theories, which are mainly macro-based (see Nelson and Winter 2002).[7] To go beyond noticing this, it would be useful to identify factors that engender value and wealth at the firm level, but also the meso and macro levels when suitably understood and aggregated-augmented.

The concept of value, first, is very loaded in economics and management (see Dobb 1973, and Bowman and Ambrosini 2000 respectively). To avoid entering the interesting, albeit as of yet unresolved, debate on the nature and theories of value we focus instead on the much better understood concept of "value added". Of course, this still incorporates the word "value" a definition of which seems inescapable (yet is missing and/or highly contested in the literature, see Dooley 1990). For our purposes we propose value to be defined as perceived worthiness of a product or service to a (potential and/or target) user. In this context, value added is the additional value conferred to a product or service by an economic agent, be this an individual, a firm, a sector, or a nation. Value added can be potential or realized. It is potential before users have been convinced to pay a market price to purchase the product or service, and it is realized once the product or service is purchased. Value-added may never be realized if consumers lack the power to purchase (effective demand) and/or when sellers are outcompeted by rivals who possess substitute products, and/or superior competitive advantages (such as complementary assets and capabilities, see Teece 1986). This renders a discussion of value realization and value appropriation/capture strategies critical.

Value added is engendered in two fundamental ways: one is through increased efficiency and/or productivity, therefore a reduction of the cost of production; the other is an increase in the perceived utility-worthiness of the product or services

[6]For a relatively recent comprehensive discussion on catching-up, see Fagerberg and Godinho (2005) and Fagerberg and Srholec (2005). The authors deal with most levels of analysis, but not the very micro (strategic management) one, as they themselves acknowledge.

[7]Microfoundations, in the sense of optimising behaviour by economic agents, is at the very heart of the neoclassical theory, not least its endogenous growth variety (see Fine 2000). In this context our claim may sound paradoxical. However, it is simply in line with the well known criticism by Coase (1937), Penrose (1959) and others, that the neoclassical theory treats the firm as a black-box. What microfoundations there exist are in terms of profit maximising black-boxes, or the price-output decision of firms – not the creative role of firms and its impact on the macroeconomy. It is this type of microfoundations that we have in mind, that it is missing and that requires much more work and progress than there exists, including our own limited contribution here.

through "differentiation".[8] This can be due to real factors, such as increased functionality and/or aesthetic appeal, or to "imaginary" factors, effected for example through advertising. There are long debates on these issues in industrial organisation (IO) and strategic management (see Tirole 1988; Grant 2005); usually real and imaginary elements coexist, and it is arguable that through innovation, cost reductions and increased appeal (product differentiation) can take place simultaneously (see Pitelis and Taylor 1999, who propose a "value for money" strategy that integrates Porter's 1985 two major "generic strategies"-cost leadership and differentiation).

The crucial question is what are the major determinants of value added at the firm level, and to what extent the same or similar determinants exist at the meso and macro levels; so as to build on the firm-level microfoundations, in order to derive the determinants of the wealth of a nation. Drawing on extant theory of economics and management, Pitelis (2004) suggests that four major factors interact to explain value-added (through efficiency and/or differentiation) at the firm level: firm strategy and infra-structure; unit cost economies/increasing returns; resources, notably human ones; and technology and innovativeness. The importance of all four factors is well rehearsed in the literature which involves virtually all all-time classics in economics and management. Important, however, in this framework is that the same four factors can be re-interpreted to apply to the meso (region, industry, sector) and macro-levels (Pitelis 2004), thus allowing a relatively smooth aggregation, based on microfoundations.

The emergent "wheel of value" is shown in Fig. 13.1:

The "wheel" has the added advantage that one can examine in its context, the role of FDI, clusters and government (policy) as well as their interrelationships as these interact and impact on all three levels. For example, Fig. 13.1 shows that large size and FDI by MNEs as well as clusters (by SMEs and/or MNEs) and the "government" (policies) are interrelated (with clusters attracting FDI and FDI creating and/or being linked to clusters government policy affecting and/or being affected by both), and they all impact on the determinants of value-added. The impact, however, need not always be positive or beneficial. FDI can do harm, or good; clusters can lead to congestion effects or wither away (see Martin and Sunlay 2003); governments can be corrupt and/or ineffective and (thus) create (as opposed to solving) market failures see Krueger (1974), Shapiro and Taylor (1990) and Stiglitz (1998) for discussions.

Identifying the major determinants and actors of potential value added need not lead to realized value and wealth. This is where strategic management becomes crucial in informing policy makers. In particular, the determinants of value added in the "wheel of value" impact on potential value, not realized value, with one

[8]It could be argued that "utility" suffices and that cost production is of no additional use, as neoclassical economists do, see Robbins (1935). However, this would preclude one route through which perceived utility may increase; for business this is important. In any event, most neoclassical textbooks use the Demand-Cost Curve apparatus, which incorporates both a utility (through Demand) and cost (through the Cost curve) element.

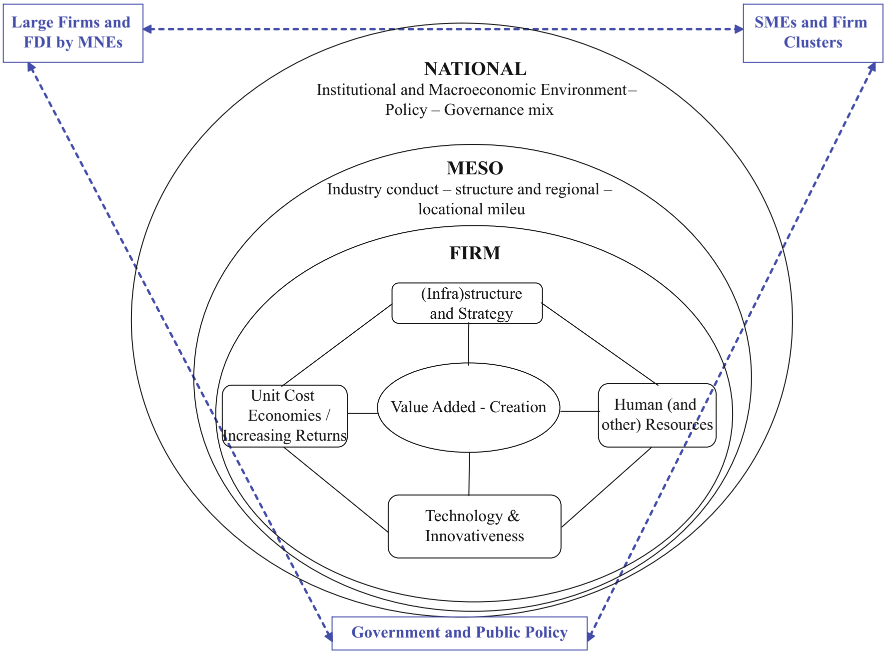

Fig. 13.1 The relative costs/differentiation ("image") matrix and country positioning

exception: that of firm (sector, industry and/or national) strategy. At the macro economic level there has been limited interest on the issue of strategies for capturing value. Instead in IO and strategic management there is extensive discussion on strategies for value realization/capture. There are four major types of such strategies: integration, diversification, and cooperation strategies; "generic strategies"; entry deterrence strategies (through strategic or "innocent"-technological barriers to entry); and "firm differentiation/heterogeneity" strategies - see Pitelis (2009b) for an account. There is some overlap and extensive interaction between these strategies (for example, Porter's (1985) "generic strategies" include two out of the four barriers to entry of Bain (1956), namely product differentiation and cost advantages). It is also arguable that such strategies are co-determined and co-evolving. Nevertheless, crucial about them is that in their interaction with product promotion and competitive strategies they help firms to realize potential value as profit and capture more value than their competitors (sometimes even by capturing potential value created by their competitors, see Pitelis 2009b, and Research Policy 2006).

It is arguable, that such strategies for value realization and value capture are applicable at the meso and national levels, albeit to different degrees. For example, countries can use strategic trade/protectionist policies. In addition, countries (and regions) may adopt regional/national differentiation strategies by strengthening, engendering and/or promoting their comparative or competitive advantages. In some cases, integration (or dis-integration) strategies are adopted by nations (for example, the integration of Germany, or the de-integration of countries from the former Soviet Union). Regional integration of countries, such as the EU, NAFTA or ASEAN, is common. The concept of generic strategies is also of much relevance to nations who may choose (or turn out) to be cost leaders (e.g. China in manufacturing, India in IT services) differentiation (e.g. Italian design), or niche strategies (for example, Switzerland in banking and/or watches). More complex cases could involve attempts to combine elements of niche (cost leadership and/or product differentiation) in specific activities (like for example, Finland in the case of mobile telephony). Such strategies, in addition can be partly history-determined, partly the result of policy initiatives, or usually a combination of both, such as the Finnish case – see Hill (2006). Fagerberg et al (2005), Freeman (1995) and Shapiro and Taylor (1990) provide discussion of various cases.

An awareness of the determinants of potential value added and the factors that can help realize/capture value can provide useful insights to policy makers who seek to achieve superior economic performance to that of their peers. At the broadest possible level, a superior ability to create and, especially, capture value in international markets is tantamount to superior economic performance by a particular nation. The mix of market/hierarchy/cooperation, private-public-hybrid, institutional, micro and macroeconomic policy, and the effectiveness and innovativeness of institutions, organisations and policies, will tend, in their interaction to help the "leaders" and "laggards", in this game, see Abramovitz (1986) and, for a critical survey, Fagerberg and Godinho (2005). It is not possible to go into further detail on exact policies here. This would, in effect, be the economic equivalent of searching for the "holy grail", but see Shapiro and Taylor (1990), Solow (1997), Rodrik (2004) and Serra and Stiglitz (2008) for more on this.[9] Instead we focus on how public policy can help address issues such as country positioning and "vehicles" through which competitiveness can be enhanced.

Competitive Advantage, Competitive Positioning and Vehicles to Competitiveness

Countries need to diagnose their comparative advantages, and reach a decision on whether they wish to "compete" on their basis, or to try to develop new competitive advantages in activities where they perceive to have more potential for the country and in international markets. Countries, that is, need to diagnose their "productive opportunity" (Penrose 1959), (the dynamic interaction between their internal

[9]Shapiro and Taylor (1990) discuss seven "boundary conditions" that can help devise and implement successfully state developmental policies, country size being one of them-see below. Rodrik (2004) distinguishes between first principles (market-based competition, property rights, incentives, sound money) and the plethora of specific policies that can be in line with the first principles, in an attempt to explicate the failure of "Washington consensus-type policies", while salvaging the core of the neoclassical agenda.

resources and competencies and the external opportunities and threats). Sometimes potential advantages are latent and hard to identify. For example, in many transition economies post-1989 in Eastern Europe people found themselves with ample time at their disposal and few opportunities for employment. Many were educated with mathematical and computing aptitudes. Some originally used these for quasi-illegal or outright illegal IT-related activities. In time accumulated expertise could be applied to legitimate activities and help create IT clusters (for example in Romania). This latent IT cluster was possible to diagnose already in the early 1990s, and indeed it was diagnosed in some studies (see Pitelis 1997). The desired mix of comparative and competitive (comparative-to-be) advantages for each country and for each case requires in-depth investigation and cannot be decided on a priori grounds without analysis on the ground.

Once the comparative or competitive advantages have been diagnosed, selected and pursued (in the case of competitive ones), the next decision is the positioning stance. Building on our earlier analysis, countries like firms could choose to position themselves along the relative cost-differentiation ("Image") spectrum. This is shown in Fig. 13.2.

In the relative cost-differentiation spectrum, the best position to be in is low cost/high differentiation. This is normally effected by countries with a high innovation culture and performance – with strong "systems of innovation", so to speak. This allows them to simultaneously reduce costs (through organizational and institutional innovation), and produce products, services and an "image" (country differentiation) of a leader, an innovator, a quality player. Small European players such as Sweden and Finland may be cases in point, see Freeman (1995) and Fagerberg et al. (2005)

Countries with high costs and low differentiation are laggards, they produce expensive goods and services and the image of the country is one of low quality. High relative costs can be due to low innovative capability, poor infrastructure, lack of increasing returns, poor organizational and institutional configuration. Greece in the 1980s is an example.

		Relative Differentiation ("Image")	
		High	**Low**
Relative Costs	**Low**	Competitive	Stuck in the middle (In need of direction)
	High	Stuck in the middle (Losing ground)	Non-competitive

Fig. 13.2 The relative costs/differentiation ("image") matrix and country positioning

Countries with high costs and high differentiation are likely to be developed ones with high technical and operational competencies but without a strong innovation system, at least not presently. These countries can have relatively high costs, because, for example, of high labour costs, themselves the result of distributional and welfare policies, that resulted from a "glorious past". Lack of innovative capabilities can be the outcome of organisational and institutional sclerosis, an insistence on doing already proven things in already proven ways. This lack of curiosity and innovation could result in this "stuck in the middle"/question-mark position. It is likely to characterize developed economies that somehow have lost their way, their incentive to compete and innovate. Germany in the 1990s may be a case in point; so is Britain in the 1970s (and it looks like in the 2010s).

Low cost, low differentiation economies are also stuck in the middle, but are likely to be at an earlier stage of their development, perhaps transition or emerging economies. Here unit costs can be low because of very cheap labour and resource costs, but the lack of differentiation/comparative or competitive advantages also place them in the question-mark category. Eastern European transition economies are cases in point.

There can be intermediate situations, for example, in more recent years, the positioning of many South European countries, for example Greece, South Italy, Portugal and Spain, has been characterised by a very sui-generis model – that of low costs/moderate or even high skills/competencies. Relative costs have been kept low, through the creation of the so called 1,000 Euro generation, usually well educated, skilful and competent graduates who, however, have to work (often far in excess of the 8 h working day), for Euro 1,000 a month (and indeed in Greece or Portugal for as low as Euro 600!). This helps the competitive positions of these countries vis-à-vis, for example, low cost/low differentiation ones. It is sustained through a sui-generis, inter-generational transfer of resources (the savings-wealth the parents accumulated in previous years), and/or through multiple jobs (when feasible) and grey market activities. All these help engender their competitiveness despite the absence of a strong innovation culture/system. At one level, they represent a form of indirect subsidisation of locally-based firms and industries, which under normal circumstances (namely if individuals earned more, the state taxed them and used the taxes to subsidize industry), they would be considered as anti-competitive practices, for example by the European Commission. They are a form of Non-direct taxation of the countries' middle classes.

The relative costs/differentiation matrix does not make an explicit distinction between stages of development although it is likely that countries in the first column are likely to be developed, while the other less so, or emerging. The matrix can be of help to all countries, to identify ways to improve their competitiveness by reducing unit costs, improving differentiation, strengthening their innovation capabilities. For example, a small country (let's say island economy), with excellent climate, low costs of labour and little manufacturing (thus production costs too) can aim to effect high country differentiation (let's say as a tourist destination), with good service (which need not require much higher costs, if effected through cultural/educational means) and low costs. Small countries with ample time to spare due to lack of employment opportunities could aim to effect differentiation through emphasising service provision, e.g. call centres, IT services, etc. These are in effect “niche-differentiation” strategies. They are likely to be more appropriate for smaller countries which cannot compete with an across the board differentiation strategy.

This prescription is supported by the excellent account by Shapiro and Taylor (1990) who point to the “importance of specialized, niche-oriented industrial strategies for small open economies” (p. 869) and go on to conclude that “There is no reason why production for appropriate niches should not initially be supported by import barriers and export subsidies; . . . full industrialization only occurs when infant firms grow up and can compete more or less effectively on international terms” (p. 873)

A third issue that all countries need to assess is the vehicles and policies through which competitiveness can be improved. Discussing specific policies is beyond the scope of this paper - see for example Shapiro and Taylor (1990), Rodrik (2004), Fagerberg and Godinho (2005), Pitelis (2007) for more detailed discussions. By “vehicles” we refer to “FDI” and “clusters”, as per Fig. 16.1. Both independently can impact on all determinants of value creation, see Pitelis et al (2006) for a more extensive account. However the sustainability of value capture requires embeddedness. This means that countries should preferably aim to create linkages between clusters and FDI so that FDI does not “fly” when conditions change, (e.g. costs go up), because margins have also gone up through higher differentiation, effected through embeddedness.[10]

The need for embeddedness is emphasized in the work of Abramovitz (1986), albeit he uses the term “social capability”. Abramovitz suggests that differences between the levels of development between countries do present opportunities for catching-up and convergence, but only provided that these countries have developed a social capability adequate to absorb existing more advanced technologies. The concept is very similar to that of “absorptive capacity”, on which recent research currently takes place in IB scholarship (see Kottaridi et al. 2006 for an account). From our point of view, the interest lies in the fact that the building of “social capability” and/of “absorptive capacity” is something that involves by definition (viz the word “social”) the government and the policy at large – it is not just a matter for the private sector. In addition in our context here local development effected through clusters represents one way through which “social capability” and “absorptive capacity” can be enhanced. Indeed the presence of clusters can also be seen as a manifestation of the existence of social capability that can be fostered through appropriate government measures.

[10]Jomo et al. (1997) comments on the issue of FDI and sustainability in the context of the development of the first-tier East Asian countries (like Singapore, South Korea, Taiwan and Hong Kong) and the second-tier ones, like Thailand, Malaysia and Indonesia as follows: “While the Northeast Asian economies have been open to foreign investment, they have also been more selective and have emphasized developing national (not necessarily state-owned, except perhaps in Taiwan) industrial, technological, marketing and related capacities. In contrast, most rentier entrepreneurs in Southeast Asia have not been obliged to deploy their rents at such ends” (p. 163).

The three issues raised above can and should be considered simultaneously. Competitive advantages could be linked to the positioning, clusters should be diagnosed and upgraded and FDI attracted in a way that is in line with advantages and supports the pursued positioning.[11]

Another consideration concerns adaptation. Detected advantages and positioning should be reviewed regularly to ensure consistency with evolving circumstances/stages of development. For example, in order to attract high knowledge intensive FDI, it may be useful to discourage some FDI which may require rendering such FDI expensive to firms through for example a high-wage policy – pursued for example by Singapore, Pitelis (1994), Lall (2000), Fagerberg and Godinho (2005). In addition, care should be taken to achieve a coincidence between what (selected) MNEs require in their quest to optimize locational advantages (see Buckley and Ghauri 2004), and what the country finds consistent with its advantages/positioning strategy. Such policies may become possible, in an era of "fragmentation" (see Venables 2003) that allows MNEs to separate the value-chain and choose "optimal" locations for each part of their production process.

It is arguable that smaller developing countries have advantages in pursuing such a strategy. Small size may help render identification of competitive advantages and positioning easier. It could also help with implementation – for example diagnose clusters, identify missing linkages, build an innovation system, effect country differentiation. Countries like Albania (for example, through the "Albania 1 Euro" initiative), Serbia (through its high-tech IT cluster in Vojvodina), Slovenia and even Greece through their nation-wide cluster diagnosis and upgrading strategies, help show that relatively smaller size can be an advantage – see Pitelis et al (2006). In addition smaller countries are less likely to invite retaliatory moves as they are too small to impact on world prices. Importantly smaller countries may only be required to make one single choice right, in order to jump-start the process of growth. This could involve developing a single leading cluster and/or MNE, such as Nokia in Finland or Teva in Israel. The success of such companies in turn can allow smaller countries to move faster from a comparative advantage to a competitive one. Last, but not least, in an era characterised increasingly by knowledge-intensity and the importance of intellectual assets it is arguable that a smaller country can institute faster and easier a successful programme of skill/capability/

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[11]The requisite conditions for achieving these are not easy, and are arguably becoming more stringent for reasons related to technological changes (Fagerberg and Verspagen 2002), but also institutional and international governance-related ones. At the time of its economic development, for example, Japan could get away with pursuing policies that would be considered as anti-competitive under current WTO regulations, and even received US support to implement them. When Washington-consensus-type free markets, free-trade policies are imposed on catching-up countries, this may be viewed as an attempt to "kick away the ladder" (see Stiglitz 2001; Chang 2002; and Fagerberg and Godinho 2005; for a discussion). Boltho and Allsopp (1987) showed that in the 1980s protectionism in the form of non-tariff barriers, was on the increase. On the other hand, the WTO can help participant countries to gain market access, partly offsetting these problems.

knowledge-upgrading for its people – sometimes by also drawing on its diaspora. Greece, Israel, Ireland are cases in point.

Another potential advantage of smallness is that it renders community links stronger. This could help with creating conditions of trust that can facilitate clustering (albeit that could be moderated by cultural factors, as "closeness" can also engender inter-personal rivalries). In any event, however, smallness is likely to lead to higher per capita remittances due to stronger family links thus helping smaller transition economies. For example, in an IMF (2005) study, countries with remittances higher than 10% of GDP were invariably smaller ones and included labour-exporting transition economies, such as Albania and Moldova. With remittances flows only second to FDI this issue is surprisingly under-researched; it could well serve as an extra competitive (albeit transitory) advantage for smaller countries.

Clearly the above is not to suggest that small is only beautiful. It is arguable that a major liability of smallness is that it renders the incentive to be corrupt higher, as it can increase substantially the per capita payoff of corruption. We argued elsewhere that corruption which involves not only local politicians, but also MNEs, and which can take many different forms to include regulatory capture by local monopolies and foreign MNEs and rent seeking, can be a potent brake to development (Pitelis 2004). It happens that this is more likely to plague smaller countries which may offset other advantages of smallness. In addition, Nolan et al. (2008) argue that the "global business revolution" implies that "firms from low-income countries" access to developed country markets has become increasingly dependent upon entering into the global commodity chains of core firms based in high-income countries" (p. 33).[12] This and increasing non-tariff barriers support the observation of new emerging difficulties for catching-up.

Summary and Conclusion

We discussed the issue of competitiveness and catching-up, paying attention to the role of FDI clusters and public policy in this context. We suggested that extant frameworks for competitiveness lack micro-(firm-level) foundations which we aimed to provide. In addition we claimed that competitiveness and catching-up include a value capture (not just value creation) element usually lacking in the predominantly macro-economic approaches to competitiveness. In this context, lessons can be derived from IB strategy to include the issues of positioning, diagnosis and creation of competitive advantages and alignment between objectives and means to achieve selected strategies. FDI and clusters can serve a country's

[12] Recent research by Monteiro et al (2008), that "subsidiary isolation" can hinder knowledge transfer to more "isolated" MNE subsidiaries. One could surmise that more isolated are likely to be subsidiaries in more distant, smaller developing economies.

public policy vis-à-vis competitiveness, especially when they are combined and aligned with the country's competitive advantages and selected competitive stance/ positioning.

Emerging and transition economies could devise strategies for FDI and/in relation to clusters that can be aligned to their created competitive advantages and competitive positioning to serve the purpose of superior competitiveness, and thus catching-up.

At the same time the margins of opportunity may becoming narrower – not least because of the shifting landscape concerning globalization and global governance, see Dunning and Pitelis (2008). It is arguable that successful catching-up especially by smaller developing countries could be made much easier, were the international community to appreciate that such catching-up is good for global economic sustainability.

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Chapter 14
The Role of Public Policies in Fostering Innovation and Growth: Theory and Empirical Evidence

Marc Schiffbauer

Abstract This survey outlines the literature on economic growth and development with respect to the following questions: (a) To what extent do public policies influence economic growth? (b) Which policy mix might optimize a country's rate of growth and development? While the importance of identifying the key determinants of economic growth is obvious, a unified theory that matches empirical facts is still missing. It is shown that a successful theory needs to explain why some countries catch up in terms of productivity while others lag behind. This literature review demonstrates that public policies influence a country's productivity growth rate in several different ways. However, it also demonstrates that policy effects are often far from obvious ex ante. Instead, some detailed knowledge of the stage of developments or country-specific characteristics are necessary to achieve the desired outcomes.

> "economies that adopt the formal rules of another economy will have very different performance characteristics than the first economy because of different informal norms and enforcement [with the implication that] transferring the formal political and economic rules of successful Western economies to third-world and Eastern European economies is not a sufficient condition for good economic performance."
>
> – North (1994, p 8)
>
> "Institutional copycatting may have been useful for Poland, but it is much less clear that it was relevant or practical for Ukraine or Kyrgyzstan."
>
> – Rodrik (2005, Handbook of Economic Growth, Elsevier, Amsterdam, p 29)

Research Questions

This survey outlines the literature on economic growth and development with respect to the following questions: (a) To what extent do public policies influence economic growth? (b) Which policy mix might optimize a country's rate of growth and development?

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Indeed, if we succeed in identifying key policies that foster economic growth, the implementation of optimal growth strategies could cut world poverty and affect income inequalities across countries.[1] However, we implicitly need to solve a closely related puzzle first in order to be prepared to define the scope of public policies: What are the key determinants of economic growth and development?

While the importance of identifying the key determinants of economic growth is obvious, a unified theory that matches empirical facts is still missing. Instead, the emergence of endogenous growth theory since the early 1990s induced a vast strand of literature covering numerous potential determinants of economic growth and development ranging from macroeconomic policies to trade and industrial policies and deep-seated institutional factors and initial conditions. Clearly, policymakers have direct control over some of these factors, but only limited (long-term) or no control over others.

If we have a closer look at the empirical part of the literature, the overall picture still remains puzzling. In particular, Summers (2003) suggests three main ingredients for growth: (a) economic integration through trade and investment, (b) maintenance of sustainable government finances and sound money, and (c) an institutional environment in favor of contract enforcements and property rights. He concludes: "I would challenge anyone to identify a country that has done all three of these things and has not grown at a substantial rate" (Summers 2003). Indeed, this policy mix appears to be intuitively appealing. Yet, Rodrik (2005) illustrates that corresponding inferences for policy implications are not generally consistent with empirical facts. Table 14.1 shows that Latin American countries experienced sustained growth during the 1960s and 1970s which represent periods of import substitution policies (high barriers to trade and capital flows) – e.g., El Salvador undertook tremendous reforms since 1989 in favor of macro stabilization, trade liberalization and private sector deregulations without achieving higher growth (see Fig. 14.1). In contrast, Fig. 14.2 illustrates that economic growth

Table 14.1 Sources of growth in Latin America

Source of growth, Latin America, 1990–1999					
	Output	Output per worker	Contribution of:		Factor productivity
			Physical capital	Education	
1960–1970	5.72	2.88	0.83	0.31	1.74
1970–1980	6.48	2.92	1.32	0.38	1.16
1980–1990	1.47	−1.66	0.05	0.45	−2.12
1990–1999	3.01	0.71	0.14	0.32	0.21

Source: Bosworth and Collins (2003)

[1]The poverty line is defined by 1$ in purchasing power parities per day (static) by the Worldbank so that better growth strategies would reduce world poverty if the status quo is suboptimal. Moreover, Rodrik (2005) illustrates that disparities in income across countries account for the bulk of global disparities.

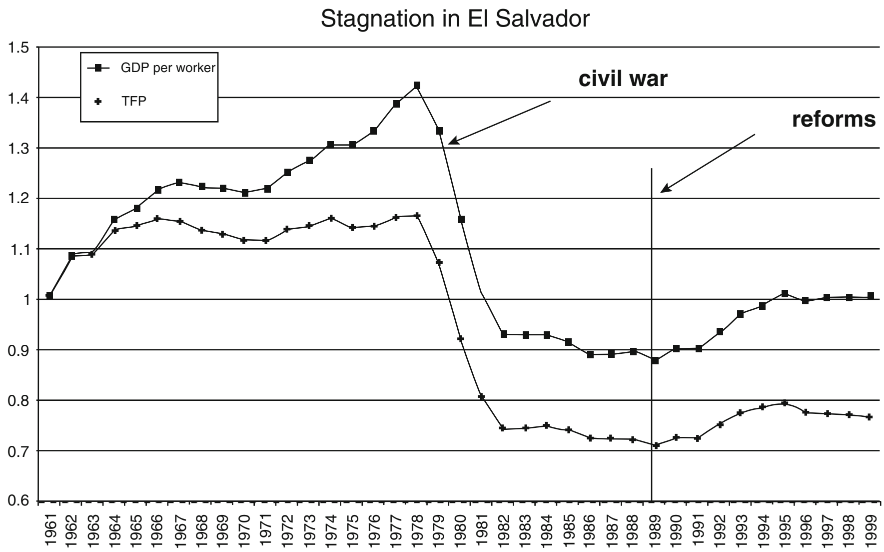

Fig. 14.1 El Salvador – failure of institutional reforms
Source: Rodrik 2005

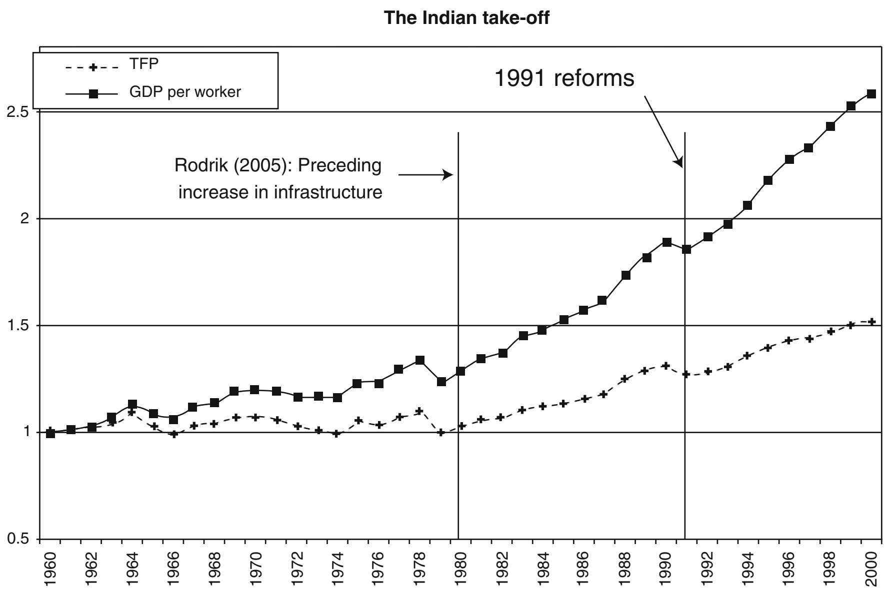

Fig. 14.2 India's growth takeoff
Source: Rosworth and Colins (2003)

Table 14.2 World bank's "star globalizers"

Country	Growth rate in the 1990s (%)	Trade policies
China	7.1	Average tariff rate 31.2%, national trade barriers, not a WTO member
Vietnam	5.1	Tariffs range between 30% and 50%, national trade barriers and state trading, not a WTO member
India	3.3	Tariffs average 50.5% (second highest in the world)
Uganda	3.0	Moderate reform

Source: Collier and Dollar (2001: p 6)

took off in India in the early 1980s while economic reforms did not take place before 1991. Instead, the initial growth take-off was preceded by substantial public investments in infrastructure in the late 1970s and early 1980s as well as a gradual shift towards a more "business-friendly" policy environment at that time.[2] Table 14.2 shows that China, Vietnam, India, and Uganda have experienced tremendous growth during the 1990s in the presence of major barriers to trade and capital flows.[3] Moreover, the index of overall property rights from the Frasier Institute of Economic Freedom reports an index number for China of 6.8 in 1985 and 4.9 in 2000 which are below the ones of Mali, Iran, Panama, or Romania.

Consequently, it appears that we need to take some care in isolating growth-enhancing policies and keep in mind to incorporate country specific conditions accurately. Nevertheless, recent advances in development accounting are pointing the way for future research. Caselli (2005) provides a comprehensive survey and various robustness checks of contributions in development accounting. He concludes that the fraction of the variance of income across countries that is explained by variations in factor accumulation (labor, physical, and human capital) accounts exclusively for around 40% (upper bound). Thus, the bulk of international income differences is due to variations in total factor productivity (TFP). It follows that a successful theory needs to explain why some countries catch up in terms of productivity (TFP) while others lag behind.

In general, endogenous growth theories initiated by Romer (1990) and Aghion and Howitt (1992) (where by endogenous we refer to models of endogenous technical change) are able to explain TFP-differences due to technical change across countries. These theories disclose new theoretical mechanisms for public policies to influence innovative activities and TFP-growth – each policy which affects the productivity or cost structure of specialized intermediate producers impacts on the rate of technological progress in the economy.[4] This class of models was extended to distinguish between economies that adopt technologies developed

[2]See Rodrik (2005) for a more detailed description of the growth take-off in India.

[3]In particular, China and Vietnam achieved sustained growth in the absence of trade liberalizations or enhancements of property rights for almost three decades.

[4]In particular, this approach to economic growth concedes an important role to industrial policies discussed below.

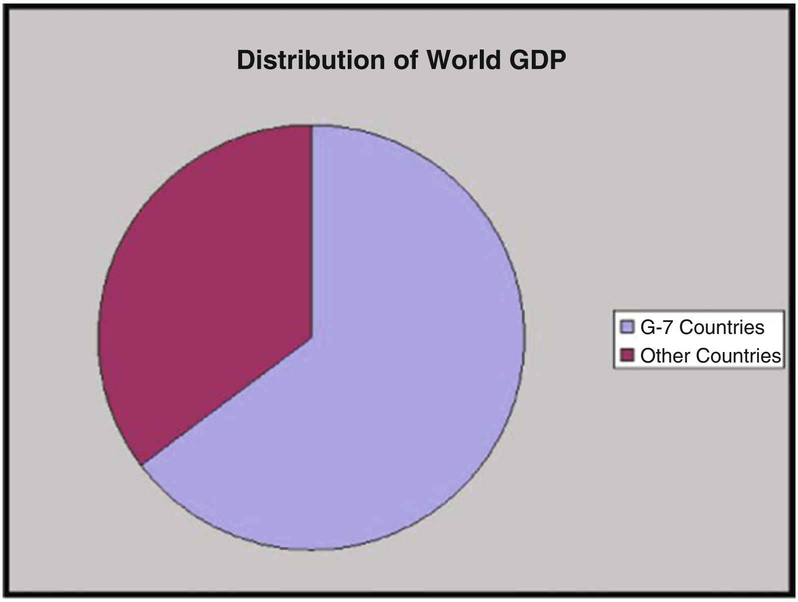

Fig. 14.3 Distribution of World's GDP
Source: Keller (2004)

elsewhere and innovating ones. Indeed, it is a well-founded stylized fact that almost all technologies are developed within a few advanced countries. Figures 14.3 and 14.4 support this finding. Moreover, Fig. 14.5 exemplifies the importance of international technology diffusion (from the US) in the Canadian pharmaceutical sector.[5] The theoretical work of Barro and Sala-i-Martin (1997) or Eeckhout and Jovanovic (2002) distinguishes between imitating (adopting) and innovating countries and predicts that a country's long-run growth rate depends exclusively on the rate of technical progress in a few leading countries. The innovator and the imitator exhibit the same conditional growth rate in a balanced growth path. The corresponding income differences depend on the capacity of imitating countries to absorb foreign technologies. Barro and Sala-i-Martin (1997) view the security of property rights, taxation and infrastructure as the key determinants of a country's absorptive capacity. Some later models show that growth rates might even diverge if a country's stage of development is too low leading to "convergence clubs" of economies with similar stages of development.[6] Apart from political or institutional

[5]More generally, there is various empirical support in favor of the importance of international technology diffusion to determine a country's TFP-growth rate, see Keller (2004) for a comprehensive survey.

[6]See, for example, Basu and Weil (1998) or Acemoglu and Zilibotti (2001) for divergence in growth rates because of skill-biased technical change and Benhabid and Spiegel (2005) because of a lack of human capital.

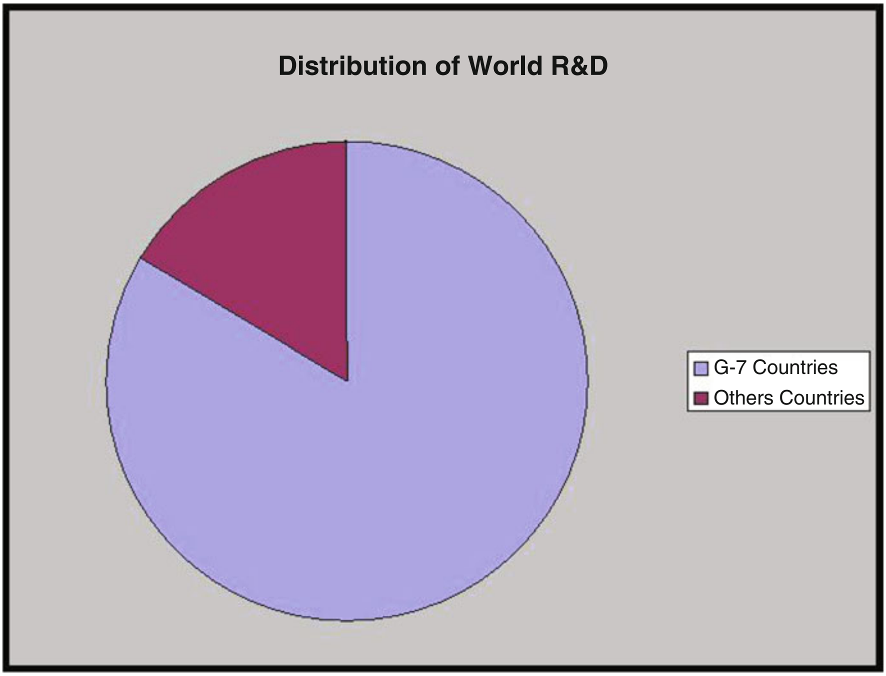

Fig. 14.4 Distribution of World's R&D
Source: Keller (2004)

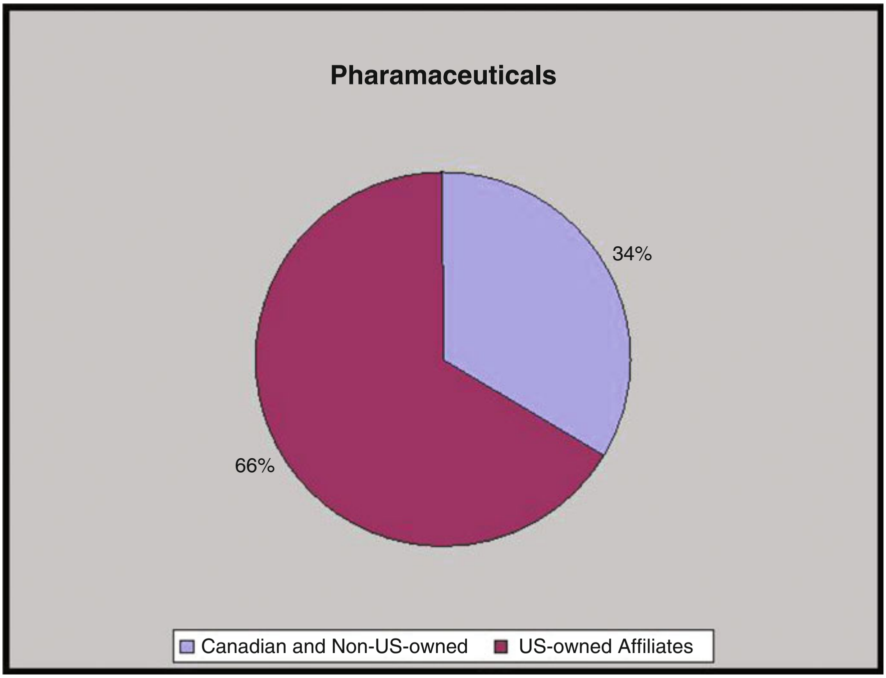

Fig. 14.5 Share of R&D investments of US-owned affiliates in Canada – pharmaceutical sector
Source: Keller (2004)

constraints to adopt innovative technologies, see, for example, Parente and Prescott (1999) and Acemoglu et al. (2002), the determinants of a country's absorptive capacity are seen as the key for its economic development and technological (TFP-) catch up.

Indeed, a closer look at some case studies supports the pivotal role of TFP-growth as an engine of overall growth in GDP per capita. Table 14.1 clearly indicates that variations in the growth rate of GDP per capita in Latin America from 1960 until 2000 are primarily due to variations in TFP-growth. The periods of high sustained growth in the 1960s and 1970s comply with periods of high TFP-growth, while the large decrease in GDP-growth in the 1980s is accompanied by a sharp drop in TFP-growth. Moreover, Fig. 14.2 shows that growth in India is driven primarily by TFP-growth. More precisely, Figs. 14.6 and 14.7 reveal that before 1980, states with a lot of manufacturing activity performed generally poorly, while thereafter, growth is driven primarily by manufacturing intensive states.[7] The catch up in TFP of India's manufacturing sector, accompanied with increasing technical

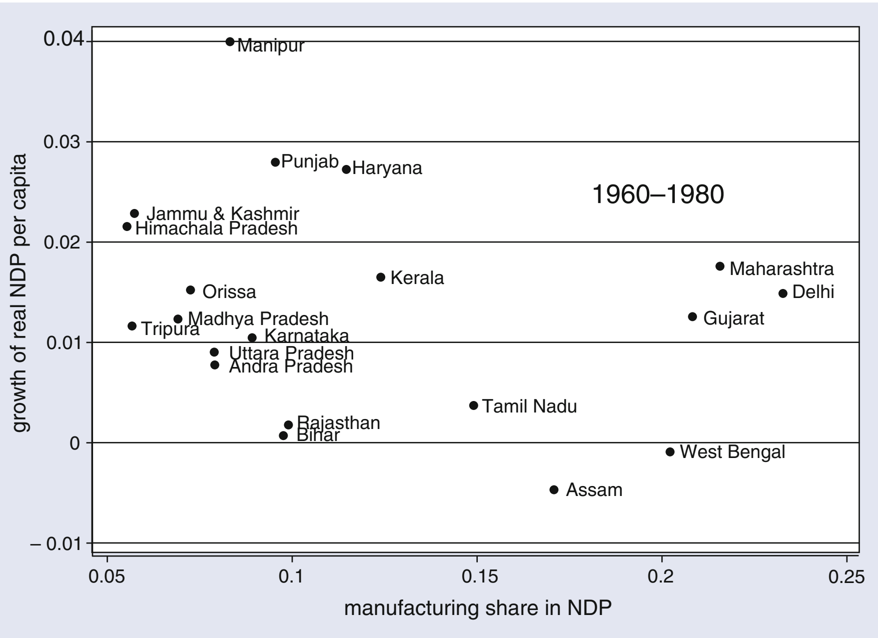

Fig. 14.6 Growth and manufacturing across Indian states before 1980
Source: Rodik (2005)

[7]See Rodrik (2005) for a more detailed description of the growth take-off in India.

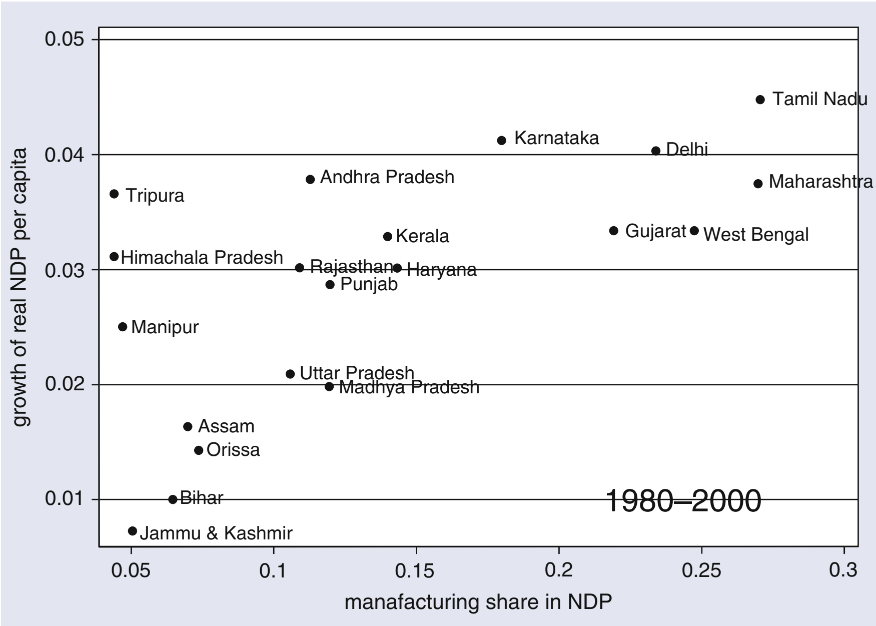

Fig. 14.7 Growth and manufacturing across Indian states after 1980
Source: Rodrik (2005)

change in that sector, appears to support theories of technology diffusion and adoption of foreign technologies. Fig. 14.3 illustrates that TFP-growth is also the primary source of China's "growth-takeoff." It also suggests that the enhancement of productivity may be linked to improvements in the provision of telecommunication infrastructure which also took off in the end of the 1970s. Consequently, we mainly focus on the role of public policies to foster economic growth via innovations and technological catch-up.

The rest of the paper is organized as follows. In Sect. 2 we discuss theoretical and empirical approaches to isolate key mechanisms for innovation and growth that allow for a direct or indirect role of public policies. In particular, we analyze the literature with respect to the following questions: whether and how does human capital facilitate the diffusion of technologies across countries? Are local complementarities between human capital – knowledge flows – important and what measures (e.g., brain gain policies) support them? Does the optimal composition of education change with the transitional path of an economy? What are the dynamics gains from trade liberalization – does trade convey technology spillovers? How do trade policies influence incentives to innovate? Under which circumstances do foreign direct investments (FDI) lead to technology transfers? What policy measures support such environments of knowledge flows via FDI? Do infrastructure investments influence the incentives to innovate and foster technological catch-up? Do macroeconomic policies/stability affect the composition of investments and hence innovations and long-run growth? What is the role of financial development in fostering the incentives to innovate or imitate – is there a compositional effect (e.g., credits vs. market-based system)? How do industrial policies (e.g., deregulation of entry) impact on technological progress? Do R&D subsidies promote innovation and growth? In Sect. 3, we derive the corresponding open empirical hypothesis from the literature.

Theoretical Approaches and Empirical Evidence

In the following, we discuss theoretical approaches and the corresponding empirical support for several key determinants of innovation, growth and technology diffusion that are either directly or indirectly (institutional reforms) controlled by policymakers.

Human Capital

Initially, Lucas (1988) and Rebelo (1991) account for human capital as a productive input that accumulates knowledge by assuming the absence of diminishing returns for the combination of private and human capital. That is, the authors explicitly assume that human capital and technological knowledge are one and the same. Based on this (*AK*-) assumption they are able to show formally that an increase in human capital is growth-enhancing. Benhabib and Spiegel (1994) and Foster and Rosenzweig (1995) consider an alternative growth-channel of human capital: Human capital facilitates the adoption of foreign technologies. The policy implications of distinguishing between education as a factor of production or technology diffusion (TFP) are significant. In the former, the benefit of a rise in education is its marginal product, while in the latter it is the sum of its effect on all output levels in the future. Benhabib and Spiegel (1994) discriminate between both effects empirically. They estimate equations of the following type:

$$\Delta a_{i,t} = c + g h_{i,t} + m\left[\frac{h_{i,t} y_{max,t}}{y_{i,t}}\right] + \phi t + \theta i \qquad (1)$$

where a refers to TFP, h to human capital and y_{max}/y_i to the productivity-distance of country i with respect to the leader country. The authors detect positive estimates for the coefficient m which reflects that a country's capacity to absorb foreign technologies is increasing in its level of human capital. The same authors extend this idea in a later article to account for the possibility of a disadvantage in technological backwardness à la Howitt (2000). That is, Benhabid and Spiegel (2005) assume a tradeoff in relatively technological backwardness: On the one hand, there is an advantage of backwardness since the country can choose to adopt new technologies from a larger menu. On the other hand, it is harder to adopt more complex, skilled-biased technologies if the country lags behind the world technology frontier. It follows that technological laggards may converge or diverge in terms of productivity and growth depending on their level of human capital. In the empirical part of the article, the authors show that the predictions of the model based on the educational levels within countries match the growth performance of many emerging economies during the last 40 years quite well.

The positive link between human capital and growth raises the issue of policy interventions and the financing of education. Interventions are justified if social returns exceed private returns.[8] This is the case in Benhabib and Spiegel (1994) due to the positive social externality on technological progress. Yet, a number of studies do not confirm their results. Heckman and Klenow (1997) compare individual with cross-country Mincer wage regressions. If the latter outweigh the former, social returns exceed private. The authors find positive support for excessive social returns. Yet, when they control for technology differences across countries the rates become similar. Likewise, Topel (1999) shows that the social coefficient resembles the private if year-dummies are accounted for. Acemoglu and Angrist (1999) conduct an instrumental variable approach and cannot approve deviations between social and private returns.[9] Yet, their results depend crucially on the validity of their instruments – individual education is instrumented by a dummy for the quarter of birth and average education is approximated by compulsory school attendance laws. Krueger and Lindahl (2001) provide robust micro-economic evidence for the existence of private returns, but assess weak macro-economic support for externalities on technical progress from the stock of human capital. In particular, its coefficient is not significant when restricting the regression to OECD countries.[10] Their results are contrary to Benhabib and Spiegel (1994). An attempt to reconcile both studies suggests that education matters only for technological catch-up, but not for frontier innovations.

A general critique which applies to all of these studies is the negligence of qualitative aspects of education. Yet, empirical examinations suffer from the scarcity of available qualitative measures of human capital since conventional proxies are typically based on quantitative measures of education, e.g., years of schooling. Still, several authors suggest empirical strategies to account for the quality of education. Barro (1991) applies student–teacher ratios across countries as a measure for quality. Yet, the evidence is weak since the ratio is negatively related to the number of primary, but not secondary years of schooling. Klenow and

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[8]Social rate of returns are typically measured as the effect of human capital on GDP, while private ones follow from Mincer wage regressions that estimate the individual return from an additional year of schooling.

[9]Similarly, Teulings and van Rens (2003) approve that private and social returns to education are equal in the short run.

[10]The authors argue that the assumption of a constant coefficient between initial education and growth across countries is flawed.

Rodriguez-Clare (1997) and Bils and Klenow (2000) provide positive evidence that the human capital of the young generation (students) depends on the amount of human capital of the old generation (teacher). Finally, Hanushek and Kimko (2000) demonstrate the importance of the quality of human capital. They detect a strong causal relation running from the quality of the labor-force to economic growth. Their results are based on international measures of math and science test scores for 39 countries from Barro and Lee (1996).[11] At the same time they find no evidence that public spending on schooling resources influences performance differences of students. Their findings support R&D based growth theories *à* la Romer (1990) where human capital affects the supply of technologies and knowledge transfers. Thus, the large social growth-externality from the quality of the labor force acknowledges the earlier results from Benhabib and Spiegel (1994). Still, the discussion shows that there appears to be a non-trivial mapping from (quality) measures of schooling to the quality of the labor-force.

A different strand of the literature focuses on strategic complementarities between human capital. Kremer (1993) assumes a special production function where production consists of different production processes. In each production process workers can make mistakes with a certain probability depending on their quality. Thus, it differs from the standard specification in the sense that the quality of workers cannot be substituted by the quantity in each production process.[12] The specification yields strategic complementarities in human capital and hence multiple equilibria. Finally, some authors stress persistent differences in the world income distribution due to a complementarity between technology and skill (skill-biased technologies), e.g., Redding (1996), Basu and Weil (1998), Acemoglu and Zilibotti (2001) or Jovanovic (1996). This complementarity leads to imperfect technology diffusion and hence international income differences. Hence, it provides a microeconomic foundation for the Benhabib and Spiegel (1994) approach. Moreover, it implies growth-effects due to improvements in human capital, higher protections of intellectual property rights (IPR) and lower import tariffs. In general, strategic externalities in human capital exhibit a promising approach to refine our understanding of (local) knowledge interactions and hence the process of technology diffusion.

Finally, a number of recent studies associate the composition of human capital and education with economic growth. In the models outlined above, primary, secondary, and tertiary education are implicitly regarded as perfect substitutes. In particular, Acemoglu et al. (2002) and Aghion and Howitt (2005) argue that different stages of economic development require different skills. Thus, the closer a country gets to the world technology frontier, the more important is higher (tertiary) education to promote R&D. In contrast, imitation of foreign technologies

[11]Note that the authors identify implausibly large estimates since an increase of one standard deviation in the test scores enhances annual economic growth by more than one percent.

[12]He motivates the approach by the “O-Ring” – a component of the Challenger space shuttle that costs a few cents but finally caused its explosion.

requires basic (primary and secondary) education. Aghion and Howitt (2005) use this approach to explain productivity differences between the US and the EU. That is, 37.3% of the US population between 25 and 64 have completed a higher education degree in 1999–2000 as opposed to only 23.8% in the EU. Furthermore, educational expenditure on tertiary education amounts to 3% of GDP in the USA against 1.4% in the EU. Vandenbussche et al. (2004) and Aghion et al. (2005b) provide empirical evidence in favor of this hypothesis, whereas the former apply data for 22 OECD countries and the latter data for US states. In both cases, they detect a positive interaction term between the distance to the world technological frontier (measured in TFP) and higher education, albeit it loses its significance if they control for country fixed effects in the former case. Likewise, Caspari et al. (2004) underline the empirical importance of the lack of tertiary education in Germany vs. the US to explain growth differences between the two countries and Krueger and Kumar (2004) stress that skill-specific rather than general education in Europe vs. the US causes a productivity gap. In general, this approach can be regarded as an application of a broader theoretical framework which suggests that different institutional frameworks are required for different stages of economic development as argued by Rodrik (2005).

Trade Policies and Partners

The literature on trade and growth identifies three static gains from (completely) integrating in the world economy with respect to international trade in goods and factors[13]: (a) an improved allocation of input factors (e.g., capital and labor), (b) higher productivity due to a specialization of production, and (c) increase in market size. The first effect is due to efficiency gains from reallocating factors from regions/industries in which they were abundant in autarky into those in which they were scarce. The second results from a specialization of production in products where a region's comparative (productivity) advantage is highest. The last captures the fact that fixed costs for the design of new specialized products need to be paid for only once, but can be sold in the entire (integrated) market. While all regions share the gains from the last two effects, the reallocation of factors might create losses for regions where factors are scarce. Ventura (2005) points out that the entry of large regions in the integrated economy might generate losses for countries with similar factor proportions because that region absorbs scarce factors. Consequently, trade liberalization in China or India might create negative externalities for economies with similar factor proportions in Latin America or Eastern Europe.[14] Nevertheless, it can be shown that an economic integration of the world economy leads

[13]See Ventura (2005) for a unified approach to demonstrate these gains from trade under several market imperfections.

[14]Contrary, gains from trade are larger for countries with different factor shares like the USA or EU.

to a Pareto-improvement for all countries if it is coupled with an appropriate (intraregional) transfer scheme. The author infers a general prescription for development: "open up and integrate in the world economy."

The translation of static into dynamic gains depends on the scope of diminishing returns and market size effects. Ventura (2005) illustrates that economic integration features only level but not growth effects if diminishing returns to capital, which is the only state variable, are strong and market size effects are weak. Contrary, the framework results in persistent growth effects due to increasing/constant returns to capital if diminishing returns are weak relative to market size effects. Moreover, the author analyzes the consequences of several impediments to international trade. He shows that the gains from economic integration can be sustained completely if we exclusively allow for trade in goods and not factors as long as the factor price equalization (FPE) holds – e.g., differences in factor proportions across regions are small relative to differences in factor proportions across industries. In addition, he characterizes the dynamics of the world income distribution accounting for deviations from FPE due to extreme factor proportions across regions, the existence of regions with insufficient high-productivity industries or the presence of transport costs (gradual globalization). In many cases, these deviations generate additional forces towards the stability of the world income distribution due to supplementary mechanics in favor of diminishing returns and the general prescription for development of "opening up and integrate in the world economy" is sustained.[15]

However, the dynamics described above exclusively focus on the evolution of the private capital stock over time. That is, the capital stock, possibly embedding technical knowledge, is the only state variable of the system. Yet, a complementary strand of the literature on trade and growth emphasizes the existence of dynamic gains from trade via transfers of embedded technologies.[16] Growth models of endogenous technical change provide a natural framework to study the effect of trade (in intermediates) on the incentives to innovate.[17] In this context, Rivera-Batiz and Romer (1991) study the effect of a liberalization of trade in goods in a symmetric two-country model. In this case, opening up to free trade does not imply permanent effects on the incentives to innovate (and hence growth) if the diffusion of knowledge is intra-national in scope. The reason is that the benefits as well as the (labor) costs of R&D increase by the same amount. Yet, Devereux and Lapham (1994) show that the outcome is different in the asymmetric case because the initially richer country carries out all research in equilibrium while the incentive to innovate is eliminated forever in the poorer one. Thus, the former specializes in

[15] An exception is the friction of transport costs that apply only to intermediate goods. These entail potentially agglomeration effects across regions.

[16] To capture these dynamics formally, one needs to introduce the stock of technologies as an additional, independent state variable.

[17] Grossman and Helpman (1995) provide a comprehensive survey of the early literature on trade and technology.

research and the latter in manufacturing which augments the overall resources devoted to research in the richer country and the welfare in both countries (equally). In contrast, the rate of technical change and hence long-run growth increases in both cases if technology diffusion is international in scope. This results directly from the public good characteristics of knowledge – the combined stock of knowledge/technologies exerts a higher externality on future research. A more empirically founded framework provides *product cycle models* which are based on the observation that new goods are invented in the *North* while the *South* imitates vintage goods.[18] Helpman (1993) analyzes the effect of IPR in this framework. He demonstrates that tighter IPRs do not necessarily improve the rate of innovation in the *North*, but unambiguously reduce the rate of imitation (and hence convergence) in the *South*. Finally, Acemoglu and Zilibotti (2001) argue that in the presence of skill-biased technical change as discussed above, the *South* has an incentive to protect IPRs in order to attract more suitable innovations.[19] It follows that a combination of trade opening and weak protection of IPRs in the *South* can impede their rate of growth (in the absence of FPE) as outlined by Gancia (2003). The discussion shows that the role of IPRs in innovation and growth is not obvious and that the dynamics between trade and growth (at least quantitatively) depend on the strength of international technology diffusion.[20]

A number of empirical studies verify the global dimension of technology spillovers. Yet, the diffusion process is far from perfect. Keller (2002a) finds that the geographic distance is an important determinant of the diffusion of technologies between countries.[21] Indeed, a number of studies also demonstrate the importance of international trade flows in order to explain spillovers of technologies. Thus, trade itself provides a mechanism for international technology diffusion. Coe and Helpman (1995) apply a cointegration analysis to investigate the effect of domestic and foreign R&D on domestic TFP. The econometric framework seems appropriate since conventional tests indicate the presence of a unit root for both variables. In particular, they estimate the following specification for 22 OECD countries:

$$\ln f_{ct} = \alpha_c + \beta^d lnS_{ct} + \beta^f lnS^f_{ct} + \varepsilon_{\mathrm{ct}} \tag{2}$$

[18]Hence, these models suppose a slow diffusion of technologies across advanced and less developed countries.

[19]One might conclude that trade openness increases international income differences by aggravating the skill-biased in technologies in this case. Yet, general statements are difficult since they depend on the equalization of factor prices (FPE) across countries which in turn depend on factor compositions, the productivity of industries, etc.

[20]Again, we stress that the impact of trade on growth is in general positive if FPE holds. If not, as is often the case in reality (compare wages across countries), Grossman and Helpman (1995) illustrate that opening up to trade can reduce economic growth in certain circumstances.

[21]He also isolates common languages as an important component. This hints at a role of cultural factors (similarity) in the identification of global knowledge spillovers.

where S^f_{ct} is defined as the bilateral import-share weighted R&D stocks of the trade partners. The authors find large positive effects from import-weighted foreign R&D (β^f). Coe and Hoffmaister (1997) generalize these findings for a larger set of 77 advanced and developed countries. Keller (1998) relativizes these findings by demonstrating that the import shares in the construction of the foreign R&D variable are not essential to achieve their result. Yet, Keller (2002b) detects significant spillovers from foreign R&D to TFP via international trade using industry data for thirteen industries and eight countries. Overall, the impacts of foreign R&D from the same and different industries amount for 20% of the overall spillovers. Xu and Wang (1999) and Caselli and Coleman (2004) refine the link between trade and technology spillovers by focusing on trade in differentiated intermediate capital goods. The estimates for the effects of foreign R&D for domestic productivity increase in this case. Eaton and Kortum (2002) impose a more structural approach to estimate the importance of international trade for the transmission of technologies. They embed a Ricardian model of trade in an endogenous Schumpetarian growth model of quality improving innovations. Based on a cross-section of 19 OECD countries, the authors find that an improvement in a country's technology raises the welfare of all other countries. Finally, Clerides et al. (1998) and Bernard and Jensen (1999) reject the hypothesis that exports of goods influence firm-level learning effects using case studies of three developing countries and the US respectively.

The interrelations between trade and technological progress also provide a potential basis for trade policies. Note that the type of models outlined above imply two different sources of market imperfections: (a) a positive non-internalized externality of technologies on future research and (b) market power in the intermediate goods sector. Grossman and Helpman (1995) demonstrate that trade policies as well as industrial policies in general can lead to second-best welfare benefits. Still, they stress that universal policy prescriptions are far from obvious due to complex general equilibrium effects. The authors consider an example in which the success of a tariff on an import-competing sector to foster innovations depends on whether the favored sector is a complement or substitute for the R&D sector in the general equilibrium production structure. That is, if the favored sector requires the same input factor (e.g., skilled labor), the equilibrium costs of this factor rise and R&D declines. However, some empirical case studies support the view that a mixture of active trade and industrial policies can enhance innovation and growth. In this regard, Rodrik (2005) describes the successful policy mix of tariff protection for traditional industries and export subsidies for innovative sectors in South Korea or Taiwan. We will discuss some of these aspects in greater detail in the section on industrial policy.

Finally, Baldwin and Forslid (2000) argue that trade liberalization influences the market structure in the R&D sector. More specifically, they illustrate that reductions in transport costs (a) reduce the value of intermediate firms by increased competition in R&D and (b) improve financial intermediation by promoting asset trade. Both effects improve the incentives to invest in R&D in their framework.

Foreign Direct Investment

FDI provide an additional potential transmission channel for the diffusion of technologies. The link is plausible since the sharing of knowledge among multinational parents and subsidiaries represents a natural channel through which technology can diffuse internationally. Moreover, foreign investors typically need to standardize their production process to local environments which facilitates the local adoption of technologies. In this regard, FDI appears to be superior to trade in order to convey technology spillovers.

In general, a potential foreign investor has a choice between direct investments and the licensing of a technology to a foreign firms. The latter approach prevents the operation in an unfamiliar business environment, but comes at the cost of moral hazard and the reliance on contract enforcements which seem to be severe in an international context. Indeed, Fig. 14.8 suggests that most technology spillovers are due to indirect spillovers. Additionally, Figs. 14.9 and 14.10 illustrate that FDI of the USA (the technological leader) as well as in the USA increases significantly during the 1990s respectively. Hence, we focus our analysis on FDI.

Grossman and Helpman (1995) emphasize two crucial theoretical aspects of the role of technologies in FDI. First, investors need to enter the market with superior technologies in order to be in a position to compete with locally owned firms in an unfamiliar business environment. Second, R&D is the type of firm level fixed costs that generates economies of scale and hence incentives for FDI. Thus, technological progress boosts the incentives for FDI of the investor and the host country which hopes for larger productivity spillovers. In this regard, FDI is also a major policy issue. Keller (2004) denotes that governments spend large amounts of resources to attract FDI.[22]

The empirical evidence, however, is not that clear-cut. Recent surveys based on micro-level productivity studies concluded that there is no evidence for productivity spillover via FDI [Hanson (2001), Goerg and Greenaway (2002)]. Aitken and Harrison (1999) confirms these results in a case study for Venezuela. Yet, the case studies of Larrain et al. (2000) and Liang (2003) report tremendous knowledge spillovers from Intel's investments in Costa Rica and FDI for Chinese telecommunication firms, respectively. Branstetter (2001) and Singh (2003) exploit data on patent citations to investigate knowledge spillovers of FDI. The former detects positive spillovers from the investor to the host country for Japanese FDI in the USA as well as the other way around. The latter author even finds that foreign subsidiaries learn more from firms in the host country than vice versa for a panel of ten OECD countries. These results are somewhat surprising. Yet, Keller (2004) underlines that they might be due to an endogeneity problem. Still, a number of studies provide robust empirical evidence in favor of technology transfers to the

[22]The US state of Alabama spent $230 million in 1994 to attract a new plant of Mercedes Benz. Likewise, the German state of Saxony spent a similar amount to attract a new plant of AMD in 2004.

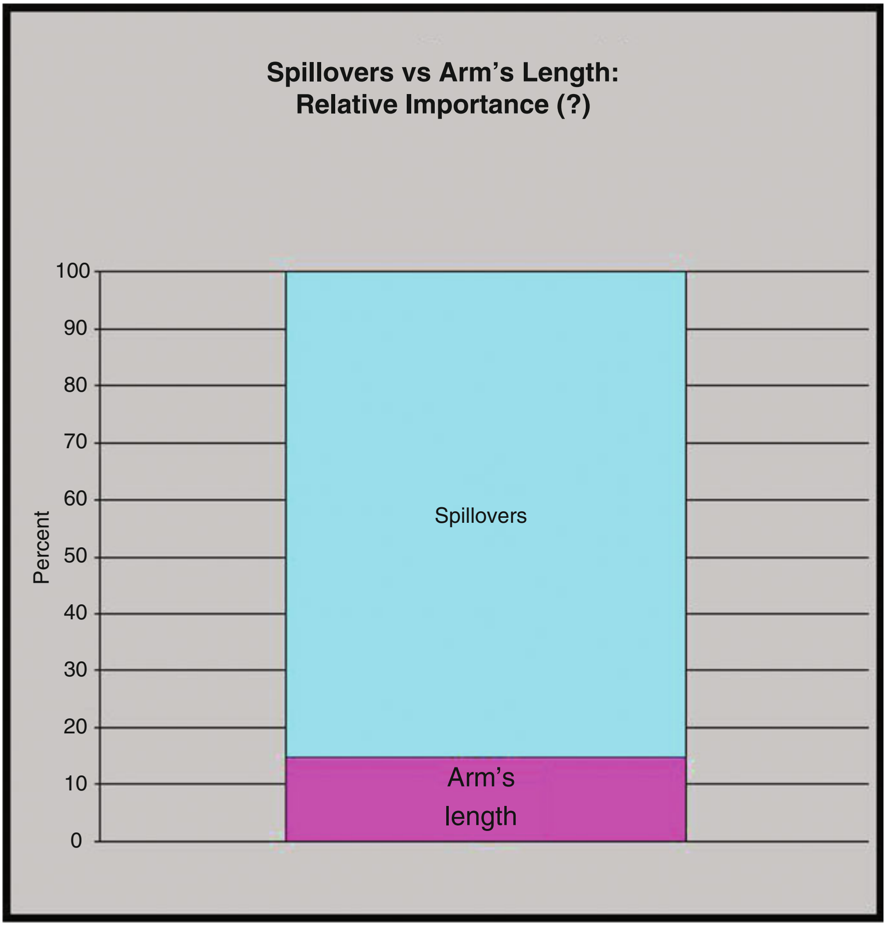

Fig. 14.8 Spillovers vs. arm's length technology licensing
Source: Keller (2004)

host country focusing on a more direct approach, e.g., Xu (2000), Griffith et al. (2003), Keller and Yeaple (2003). These studies, based on FDI-data for the US or UK, find that productivity growth in the host country is systematically higher in industries with more FDI. In particular, Keller and Yeaple (2003) estimate large quantitative effects in high-technology compared to low-technology sectors. Consequently, there exists various positive as well as negative evidence in favor of technology spillovers from FDI, whereas, apart from methodological issues, the difference depends on the country under study.[23]

[23]Note that the results are spurious if additional effects of FDI are not accounted for. For example, Aitken and Harrison (1999) do not control for the effects of FDI on the market structure in Venezuela.

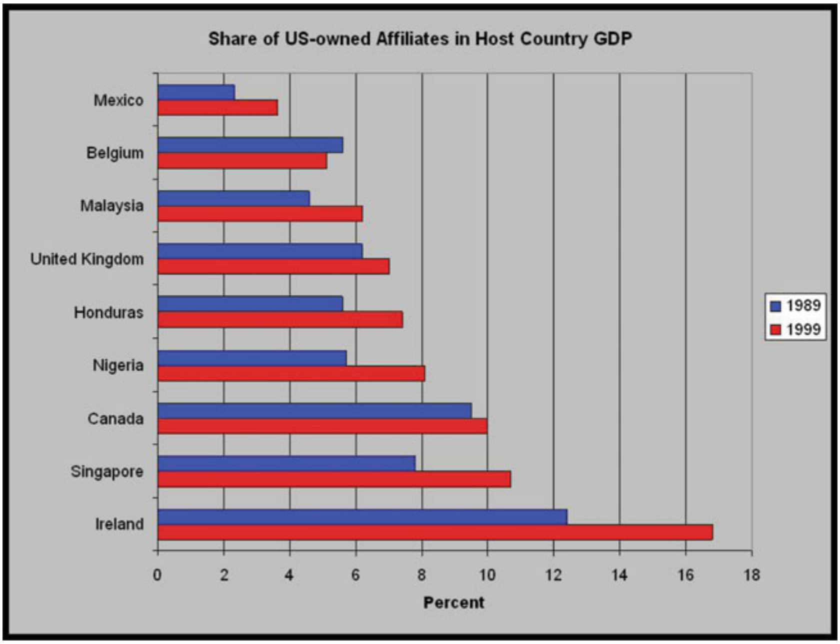

Fig. 14.9 Share of US-owned affiliates in host country
Source: Keller (2004)

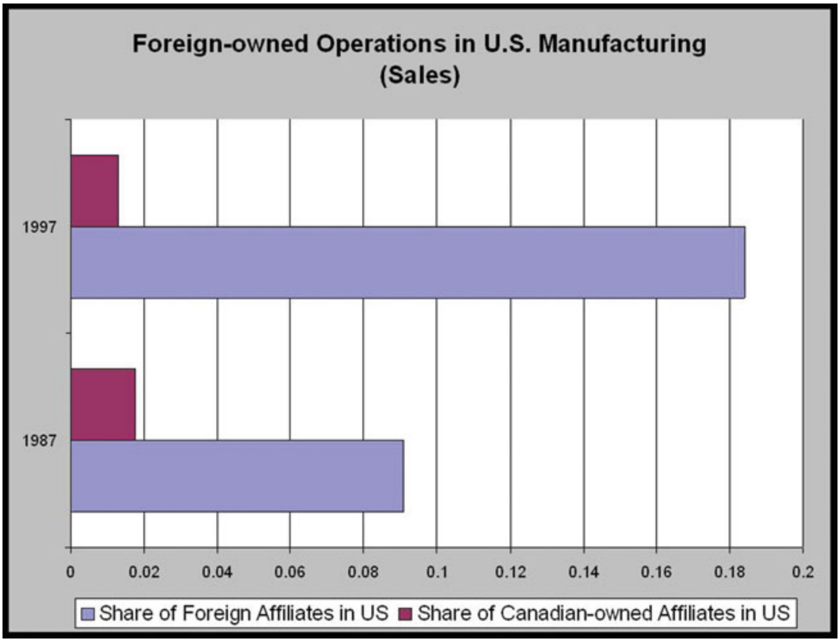

Fig. 14.10 Foreign-owned affiliates in the USA
Source: Keller (2004)

We will see in the following that theory can reconcile the conflicting empirical evidence in a number of ways. Rodriguez-Clare (1996) employs a static equilibrium model where productivity effects arise via the provision of high-quality intermediate inputs. He highlights a tradeoff for the host country: FDI increases the demand for intermediate goods and services of local suppliers while it suppresses local competitors (reducing the demand for local intermediates). Whether the net demand effect is positive depends on transportation costs and initial productivity differences in the model. Thus, the approach predicts that the productivity effect of FDI differs according to country-specific conditions.[24] Fosfuri et al. (2001) concentrate productivity spillovers through labor training and turnover in the host country to justify FDI-spillovers. Indeed, Larrain et al. (2000) outline that Intel funded schools that taught local workers in Costa Rica. Several contributions suggest a number of additional factors that influence the existence of productivity spillovers from FDI. Blomstrm and Kokko (1998) and Peri and Urban (2006) emphasize the pivotal role of the absorptive capacity of the host country or the productivity gap between the home and the host country. That is, spillovers are larger if the technology gap is tighter which can be justified, e.g., due to skill-biased technologies. The absorptive capacity usually refers to factors like the quality of institutions, human capital, regulations etc. These findings are analog to the ones of imitator–innovator models described earlier. Antras and Helpman (2004) and Antras (2005) point out that technology transfers also depend crucially on the strategic decisions of the investor. The foreign investor might want to outsource or externalize a certain degree of knowledge to foreign affiliates or partners depending on firm-strategic considerations.

This approach discloses the possibility for a number of supplementary determinants of technology spillovers from FDI. For example, the firm's entry-strategy into the foreign market might change with the initial market structure in the host country. That is, the investor might prefer to enter the market with a more sophisticated production technology to escape from competition if the market structure in the host country is competitive.[25] In fact, Liang (2003) underlines the importance of this escape-competition effect for FDI in the Chinese telecommunication sector. Finally, Eichgreen and Tong (2005) and Mercereau (2005) explore the competition of host countries in order to attract potential foreign investors, e.g., arising from the entry of new players like China or India. Summing up, the success of FDI for the host country depends on a number of complementary factors that pin down the probability for technology spillovers. Even though the literature examines some mechanisms for FDI-spillovers, substantial further research needs to be done in order to isolate the key determinants of empirical differences across countries, in particular with respect to supportive policy measures. In this regard, Grossman and Helpman (1995, p 66) conclude: "[to identify determinants of technology

[24]Note however, that the author totaly abstracts from the possibility of long-run learning effects of firms in the host-country.

[25]This effect is suggested by Aghion and Howitt (2005) in a different framework.

transfers] ... we will need models that pay closer attention to how knowledge is transmitted within and between firms."

Infrastructure

A brief comparison of power generating capacities, telecommunication and transportation equipments across countries suggest immediately a close connection between the provision of infrastructure and a country's past economic performance. A substantial amount of empirical work confirms this correlation between infrastructure investments and economic growth across time (within a panel of countries).[26] In fact, the prediction of a net positive growth effect of infrastructure investments constitutes a powerful growth strategy since policymakers exhibit direct control over infrastructure investments/subsidies. Yet, it is not surprising that episodes of high growth and economic activity comply with episodes of high expenditures for (public) infrastructure. Thus, the main empirical challenge is the identification of *cause and effects* between infrastructure investments and GDP-growth.

Indeed, several recent empirical contributions report a positive causal relation for different regions and time periods. Fernald (1999) shows that the rise in road services substantially increased the productivity (TFP) across industry in the USA from 1953 to 1973.[27] The author employs an implicit test for endogeneity by showing that productivity growth is above average in vehicle intensive industries. Roeller and Waverman (2001) formulate a structural model for the supply and demand of telecommunication infrastructure to separate cause and effects on aggregate production.[28] They find large positive effects of telecommunication investments on economic growth in a panel of 21 OECD countries from 1970 to 1990. Belaid (2004) confirms the results for a panel of 37 developing countries from 1985 to 2000. Finally, Caldern and Servn (2005) apply an (internal) instrumental variables approach to estimate a positive causal effect of different infrastructure measures on GDP-growth in a panel of 121 countries from 1960 to 2000. Besides, several empirical studies employ firm-level data on business costs to investigate the exact microeconomic functioning of infrastructure capital. In this regard, Holtz-Eakin and Schwartz (1994) and Morrison and Schwartz (1996) find robust empirical evidence for a negative relation between firm-level business costs and the provision of infrastructure capital in the economy. Moreover, Bougheas et al. (2000) detect a positive relation between infrastructure capital and the degree of specialization in

[26]Gramlich (1994) or Holtz-Eakin and Schwartz (1994) survey the early literature.

[27]He measures a rate of return of 100% before 1973 and a negative rate from 1973 to 1989. To put it in the words of Fernald (1999): "the interstate highway system was very productive, but a second one would not be."

[28]The identification of cause and effects crucially hinges on the specification of demand and supply functions and congruence of price elasticities across the OECD countries.

intermediate production for the US economy. The empirical evidence refers to a quite heterogenous set of countries, time periods, or infrastructure variables. The impact on growth appears to be substantial in advanced as well as developing countries for certain periods.[29]

Most of the theoretical literature suggests that the provision of infrastructure affects economic growth boosting private capital investments. This literature is substantially influenced by the work of Barro (1990) who incorporates productive public capital in an extended two sector *AK-growth model*. He assumes a (Cobb-Douglas) production function featuring constant returns to scale for the combination of private and infrastructure capital. Thus, he implicitly supposes that (broader) capital accumulation, which is studied by neoclassical theory, and technological knowledge, which is necessary to counteract diminishing returns, are one and the same. It follows that infrastructure or private capital investments feature not only level but also growth effects in the long-run. Yet, the growth effect of infrastructure is limited due to a financing by distortional taxes. Consequently, the author can derive an optimal level of infrastructure capital. In the literature this finding is referred to as the *Barro Curve*. It predicts that high saving rates and efficient tax systems sustain high economic growth. This approach has been generalized in several ways since – Turnovsky (1997) accounts for public capital which is subject to congestion, Kosempel (2004) for the case of finitely lived households, Turnovsky (2000) for an elastic labor supply and Ghosh and Mourmouras (2002) for an open-economy framework. An alternative approach is followed by Bougheas et al. (2000) who show that infrastructure investments increase an economy's degree of specialization.

The link between infrastructure and private capital accumulation may be appropriate to explain its growth-effect in less developed countries. Yet, it may not be adequate to explain recent growth performance in advanced countries. However, the provision of infrastructure can directly cause investments in R&D and innovations if it reduces costly distortions between the final output sector and a specialized innovative intermediate goods sector. This refinement can be important at least for two reasons: (a) it relates long-run productivity/GDP-growth to the stock of infrastructure capital instead of its growth rate (as in the former literature), and (b) it comprises different policy implications than the existing models which are based on neoclassical inference. That is, policies that influence the efficiency of the R&D sector (higher education, industrial and innovation policy, absorptive capacity), instead of neoclassical policies that influence the saving behavior, determine the growth effect of infrastructure investments. So far, the empirical relation between infrastructure and productivity growth is studied by Fernald (1999), Bougheas et al. (2000) Hulten et al. (2003) who analyze the impact of infrastructure on productivity and product specialization in the USA and India. In fact, as we outlined above,

[29]Roeller and Waverman (2001) and Belaid (2004) quantify similar elasticities of GDP with respect to telephones per worker for advance (0.45) and developing countries (0.5) for similar time periods using identical estimation techniques.

Rodrik (2005) highlights the importance of initial infrastructure investments for TFP-growth in India since 1980. Figure 14.11 displays the TFP-growth and the change in the stock of paved roads (as % of total roads) and railroads in India from 1960 to 2000, which supports the author's view. The same analysis is carried out for China in Fig. 14.12 for the stock of paved roads and telephone mainlines per worker. Finally, Figs. 14.13 and 14.14 illustrate the accelerations of the

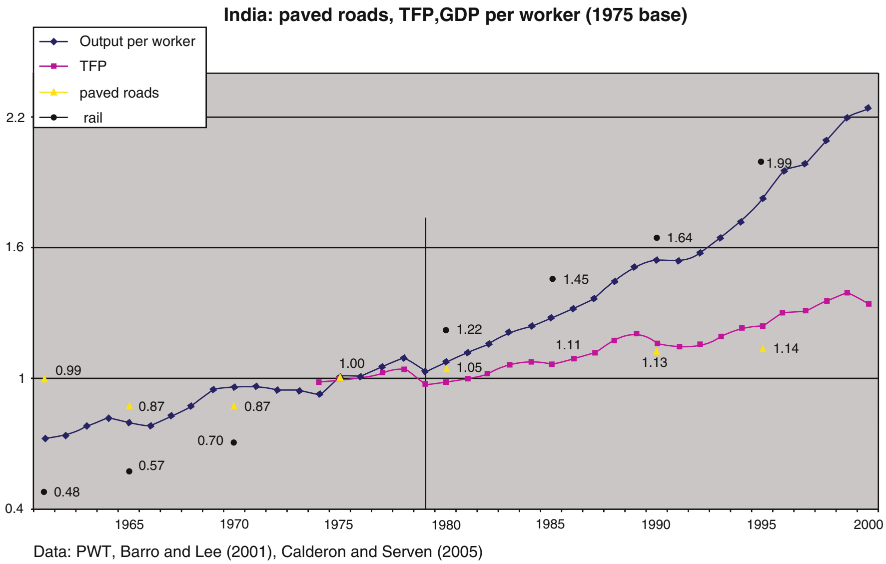

Fig. 14.11 India's "growth-takeoff": The change in infrastructure stocks and TFP-growth – Data: PWT, Barro and Lee (2001), Caldern and Servn (2005)

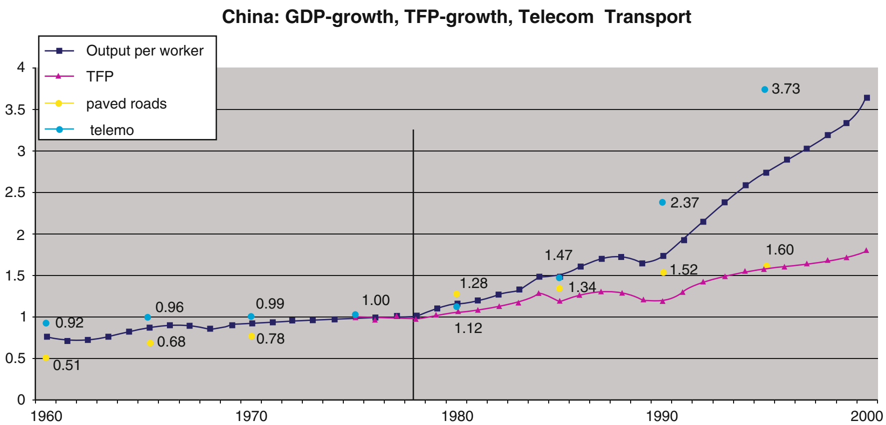

Fig. 14.12 China's "growth-takeoff": The change in infrastructure stocks and TFP-growth – Data: PWT, Barro and Lee (2001), Caldern and Servn (2005)

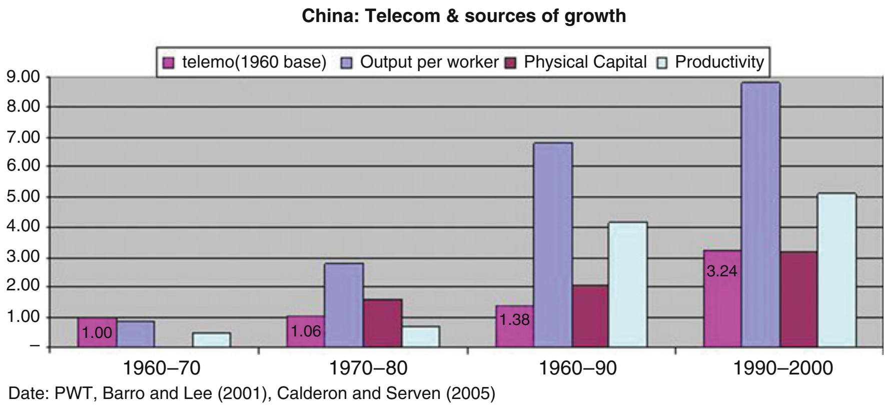

Fig. 14.13 Sources of growth in China — telephones mainlines per worker and TFP – Data: Bosworth and Collins (2003) and Caldern and Servn (2005)

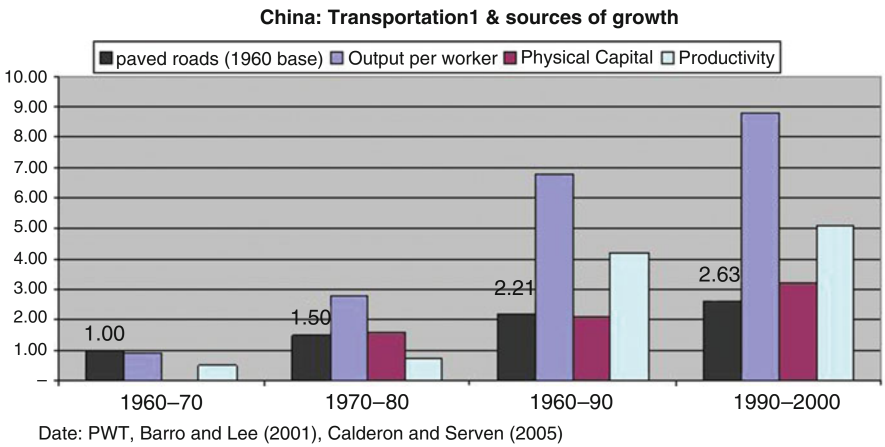

Fig. 14.14 Sources of growth in China — paved roads and TFP – Data: Bosworth and Collins (2003) and Caldern and Servn (2005)

infrastructure stocks and TFP for China from 1960 to 2000. Consequently, the figures suggest that the provision of infrastructure capital is connected to TFP-growth in these two major success stories in terms of economic growth during the last three decades.

Macroeconomic Stability

The appearance of endogenous growth theory challenges the traditional separation of business cycle and growth theory in the earlier literature. Conceptually, the notion of capital in endogenous growth theory is broader, e.g., capturing the accumulation of knowledge. Thus, short-run fluctuations in private capital entail externalities on the stock of knowledge/technologies and hence future investment opportunities and growth. The work of King et al. (1988) represents a prominent example for the integration of growth and business cycle theory. The authors incorporate endogenous growth in a real business cycle model in order to show that temporary shocks can induce permanent effects on output. It follows that national policies can induce long-run growth effects.[30]

The empirical literature has evolved predominantly in two distinct branches that separate the dynamics of low and high frequencies. In contrast, Ramey and Ramey (1995) reveal a negative correlation between the overall volatility and the trend of GDP growth which is robust to the inclusion of the investment share of GDP. They apply cross section and (static) panel estimations for a sample of 92 as well as a subset of 24 OECD countries from 1960 to 1985. In addition, they are not able to find a robust empirical correlation between inflation and the share of aggregate investment. Furthermore, they show that most of the correlation between volatility and growth is due to variations in unexpected innovations to GDP-growth by considering deviations from a forecasting equation. Hence, their results suggest that uncertainty induced by nominal or real innovations links volatility and productivity growth. These findings are confirmed by study of Aghion et al. (2005a). The authors detect a negative causation from (exogenous) commodity price shocks to economic growth. Moreover, they illustrate that commodity price shocks reduce investments in R&D but not overall private investments. Hence, the transmission channel is via productivity growth and not factor accumulation. Several studies analyze the direct impact of certain macro-policies on economic growth. Fisher (1993) focuses on the link between inflation and GDP-growth. He finds a negative empirical relationship between the two employing cross sectional and panel growth regressions for yearly data. The author also investigates the causal mechanism by splitting the sample into two sub-periods of mainly demand (1960–1972) or supply shocks (1973–1988). He argues that adverse supply shocks, which entail periods of high inflation and low growth, are the main source for the endogeneity of inflation, but finds no significant differences between the relation in both periods.[31] Several studies analyze nonlinear effects of inflation on growth.[32] Barro and Lee (1996) apply low frequency

[30]The same causation is predicted by business cycle models with investment irreversibilities; e.g., compare Aizenman and Marion (1993).

[31]The difficulty to identify a causal relation between inflation and growth is a general problem in the literature since appropriate instrumental variables for inflation barely exist. The most promising instrumental variable approach is due to Cukierman et al. (1993) who incorporate measures of central bank independence as instrumental variables and detect negative correlations with economic growth.

[32]Intuitively, nonlinearities are appealing since there exist no economic advantages of excessive inflation. Thus, periods of extreme inflation arguably represent scenarios where authorities lost control over inflation dynamics and are expected to enforce counteracting policies. This reasoning also suggests that the degree of uncertainty is aggravated by the level of inflation.

data (10-year averages) and detect a negative relationship if annual inflation exceeds 20%. Similarly, Bruno and Easterly (1998) exclusively find a strong negative temporary correlation if inflation surpasses a specified value of 40% ("inflation crises"). Sarel (1996) endogenously determines a structural break in the inflation–growth relationship if the former exceeds 8%. Along the same lines, Sepehri and Moshiri (2004) estimate different structural breaks which vary from 5 to 15% depending on a country's stage of economic development. In contrast, Fisher (1993) uses splines, setting breakpoints at 15 and 40%, to test for non-linearities and finds that the negative correlation between inflation and TFP growth is, if anything, larger in low-inflation (OECD-) countries. In summary, most authors report evidence of a stronger negative relation in episodes of high inflation, albeit there exists a striking disagreement as to where that threshold is.

Against this background, Easterly (2005) provides important insights with respect to the interpretation of these results. He underlines that the negative correlation between national policies (inflation, budget balance, real overvaluation, trade openness, and black market premium) and growth crucially depends on inflation-outliers, which represent episodes of low institutional quality. In particular, he illustrates that the explanatory power of national policies disappears if one controls for institutional measures such as geographic and ethno-linguistic variables.[33]

Fisher (1993) stresses three potential theoretical mechanisms to justify a link between inflation and growth: (a) a reduction in productivity growth because of distortions in the informational content of the price level due to aggregate uncertainty, (b) a reduction in capital accumulation stemming from temporary hold up of investment decisions in the presence of aggregate uncertainty, and (c) inflation tax on returns from capital and R&D investment if investors must hold cash-in-advance. Aghion et al. (2005a) provide an alternative explanation. They show that volatility influences the composition of private investments. More specific, they distinguish between more productive but risky investments from secure but return-dominated ones. It follows that an increase in the idiosyncratic risk of innovative investments induces a shift of private investments into return-dominated projects if financial markets are incomplete.[34] The investment composition effect provides a potential for national policies to affect innovative activities and hence aggregated TFP- and GDP-growth. That is, macroeconomic stability influences the quality of investments without changing its quantity – private capital accumulation. In this regard, Aghion and Howitt (2005) argue that the study of Easterly (2005) is based on average policies over time and abstracts from the effects of shocks and business cycles. Thus, he ignores the potential mechanism for macro-policies to influence economic growth through stabilizing the economy and improving the ability of producers to smooth out the effects of cycles and shocks. In fact, Aghion

[33]Easterly (2005) estimates cross section as well as dynamic panel growth regressions based on the general method of moments.

[34]In the empirical part, the authors are indeed able to identify a positive interaction term between volatility and financial development so that the negative effect of volatility declines in the degree of financial development.

and Howitt (2005) find that counter-cyclical policies (e.g., primary budget deficit) increase economic growth using annual panel data on 17 OECD countries from 1965 to 2001.[35] The authors distinguish several macro-policies and reveal that counter-cyclical public investments or direct firm subsidies are growth-enhancing while government consumption is not. Summing up, a negative relation between volatility and growth provides a mechanism for a growth-enhancing effect of (stabilizing) macro policies.

Financial Development

The degree of financial development of an economy has long been considered as an engine for economic growth and development. The theoretical literature provides several explanations that support this view. Acemolgu and Zilibotti (1997) emphasize that the possibility to diversify investment projects improves the investment opportunity of firms. They assume that more productive investments are also riskier. Thus, the lower the opportunities for risk-sharing activities, the slower is the accumulation of capital. In addition, their model predicts that the uncertainty of a country's growth process is linked to its degree of financial development. That is, shocks impede economic growth when risk-sharing opportunities are low. However, in the absence of larger shocks, growth and in turn better financial institutions can still develop in these countries. It follows that "luck" determines to a certain extent the path of economic development in their world.[36] Among others, King and Levine (1993a) and Aghion et al. (2005a) formalize that the quality of private investments is related to the outside financing opportunities. Thus, financial intermediation promotes innovative activities and hence economic growth.

While most economists would agree that financial development is good for growth, there exist several alternative financial systems. Financial intermediation may be based on stock markets or credits. Numerous contributions to the literature from different backgrounds analyze implications of competing financial systems. The development of imitator–innovator growth models and the formalization of the process of technology adoption adds a new dimension to think about competing financial systems. That is, a market based system may be more adequate to finance investments in technologically developed, R&D based countries since stock markets are more appropriate to monitor the quality of products. However, producers in technologically backward countries need to adopt/imitate foreign technologies in order to compete in the world market. This learning process takes time and delays the "break-even" of investments. Moreover, firms in less developed countries do

[35]The set of countries exhibits sound institutions so that Easterly would have predicted no policy effect. In addition, Aghion and Howitt (2005) illustrate that the effect declines in the degree of financial development of an economy (negative interaction term).

[36]The fact that the variability of economic growth is higher in less developed economies is well documented by economic historians.

often not dispose of internal financing sources (to finance riskier projects in the presence of incomplete financial markets). Therefore, a financial system based on long-term relations between producers and investors may be more adequate. This reasoning already dates back to Gerschenkron (1962). It is an application of the idea that different stages of development require different institutions (appropriate institutions) which is outlined above.

There exists robust empirical evidence on the positive impact of financial development on long-run growth, e.g., King and Levine (1993b), Levine (1997). The degree of financial development is typically approximated by the amount of liquid liabilities, the amount of private credit relative to GDP or the value of private banks relative to central banks assets. These studies apply dynamic panel estimations based on a large number of advanced as well as less developed countries, whereby the heterogeneous sample is important to ensure the validity of the financial proxies. Levine et al. (2000b) apply an instrumental variable approach to identify a causal relation running from the degree of financial intermediation to economic growth. Moreover, they show that differences in financial development across countries can be explained by differences in legal and accounting systems. Benhabid and Spiegel (2000) and Levine et al. (2000a) investigate whether the link between financial development and growth is due to improvements in private factor accumulations or productivity (TFP). The former detect positive evidence in favor of both transmission channels while the latter find larger (more robust) effects in favor of TFP-growth.

Industrial and Innovation Policy

Endogenous growth models are based on the assumption that current R&D entails a positive externality on future research. Likewise, most approaches account for the existence of monopoly rents from innovations that justify investments in R&D.[37] These market imperfections lead to inefficiencies in the decentralized equilibrium allocations which imply a potential role for public policies to influence innovations and growth. The general equilibrium welfare effects of such policies, however, may not be obvious ex ante as is underlined by Grossman and Helpman (1995). For example, an export subsidy in favor of a manufacturing sector, which is intensive in unskilled labor, induces a rise the equilibrium wage and hence a decline in the return to skilled labor in manufacturing. This enhances innovations since the R&D sector absorbs some of the released human capital from the manufacturing sector. Still, the equilibrium welfare effect also depends on the resulting change in the output of the intermediate sector. Grossman and Helpman (1995) also stress that innovation policies may have an international transmission effect. For example, a

[37] Hellwig and Irmen (2001) illustrate that endogenous technical change is still possible under perfect competition.

permanent subsidy for R&D in one country might reduce R&D investments of the trade partner by raising the costs of human capital in both countries via the equalization of factor prices. In the following, we analyze the equilibrium effects of policies that influence both sources of inefficiency: (a) the market structure in the intermediate sector and (b) direct subsidies to R&D.

The standard model of endogenous technological change following Romer (1990) or Aghion and Howitt (1992) implies that an increase in product market competition between intermediate producers reduces expected future profits from innovations and hence the rate of technical change ("rent dissipation effect"). In addition, more intense competition lowers the expected durability of new innovations ("creative destruction") and hence the incentives to innovate in the quality ladder model à la Aghion and Howitt (1992). In contrast, Aghion et al. (2001) extend the basic framework to incorporate an escape competition effect. They consider an oligopolistic intermediate sector where innovation enables a firm to break away from intense competition for a certain period of time. It follows that an increase in product market competition involves an innovation-tradeoff: It reduces the static gains from imperfect competition, but enhances the incentive to innovate in order to escape from competition. The authors show that the first effect dominates if the oligopolistic firms are close technological rivals ("neck-and-neck"), while the second outweighs when one firm has a large technological lead. This results in an inverted U-relationship between the incentives to innovate and the intensity of product market competition. Again, this finding demonstrates the appropriateness of different policies in different stages of economic development: little competition does not impede growth when firms are far from the world technology frontier, but matters if they catch up and compete with leading edge innovators.

Most empirical evidence suggests a positive relation between the degree of product market competition and (productivity) growth. Nickell (1996) applies several measures to approximate competition using firm level panel data of 147 stock market listed firms in the UK from 1975 to 1986. He detects a positive relation between TFP (-growth) and import penetration and a negative relation with higher concentration rates or higher rents. Blundell et al. (1999) reveal similar results from dynamic panel estimations of 340 UK-firms from 1972 to 1982. They find that less competitive industries induce fewer aggregate innovations using the SPRU innovation data set to approximate innovations and concentration or import penetration data to approximate competition across sectors. Yet, they estimate a positive correlation between the market share and innovations within industries. Finally, Aghion et al. (2005c) provide positive empirical evidence in favor of the inverted U-relationship between patent rates and product market competition in a panel of manufacturing firms from 1973 to 1992.[38]

[38]The authors measure the degree of competition by the Lerner-index as well as exogenous policy reforms. The degree of technical neck-and-neckness between firms is measured by the distance of a firm's TFP from the technology frontier.

Aghion and Howitt (2005) formalize a similar positive relation between technical change and entry, exit or turnover rates. They illustrate that this link not only results from direct innovations of new entrants but also from an escape entry effect. Likewise the escape competition effect, the threat of potential entrants augments the incumbents incentives to innovate. Again, the model implies that the escape entry effect is stronger if a firm is closer to the technology frontier. Aghion et al. (2005d) provide positive empirical evidence in favor of this hypothesis. In addition, Nicoletti and Scarpetta (2003) detect that productivity differences between Europe and the US can be explained by higher entry costs and a lower degree of turnover in Europe. Aghion et al. (2005e) analyze the effect of entry deregulation in less developed countries. They employ panel data for Indian firms from 1980 to 1997 and find that policy reforms have no influence on GDP-growth. Yet, the interaction term between entry deregulations and labor market regulations is positive which implies that entry affects growth in industries with less restrictive labor markets.[39]

In the original Romer (1990) model public subsidies for R&D enhance the rate of technical change. However, common wisdom suggests that there exist some natural limits for this growth-channel. In fact, Jones (1995) pinpoints that the number of resources devoted to R&D grew exponentially in advanced countries since 1950without shifting the trend in growth. Therefore, Jones (1995) and Segerstrom (1998) introduce so called semi-endogenous growth models to match these empirical facts. In this class of models, long-run growth (in the stock of knowledge) can only be sustained if the level of R&D resources (the labor force) rises accordingly. It follows that R&D subsidies have no impact on long-run technical change and hence growth. Yet, Howitt (1999) extends the framework to show that long-run growth effects of R&D subsidies are still sustainable.[40] Finally, Segertrom (2000) generalizes the approach of Howitt (2000) and isolates a tradeoff in public R&D subsidies for innovation and growth. He also distinguishes between vertical and horizontal R&D, whereas the former reflects improvements in the quality of existing products and the latter increases the number of intermediate goods (industries) in the economy.

In addition, he assumes that the complexity of new innovations (need for resources) increases with the stock of knowledge. Thus, more resources (labor) must be devoted to R&D over time in order to sustain the rate of innovations. Segertrom (2000) shows that under these conditions R&D subsidies can never permanently increase horizontal and vertical innovation rates because they do not affect population growth (the resource pool). However, it is still possible that subsidies in favor of either the qualitative or the quantitative dimension impact on overall innovations and growth if the parameter constellation is such that one innovation channel is stronger. He highlights that in general one channel will be

[39]For positive evidence in favor of a positive relation between innovations and exit deregulations or turnover rates see Comin and Mulani (2005) and Fogel et al. (2005), respectively.

[40]He allows for horizontal and vertical R&D and links economic growth to the growth rate (not the level) of the population. His model is also in line with the Jones (1995) facts.

stronger so that onesided R&D subsidies might either promote or impede economic growth depending on the parameter values in both research sectors.[41] This study can explain the ambiguous empirical cross-country evidence of public R&D subsidies and demonstrates that policymakers may need some detailed knowledge about the bottlenecks of different research channels in their economy. Likewise, Nelson and Romer (1996) distinguish basic research by universities from practical innovations by industries. However, they assume that un-internalized social returns to R&D are so large that advanced countries still under-invest in R&D. More specifically, Nelson and Romer (1996) presume that basic research provides the pool for practical innovators to invent new products. In this regard, they stress that extreme onesided government subsidies might not be effective, in particular, when they involve a reduction in the budgets for the other type.

Potential Directions for Future Research

The literature review underlines that public policies can influence innovations and growth in various ways. Yet, it also demonstrates that policy effects are often far from obvious ex ante. Instead, some detailed knowledge of the stage of developments or country-specific characteristics are necessary to achieve the desired outcomes. Still, the empirical growth literature provides multiple examples for public policies which have promoted technological catch-up and sustainable growth. In the following, we use the recent theoretical insights outlined above to develop verifiable hypotheses that help to gain insights into how and which public policies are appropriate to foster innovation and growth.

The literature on human capital and growth suggests that the level of human capital is a key input factor for R&D and the diffusion of knowledge (see above). Benhabib and Spiegel (1994, 2002) provide some empirical evidence in favor of this hypothesis based on educational measures. In contrast, Krueger and Lindahl (2001) do not find evidence for the R&D externality of human capital based on educational measures in a sub-set of OECD countries. We discussed above that more appropriate measures of human capital are available, which are based on qualitative test scores of the labor force. These have not been related to the diffusion of knowledge and technological catch up to test the Benhabib and Spiegel (1994) hypothesis, yet. A positive relation between human capital and the diffusion of knowledge on a macroeconomic level does still not explain how the knowledge is transferred between agents or firms. The literature underlines the importance of local complementarities between human capital (and R&D). If technologies are directly transmitted via agents, the (global) mobility of labor affects regional stocks of knowledge/technologies. It follows that regional/national brain gain policies provide an important policy tool to foster innovations and regional development.

[41]The two research channels may be interpreted as basic research (horizontal) and learning-by-doing (vertical).

This hypothesis can be tested via surveys from corresponding agents. Recent work of Aghion and Howitt (2005) suggests that tertiary education is more important for advanced (innovating) countries, while primary and secondary education is crucial for less developed (imitating) regions. Aghion et al. (2005b) test this hypothesis in an international perspective employing a panel of 22 OECD countries. Their positive evidence is not robust to the inclusion of country fixed effects. It is straightforward to test this hypothesis for a larger set of more heterogeneous countries. In fact, the inclusion of non-OECD countries appears to be crucial to test for the importance of basic education for the adoption of foreign technologies.

Apart from the static gains of trade liberalizations, the literature emphasizes the dynamic gains from the diffusion of technologies via trade in goods. It follows that the technological progress of the trade partners impacts on the potential scope for technology spillovers. Indeed, a number of empirical studies affirm this hypothesis. These studies apply macro- and industry-level data from advanced countries. In fact, the evidence in favor of this mechanism is more robust for industry data, see Keller (2002b). This underlines the importance of microeconomic data to test the hypothesis.

The literature provides ambiguous empirical evidence for the hypothesis that FDI creates growth-enhancing technology spillovers for the host country. Most studies focus on advanced countries and the few case studies for transition countries yield conflicting empirical evidence (Venezuela vs. Costa Rica, China). Theoretical models suggest that the link between FDI and growth depends crucially on the absorptive capacity of the host country and the investment strategy of the foreign investor. Thus, future research on the link between FDI and growth needs to isolate the empirical relevance of such complementary factors. The identification of the determinants of productivity spillovers from FDI helps to understand the ambiguous empirical results across regions. Moreover, it enables policymakers to create an optimal economic environment (e.g., legislation, joint ventures) that maximizes the gains from FDI for the host country.

Empirical studies illustrate that innovative infrastructure investments enhance economic growth. The theoretical and empirical contributions focus on private factor accumulation as the relevant growth-channel. However, there are good reasons to suppose that the provision of infrastructure capital also directly affects a country's rate of technical progress. First, telecommunication and transportation infrastructure facilitate the use of various different specialized intermediate goods in the production process and hence reduce the costs to use specialized innovative inputs. This in turn increases the demand for innovative inputs which spurs investments in new technologies. Second, the provision of telecommunication infrastructure might directly increase the efficiency of R&D by facilitating the flow of knowledge.

The distinction between the effect of infrastructure capital on capital accumulation and R&D involves crucial policy implications (e.g., the importance of complementary investments in higher education or innovation policy). Moreover, the framework can be extended to examine the hypothesis that the provision of infrastructure capital in less developed countries improves their ability to catch-up with the world technology frontier (absorptive capacity).

The classical dichotomy between the short- and long-run limits the long-run growth-impact of macroeconomic policies right from the start. However, endogenous growth theory provides a channel for short-run fluctuations to influence long-run growth. Thus, macro-policies that smooth the short-run variability of output augment long-run growth. Indeed, this view is supported by recent empirical studies. The investment composition effect, outlined above, suggests that the link is due to productivity effects instead of factor accumulation. Therefore, it is crucial to investigate if macroeconomic volatility impedes innovation and hence growth.

The literature provides theoretical and empirical support that financial development boosts innovation and growth. Still, financial development can be linked to different financial systems. Gerschenkron (1962) already argues that long-run relations between producers and financial investors (e.g., credit-based) might be more effective in technologically backward countries, while market-based might be preferable in advanced economies. It is important to explore this hypothesis empirically to better understand the role of financial development at different stages of economic development.

The framework of Aghion et al. (2001) and Aghion et al. (2005c) implies a tradeoff in product market competition for innovation, whereas the positive effect dominates if the firm is closer to the (world) technology frontier. This non-linearity in the relation between competition and growth involves that the effect of product market regulations (industrial policy) depends on the stage of development of a country. It might very well be the case that excessive product market deregulations impede economic growth in transition countries, but promote growth in advanced countries (EU). The effects must be analyzed separately in different countries since most of the existing empirical evidence stems from advanced countries (US, UK).

The emergence of R&D based growth models induced lively political and academic debates as to whether R&D subsidies can boost innovation and growth. Recent endogenous growth theory provides conflicting predictions depending on the application of endogenous or so called semi-endogenous growth models (see above). Cross-country empirical evidence based on macro-data also yields ambiguous results. The application of microeconomic data implies a more direct approach to examine the impact of R&D subsidies on the dynamics of innovation at the appropriate level. Results based on firm-level data would help to discriminate between the conflicting theories and refine the determinants of successful R&D subsidies at the firm-level.

Finally, we emphasize that many determinants of innovation and growth, which can be influenced by public policies, are likely to be strategic complements or substitutes. That is, the provision of infrastructure, human capital and innovation policies are strategic complements if they are components of a country's absorptive capacity. Thus, improvements in human capital enhance growth-effects of infrastructure or R&D subsidies. In addition, the scarcity of one factor (e.g., infrastructure capital) might even block any potential growth-effects of FDI, trade or innovation policies. These interrelations need to be tested empirically by the inclusion of the corresponding interaction terms.

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Chapter 15
European Competition and Industrial Policy: An Assessment and a New Framework

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Abstract This chapter discusses alternative perspectives on private–public interactions and supply-side competition and industrial policies in theory and in practice. It also critically assesses recent European policies in this context. It then develops a new framework that emphasises the sustainability of value creation at the firm, meso and national levels, and explores its policy implications. It views current EU policies as a step in the right direction, but argues that they need to pay more attention to the issue of economic sustainability, the link between corporate, public and global governance, and the impact of different power structures and hierarchies of agencies on industrial policies for sustainable value creation. The limitations of self-monitoring and diversity suggest the need for a global competition and regulatory policy regime that place sustainability at the core of its Agenda.

Introduction

The objective of this chapter is to critically assess extant perspectives on supply-side competition (anti-trust) and industrial policies, paying particular attention to the case of the European Union (EU). The next section of the article discusses alternative perspectives on business, government and their relationship and supply-side policy in theory and practice. The third section discusses international practice and European supply-side policies, as well as new trends. The fourth section sketches a new conceptual framework and explores its implications on supply-side competition and industrial policies. The last section offers a summary and conclusions.

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Industrial and Competition Policy: Alternative Perspectives

The term 'industrial policy' (IP) refers to a set of measures taken by a government that aim at influencing a country's industrial performance towards a desired objective as well as the measures they take to implement this objective.[1] Competition policies (CPs) refer to the stance governments adopt towards competition and cooperation between firms and industries, and the measures they take to implement their objectives. CPs usually attempt to influence the degree of competition (or monopoly) in industries, such as, for example, the car industry.

Most government measures and policies affect industry one way or the other, so boundaries between industrial/competition policy and other policies such as technology policy, regional policy, structural policy, competitiveness policy, and even macroeconomic policy are not always clear. The closest we can get to a demarcation line is arguably by referring to government's own perceived intentions, alongside an underlying body of theoretical knowledge, purposely informing such perceptions. The government's objective is usually assumed to be the improvement of the welfare of its citizens, which is achieved when resources are allocated efficiently, and wealth creation and appropriation are taking place at a pace preferably faster than in other countries (improved international competitiveness).[2] Industry is believed to be an important contributor to the wealth creation process because of the tradability of its products, its positive impact on technology, innovation and productivity growth, and the close links between manufacturing and services; see Pitelis and Antonakis (2003), Chang (2009), Amsden (2008), Pitelis (2009), and Rodrick (2009) for accounts. It follows that a government wishing to improve welfare will be well advised to design measures that lead to a productive and competitive industrial sector. There is agreement among economists that a degree of competition between firms in industries can be a potent means of facilitating the desired objective. However, views differ as to the role, the type, the exact degree, and even the nature – including the very definition – of competition. It is not possible to discuss all these issues in detail in this article, but a bird eye's view of alternative perspectives may facilitate understanding.

[1]Industry usually refers to manufacturing. This, however, tends to recede, given an emerging fuzziness of the boundaries between manufacturing and services; see Pitelis and Antonakis (2003) and Amsden (2008) for a discussion.

[2]For other definitions and a discussion of competitiveness, see Aiginger (2006a, b) and Pitelis (2009).

The Neoclassical Industrial Organisation (IO), Market-Failure-Based Perspective

The dominant perspective on industrial and competition policy remains the mainstream neoclassical economics one, which is based on the theory of competition, monopoly and industry organisation (IO). It assumes that government intervention is only called for in cases of market failures – so hereafter we will call it a Market-Failure Theory (MFT).

The major elements of MFT are expounded in Alfred Marshall's 1920 *Principles of Economics*. While Marshall himself had a rather nuanced approach to firms and their internal operations and capabilities, subsequent developments in microeconomics and IO economics focused on the industry as the unit of analysis. The main economic question raised by this perspective is how the price-output decisions (equilibrium) of firms operating in industries (being collections of firms producing similar products, such as cars), impact on the efficient allocation of resources, such as capital and labour, which are assumed to be scarce, and therefore on the optimality of the market system as a whole.[3]

The method used to answer this question involves the assumption of 'optimising behaviour' (for example, firms are assumed to maximize profits). Given this objective, all one needs in order to determine the price-output "equilibrium" in an industry, is knowledge of the cost structure, the demand conditions and the type of industry structure. The last mentioned can be perfectly competitive or imperfectly competitive. "Perfect competition" exists when firms are numerous, produce homogenous products and there exists free entry and exit in the industry. Under these assumptions firms can only make "normal" (or zero economic) profits, that is they will simply cover their average costs (defined to include compensation for all factors of production, including managers and entrepreneurs).

"Imperfect competition" refers to all types of non-perfectly competitive markets, such as monopoly (a single seller in the industry) or oligopoly (relatively few sellers whose actions impact on each other – there exists interdependence). A limiting case of oligopoly is duopoly (two firms in the industry). In the case of imperfect competition, profit maximising behaviour often leads to prices in excess of the perfectly competitive ones, therefore to super-normal profits or, in the case of monopoly, to 'monopoly profits'.

Assuming the same cost and demand conditions, the "monopoly profit" represents an equivalent reduction in the "consumer surplus" (the benefit consumers receive by not paying the highest possible price they would be willing to pay for lower quantities as portrayed by their demand curve). This simply represents a re-distribution from consumers to producers and it is not seen as necessarily bad *per se* (this depends on how monopolists use their profits). The real problem with monopoly, however, is that in order to maximize profits, monopolies need to restrict

[3]Thus Structure, Conduct, Performance (SCP) model, see Scherer and Ross (1990) for an account.

output. This leads to lower levels of output than are possible under perfect competition, leading to under-utilization (misallocation) of scarce resources. This is the anathema of neo-classical microeconomics, which explains why in this perspective monopoly is bad. It represents a structural market failure and needs to be addressed, through government intervention.

Monopoly and perfect competition are two extremes; in practice most industries will tend to be oligopolistic. Analysing oligopolies is more exciting but not as straightforward. Given the many possibilities available for the possible behaviour of oligopolies, there exist many oligopoly models. In the original duopoly models of Bertrand and Cournot, different equilibria follow depending on assumptions of oligopolistic behaviour. Betrand assumed that oligopolies will compete over price, and thus he derived competitive pricing behaviour, despite oligopolistic market structures. Cournot instead assumed firms compete over output and derived a positive relationship between firm numbers and output – the more firms exist the higher the output will be (see Cabral 2000).

Starting with the classic work of Joe Bain in 1956 on *Barriers to New Competition*, modern IO theory built oligopoly models that derive equilibria which range between perfectly competitive and monopolistic, depending on assumptions of entry and exit. For example, in the limit pricing model of Modigliani (1958), it is shown that oligopolies will charge a price above the competitive one (because, and up to the point where, they are protected from barriers to entry, notably economies of scale), but below the monopolistic one because of fear of entry and in order to deter it. Others, notably Cowling and Waterson (1976) argued that firms do not need to reduce prices; instead they can deter entry through strategy, for example by investing in excess capacity. If their threat of using this capacity post entry is credible (in that it involves pre-entry commitments that make it more profitable for firms to act on their threats post-entry), entry will not occur and incumbents will be able to charge prices, which can be as high as the monopoly price (depending also on the degree of price collusion). In stark contrast to this, Baumol's (1980) "contestable markets" theory claimed that even oligopolistic industries will tend to behave competitively (i.e. charge competitive prices), if there exists powerful potential competition (other firms that may be attracted to the industry). The threat of potential competition will tend to render markets contestable, re-establishing the perfectly competitive ideal even in the presence of oligopolistic structures.

All the above can be examined using simple game theory (Dixit 1982). Building on such earlier works, the "new IO" put emphasis on the conduct of firms (in contrast to the focus on structure of the industry of the Bain tradition, which in effect posited a mostly uni-directional causal link from structure to conduct to performance). The emphasis on conduct affords a more realistic approach to the link between structure and performance that allows for co-determination of structure-conduct performance links and simultaneity. It can also be mathematically more rigorous. On the minus side however, game theoretic models of oligopoly have been plagued by the possibility of "multiple equilibria" – in effect a good mathematician can prove anything he or she may wish depending on the initial specification of the "game" (see Tirole 1988). More recently, Sutton (1998), made a very important contribution towards marrying formal modelling with reality. His 'bounds' approach employs stylised facts and theoretical insights to predict where, within expected bounds, price-output equilibrium should lie – and adopts formal modelling to analyse and test for such a reality-bound range of expected outcomes.

In the absence of perfect competition or perfect contestability, there exists scope for the government to step in to restore perfectly competitive conditions. A problem here is that in the absence of perfect competition across all industries in the economy, intervention in one market is not guaranteed to improve efficiency (the problem of "second best") except under rather restrictive assumptions (Gilbert and Newberry 1982). This limits the power of IO to provide useful public policy prescriptions, which is its purported aim.

The above is just one of the problems of the microeconomic and IO approach. Other related problems relate to restrictive assumptions (which include perfect information/knowledge, optimizing behaviour, inter-firm co-operation being seen mainly as price collusion, and technology/innovations being exogenous, or at best influenced by the type of market structure). In this context perfect competition in effect implies the absence of any competition at all.[4] In addition, the whole focus on efficient allocation of scarce resources ignores the fundamental issue of resource-creation. While changes in resource allocation can lead to changes in resource-creation, it is far from evident that the efficient resource allocation at any given time is the only way to affect resource-creation. Indeed resource-creation is automatically related to inter-temporal issues, which poses another problem for the neo-classical perspective – its focus is on comparative statics, not on inter-temporal efficiency. The last mentioned involves knowledge and innovation which the neo-classical view considers to be exogenously given (Baumol 1991).

The difficulties of the IO perspective to deal with knowledge and innovation and therefore with inter-temporal efficiency (the theme of the founding father of economics Adam Smith and many leading economists since), led IO scholars such as Baumol (1991) (the inventor of contestability theory), to lament the sub-optimal properties or "perfect competition" and "perfect contestability", as regards innovation, thus dynamic inter-temporal economic performance. A reason, Baumol observed, echoing Schumpeter (1942), is that both these types of market structure remove the incentive to innovate, which is of course the above-competitive rates of return (or escaping the 'zero-profit' trap (Augier and Teece 2008)).

The usefulness of the neo-classical IO perspective has been questioned widely, both from within and from without economics. From within, "managerial theories" drew on Berle and Means' (1932) classic statement of separation of ownership from control to claim that controlling professional managers maximize their own utility, not profits. This includes sales, discretionary expenditures, growth and other (see Marris 1996). Subsequent developments in economics tried to address the resultant problem of "agency" between different intra-firm groups, such as owners and

[4]For an account of alternative approaches to competition and competition policy within and without IO, see Hunt (2000), Pitelis (2007b).

managers, (for example, Alchian and Demsetz 1972; Jensen and Meckling 1976). The emergent "agency" literature gradually became the foundation of the "shareholder value" approach to corporate governance that stresses the importance of owner's pursuit of profits (see Pitelis 2004 and below).

In contrast to IO, Schumpeter suggested that competition should be viewed as a process of creative destruction through innovation, not a type of market structure. Hayek (1945) pointed to the efficiency of markets, in terms not of allocative efficiency, attributed to perfectly competitive structures, but instead in terms of their ability to address the problem of coordination in the presence of dispersed knowledge. Cyert and March's (1963) classic book questioned the ability of firms to maximize profits, in the presence of uncertainty, and intra-firm conflict. They suggested "satisficing" as a better objective of firms. Coase (1937) lamented the failure of mainstream theory to enter the "black box" (the firm), while Penrose (1959) pointed to the failure of mainstream theory to deal with the issue of firm growth. Building on Penrose, Richardson (1972) viewed co-operation, not just on a form of price collusion, but like a mode of organising production, similar to markets and firms, explicable in terms of firm capabilities relevant to such activities.[5]

Given the strength and prominence of its critics and the unrealism of its assumptions, a non-economist could be baffled as to what, if any, is the usefulness of the MFT to policy makers. It is ironic, perhaps, that many microeconomic textbooks provide extensive treatment of the 'Theory of the Firm', with little if any reference to what a real firm is. In Penrose's apt observation, in traditional theory firms are simply points in a cost curve. This seems clearly unsatisfactory, but it need not be – the main issue is the objective such theories aim to satisfy, whether they achieve it, and whether the objective is a useful one.[6]

The objectives the traditional theory tried to serve were mainly two. The first was to explain price-output decision of firms under different type of industry

[5]From the aforementioned economic theories-critiques, it is only Penrose and Cyert and March that really entered the "black box" of the firm, (Coase "merely" tried to explain its existence). Penrose focused on intra-firm resources and knowledge-creativity; Cyert and March considered intra-firm decision making and conflict. It is therefore hardly surprising that these two economic theories proved to be very influential to non-economists (Pitelis 2007), with Penrose claiming motherhood of the currently influential resource-based-view (RBV) and the dynamic capabilities (DCs) approach (Teece 2007). We explore these theories and their implications on industry structure in the next sub-section.

[6]The above is a big debate that cannot be addressed satisfactorily in an entry of this length. However, some points are worth making. On the realism of assumptions, Friedman (1967) claimed that it is predictive ability that counts, not the realism or the assumptions per-se. On this basis, traditional theory is claimed to fare well. On "objectives", profit maximization has been re-justified in terms of survival of the fittest arguments and the market for corporate control (takeover of ineffective firms). Alchian and Demsetz (1972) claimed that markets and firms do not really differ, firms are simply "internal markets"; the crucial issue for them being incentive alignment through monitoring and self-monitored "residual claimants" of profits. The view that even firms (hierarchies) are markets could serve as a pure neo-classical MFT. However, both Alchian and Demsetz have subsequently conceded that markets and firms could not be seen as being the same (Pitelis 1991).

structures, with an eye to predicting changes by suitably modifying the assumptions. The second aim was grander – to prove the efficiency of the market system vis-à-vis alternatives such as central planning, in terms of allocative efficiency. A major achievement of economic theory was its ability to prove that under perfect competition a market economy can affect Pareto – efficient allocation of scarce resources (a situation where no change can make one person better off, without making someone else worse-off). This is suitably celebrated as the First Fundamental Theorem of Welfare Economics.

It is arguable that the apparent irrelevance of MFT in terms of explaining firms and organizations is due to its focus on static allocative efficiency, which renders any relation to real-life firms, organizations and the organization of industry distant. Real life is, if anything, fluid and the objective of economic agents (be they firms or nations) is to improve their conditions over time (that is inter-temporal performance). MFT is ill suited for this purpose. Considering that issues such as knowledge and innovation are critical determinants of long-term performance (Pitelis 2009), given that firms, organizations and the organisation of industry can impact crucially on them; and considering that economic performance over time is certainly an important economic issue (arguably *the* important one), one would be forgiven for believing the MFT fails, even in terms of its own objective.[7]

Despite its failures to account for firm heterogeneity and the role of the intra-firm environment (resources, decision-making, conflict etc.), industry is arguably an influential concept and an important determinant on performance. It is not surprising that Penrose (1959) combined her focus on internal resources with the role of the external environment (which includes the industry), in the context of her concept of "productive opportunity" (the dynamic interaction between internal resources and capabilities and the external environment). Evidence shows that with regards to firm performance, firm-level factors are more important than industry-level ones, but the latter are still significant (McGahan and Porter 1997).[8]

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[7]That might be wrong. The resilience and strength of MFT is quite amazing and needs explaining. First, most currently popular discussions of organisation and strategy, notably transaction costs economics, the RBV and corporate governance, rely heavily on ideas originally developed within economics, (even as critiques of the mainstream paradigm). Importantly the very mainstream paradigm still serves as the only available analysis of the role of industry structure on firms price-output decisions, profitability and performance and has led to the first conceptual framework for the industry-based analyses on firm performance in the context of Porter's (1980) five-forces model of competition. Porter's approach was fully reliant on the neo-classical IO model of industry structures, where Porter himself had contributed significantly before turning to business strategy.

[8]Other potential purposes of the mainstream approach are that it serves as a benchmark against which to compare reality. In addition, in mature industries, characterized by stability, and high knowledge of the environment, the mainstream model can even help approximate reality (Pitelis 2002). In addition, the model may help provide a neat, rigorous diagrammatical and mathematical exposition, which can help facilitate student learning. For others, however, the static, unrealistic models used by mainstream economists do not lead gradually to a more nuanced understanding of reality described above, but are often seen as *the* reality, especially by younger students. This does not help them be critical and think outside the box. To many, it is responsible for the failure of neoclassical economists to predict the latest financial crisis.

To conclude MFT has a long history of distinction (and frustration). Its concepts and models have proven resilient, influential and of importance to other disciplines. Many fundamental ideas have emerged as their criticisms and have helped further the appreciation of organisations, markets and economies. To date there exists no alternative explanation of price-output decisions by firms operating in industries, of equal generality and rigour. In its Porterian version, MFT has informed management theory and managerial practice. Then again, it is important to look at MFT as it is – an abstraction which is potentially dangerous when taken at face value.[9]

The search for a rigorous alternative perspective which focuses on organizations and not markets (as required by reality and proposed by Nobel Laureate Herbert Simon 1995) and can explain price-output decisions with a degree of generality as well as having applications to other disciplines has not been achieved yet. Arguably the nearest we have is Nelson and Winter's (1982) evolutionary theory. Partly drawing on their ideas are the endogenous growth theory (Romer 1990), North's (1990) institutional approach and more recently the work by Acemoglu et al (2001) on institutions and inter-temporal economic performance. Such works do at the very least add credence to the idea that inter-temporal economic performance and the factors that affect it are within the scope of mainstream economics.

Transaction Costs, Property Rights and Resource, Evolutionary and System-Based Views

The first major challenge to the mainstream IO approach has been Coase's (1937) transaction costs perspective. This is still a market-failure-based approach, only now market failure is "natural" (not structural) and attributable to high market transaction costs. In addition, the private firm is seen as a device that can solve market failure, by internalising market transactions.

In Coase's (1937) article, the nature of the firm was considered to be the "employment contract" between an entrepreneur and labourers. While conceptually, it is always possible to organise production through the exclusive use of the market mechanism, (where hierarchical relationships are absent and relative price changes determine the allocation of resources), Coase observed that the employment contract-firm, can have advantages in terms of transaction costs. These can be the result of fewer transactions, but also lower average cost of transaction. The former is the case when an entrepreneur directs resources, such as employees, instead of having to transact with an equal number of independent contractors (who may also liaise between themselves), and when a single general longer term contract replaces spot market contracting (which would involve continuous re-negotiations of contractual terms). The latter is the case when hierarchy

[9]Last, but not least, it is not clear that less progress would have been made in economics and organization scholarship, were the mainstream approach not so dominant.

leads to less protracted intra-firm negotiations, for example because of the fear of redundancy by employees. As intra-firm transactions also involve costs, the internalization of market transactions will take place up to the point where the transaction costs involved in having a transaction organized by the market are equal to the intra-firm transaction (organizational) costs of undertaking this transaction intra-firm. According to Coase, both horizontal integration and vertical integration can be explained in terms of this logic (Pitelis and Pseiridis 1999). Accordingly the nature and boundaries of the firm can be explained in terms of overall market and organizational costs minimisation (Teece 1982; Pitelis 1991).

The development of Coase's work, mainly by Oliver Williamson (1975, 1985), focused on asset specificity (assets which redeployment involves loss of value) as the driver of integration (in particular vertical) but also through conglomerate diversification and cross-border (Williamson 1991). Buckley and Casson (1976) zeroed in the public good (non-excludability in use) nature of knowledge, to explain integration (foreign direct investment – FDI) by multinational corporations (MNCs). Teece (1977) and Kogut and Zander (1993) instead, explained FDI in terms of differential costs-benefits of transferring tacit knowledge intra-versus inter-firm. Coase (1991) questioned the importance of asset specificity and even the concept of rationality (Pitelis 2002). Moreover he has later expressed regrets for his almost exclusive focus on the 'employment relationship'; claiming that one should not just focus on the (Coasean) nature of the firm, but also its essence which is 'running a business'. In his view this involves more than the employment contract and includes the use of non-human resources and one's own time and capabilities to produce for a profit (Coase 1991; Pitelis 2002).

Despite a very extensive literature on transaction costs, which includes support and criticisms (see David and Han 2004 for an assessment of the evidence, which is found to be mixed), Coase's distinction between the 'nature' and the 'essence' was little noticed. Subsequent developments zeroed in on 'property rights' (Hart 1995; Grossman and Hart 1986) and problems of metering and (self)-monitoring (Alchian and Demsetz 1972), to address the question of the existence and scope of the firm, as well as the question why does capital employ labour rather than the other way around. The answer was in terms of the efficiency benefits of property-rights, and the need for (self)-monitoring, in the context of team production respectively, see Kim and Mahoney 2002; Foss and Foss 2005; Pitelis 2007a for more detailed critical assessments and syntheses. None of these theories attempted to deal with Coase's 'running a business'.

Early contributions in the resource-based view (RBV) of the firm (Teece 1982; Wernerfelt 1984; Barney 1991; Peteraf 1993; Mahoney and Pandian 1992) did not aim to explain the nature of the firm, see Priem and Butler 2001; Barney 2001. For Pitelis and Wahl 1998, the Penrosean version of the RBV, however, could be interpreted as a theory of the nature of the firm too. The superiority of firms in terms of knowledge creation, innovation, endogenous growth and productivity for production for sale in the market for a profit, (attributed by Penrose to learning by doing and teamwork in the context of the cohesive shell of the organization), could be seen as an alternative to and complementary with Coase's efficiency-based explanation of the employment relationship and thus the nature of firms. Subsequent literature summarized in Mahoney (2005) has used the two theories as partly complementary, partly incompatible. Issues of potential incompatibility revolved around the question of 'opportunism' (self-interested behaviour that also involves guile) and 'asset specificity' (Spender et al. 2009).

Subsequent contributions by Demsetz (1988), Demsetz and Jacquemin (1994) and Kogut and Zander (1996) as well as the emergence of the resource-based view (RBV) drew on earlier works by Demsetz (1973) and Edith Penrose (1959) and went some way toward explicating what do firms do, thus addressing in part the problem of the 'essence'. A critical concern, for example, of the strategy literature is to explain how do firms aim to acquire a sustainable competitive advantage (SCA), (see for example Lippman and Rumelt 2003; Peteraf and Barney 2003). This involves definitionally issues pertaining to 'running a business'. For example, in the resource-based view (RBV) the diagnosis, building, re-configuration and leveraging of intra-firm resources that are valuable, rare, inimitable and non-substitutable (VRIN) help firms acquire SCAs. This is at least part and parcel of Coase's 'essence' (Pitelis and Teece 2009).

It is arguable that the most relevant recent development on the Coasean 'essence' of the firm, is the dynamic capabilities perspective (Teece et al. 1997; Eisenhardt and Martin 2000; Teece 2007; Zollo and Winter 2002; Helfat et al. 2007). While Penrose (1959); Richardson (1972) and resource-based scholars used the concept of capabilities to explain the growth, scope, and boundaries of firms, as well as the institutional division of labour between market, firm and inter-firm cooperation (Richardson 1972), they have not gone far enough in terms of analysing how can firms leverage these resources and capabilities so as to obtain SCA, in the context of uncertainty and radical change (Spender et al. 2009). Additionally there has been limited discussion on the nature and types of capabilities that can help engender SCA. This has been the agenda of the DCs perspective. By focusing on DCs as higher-order capabilities that help create, re-configure and leverage more basic, such as operational (Helfat et al. 2007), organizational resources and capabilities, and by identifying the sensing and seizing of opportunities, as well as the need to maintain SCA, as key objective and functions of DCs, the DC perspective has arguably been a major advance in terms of explicating Coase's 'essence' of the firm. In addition, Pitelis and Teece (2009) claimed that the Coasean distinction between the 'nature' and the 'essence' is suspect and that DCs in market, value and price co-creation can help explain both. This claim also questions the widely popular approach to define the nature of the firm independently of the objective of its principals or principals-to-be (Pitelis 1991).

The transaction costs, property rights RBV and DC-based theories of the firm have efficiency implications on industry structure; they both explain more concentrated industry structures in terms of transaction costs and/or productivity-related efficiencies. In the transaction costs view, integration strategies can lead to more concentrated industry structures, but in so doing they reduce transaction costs. Similarly, firm heterogeneity in the RBV can explain firm-level sustainable competitive advantages (SCA), thus provide a reason why more efficient firms can grow faster, increasing industry concentration. Despite such similarities, however, the RBV and DCs and related evolutionary and system-based views (see below), also differ in many significant respects from both the IO and transaction costs perspectives. In particular, despite their own differences, these perspectives share between them the view that competition is not a type of market structure and that what is important is not just the efficient allocation of scarce resources but also the creation and capture of value and wealth through innovation and strategy. Efficient resource allocation through perfectly competitive market structures, moreover, is not seen as the only, let alone the best way to effect value and wealth creation and capture. There is a wide belief that firms are very important contributors to value/wealth creation and capture, and also that each firm is an individual entity, which differs from other firms primarily in terms of its distinct resources, capabilities and knowledge.

The lineage of this perspective includes founding fathers in economics, such as Adam Smith (1776) and Karl Marx (1959). Smith and Marx focused on wealth creation, not just resource allocation. They both saw competition as a process, regulating prices and profit rates, not a type of market structure. Smith described the productivity gains through specialisation, the division of labour, the generation of skills and inventions within the (pin) factory. Marx also suggested there is a dialectical relation between monopoly and competition (whereby competition leads to monopoly and monopoly can only maintain itself through the competitive struggle) and their impact on technological change the rate of profit and the 'laws of motion' of capitalism at large. Marx focused in addition on conflict within the factory, and in society at large, mainly between employers and employees.

Building critically on Marx, Joseph Schumpeter (1942) described competition as a process of creative destruction through innovations. He saw monopoly as a necessary and just, (yet only temporary) reward for innovations. He attributed firm differential performance to differential innovativeness and saw concentration to be the result of such innovativeness.

Penrose's now classic 1959 book on *The Theory of the Growth of the Firm*, can serve as the glue that can bind such contributions together. In her book, firms were seen as bundles of resources in which interaction generates knowledge, which releases resources. 'Excess resources' are an incentive to management for growth and innovation as they can be put to use at almost zero marginal cost (since they have already been employed and their release is hindered by indivisibilities). Differential innovations and growth lead to concentration, which, however, can also be maintained through monopolistic practices. The world is seen as one of big business competition where competition is god and the devil at the same time. It drives innovativeness yet it is through its restrictions that monopoly profit can be maintained.

Building on Penrose, Richardson (1972) observed that firms compete but also co-operate extensively. Such cooperation is not just price collusion as the neoclassical theory assumes. It lies between market and hierarchy, and occurs when firm activities are complementary but dissimilar (require different capabilities).

Nelson and Winter (1982) developed ideas currently of import to the resource-based view. Notable are those of firm 'routines', which simultaneously encapsulate firms' unique package of knowledge, skills and competences, allows firms to operate in an evolving environment with a degree of path dependent institutionalisation.

The focus on the evolutionary RBV and DC views on change, knowledge and innovation, as well as its 'systemic' (as opposed to market) perspective, has arguably facilitated the emergence of a major change in the economics of firms, business and industry organization one that emphasises the knowledge and innovation-promoting potential of different institutional configurations. The 'national', regional and sectoral systems of innovation approach, the literature on clusters of firms, and the work of Michael Porter (1990) on national competitiveness as well as the varieties of capitalism perspective (Hall and Soskice 2001) draw upon and relate to the evolutionary/resource system-based view, see Wignaraja (2003); Edquist (2005); Lundvall (2007); Pitelis (2003, 2009), for various contributions.

There are various other implications of the evolutionary/resource and systems-based perspective. First, the focus on value and wealth creation suggests a broader welfare criterion than just the static consumer surplus. Second, superior capabilities provide another efficiency-based reason for concentrated industry structures. Third, competition as a dynamic process of creative destruction through innovation implies a need to account for the determinants to innovate, when considering the effects of 'monopoly', but also more widely, including business organization and strategy. Fourth, competition with cooperation (co-opetition), as in Richardson, implies the need to account for the potential productivity benefits of co-opetition in devising business strategy and public policies.[10] While the former are the prerogative of firms the latter are the responsibility of government. This necessitates a discussion of the theory of the state and the public–private nexus in market economics.

Economic Theories of the State and the Public–Private Nexus

The abovementioned theories of the firm, business and industry organization have implications on the theory of the state and government intervention. We explore these below and draw on them to examine the relationship between firms, markets, business (and industry organization), states, and supra-national organisations (such as the EU) with an eye to appreciating and informing their policy.

The state is widely acknowledged to be one of the most important institutional devices for resource allocation and creation along with the market and the firm. In

[10]Another dimension of competition relates to its strength, and the role of proximity and location. This links to the work of Richardson, but has been developed by Porter (1990), Krugman (1991), Audretsch (1998), Dunning (1998), and others (see Jovanovic 2009). For example, Porter claims that local competition is more potent than distant (foreign) for example competition. This may have important implications in devising public policies.

centrally planned economies the state has been the primary such device. However, in market economies the role of the state has been generally increasing steadily since the Second World War. In most OECD countries today, government receipts and outlays as a proportion of GDP are very high, in some cases as high as 60% (Mueller 2006). Many theories tried to explain the growth of the public sector in market economies (the so-called Wagner's Law), originating from a number of different perspectives. In brief, neoclassical theories considered such growth as a result of increasing demand for state services by sovereign consumers, while "public choice" theorists regard it as a result of state officials, politicians and bureaucrats' utility maximizing policies. In the Marxist tradition the growth of the state is linked to the laws of motion of capitalism – increasing concentration and centralization of capital, and declining profit rates – which generate simultaneous demands by capital and labour on the state to enhance their relative distributional shares, for example, through infrastructure provisions and increased welfare services, respectively. There are variations on these views within each school as well as other views from institutional, feminist and post-Keynesian perspectives (see Hay et al. 2007; Pressman 2006).

Besides explaining why states increase their economic involvement over time, many economists in the 1980s focused their attention on why states fail to allocate resources efficiently and, more particularly, on the relative efficiency properties of market versus non-market resource allocation. Particularly well known here are the views of the Chicago School, in particular Friedman (1962) and Stigler (1988). Friedman emphasized the possibility of states becoming captive to special interests of powerful organized groups, notably business and trade unions. In addition, Stigler pointed to often unintentional inefficiencies involved in cases of state intervention. Examples are redistributional programmes by the state which dissipate more resources (for example in administrative costs) than they redistribute. These reasons – and the tendency generated by utility-maximizing bureaucrats and politicians towards excessive growth – rising and redundant costs, tend to lead to government failure. Wolf (1979) has a classification of such failures in terms of derived externalities (the Stigler argument), rising and redundant costs because of officials' "more is better" attitude, and distributional inequities, for powerful pressure groups.

On a more general theoretical level, the case for private ownership and market allocation is based on three well-known theories. First, the property rights school, which suggests that the communal ownership (the lack of property rights) will lead to dissipation – the "tragedy of the commons". Second, Hayek's (1945) view of dispersed knowledge, according to which, knowledge is widely dispersed in every society and efficient acquisition and utilization of such knowledge can be achieved only through price signals provided by markets. Third, Alchian and Demsetz's (1972) residual claimant's theory which suggests, much in line with the property rights school that private ownership of firms is predicated on the need for a residual claimant of income-generating assets, in the absence of which members of a coalition would tend to free ride This will lead to an inefficient utilization of resources.

There is a large literature on the merits and limitations of these theories (see for example Eggertson 1990 for coverage). Some weaknesses have been exposed in each defence of private ownership and market allocation. Concerning the "tragedy of the commons", it has been observed historically that communal ownership could have efficiency enhancing effects (Chang 1994). Hayek's critique of pure planning loses some of its force when one considers choices of degree between public and private in mixed economies. The residual claimant theory downplays the potential incentive-enhancing attributes of co-operatives and becomes weaker when applied to modern joint-stock companies run by a controlling management group, as well as to knowledge workers (Pitelis and Teece 2009).[11]

Some of the above are in line with Marxist criticism of the role of the state, for example, the view that the state is captive to capitalists' interests (Milliband 1969), and that some state services involve no surplus value-generating labour (Gouph 1979). This is often linked to the falling tendency of the rate of profits, and the tendency for government spending under advanced capitalism to exceed government receipts for reasons related to demands by both capital and labour on state funds and the resistance of both sides to taxation, which are particularly intensified under conditions of monopoly capitalism (O'Connor 1973).

Concerning more specifically the relative efficiency properties of private sector versus public sector enterprises the focus of attention has been on issues of managerial incentives, competitive forces and differing objectives. It was claimed that public sector enterprises achieve inferior performance in terms of profits or the efficient use of resources. While private sector managers are subject to various constraints leading them to profit-maximizing policies. This is not the case with public sector managers. Such constraints arise from the market for corporate control (that is, the possibility of take-over of inefficiently managed firms by ones which are run more efficiently), the market for managers (that bad managers will be penalized in their quest for jobs) and the product market, including the idea that consumers will choose products of efficiently run firms for their better price for given quality (Pitelis 1994).

Among other factors which tend to ensure that private sector agents (managers) behave in conformity with the wishes of the principals (shareholders) – by maximizing profits in private firms – are, the concentration of shares in the hands of financial institutions; the emergence of the M-form organization which tends to ensure that divisions operate as profit centres; and the possibility of contestable markets, that is, markets where competitive forces operate through potential entry by new competitors as a result of free entry and costless exit. It is assumed that public sector enterprises are not subject to such forces to the same degree which

[11]Other well-known mainstream arguments relating to the problem of government failure are Bacon and Eltis' (1976) claim that services, including state services, tend to be unproductive and Martin Feldstein's (1974) view that pay-as-you-go social security schemes reduce aggregate saving- capital accumulation. The reason is that rational individuals consider their contributions to such schemes as their savings, and reduce.

implies the possibility that managerial incentives for efficient use of resources and profit maximization may be less pressing in public sector firms (Pitelis 1994).

Many of the above factors are linked to competition and competitive forces. The claim is that public sector enterprises may be more insulated from such forces and are less likely to pursue efficiency and profit maximization. The latter will also be true if public sector enterprises do not aim at such policies, for example, because they are used as redistribution vehicles by the government; and/or for non-economic reasons such as the need for electoral support; and/or because they aim at correcting structural market failure of private sector monopolies. All these tend to establish the economic-theoretical rationale for the superior efficiency of private firms and therefore for privatization. Vickers and Yarrow (1987), Kay et al. (1986), Clarke and Pitelis (1993), Rodrik and Hausmann (2006) offer discussions and critiques.

Various limitations can be identified in the case for the superior efficiency of the private sector. One arises from the possibility that the various constraints on private sector firms' managers are not as strong as they are suggested to be. For example, large size may protect inefficient firms from the threat of take over, it may be difficult to tell when a manager has performed well, given the often long-term nature of managerial decisions; and bounded rational consumers may often fail to tell differences in the quality of similarly priced products. Concerning competition a private sector monopoly is as insulated from it as a public sector monopoly, ceteris paribus (assuming no difference in the forces of potential competition). Furthermore, the absence of competition is not per se a reason for privatization: it could well be a reason for opening up the public sector to competitive forces, for example, through competitive tendering and franchising (Yarrow 1986). Such considerations led many commentators to the conclusion that the issue is not so much that of the change in ownership structures as the nature of competitive forces and of regulatory policies themselves (Clarke and Pitelis 1993; Kay and Silberston 1984; Vickers and Yarrow 1987; Yarrow 1986).

An important issue often downplayed by proponents of privatization is that the very reason for public sector enterprises has often been market, not government, failure (Rees 1986). The first fundamental of welfare economics shows that markets can allocate resources efficiently without state intervention provided that market failures do not exist. Such failures, however, are widely observed, famous instances of market failure being the existence of externalities (interdependencies not conveyed through prices); public goods (goods which are jointly consumed and non-excludable); and monopolies, which tend to increase prices above the competitive norm. The observation, among others, that efficient government itself is a public good, has led to the idea of pervasive market failure (Dasgupta 1986), which is viewed as the very raison d'être of state intervention (Stiglitz 2002). The very reason why public sector enterprises are run by the state is that they have been seen as natural monopolies (firms in which the minimum efficient size is equal to the size of the market as a result of economies of scale, leading to declining costs). If private, it is assumed that these firms would induce structural market failure in terms of monopoly pricing. The undertaking of the activities of such natural monopolies (often known as public utilities) by the state could solve the problem through, for example, the introduction of marginal cost-pricing policies. Although such policies need not necessarily re-establish a first-best Pareto optimal solution (given imperfections elsewhere in the economy), they could question the value of the critique that public utilities do not maximize profits given that this was not their objective to start with.

Theory and evidence seem to be less clear-cut on the issue of the relative efficiency properties of different ownership structures than would appear to be the case on the basis of the privatization drive of the 1980s and 1990s. This is not to say that ownership does not matter, but rather that the issue of market versus non-market allocation is far more complex than sometimes acknowledged (Pitelis 2003).

Recent work by Rodrik (2009) and colleagues (e.g. Hausman et al. 2008) focused on wider market-failure-related issues (such as information, co-ordination and missing linkages) to defend the need for regulation. Despite progress, such work remains market-failure-based. It is arguable that we need to go beyond this, to explore the differential capabilities of the public (versus the private) sector. Such a differential-capabilities-based perspective is adopted below and is applied to the private–public interaction at the national but also international levels. This is because of the currently topical concern with global governance, especially in view of the current global crisis.

Business-State Interactions and Supra-National Organization

The firm, particularly the multinational enterprise (MNE) and the state most commonly in the form of a nation state are today arguably the two major institutional devices, along with the market of resource allocation and creation globally. The voluminous and fast-growing literature on the market and the hierarchy, particularly their raisons d'être, evolution, attributes and interrelationships, represents a recognition of their importance (see Mahoney et al. 2009). The relationship between MNEs and nations states and international organizations such as the WTO has also received interest in recent years, see Hill (2009).

As noted already, the neoclassical economic perspective considers the state to be a result of market failure. In Adam Smith (1776) the state is required mainly for the provision of justice and public works. More recent accounts point to prisoner's dilemma, coordination, asymmetric information and missing linkages-related market failures (Hardin 1997; Rodrik 2004). Coase (1960) and Arrow (1970) generalized the neoclassical perspective of instances of market failure leading to the state, in terms of transaction costs. This has been taken up and extended by North (1991) and Pitelis (1991) – see below.

There is limited detailed discussion in the neoclassical literature of the relationship between the firm and the state. Coase (1960) briefly refers to the issue, to the effect that both firm and market transactions have to take place within the general legal framework imposed by the state. The implication is that firms and markets (the private sector) are seen as complements to the state. This implies a need for an explanation of the state in terms of private sector (not just market) failure. This approach still leaves unresolved the question of why states do not substitute (replace) markets and firms (the private sector); i.e. why market and not planning. An explanation can be offered in terms of the – nowadays popular – concept of government failure, generalised in terms of transaction costs, but also Coase's claim that in market economies the optimal mix between market and plan emerges endogenously and not from the top-down (Coase 1960, Pitelis 1991).

Concerning the relationship between nation states and MNEs, the neoclassical view is that MNEs tend to enhance welfare by increasing global efficiency. The latter is more evident in the transaction-cost perspective but it is also true of proponents of ownership advantage perspective, such as Charles Kindleberger (e.g. 1984). Here the reasons are not transaction costs but rather technology diffusion, know-how, employment creation, etc. A problem emerges when the power of the one actor (the state) is being undermined by that of the other, the MNE. This, Vernon (1971) observed is possible as a result of the mobility of MNEs versus the immobility of the state. The original suggestion was that of "sovereignty at bay", qualified, however, 10 years later (Vernon 1981) in view of increasing expropriations of MNE assets by Third World countries, and the increasing resistance (and militancy) of at least some states. Nye (1988) added a new interesting insight by pointing to the possible complementarity between MNE and nation states, each with a comparative advantage: MNEs on production, nation states on legitimization. This and strengthens the earlier argument concerning complementarity between the private sector (firm, in this case) and public sector and it is nearer to the capabilities-based perspective (Pitelis 1991).

The emergence of international state apparatus can, in principle, be explained in parallel to the development of the state in the neoclassical tradition. Kindleberger (1986), pointed to the relationship between international public goods (such as international stability) and international governments, i.e. organizations such as the UN and WTO. Such goods can, in principle be provided by hegemonic powers. For example, the UK, first, and the USA, more recently, played such a role in recent history. For a multitude of reasons, however, hegemons decline and/or lose their appetite for the provision of such goods. International government can be a solution to this problem.

Kindleberger's framework is one of international market failure, leading to international government, in the absence of a sufficiently strong (or interested) national government-hegemons. The relationship between international government and the MNE is seen as one of complementarity. An interesting new dimension is added in terms of the relationship between national states and inter-nation states, which again is seen as one of complementarity (in the absence of hegemons). Following Nye, it could be claimed that comparative advantage in the provision of international public goods and international production, respectively, explain the need for complementarity between international state apparatus and MNEs. Moreover, international market failures could in principle also be generalized in terms of transaction costs (Pitelis 1991; Glykou and Pitelis 1993).

In summary, the neoclassical perspective on the firm, including the MNE, the nation state and international organizations can be described as one of complementarity. This can also be suggested as regards the private sector (firm and price mechanism), because the transaction-costs perspective which views the market and the firm as substitutes provides no adequate justification for this view. It is possible therefore to claim that given firms' possible failures (e.g. excessive transaction costs within firms, or management costs (see Demsetz 1988), after a certain size as Coase and Williamson suggest) and the concept of comparative advantage advanced by Nye, this relationship too should be seen as one of complementarity as well as substitutability. If this is accepted the market the MNE and state and international organizations should be seen as complementary and substitutable institutions of resource allocation, each specializing in what they can do more efficiently (in terms, for example but not exclusively, of economizing in transaction costs). In the context of this efficiency perspective, the prevailing institutional mix could be attributed to overall efficiency-related factors.

The major alternative to the mainstream tradition is the radical left. Regarding the raison d'être of the firm (the factory system), the major contribution here is Marglin's (1974). Developed independently of the Williamson perspective on markets and hierarchies Marglin's ideas represent the major alternative to the transaction cost-efficiency argument. For Marglin, the main reason for the rise of the factory system from the previously existing putting-out system was the result of capitalist attempts to increase control over labour. In this sense, the factory system was due to control-distribution – related reasons. Any efficiency gains resulting from increased control should be seen as the outcome, but not the driving force.

Coming to the MNE, Stephen Hymer is the leading contributor in the radical left tradition and arguably the father-figure of the modern theory of the MNE as a whole, see Dunning and Pitelis (2008). Similar to Ronald Coase, Hymer regarded the market and the firm as alternative institutional devices for the division of labour. Hymer focused primarily on the evolution of firms (rather than their existence per se), from the small family-controlled firm to the joint-stock company, and then through the multidivisional (M-form) firm to the MNE. He focused on the latter in his now classic 1960 PhD thesis (Hymer 1976) and extended his analysis on the MNE and the multinational corporate capitalist system as a whole in his subsequent writings, some of the best of which are collected in Cohen et al (1979).

In brief, Hymer explained the ability of US firms to become MNEs (i.e. to compete successfully with domestic firms of host countries, despite the latter's inherent advantages of knowledge of language, customs, etc.) in terms of monopolistic advantages derived during their development process. Such were know–how, managerial expertise, technology, organization etc. He then explained the willingness of US firms to become MNEs in terms of oligopolistic rivalry, in particular as a defensive attack to guard against the threat of the rising European and Japanese firms and a means to reduce international rivalry. He also used transaction-cost related theorizing to explain FDI to market-based international activities, for example licensing, and referred to locational factors and divide-and-rule (of both labour and nation states) factors. It is for these reasons that most existing perspectives on the MNE can be seen as developments of Hymer's early insights (Dunning and Pitelis 2008).

Although the Marxist tradition explored the issue of internationalization of production and the MNE, their focus is primarily on the former, rather than on an explanation of the particular institutional form of the MNE. From a large literature the contributions of Baran and Sweezy (1966) and Palloix (1976) are noteworthy. The latter considered internationalization as a process inherent in the development of capitalism, itself the result of the process of competition. The former focus on effective demand problems (of the under-consumptionist type) in order to explain the need of capital to seek foreign markets.

As already noted, the Marxist theory paid particular attention to the theory of the state. Views here range from the instrumentalist theory, which sees the state as an instrument of capital, through the structural-functional perspective for which capitalist cohesion is achieved through the state, to the capital logic or state form derivation debate, where the state is seen as an outcome of the very logic of capital accumulation, see below.

Variations apart, all Marxist theories view the state's existence and functions as the result of a quest and/or need to nurture the class interests of the capitalist class. Hymer (in Cohen et al. 1979) has an historical justification of this need-quest. Marxists, most notably O'Connor (1973), also acknowledge the possibility of government (capitalist state) failure, but attribute it to a structural gap between receipts and outlays. Some of the Marxist perspective can be translated into mainstream terms, such as government failure. What remains as different is the focus on a distributional, class-based perspective, as opposed to the efficiency focus of the mainstream.

Marxist theory also paid attention to the relationship between MNEs and nation states. However, views here vary greatly. On the general relationship between the relative power of the state and MNEs, Murray (1971) claimed that the power of MNEs tends to undermine that of nations states, while Warren (1971) has made the opposite claim. These and other contributions are collected in Radice (1975). Concerning the relationship between MNEss and developing host-states (the hinterland or periphery), views vary from the Monthly Review school's perspective of imperialism (see for example Sweezy 1978) to Warren's (1973) claim that MNEs are a major factor contributing to the economic development of the periphery. In between lie the concepts of unequal exchange, uneven development and dependent development (Pitelis 1991).

Stephen Hymer's perspective on MNEs and nation states is insightful (see Cohen et al. 1979). On the general relationship, he claimed that MNEs erode the powers of nation states, but unequally; more so for the weak (typically developing) states and less so for the strong (developed) ones. The latter possess more leverage against MNEs, in part by being themselves home-bases to MNEs. Concerning MNEs and developing host states he conceded that MNEs can contribute to the economic development of the periphery but described the relationship as one of inequality and self-perpetuating dependency. In part, this was the result of the incentives for local entrepreneurs to co-operate with (sell to) rather than compete with MNEs. Observing a more general tendency of the world's wealthy to increase the global surplus, Hymer went on to describe a tendency for global collusion by global firms through interpenetration of investments.

Globalization of production, for Hymer, also creates the need for international capital markets and international government (organizations) – the latter in order to assist the global operations of MNEs. This observation provides a Marxist perspective on MNEs and international organizations, akin to the more general Marxist focus on control-distribution, in particular in regarding the dominant classes as the locomotive of history. Given the influence of this class on the state, too, as already discussed, one would expect nation states not to oppose the development at least of some types of international organization, see Dunning and Pitelis (2008) for a critical assessment.

To summarize, the Marxist perspective considers the firm, the market and the state, including MNEs, national states and supranational organizations, as complementary devices, for the exploitation of the division of labour and indeed of labour. The emphasis is on sectional capitalist interests, not efficiency. The latter could be the outcome, or the means, but not the driving force. Put differently, efficiency could be sacrificed for the sake of sectional-class interests.

From the discussion thus far, it could be suggested that there is an emerging consensus in economic theory to the effect that institutions of capitalism should be seen as both complementary and substitutes. Moreover, outside economics the work of Ostrom (2005), derives complementarity of public and private, on the basis of the need to unleash all human potential. The exclusive focus on either efficiency or capitalist class interests, on the other hand, is, we think, far-fetched. Interestingly, neo-classical economic historian Douglass North (1981) suggests that efficiency by state functionaries will tend to be pursued, provided that their own utility is also maximized. This may point to some emerging consensus.

The possibility of inefficiencies of state intervention (government failure), owing to opportunistic (or, more mildly, utility-maximizing) behaviour by state functionaries (bureaucrats, politicians) is explicitly entertained by the public choice and Chicago perspectives. Here internalities and redundant and rising costs result from state functionaries' desire to increase their utility (status, size of bureaux, etc.). Moreover, even though the state may emerge spontaneously in an attempt by individuals to raise themselves above the anarchy of the market (Hobbesian state of nature) in this scenario, states can be captured by organized interest groups which (thus) hinder the efficient allocation of resources. If so, markets should be left to operate freely, while the state should limit itself to the provision of stable rules of the game, for example, clear delineation of property rights. The maximization of state functionaries' utility and the demands by powerful organized groups of producers and trades unions which have captured the state, helps to explain, in this scenario, its tendency to grow.

The transaction-cost and new-right perspectives on the state have been brought together in Douglass North's (1981) attempt to provide a neoclassical theory of the state. Here a wealth- or utility-maximizing ruler trades a group of services (e.g., protection, justice) for revenue acting as a discriminating monopolist, by devising property rights for each so as to maximize state revenue, subject to the constraint of potential entry by other rulers (other states or parties). The objective is to maximize rents to the ruler and, subject to that, to reduce transaction costs in order to foster maximum output, thus the tax revenues accruing to the ruler. The existing competition from rivals and the transaction costs in state activities typically tend to produce inefficient property rights: the former, as it implies, favouring powerful constituents while transaction costs in metering, policing and collecting taxes provide incentives for states to grant monopolies. The existence of the two constraints gives rise to a conflict between a property rights structure which produces economic growth and one which maximizes rents to the ruler, and thus accounts for widespread inefficient property rights. North regards this idea as the neoclassical variant of the Marxian notion of the contradictions in the mode of production, in which the ownership structure is incompatible with potential gains from existing technological opportunities.

The similarities between the public choice and North's view of the state, on the one hand, and that of the Marxian school, on the other, do not end here. Marx and his followers were among the first to contemplate a capture theory, which Marx moreover considered to be part and parcel of capitalism's existing inequalities in production (capitalists- workers). This inherent inequity, for Marx, implied a bias of the state in favour of capitalists. This view has been elaborated by latter-day Marxists, who pointed to instrumental reasons (links of state personnel with capital, see Miliband 1969) and/or structural reasons (control of capital over investments, see Poulantzas 1969) for this capitalist capture of the state. Marxists explained the autonomous form of the capitalist state in terms of the control of labour directly by capital in the production process (thus no need for the state to assume direct control of labour) and the need of the state to support production (provision of infrastructure, etc.) as a result of the anarchy of the market (the existence of many capitals), see Holloway and Picciotto (1978). For the Marxist school, the growth of the state and fiscal crises can be explained in terms of laws of motion of capitalism such as the concentration and centralization of capital declining profit rates and thus class struggle over state expenditures (see, for example, O'Connor 1973).

North's and the Marxist theories underplay the power of consumers as electors and as a source of tax revenues. Electoral defeats and reductions in the rents accruing to the state, resulting from reduced employment levels are further constraints on the behaviour of state functionaries whether they try to maximize their own utility or that of capital. On the other hand the possibility of capture is an important point of consensus between the public choice, Marxian and North's theories. It is not alien to the conventional neoclassical tradition either, (Chang 1994). Last, but not least, the Marxian focus on the need to reduce production costs (already there in the conventional neoclassical focus on public goods, see Adam Smith 1776) counterbalances the exclusive reliance of transaction-cost theorists on the exchange side.

The above summary of alternative perspectives on the possibility of capture allows a generalization of North's theory. According to this, the state exists because of excessive private sector transaction and production costs and aims to reduce them so as to increase output and thus revenue for state functionaries. Increased output also helps to legitimize any income in-equities. A constraint on the state's functionaries' attempt to achieve their objectives arises from the possibility of capture (inherent for Marxists, but arising ex-post for public choice) which tends to generate inefficient property rights, which in turn hinder increases in output. Transaction costs in metering, policing and enforcing taxes also lead to inefficiency in terms of states granting monopolies. Moreover, costs of governing put a limit on the ability of the state to replace the private sector, leading to a need for a plurality of institutional forms.

It follows that the aim of the state is, or should be, to reduce private sector transaction and production costs by removing the constraints which hinder the realization of this notably the problem of capture by powerful constituents. This points towards the need to establish competitive conditions in product and labour markets. Competition would tend to reduce but not eliminate, if they are inherent in production the power of such constituents. It would tend to reduce problems with governing costs associated, for example, with powerful opportunist private sector suppliers of required state services. Competitive conditions, however, should not be limited to the private sector only but should be extended to a lesser extent (so as not to facilitate capture and/or inefficiency due to discontinuities of state personnel) to the market for government control so that political positions should also be contestable. This would provide useful sources of information on possible differences in the efficiency of governing. The reduction of private and public sector transaction and production costs by the state is aimed at providing the conditions for the efficient production of goods and services by the economy, i.e. to increase supply-side output and facilitate the realization of this output (its purchase by consumers, domestic or overseas). This introduces the concept of national strategy for growth, as the set of state policies intended to reduce production and transaction costs so as to increase realized output in the form of income. The internalization of private sector activities by the state should be pursued up to the point where an additional transaction or production activity would be produced at equal cost in the private sector. This reinforces the concept of pluralism in institutional forms, i.e. the complementarity between the public and private sectors for the efficient production and allocation of resources.

The notion of national strategy takes the revenue side as given, i.e. as the prerogative purely of the private sector. However, besides affecting production and transaction costs, a government can also affect the revenue side, if it consciously directs its production-transaction cost-reducing activities to particular areas, and/or through market augmentation (Olson 2000). In a semi-globalised world growth can be achieved via domestic and foreign demand, while income-rent will be affected positively through both reductions in transaction-production costs and increases in revenues through, for example, a focus on high-return sectors and/or the creation of agglomeration and clusters (Pitelis 2009). It follows that, in open economies national strategy could be designed to reduce overall production and transaction costs for the economy, but also influence the revenue side so as to increase the income accruing to the nation and (thus) taxes to the state. In this context, the state functionaries could be argued to act as political entrepreneurs (Yu 1997). This would also tend to endogenise the public–private nexus and require a theory of political entrepreneurship and its interaction with economic entrepreneurship. Despite recent progress, economic theory is still far off such an analysis, which is more akin to political science, management and entrepreneurship scholarship (Klein et al. 2010). Nevertheless, sufficient progress has been made to question the view that government should only intervene in cases of market failures. In contrast, the public–private nexus is much more complex and involves even market co-creation by states. This can usefully inform supply-side competition and industrial policies that should be consistent with and supportive of the national strategy discussed above.

International Practice and European IP in the Context of New Trends

Despite its limitations, the neoclassical market-failure-based perspective has dominated industrial and competition policy thinking in the Western world for many decades. Anti-trust legislation in the US and the original Articles 85 and 86 of the Treaty of Rome in Europe both seem to be directly informed and influenced by it, in theory at least. In reality of course, practice has varied from theory and also between countries and over time. As argued elsewhere (Pitelis 1994), European policy, for example, can be described as ad-hoc, discontinuous and inconsistent. It has been seen as ad-hoc because the theoretical basis of various policies was not clear. A notable example is the ‘national champions’ or ‘picking winners’ policy which various European countries pursued in the 1960s and 1970s. This involved identifying potentially successful firms or industries and using a number of measures like subsidies and tax breaks to promote them. It also involved a lenient and even encouraging attitude towards mergers and in cases (often in pursuit of considerations of fairness and distribution) nationalisation of utilities but also other ‘strategic’ industries. Underlying this was the hope that such firms could compete successfully with foreign rivals, thus raising export surpluses and country competitiveness. Evidently, this tended to exacerbate structural market failures, and was also inconsistent with the theoretical pursuit of ‘competition’. The policy was also pursued at a pan-European level, in the search for pan-European companies which could out-compete large American multinationals. In some cases, such policies blunted incentives for protected firms to compete, and gave rise to ‘problematic enterprises’, or ‘lame ducks’. After trying to rescue them for a number of years, European governments led by Mrs. Thatcher’s Britain eventually resorted to deregulation and privatisation, as well as a switch of focus to small firms and entrepreneurship. This also resulted in a discontinuity of policies, from large firms and the government, to small firms and the market.

The approach of Japan, and the so-called ‘tigers’ of the Far East, was different. In Japan, policy was led by the then Ministry of International Trade and Industry (MITI) and was not informed by neoclassical economics. Rather, it involved a strongly interventionist approach by the government aimed at creating advantages in certain sectors. Such sectors were chosen on the basis of being high value-added, high-income elasticity of demand and gradually knowledge-intensive. In such sectors, MITI provided financial and other support and guidance. It regulated the degree of competition (neither too little, nor too fierce) by aiming at an ‘optimum’ number of firms in it, and protected these sectors from foreign competition at the same time, while monitoring performance and effecting ‘technology transfer’ through the promotion of licensing of technology by foreign firms. It also paid attention to the benefits of cooperation and the promotion of small and medium-sized enterprises (SMEs (Best 1990). Overall, the approach to competition could be described as domestically focused competition balanced with cooperation (co-opetition). The approach of the East Asian ‘tigers’ was similar, although some of them, especially Singapore affected ‘technology transfer’ not through licensing as practised by Japan but through an inward investment policy (Pitelis 2009). The performance of the Japanese economy and that of the tigers has been very impressive until recently. It is not surprising that some commentators attributed this success in part to its approach to competition and industrial policy (as well as to other characteristics of the Far Eastern economies, such as education, an equitable distribution of incomes, a high saving ratios and so on) although views on this still vary; see Pitelis (2001).

To attribute the success of the Far East just to its approach to competition and its interventionist IP, especially given similar but less successful interventionist policies by Western and non-Western governments in the past implies either misconceived policies by the latter or a higher degree of (in)competence. This may well be the case but there is also a second potential argument. In contrast to the West, the Japanese did not adopt the neoclassical perspective and favoured an approach that focused on resource creation not just through resource allocation, but instead through big business competition for innovation, growth, productivity and competitiveness. This approach, which seems to combine Schumpeterian and Penrosean ideas with its accompanied focus on production and organisation (Best 1990) may well be a *differentia specifica* of the Far Eastern approach. It has been associated with major innovations such as total quality, ‘just-in-time’, lifetime employment, and the coexistence of competition with cooperation (co-opetition).

There have been numerous developments in economics and management in recent years such as the new international trade theory; new endogenous growth theory; new location economics; ‘new competition’; the resource-based perspective; and the national, regional and/or sectoral systems of innovation approach (see Wignaraja 2003; Pitelis 2009). Arguably these offer some support to the Japanese perspective and policies. In part due to these, and the perceived relative decline of the European economy (Pitelis and Kelmendi 2010), recent approaches to competition and industrial policies in the Western world have tended to move away from the neoclassical perspective towards an approach and policies aimed at improving competitiveness at the firm and macro levels. There are various versions of this new approach. The 'new industrial policy' approach, for example, retains a neoclassical flavour but emphasises input, linkages and technology policies as incentive-compatible means of improving firm and industry competitiveness (see Audretsch 1998). More general competitiveness models, such as Michael Porter's, focus on the role of firm clusters and other determinants of competitiveness (Aiginger 2006b, Pitelis 2009; Porter 1990). Cluster policy is seen as a new IP (Porter 1998; Jovanovic 2009), based on co-opetition. The focus by the EU on education, (soft) infrastructure, technology and innovation and (clusters of) small firms in the late 1990s represented a move in this direction.

An interesting aspect of EU IP in the 2000s is its shift to a non-neoclassical, arguably evolutionary/resource/system-based approach. First of all, and importantly the very term 'industrial policy' has returned following years of 'disrepute' and a focus on 'horizontal measures'. Related to this, the 'sectoral' element has also resurfaced. Last but not least recent EU policy reads very much like the evolutionary, resource, system-based approach (see Pitelis 1998, 2001). We focus on three recent EU documents or statements here (EC 2002, 2004, 2005, 2007). The major themes of the 2002 document were the following: industry matters; enlargement is an opportunity; sustainability matters; horizontal policy measures need to be applied in response to specific sectoral needs; and that policies need to contribute to competitiveness.[12] Following this, the objective of the 2004 document was for 'industrial policy' to accompany the process of industrial change ('deindustrialisation'). Proposed 'actions' include a 'regulation framework,' 'synergies of policies' and a 'sectoral dimension'. Similarly, in EC (2005, 2007), emphasis was placed on the importance of manufacturing, the synthesis of horizontal and sectoral measures and the need for a synergy between IP, competitiveness, energy and environmental policies in achieving the objectives of the Lisbon Programme. These documents also explicitly adopted a systemic approach and emphasises the role of innovation and regulation in the context of globalisation. In its more recent mid-term review of 'industrial policy' (EC 2007), moreover, the EC put further emphasis in placing its IP in the context of globalization, technological change and the challenges of climate change.

The importance of industry, 'deindustrialisation', 'competitiveness', the 'sectoral dimension', synergies of policies, systemic view, regulation, environmental and energy sustainability and the challenges of (semi)-globalisation in the knowledge-based economy are all well known and accepted themes within the resource-systems-based perspective. Indicatively, these are discussed among many others in Pitelis (1994, 1998, 2001, 2007b, 2009), Pitelis and Antonakis (2003), Edquist (2005) and Lundvall (2007). In this context, EU policies in the new millennium are more in line than ever before with the evolutionary/resource/system-based view and they represent continuous and incremental progress in the right direction. They are, therefore, to be welcomed and maintained especially in the context of the current

[12]For definitions and a discussion of competitiveness, see Aiginger (2006a, b) and Pitelis (2009).

crisis which seems to foster intra-EU protectionist policies that can undermine internal market competition (see *The Financial Times* 2009b).

Despite progress, the broad evolutionary-system-based perspective and the competition-industrial policy implications derived from it suffer from various limitations.

First, innovation is seen as the near exclusive determinant of value creation. Second, the sustainability of the value creation process of the system-wide level is not discussed. Third, value capture by economic agents and its impact on income distribution, unemployment and the sustainability of value creation is all but ignored. In what follows, we try to fill these gaps, by providing a more comprehensive framework of the nature and determinants of value creation, and to discuss the sustainability of value creation and its relationship with value capture strategies.

A Novel Framework: Value, Sustainability and Policy

The theories examined so far pay limited attention to the determinants of value and wealth creation and to the issue of economic sustainability. We try to address these limitations in this section. Starting with value and value creation, two major theories have been developed on the nature of value. These comprise the classical theory of Smith, Ricardo and Marx, which attributes 'value' to the cost of production, in particular the labour power expended to produce a commodity (the 'labour theory of value'), and the 'neoclassical' marginalist notion of 'value' of Jevons, Menger and others who consider value the perceived 'utility' provided by a good to an economic agent. 'Utility', in turn, is affected by 'scarcity' (see Dobb 1973).

The determinants of value/wealth creation were the theme of Adam Smith. In his Wealth of Nations (1776), Smith attributed the wealth-creating abilities of market economies to the 'visible hand' of the firm and the 'invisible hand' of the market. In analysing his 'pin factory', he observed how specialisation the division of labour, teamwork and invention create value and engender productivity. The marvels of the 'visible hand' were then realised by the 'invisible hand' of the market, that is the free interplay of demand and supply by economic agents in pursuit of their own interest. The invisible hand helps to provide information, incentives, coordination, and to realise value through exchange. Competition can ensure that 'natural' prices will tend to emerge. Restrictive practices by, for example, 'people of the same trade' will endanger this result calling for restraint and/or regulation. In the classical tradition, international wealth creation and convergence may follow from Ricardo's theory of 'comparative advantage'; a result predicated, however, on the absence of increasing returns which tend to be ubiquitous in modern knowledge-based and semi-globalised economies (Pitelis 2009).

In the neoclassical tradition, the focus shifted from value creation in production and realisation in markets to exchange relationships, subjective value and efficiency in resource allocation. The aim of economics became one of 'economising', of rational choices between ends and scarce means which have alternative uses (Robbins 1935).

Given scarcity, rationality and the need for economising, the economic aim became one of achieving an efficient allocation of scarce resources.

Efficient allocation has a static and an intertemporal dimension. The former can be achieved through perfectly competitive markets; the latter depends on innovation. Unlike static efficiency, perfect competition or perfect contestability (a market with free entry and costless exit) need not lead to intertemporal efficiency, as they remove the incentive to introduce innovations – the Schumpeterian reward of (transient) 'excess profits'. For Baumol (1991), echoing Penrose (1959), the best type of market structure from the point of view of intertemporal efficiency is big business competition. The potential presence of increasing returns, originally pointed to by Young (1928), suggests that imperfect market structures could well be inevitable, too.

Despite such, and other, challenges, neoclassical economics and economists still rely on a belief that perfectly competitive markets and free trade can deliver the goods and lead to sustainable value/wealth creation. This is true, for example, for the various Washington and post-Washington consensus-type views (see Bailey et al. 2006; Pitelis 2009; Rodrik and Hausmann 2006). A problem with the above reasoning is that it first of all fails to discuss innovation as a determinant of value creation. Second, it fails to realise that wealth/economic performance includes both a value creation and a value appropriation/capture element (and that the latter may impact negatively on the sustainability of the former). The resource-system approach improves upon the neoclassical one, by focusing on innovation, but it shares the other limitations discussed above. This we try to rectify below, by synthesising and extending the resource allocation and resource creation views.

In a capitalist economy, value is created at the level of production, and it is then realised in exchange through the sale of commodities in markets for a profit. Scarcity affects value, but so does the cost of production. The efficient use of scarce resources, notably time, can be instrumental in increasing productivity. The infrastructure of the firm (organisation management, systems), its strategy-corporate governance, its technology and innovativeness, the quantity, quality and relations of its human (managers, entrepreneurs, labour) and non-human resources, as well as its ability to exploit unit cost economies (such as economies of scale, scope, learning, growth, transaction costs and external), are also important determinants of productivity (Pitelis 1998, 2009). These are affected by the external environment. This comprises two layers. First, the meso-environment, which is industry conduct and structure and the consequent industry 'degree of monopoly'. The 'degree of monopoly' serves to realise value by determining the price/cost margin of the industry (see Cowling 1982). The meso level also includes locational aspects and the regional milieu to include the region's 'social capital' (see Putnam 1993). The four determinants at the firm level in their interrelationship with the 'external meso-environment' determine productivity value at the industry, sectoral and regional levels, as illustrated in Fig. 15.1.

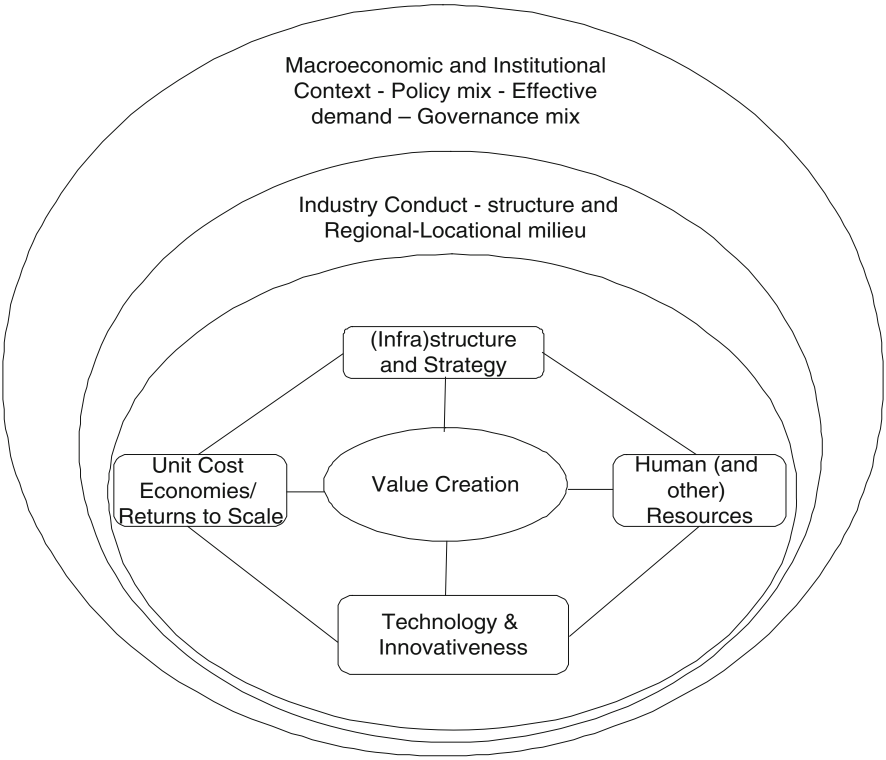

Fig 15.1 The wheel of value: the determination of value creation at the firm, meso and national levels

Moving outwards, the macro-environment (which includes the macro-economic policy mix and the nature and level of effective demand) impacts upon the context in which firms and industry operate and determines the current 'size of the market', and (thus) the value that can be realised at any point in time. It also includes the institutional context and in particular the 'governance mix', which is the 'market-hierarchy-cooperation' mix of economic governance. The institutional environment provides 'sanctions and rewards', culture and attitudes and the overall 'rules of the game' (North 1981). The 'governance mix' determines the overall efficiency of the mode through which the whole economy operates. The resultant 'wheel of a nation' is influenced by the global context. This is the sum of each nation's 'wheel', their synergies and the institutions and organisations of global governance. These impact upon the size of the global market and the overall ability of 'The Earth' to generate value and wealth. The capitalist firm has centre stage in the wheel for its ability to create value. Another important 'actor' is the government. It may, and does, influence the institutional and macroeconomic context through laws, regulations, 'leadership', etc. It can affect the meso-environment through its competition, industrial and regulation policies and the macro-environment through its macroeconomic policies. It can impart upon the determinants of value creation through education and health policies, the provision of national infrastructure, its policies on innovation and 'social capital'.

The neoclassical and resource systems views both share a failure to appreciate that value creation need not automatically imply value appropriation or value capture. To capture value, firms (and also individuals and nations) pursue a panoply of value capture strategies; for example, firms can pursue monopolistic and collusive practices and nations can adopt strategic trade policies. The pursuit of value capture (whether legitimate or not) by one agent may impact negatively on the ability of another agent to further his/her objectives. This in turn may undermine the sustainability of the value creation process. This is an 'agency' issue which, however, is more complex and wider than the traditional neoclassical forms of owners and shareholders. What we have in effect is multiple agency, structured hierarchically – that is, a hierarchy of agencies between firms, nations and the world as a whole (as well as, of course, their various sub-units).

Starting first from the controlling group of the firm (the 'agent') and the corporation as an entity comprising of the sum of its stakeholders (the 'principal'), it can be that the pursuit of personal interests by the former compromise those of the latter. This, for example, is the case when the former pursue strategies that favour short-term share valuation growth and personal compensation packages and perks which are beyond those required to provide them with adequate incentives to pursue the interest of the corporation as a whole, that is, sustainable value creation and capture. This undermines the sustainability of the corporation as a whole and has understandably been the focus of recent corporate governance debates. The second layer is that of the corporation as the agent and the government as the principal. The ability of firms to realise value/wealth can, and often does lead them to attempt to capture wealth as 'rent' through monopolistic and restrictive practices. A high degree of market power can thwart incentives to innovation and be inimical to productivity and value creation. In this context the government (and its governance) becomes crucial. Sustainable productivity value creation requires competition and regulation policies that thwart the creation and use of monopoly power (while allowing for an innovations-inducing 'degree of monopoly'), as well as policies to support small firm creation and survival and regional clusters.

In the third layer, nations themselves (now the agents) can try to capture value by adopting (strategic) trade policies that can harm the process of global wealth creation. The aim of the 'global community' (now the 'principal') should be to require individual governments to adopt policies that enhance global productivity and value/wealth creation. Indicatively governments of developed economies should refrain from policies that restrain trade, yet recognise the need of developing countries to 'foster' infant firms and industries for their expected competition, innovation and productivity effects. This is a far cry for recent crisis-induced (or at least attributed) neo-protectionist policies by the EC and the USA (*The Financial Times* 2009a).

The absence of global knowledge (and a global monitor) calls for diversity. In any country or society, a host of organisations and institutions exists – the family, the church, consumers, NGOs, and even state-owned enterprises (SOEs) – that can affect, in their interaction, the ability of firms' and governments' incentives foster the productivity and value/wealth creation. In this context the issue is the specialisation and division of labour of alternative institutions and organisations based on their respective capabilities in production, exchange, legitimacy, ideology and culture, and the identification of institutional and organisational configurations and conducts that promote efficiency in the form of enhanced productivity and value. Competition and cooperation, self-interest and altruism, big businesses and smaller cooperating firms (such as in clusters); can all impact on the goal of productivity/value improvements?

Sustainability of value creation has implications for environmental, distribution and social policies, notably education, health, and even migration, which follow endogenously from our proposed perspective. Excessive inequities in distribution (which result for example from policies that lend to unemployed), the abuse of the environment and the exodus of educated human resources can thwart a country's ability to generate value. Policies designed to deal with such problems are also part of a government's remit. For example, governments can use market prices to render the actions of 'offenders' expensive (e.g. tax pollutants, require emigrants to developed countries to return public funds-subsidies provided for their education, etc.). In the absence of a 'Dr Pangloss', an approximate way of effecting sustainable value creation is through the free interplay, pluralism and diversity of institutions, organisations, individuals, ideas, cultures, religions, norms, customs and civilisations, as each can serve in part as a 'steward' or 'monitor' for the others. Having said this it is crucial that this process is 'managed', 'guided' and 'moulded' through informed agency so that democracy is married to performance. This brings the issue of global 'governance' and 'power structures' centre stage. A fundamental question is whether different types of power structures and thus global governance impact differently on sustainable value creation. It is beyond the scope of this chapter to address this issue in detail, but some observations can be made.

First, for corporate and public governance to contribute towards sustainable value and wealth creation, internal and also external controls are required including national and global incentives and sanctions. Importantly it is necessary to eliminate corruption at all levels: intra-firm, intra-country (regulatory capture) between host governments and multinationals, and internationally. All these presuppose a degree of trust, social capital and the 'ethical dimension'. Exclusive focus on self-interest may well be the strongest foe of economic sustainability.

Innovation, competition and cooperation (co-opetition) can positively influence all determinants of value creation. All the same productivity enhancements may lead to advantages that can be used to restrict competition. The need for a competition and cooperation (co-opetition) policy thus arises from the need not to thwart the beneficial effects of co-opetition on productivity and value creation. Firm cooperating strategies (for example, firm clusters) that enhance productivity should be facilitated in this context. Non-value enhancing forms of cooperation (like collusion) instead should be forcefully discouraged. The same is true for other restrictive business practices. Mergers and acquisitions should be examined on a case-by-case basis, as they may have value enhancing attributes (Mueller 2006), but may also lead to market power, which can eventually stifle incentives to innovation and productivity. Pluralism and diversity should be encouraged, as they provide benchmarks for comparison and thus information. Institutional changes that facilitate a productivity enhancing culture and ideology and value adding legal frameworks should be aimed at.

Industrial and competition policies should be compatible with macro-economic and other policies (such as education and health), but should also be supported by a facilitatory institutional context.[13] Douglass North (1981) has shown the importance of institutions and institutional change in reducing transaction and transformation costs and increasing productivity and growth. Institutions, but also culture, attitudes and ideology can be hugely important factors in economic organisation. Governments can be a potent catalyst in institutional change, as they possess a monopoly of force and the ability to legislate and regulate. Devising a facilitatory framework is part and parcel of industrial and competition policy. The neoclassical 'market failure' theory of the state assumes the institutional context is given. The possibility to vary it implies a more proactive role for the state. In this context the state should not just intervene when markets fail. Rather, it should legislate and regulate proactively so that markets, firms and the state itself should fail less and contribute to value creation. Importantly, governments should also help augment markets (Olson 2000), but also create markets, much like firms (Pitelis and Teece 2009).

In sum, our analysis points to the need for a broader conceptual framework for industrial and competition policy, to account for the role of innovation, cooperation, institutions and knowledge, and market creation and co-creation. The need for a tough competition policy that discourages the emergence and exploitation of market dominance is maintained and strengthened in this framework. It is also extended to account for 'power structures', by individuals, nations and groups of nations, such as the EU. Our discussion of value capture, the role of 'embedded power structures' and the hierarchy of agencies goes further than extant neoclassical and resource-systems-based perspectives. It puts centre stage the issue of sustainable value creation and its potential foes. This raises the issue of diversity and 'global governance' to thwart anti sustainability practices of powerful players such as the EU itself. Consider, for example, the support the EU provides to Airbus and its Common Agricultural Policy. Both are anti sustainability and they thwart competition, innovation and trade. However, they are likely to continue to do so in the absence of diversity, stewardship and monitoring, alongside enlightenment and supranational governance. In practice, an international competition and regulation agency could arguably help foster sustainable value creation – an issue downplayed by both theory and existing EU policy.

The aforementioned critical remarks on the resource-systems approach should not hide the fact that we consider the resource-systems view and the recent EU policies to be an improvement over neoclassical ideas and a step in the right

[13]On the link between industrial and macroeconomic policies, see Michie and Pitelis (1998) and Bailey and Cowling (2006).

direction.[14] Innovation incorporates, by its very nature, sustainability and value capture characteristics that, up to a point, could help marry value capture to sustainable value creation, but it does not suffice.

Summary and Conclusions

Industrial and competition policies were long being motivated by neoclassical ideas, which are currently challenged by alternative views. In practice competition policies varied between and within countries and were often inconsistent with their alleged objectives. We suggested that the theory of value creation requires a synthesis of resource allocation and resource creation but also the identification of the requisite power structures that allow value creation not to be prejudiced by the pursuit of value capture. We developed a perspective on the determinants of value creation at the firm, meso and national levels. We then explored the limitations of extant theory of the firm, concerning governance and value in its context, and explored some prerequisites of sustainability. Sustainability requires both internal and external controls, to include the market, but also hierarchy (firm and state), as well as institutional and global controls. Institutional diversity and pluralism can help effect mutual ‘stewardship’ and monitoring. For sustainable value creation, corporate governance needs to be aligned with national and global governance, in a way that thwarts the potentially negative impact of some agents’ pursuit of value capture on sustainable value creation. Eliminating corruption at all levels is a crucial prerequisite. All these have important implications for competition and industrial policy.

Industrial and competition policies should be seen within the broader context of enhancing global sustainable value creation. Competition policy should aim at maximising the net benefits from co-opetition. The road to sustainable value creation is not one-way. Countries should exploit the informational benefits from the existence of a plurality of institutional and organisational forms. Theory and history suggest there are no panaceas. Current EU policies are a step in the right direction, but need to pay more attention to the issue of economic sustainability, the link between corporate and public governance, and the impact of different power structures and hierarchies of agencies on supply-side policies for sustainable value creation. The limitations of self-monitoring and diversity suggest the need for an international competition and regulatory policy organisation that aims to foster economic sustainability. This may operate alongside enlightenment and mutual stewardship and monitoring to help sustain the value creation process.

[14]See Bianchi and Labory (2006) and special issues of the *International Review of Applied Economics* (2006), the *Journal of Industry, Competition and Trade* (2006), and *Policy Studies* (2007).

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