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Reengineering Capitalism

From Industrial Revolution towards Sustainable Development

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To the future of my little boys—Oskar and Edvard,
Now you know where effort and hours have passed.
I have been reading, pondering and working so hard,
trying to understand how modern society should last.

Not that I am a prophet, fortuneteller, wizard or such,
telling the future in images and words of convolution.
I am simply afraid we humans have not learned as much,
as we should from 200 years of Industrial Revolution.

Rio, Kyoto, Copenhagen, Paris, Lima and what's more,
what have really changed from all these years of discussion?
Most of us agree on the inconvenient truth from Al Gore.
Yet, all we are left with is just intellectual concussion.

We need not know the impact of every gas and emission,
neither do we need politics based on scientific taxonomy.
All this just hides the simple fact, an obvious omission,
what we need is many, small steps across the economy.

A long journey is made of many small steps in direction,
as an invisible hand guiding every thought and action.
The sum of many over time is the road to true perfection,
provided a consistent system is behind every transaction.

This system can be complex and political or simple and fair,
I am without any doubt what to choose if the choice was mine.
Better to work towards a 70 percent solution than to split the hair;
endless inaction ensues in our search for an optimum too fine.

Special interests, fear, greed and shortsighted transactions
must be rooted out from our economic system forever.
We must amend our capitalist system for concerted action
to move the world with talent and finance as a lever.

Preface

There are risks and costs to a program of action, but they are far less than the long-range risks and costs of comfortable inaction.

John F. Kennedy

This book is borne out of almost 20 years of research in various fields. In the 1990s, I studied cost management, life cycle costing, life cycle assessments, environmental impact assessments, design for the environment, engineering design, simulation models using Monte Carlo methods, and so on. When I started to work as a consultant around 2000, however, I quickly ventured into financial modeling, more cost management, business development, and risk management (both quantitative and qualitative). Then, upon leaving consulting and starting my career in industry in 2004, I studied lean, planning, general management, language and communication and other areas related to the aforementioned areas. All in all, however, this gave me a quite broad background, and as my background widened, I realized more and more the futility of some of the avenues many academics are pursuing and ultimately the current climate approach.

If you have been in a contract meeting and witnessed the amount of energy put down in haggling over relatively minor details, we can just start trying to fathom the amount of disagreement value-laden science will cause of huge, global issues like global warming and general resource usage. I realized two relatively obvious things: (1) Without strong political leadership on global scale, the current approach will never succeed and (2) value-laden approaches make the leadership issue even more demanding and in my opinion impossible. From this, other obvious conclusions are drawn for me—we need (3) a simple and rugged/robust approach free from value judgments and hence no special interest discussions and (4) we must properly engage the economic/financial system because at the end of the day economic/financial considerations prevail in a free market.

Please note that the views presented in this book are solely those of the author and do not represent Rolls-Royce in any fashion whatsoever.

With these ideas, I felt an urge to test my thinking on a qualified audience, so I wrote some papers on the topic and topics related to it. One of the papers resonated with Anthony Doyle at Springer Verlag in London. He read the paper[1] I published in 2013 and found it interesting enough to contact me concerning writing a book—so, here it is.

I have tried to write the book starting from the premises and main ideas in Chap. 1 via the observations I and others have made concerning current efforts as discussed in Chap. 2. The topic of the book is very complex, large, and difficult to present in a clear and coherent fashion because it touches almost every aspect of human civilization. Clearly, this book has greatly reduced the scope of study down to what we can call the capitalist/systemic side of sustainability. This means that I have limited the discussion to issues that have to do with transactions in the global economy as well as changing these transactions via innovation, risk management, public policy, and the like. This is purely systemic issues, and they are far from enough to find a complete solution toward sustainable development. For example, the social aspect of sustainability is a huge field in its own right as is regional issues related to pollution, biodiversity, and the like, but these are omitted in this book due to space restrictions and it is also outside my area of expertise. However, with all these limitations in mind, I still believe that the book can offer valuable discussions or hopefully perhaps trigger some valuable discussions by more competent people.

Both finance and innovation are issues that come natural as a part of this book, so there are chapters discussing finance (Chap. 4), capitalism in general (Chap. 5), and technological development or innovation (Chap. 7). The purpose of these chapters is to show not only that there are significant problems today concerning these topics, but also that in the same topics, there are probably solutions as well known today.

I have provided a more technical discussion on both risk and uncertainty in Chap. 3 because I believe that these twins are often mistreated both in finance, as shown in Chap. 4, and in technological development (innovation)—particularly when we talk about technology with major potential for destruction, as discussed in Chap. 7. Some people may find these technical discussions out of place in relation to the main themes of this book, but I have provided them because the devil is in the details and I believe that we in a number of areas blindly apply theories of risk developed for entirely different purposes. This is a problem as it leads to erroneous decisions. The same is also true for some basic issues like discounting factors, which is why I have included a discussion about that as well. The fact is that much of what we need to know to embark in a more sustainable direction is already known—connecting the dots and making decisions thereafter is perhaps the most important thing we can do in the next years ahead.

But it is probably not enough if we want changes to take root relatively quickly. In the corporate world, it is well known that an important part of change

[1]Emblemsvåg, J. (2013). "How economic behavior can hamper sustainable development." World Journal of Science, Technology and Sustainable Development **10**(4):pp. 252–259.

management is to change performance measures. Therefore, I have launched a relatively straightforward idea as well in Chap. 6—Energy Accounting. Today's climate issues arise from our quest for energy, which is not strange since energy is such a critical input to socioeconomic development. Instead of making complex trading regimes that do not work, why not simply start keeping account for energy consumption in a rigorous way across the economy—just like monetary accounting? Then, the economy will get the information flow necessary to start focusing on energy explicitly and not like today where energy costs are mingled with everything else and are completely lost for most of the economy.

Then, in Chap. 8, it becomes natural to discuss the role of the government—the great leviathan. Political governance and corporate governance are two sides of the same coin, and it is simply naïve to believe that we will have significant changes unless there are significant changes made in political governance. Corporations respond to the frameworks provided by politicians—unfortunately, the reverse has been increasingly true in the shape of special interest groups winning the day and adds to that the fact that political governance is very unclear in many cases. Obviously, this cannot continue. Political leadership is paramount, but not the kind that seeks to satisfy current wants—we need leadership that seeks to take us where we ought to go.

Ålesund, Norway Jan Emblemsvåg

Acknowledgments

This book would never have been published had it not been for Anthony Doyle at Springer Verlag in London who contacted me in 2013. The work presented herein, however, was not all done in 2013—this is the result of work I conducted from the 1990s when I completed my Ph.D. at Georgia Institute of Technology in Atlanta, USA. Since then, I have continued with an interest in the field to stay updated and write papers about relevant topics every now and then. Therefore, I owe many thanks to the people then—and up to now—that have assisted me in various ways, notably Professors Bert Bras at Georgia Institute of Technology and Farrokh Mistree at Georgia Institute of Technology (Kansas University now) who were my closest supervisors and mentors. They taught me how to write and the process of scholarship and research. To regurgitate knowledge is not to think although too often this is the *modus operandi* in school, but they taught me how to think critically and find hidden assumptions from which I could do research and add knowledge through the process of scholarship.

Then, during the course of my Ph.D. work, I realized that what is missing is not so much knowledge or local systems, but will. During my years in industry, as consultant and later as leader, I realized that too often we make things too complex and hence susceptible of discussion and inaction. Then, I started to publish again but with less explicit focus on environmental issues *per se* and more on general resource management including making economically sound decisions because often this is missing. This was learning that became very important for this book, and I would like to thank those I have worked with over the last 15 years to help me realize the utter futility of overly complex methods and tools. Aristotle once said that

> It is the mark of an educated man to look for precision in each class of things just so far as the nature of the subject admits.

How true, but it was industry who taught me this the most effectively—in academia, this often becomes empty words because implementation in the real world is often forgotten or ignored or undervalued. Also, implementing modern thinking with blue-collar workers can be more demanding than with highly educated people—although, to my amazement, I have in many cases experienced blue-collar workers who are more flexible in their mind than many that are highly educated. Education of the mind is clearly something different than education of the heart not to mention common sense!

When it comes to sustainable development, I hope Max Plank is not right, although I fear he is, when he wrote in *The Philosophy of Physics* (1936) that "An important scientific innovation rarely makes its way rapidly winning over and converting its opponents; it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning." Human history has, after all, rarely been characterized by planned changes—too often, crises have led the way.

I would also like to thank the reviewers of this book and people at Springer Verlag for believing in the book in the first place and for helpful comments and suggestions for improvements along the way. I would also like to thank my friend Kristina Kjersem for carefully reading through the manuscript and in the process finding lots of things to fix. When you are deep in the trenches, it is very helpful if someone can give an honest and impartial review. After all, like Wittgenstein said, "The meaning of a word lies with its use."

Thank you all!

Contents

Chapter 1
Frame of Reference

> *All men seek one goal; success and happiness. The only way to achieve true success is to express yourself completely in service to society. First, have a definite, clear, practical ideal—a goal, an objective. Second, have the necessary means to achieve your ends—wisdom, money, materials, and methods. Third, adjust your means to that end.*
>
> Aristotle

The Kyoto Protocol from 1997 heralded a new era toward a sustainable future many believed; however, it should come as no surprise that little has happened. While some might argue that it is because some has not ratified the agreement, the reality is that it could never succeed. This book will make it clear why, and in response present a different approach based on insights from the Industrial Revolution. This said, to directly transfer findings from one historical context to another will not work so we are talking more about the underlying concepts, principles and ideas resulting during and from the Industrial Revolution.

Many believe that the Industrial Revolution in Great Britain, and later worldwide, was a technical revolution alone. This is a common simplification that is important to discuss and debunk if our societies are to become sustainable. The technical marvels of James Watt (1736–1819), George Stephenson (1781–1848) and other pioneers were naturally an ingredient of the revolution, but they were far from sufficient. In fact, Georg Friedrich List (1789–1846) claims outright that[1],

> It is absurd to attribute specially to the English greater mechanical talent, or greater skill and perseverance in industry, than to the Germans or to the French. Before the time of Edward III the English were the greatest bullies and good-for-nothing characters in Europe; certainly it never occurred to them, to compare themselves with the Italians and Belgians or with the Germans in respect to mechanical talent or industrial skill; but since then their Government has taken their education in hand, and thus they have by degrees made such progress that they can dispute the palm of industrial skill with their instructors.

[1]See his classic from 1841; List, F. (2005b). *The National System of Political Economy—Volume 3: The Systems and the Politics*. New York, Cosimo Classics. p. 124.

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The plain fact is that the British Industrial Revolution depended on water power (and not steam power) for more than half a century, and by improving the design of water wheels, Joseph Smeaton (1724–1792) more than doubled the power output in the late 1700s.[2] In fact, at the beginning of the Industrial Revolution, *natural* advantages were the key, but these were soon overtaken by *created* advantages.

Technical marvels are no strangers to human history—take the invention of concrete in Roman time… yet, nothing revolutionary happened except that they could make buildings like nobody else for centuries to come. Even the financial contract itself had been invented without triggering a revolution, although it has been an indispensable innovation in human development for at least 7000 years.[3] Interestingly, even the results after the so-called digital revolution are hard to detect. In fact, Nobel laureate Robert Solow points to the failure of new technology to boost productivity stating that "like everyone else, are somewhat embarrassed by the fact that what everyone feels to have been a technological revolution… has been accompanied everywhere… by a slowdown in productivity growth."[4] The phenomenon is now known as the Solow paradox. There are several explanations for this—based on my review on innovation the last years—I believe that it is due to time lag between the potential new technology offers and society's ability to harvest this potential through changes in work practices, organization, leadership, etc. This also occurred during the Industrial Revolution.

This is essentially what List also says—it is everything *around* technology that takes time to build and is hard to establish. It requires a systemic effort where technology is actually a rather small piece of the puzzle. It is tempting to draw some linkages to lean conversions where it is often said that 20 percent of the result is created by technology changes (hardware), whereas changing people (software) produces 80 percent of the results and naturally takes most of the time and effort.[5] Therefore, I believe that the Industrial Revolution did not really come in place due to technology, but the changes that came put technology in a better context enabling a self-reinforcing, and hence revolutionary, process to take place. Providing this context must be the primary objective in our quest toward sustainability—not researching new technology per se.

In short, changes in legislation and institutions were the key, as we will see later. One of the most important legislative changes was the law of limited liability because they were a key to industrial capitalism which fueled the revolution.[6]

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[2]See Freeman, C. (2002). "Continental, national and sub-national innovation systems—complementarity and economic growth." *Research Policy* **31**(2): pp. 191–211.

[3]According to The Economist (2014c). The slumps that shaped modern finance. *The Economist*. **411:** pp. 47–52.

[4]See The Economist (2014d). *Special report on World Economy: The third great wave*. London, The Economist. p. 18.

[5]See for example Mann, D. (2010). *Creating a Lean Culture: Tools to Sustain Lean Conversions*. New York, Productivity Press. p. 316.

[6]According to The Economist (1999b). The key to industrial capitalism: limited liability. *The Economist*. **353:** pp. 97–98.

The first law of limited liability was passed in the State of New York in 1811, and in 1854, Great Britain followed suit. This meant that shareholders were no longer personally liable for what the corporation did; they only risked losing their capital. Prior to limited liability investors "…would be potentially liable to the full extent of his personal wealth for the debts of the corporation,"[7] which meant that he could lose everything he owned and possibly being imprisoned. This new system unlocked vast sums of money that spurred innovation, and it ultimately financed the Industrial Revolution and made it truly revolutionary and gave basis for industrial capitalism for which America is so famous for. In other words, the laws of limited liability shifted the risk calculation for investors over from "too risky" to "acceptably risky." The interesting thing is that the conditions affecting innovation during the Industrial Revolution are still important for success today.[8]

A second important change in legislation was the rule of law and a strategic approach to building industry. The fact that the Industrial Revolution started in Great Britain is not accidental if we are to believe the excellent account of List,[9] which we will discuss in length later. A third important change, interrelated with the two first, was the systematic application of science—or at least knowledge—to solving problems. A fourth important change—as important as the technical innovations—was innovations in organization and management.[10] Professionalism and specialization of key management functions and standardization of information, accounting, and administrative procedures were among these innovations. The Ford Model T, for example, fell in price from USD 850 in 1908 to USD 350 in 1916, and this is due to the interplay between organizational, technical, and social innovations. In *The Economics of Industrial Innovation*,[11] Christopher Freeman (1921–2010) and Luc Soete describe innovation through the Industrial Revolution to these days and this book is a must-read for anyone interested in understanding innovation where this and many more examples are provided.

The lesson is clear: The technical marvels and the revolution itself were products of more fundamental processes in society, and if we are to achieve sustainable development, we must at the very least make sure that (1) the economic system pulls in the desirable direction by (2) fostering systemic development which will help us (3) leverage all available knowledge at any time for the best of mankind.

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[7]See Jensen, M. C. and W. H. Meckling (1976). "Theory of the Firm: Managing Behavior, Agebcy Costs and Ownership Structure." *Journal of Financial Economics* **3**(4): pp. 305–360.

[8]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

[9]See the historical account of List, F. (2005a). *The National System of Political Economy—Volume 1: The History*. New York, Cosimo Classics. p. 142.

[10]This claim is made by Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

[11]See Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

Then, and only then, it will work. If sustainability is to take place despite the economic system, without democratic processes and based on ignorance chances are that there will be no, or very limited, sustainable development.

As of today, compliance is seen as a cost by most and not as an opportunity because on the one hand, it is not internal to the economic system, and on the other hand, the societal system is not rigged to embrace sustainability as a genuine new way. Nobody sees international banking agreements as costs, nobody sees printing money as a cost, nor do we consider accounting a cost… they are seen as inherent in the system and hence necessary and therefore acceptable. Where is a similar information and transaction system supporting sustainable development? What we have thus far is a value-laden system causing more political stir than real actions.

The fact is that over the years after the Kyoto Protocol, corporations still find it difficult to implement comprehensive change and even more so to drive strategic innovation for sustainability.[12] This finding is also echoed in the sustainability management literature, as well.[13] What corporations pursue today is just easy, incremental improvements like energy efficiency initiatives with quick paybacks.[14] This is laudable efforts, but not enough to constitute sustainable policies in themselves. In fact, a study shows[15] that corporations that adopted sustainability policies between 1992 and 2010 not only were more profitable than others but also commanded a higher stock market valuation than corporations that did not (though it should be mentioned that this may actually be the other way around; well-run corporations adopt sustainability policies). Such efforts, *The Economist,* refer[16] to as the first wave of sustainability, and they rightfully claim that this wave is profitable in itself because it ultimately concerns using resources more efficient, and the potential is obviously there. In fact, it is estimated that the economic value of the entire biosphere is in the range of 16–54 trillion USD with an expected value of 33 trillion USD.[17] The global gross national product (GNP) in contrast constitutes about 18 trillion USD. Clearly, the services provided by the world's ecosystems are more valuable than our own economy, and it must be so since the human world is a subset of the natural world. Later, when we discuss the financial world, these numbers are interesting to keep in mind when we look at the total notional value

[12]According to Steger, U., A. Ionescu-Somers, O. Salzman and S. Mansourian (2009). Sustainability Partnerships. The Manager's Handbook. New York, Palgrave Macmillan. p. 296.

[13]According to Szekely, F. and H. Strebel (2013). "Incremental, radical and game-changing: strategic innovation for sustainability." Corporate Governance **13**(5): pp. 467–481.

[14]According to Winston, A. (2014). "Resilience in a Hotter World." *Harvard Business Review* **92**(4): pp. 56–64.

[15]The study is authored by Robert Eccles and George Serafeim of Harvard Business School, see The Economist (2014b). A new green wave. *The Economist*. **412:** pp. 53.

[16]See The Economist (2014b). A new green wave. *The Economist*. **412:** pp. 53.

[17]See Constanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton and M. van der Belt (1997). "The value of the world's ecosystem services and natural capital." *Nature* **387**(15 May): pp. 253–260.

for the financial markets. Apparently, the notional value of trading risk is more valuable than our entire biosphere…

If we then start to realize that what we have treated as economic externalities for hundreds of years in fact have economic value in the long run, then some interesting discussions can emerge. The problem is that the long run is a hard sell in many cases and estimating the value is hard to say the least. In fact, Adam Smith (1723–1790) pointed out this reality many years ago stating that[18]:

> Nothing is more useful than water: but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it.

Bowing to the primacy of economics, the Millennium Ecosystem Assessment, a huge global study of the state of the planet published in 2005, pushed the idea that nature provided "ecosystem services" to people as a way of persuading humanity that it trashed nature at its peril. That led to the establishment of The Economics of Ecosystems and Biodiversity, an initiative designed to estimate and publicize the economic benefits of biodiversity.[19] The same ideas are explored in a number of concrete cases.

The National Research Council in the USA, for example, presents a case[20] where the city government of New York changed its strategy concerning its water supply based on sound economic analyses. New York City government realized that changing agricultural practices would force it to act to preserve the water quality of the city's drinking water. The traditional approach would have been to build a water filtration plant at the cost of staggering 4–6 billion USD in investments and then annual operational costs of about 250 million USD. However, they realized that by buying land worth 250 million USD to prevent development and then pay farmers 100 million USD to minimize pollution, a huge saving was achieved. Needless to say, in this case, protecting the environment and sound economic thinking went hand in hand. Another case is Procter & Gamble whose cooperation with environmental Nongovernmental Organization (NGO) has help them save almost $1 billion over the last 10 years.[21] Such win-win situations are probably much more common than we believe,[22] but all too often decisions are based on erroneous analysis, and hence, economic and environmental concerns seem to be trade-offs when they in reality often are win-win situations.

[18]Quoted by The Economist (2014e). "Valuing the long-beaked echidna." *The Economist*.

[19]Quoted by The Economist (2014e). "Valuing the long-beaked echidna." *The Economist*.

[20]See National Research Council (2000). *Watershed Management for Potable Water Supply: Assessing the New York City Strategy*. Washington, National Academy Press. p. 564.

[21]See The Economist (2013). "The butterfly effect." *The Economist* **409**(8860): pp. 63.

[22]For more examples see Pagiola, S., K. von Ritter and J. Bishop (2004). *Assessing the Economic Value of Ecosystem Conservation*. Washington DC, World Bank. p. 58.

From successful stories like these, much of industry sees the economic potential in leading the way toward sustainability at least in the long run, and some therefore call the quest toward sustainability "the biggest investment opportunity in history."[23] Currently, however, environmental management is at best left-hand work in most corporations. The reasons are many such as:

1. Management is unaware of the great savings environmental management can yield. The Rocky Mountain Institute estimated in 1997 that in the USA alone, the annual potential savings from improved energy management are roughly $300 billion.[24] Today, it must be higher or at least in the same ballpark figure.
2. Industry is becoming increasingly focused on short-term financial gains often with damaging consequences for both the environment and the long-term economic performance of businesses. This problem is complex as discussed in Chap. 4, yet much can be improved by putting risk back where it belongs and also limit some of the most questionable aspects of the financial markets.
3. Environmental management approaches are still in their infancy, impractical and largely "indecipherable to the non-expert,"[25] and they have not improved much over the years.
4. There is no common baseline for benchmarking due to lacking comparability, which unfortunately means that we do not know what is better than the other and how we should prioritize. Ultimately, this will prevent us from making any *real* progress toward sustainability, and it can become the demise of environmental management if it continues.
5. There is limited market thrust toward sustainability, i.e., there is no *green* Invisible Hand as it were. There are several reasons for this as discussed later, but some related to the legal side alone are as follows:

   (a) The political and legislative processes are subject to vested interests that can block any meaningful change.[26]
   (b) The policy and legislative processes prevent the introduction of new improved technologies. In the USA, for example, it is estimated that[27]:

      - The legislative structure is at the best unconcerned with, or at the worst inimical to, technological innovation.

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[23]See Lovins, A. B. and L. H. Lovins (1997). *Climate: Making Sense and Making Money*. Old Snowmass, CO, Rocky Mountain Institute. p. 39.

[24]See Lovins, A. B. and L. H. Lovins (1997). *Climate: Making Sense and Making Money*. Old Snowmass, CO, Rocky Mountain Institute. p. 39.

[25]According to Vigon, B. (1997). SETAC Foundation Life-Cycle Assessment Newsletter, Society of Environmental Toxicology and Chemistry (SETAC). **17:** pp.

[26]According to Bradbrook, A. J. (1994). "Environmental Aspects of Energy Law—The Role of the Law." *Renewable Energy* **5, part III**(5–8): pp. 1278–1292.

[27]See Heaton Jr., G. R. and R. D. Banks (1997). "Toward a New Generation of Environmental Technology; The Need For Legislative Reform." *Journal of Industrial Ecology* **1**(2): pp. 23–32.

- Various environmental problems have different legal and administrative regimes, while companies often perceive environmental problems as more integrative than the law effectively allows.
- There is an implicit bias against new technology, e.g., in pollution control, often there are stricter regulations for new facilities than for old.
- The regulatory decision process is slow and discontinuous so that standards quickly become obsolete in the face of continuing technical advance.

Of the five aforementioned points, we see that the first is concerning general ignorance, which is the easiest to overcome because it is a matter of education. The second point we will discuss in Chap. 4, which leaves us the three last points. These points are concerning systems in general which are crucial because systems determine behavior, and behavior determines what we do which ultimately determines our future: We must reengineer business so to speak and to do that we must reengineer some of the rules of capitalism.

Unfortunately, major systemic problems are not solved at all and this is probably because the system boundary of most corporations starts too late and ends too early to make any real impact in environmental footprint. In fact, the majority of corporation's environmental footprint and social impact are not within their direct control but lies also upstream with suppliers as well as downstream with customers using the product.[28] Basically, the current approach does not work well and as it will be shown later—it cannot work well.

Some corporations have anyway embarked on what *The Economist* refers to as a second wave of sustainability.[29] These corporations pursue policies both upstream and downstream to do good even though there are no direct economic gains—in fact, there can be outright costs. This is extremely laudable, but these corporations have a wider strategic intent than merely cost and resource efficiency; they prepare for the days when customers, regulators, and others demand better behavior to such an extent that it can indeed become a license to operate. These corporations also face similar problems even though they have extended their system boundaries—they have no consistent source of information which can help them make informed and correct choices. Efforts today are laudable, but essentially they are islands of actions in a sea of incoherent policies. Sustainability is "a buzzless buzzword," as William Ernest McKibben eloquently dismissed current efforts.[30]

So how do we reengineer the capitalist system to better foster sustainable development? That is the supreme question in this book, and I hope this book

[28]According to Winston, A. (2014). "Resilience in a Hotter World." *Harvard Business Review* **92**(4): pp. 56–64.

[29]See The Economist (2014b). A new green wave. *The Economist*. **412:** pp. 53.

[30]Quoted by The Economist (2014b). A new green wave. *The Economist*. **412:** pp. 53.

will give some ideas. It should be noted that the term "the capitalist system" is a bit ambiguous because it does not capture everything that belongs there—only what is pertinent to the discussions in this book. It includes laws, regulations, policies, markets of various kinds, and other impersonal aspects impacting the global resource usage. Note that we focus on resource usage and not just the economy. This is due to the problems of many resources being external to the economic system or at least very poorly captured. Trying to reduce the externality problems of the current economic system is therefore fundamental in improving the capitalist system out of which the financial and economic systems constitute major parts.

Before continuing, the term "sustainable development" must also be defined. Until the late 1970s, the word "sustainability" was only occasionally employed and typically in the context of forest management.[31] Over the years, there have been many definitions[32] until 1987 when the World Commission on Environment and Development (WCED) published its report—also known as the Brundtland Report.[33] This report offered the following definition on sustainable development: "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition is now the one that is most commonly used. However, to operationalize it is very difficult—it seems—because that is what most researchers and policy makers attempt when they want to legislate ourselves toward a sustainable future. It is almost like a Marxist approach toward growing an economy—a central body makes some plans based on some input, roll them out, and handle deviations… Like Karl Marx (1818–1883), these people have an excellent understanding of the problem, but they go about solving it without understanding complex social systems, which results in failure. This will be addressed as well in this book.

Then, we have some practical issues. Current environmental management and policy efforts such as the ISO standards are not working properly because they do not provide comparable results and consistent decision support.[34] The lack of comparability is a major problem several industry representatives have pointed out,[35] and they have not abated since 1997. This means that standardizing ourselves toward a sustainable future will also not be sufficient. Just like ISO 9000

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[31]According to Filho, W. L. (2000). "Dealing with misconceptions on the concept of sustainability." *International Journal of Sustainability in Higher Education* **1**(1): pp. 9–19.

[32]See Filho, W. L. (2000). "Dealing with misconceptions on the concept of sustainability." *International Journal of Sustainability in Higher Education* **1**(1): pp. 9–19.

[33]See World Commission on Environment and Development (WCED) (1987). *Our Common Future*. New York, Oxford University Press. p. 400.

[34]According to Emblemsvåg, J. and B. Bras (1999). "LCA Comparability and the Waste Index." *International Journal of Life Cycle Assessment* **4**(No. 5, September): pp. 282–290.

[35]According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

quality management system standard in many ways has not properly delivered[36]—although it is perceived as a step in the right direction by most—the ISO 14000 environmental management system standard is likely to work the same way since they are built around the same concept. The most commonly cited advantage for ISO 9000 implementations is increased market opportunities and subsequent sales; however, when it comes to the quest for sustainable development, we must aim for real, physical effects—not effects due to signaling effects and the like. While signaling effects would be beneficial if we knew that this would promote sustainable development, the problem is that as long as we cannot be sure about the real, physical effects, a signaling effect can just as easily pull us away from sustainable development as toward it.

This does not mean that such standardization is counterproductive—it means that it is insufficient as the main approach toward sustainability, but it is definitively useful for organizations that want to improve and have a desire to do so. As former COO of Toyota and key member of the people that invented lean, Taiichi Ohno (1912–1990) said, "Without standards, there can be no improvement." Although he spoke of a different type of standards, the idea is fundamentally right. A more deep-reaching approach is nonetheless warranted and using the Industrial Revolution as guide—it has to be achieved by internalizing the environmental issues into the economic system in one way or the other.

One attempt of internalizing environmental issues—or commonly referred to as externalities—into the economic system is to estimate their value and then say that a certain loss of this value translates into a cost for society. Typically, we have values related to use—for example, water to drink, bees that pollinate, and bacteria that fertilize soil—and we have values related to nonuse such as a beautiful sunset and open areas for free usage for everybody but also man-made marvels such as the Bamiyan Buddhas that Taliban destroyed. However, as *The Economist* points out[37], "setting a price on nature is a useful exercise, up to a point." The problem is

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[36]In the literature, the findings are mixed, for example:

1. Virtually all studies find little or no impact on operational performance and actual quality levels. Many studies are also constrained by the fact that the researchers have vested interests in the continuation and evolution of the ISO 9000 standard, see Douglas, A., S. Coleman and R. Oddy (2003). "The case for ISO 9000." *The TQM Magazine* **15**(5): pp. 316–324.
2. Some studies find increase in sales and improved market opportunities, see, for example, Terlaak, A. and A. A. King (2006). "The effect of Certification with the ISO 9000 Quality Management Standard: A Signaling Approach." *Journal of Economic Behavior & Organization* **60**(4): pp. 579–602.
3. Some studies find ISO 9000 implementations correspond to higher sales and profitability in companies; however, what is the cause and what is the effect is unclear—and this is a problem in most studies, see Heras, I., G. P. M. Dick and M. Casadesus (2002). "ISO 9000 registration's impact on sales and profitability: A longitudinal analysis of performance before and after accreditation." *International Journal of Quality & Reliability Management* **19**(6): pp. 774–791.

[37]See The Economist (2014e). "Valuing the long-beaked echidna." *The Economist*.

that such approaches are relying heavily of value judgments and this invites debate once we go beyond what some people find reasonable.[38] Also, collaboration across corporations is often hindered due to competitive self-interest, lack of fully shared purpose, and shortage of trust, and ultimately, "the best way to scale collaboration is through markets that have the right incentives in place." [39]

Therefore, we need an approach that is consistent and value neutral and covers entire industries and supply chains so that investors, executives, and policy makers—people in short—can make proper decisions from "…standardized, comprehensive information that is consistent over time. So far they are not getting it," *The Economist* laments[40] and points out that there ought to be generally accepted accounting principles for the environment. The lack of it is indeed one of the greatest hurdles in environmental management, something I pointed out more than 15 years ago in my PhD research which led me to conclude that current efforts were largely wasted.[41]

Another practical issue is the political problems with some solutions to our quest for energy. Nuclear power and hydraulic fracturing (fracking) are currently under strong suspicion from the public and others. This we must solve because energy consumption is a vital factor in socioeconomic development.[42] If we fail here, there may be no solution. A major issue is therefore how policy makers, scientists, and engineers alike can regain the trust of the public concerning major facilities such as nuclear power plants. One way of doing that is to change the way risk management is performed because today, it fails too often eroding the public trust for every instance. We cannot afford this. Trust can be quickly ruined, but it can take decades to rebuild.

We also have a number of behavioral issues in today's financial markets and the corporate world that must be handled. With short-termism and herding on epic scale, it is hard, if not impossible, to implement anything that cannot have quick payback. Issues concerning sustainability do not spring to mind as quick wins for boosting corporate profits. In fact, the opposite is often the case; we squander the natural as well as the human resources with little respect for what happens down the road. This cannot continue but as outlined in this book; there are remedies.

Before continuing, I cannot emphasize enough the importance of also working toward sustainability on local and regional level. The approach advocated here is aimed for global level only, because then we are concerning with the economic

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[38]See Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[39]See Nidumolu, R., J. Ellison, J. Whalen and E. Billman (2014). "The Collaborative Imperative." *Harvard Business Review* **92**(4): pp. 76–84.

[40]See The Economist (2014a). A green light. *The Economist*. **410:** pp. 62.

[41]See the book version of my dissertation, Emblemsvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.

[42]See Olsson, L. E. (1994). "Energy-Meteorology: A new Discipline." *Renewable Energy* **5 Part II**: pp. 1243–1246.

system, financial systems, political systems, and so on. On local and regional level, we have issues such as biodiversity, management of heavy metals, pollution of the sea and waterways in general, natural capital, and ecosystem services in general. These are incredibly important issues to address, but this beyond the scope of this book.

I would also like to emphasize another issue that often comes into play when we discuss sustainability and that is equitable distribution among countries, generations, social layers, and in general between the rich and the poor. I believe that we greatly hinder a productive debate as to some of the systemic aspects of sustainability by mixing these issues into the debate. Not because they are unimportant, because they are not—the poor has rarely the luxury of thinking 10 years ahead and is often forced to making unsound, short-term decisions in order to merely survive. In fact, poverty is a problem in itself concerning the quest toward sustainability.[43] The problem is that we too often end up in a political and ideological debate where the rich world becomes defensive, which in turn prevents sensible solutions that we all could benefit from because the solutions become tied up in a political tug-of-war and not in a quest to find a better solution for at least some aspects of the big issue of sustainability.

In other words, the challenges of finding equitable solutions for the rich and poor and the challenges of finding local and regional solutions must not prevent us from making progress as to the overall global, economic system which are good for all no matter how we see it. Since I have claimed that we can learn from the Industrial Revolution, it is useful to review what happened back then in greater detail which is briefly done next and in greater detail later. Then, we look at how complex systems work and why a systemic, deep-reaching approach is so crucial.

1.1 The Industrial Revolution in Brief

> Lost wealth may be replaced by industry, lost knowledge by study, lost health by temperance or medicine, but lost time is gone forever.
>
> Samuel Smiles, author (1812–1904)
> Self Help (1859)

The role of innovations in driving economic growth is indisputable, but it took some time before it became an area of study. One of the earliest acknowledgements is provided by Marx who wrote that “the bourgeoisie cannot exist without

[43] This view is also supported by other such as Patrick Moore, one of the five cofounders of Greenpeace, see Murphy, G. (2008). “A Conversation with Patrick Moore: Why Former Greenpeace Leader Supports Nuclear Energy.” *EIR Science & Technology* (16 May): pp. 58–63.

constantly revolutionizing the means of production."[44] Yet, it was Joseph Alois Schumpeter (1883–1950) that first gave innovation a centerpiece in his theory of economic development.[45] In his book[46] first published in 1911, he introduced the very important distinction between invention and innovation where the former is viewed as an idea, a sketch, or model for a new or improved device, product, process, or system, whereas the latter is only accomplished once the first economic transaction involving the invention is carried through. His theory focused on a sort of people he called "entrepreneurs" who were the innovators of change usually in a disruptive sense thereby altering the *status quo*.

Often, it is useful to step back and investigate the historical understanding of a word. Russel S. Sobel delineates the term "entrepreneur" like this[47]:

> The word "entrepreneur" originates from a thirteenth-century French verb, entreprendre, meaning "to do something" or "to undertake." By the sixteenth century, the noun form, entrepreneur, was being used to refer to someone who undertakes a business venture. The first academic use of the word by an economist was likely in 1730 by Richard Cantillon, who identified the willingness to bear the personal financial risk of a business venture as the defining characteristic of an entrepreneur. In the early 1800s, economists Jean-Baptiste Say and John Stuart Mill further popularized the academic usage of the word "entrepreneur." Say stressed the role of the entrepreneur in creating value by moving resources out of less productive areas and into more productive ones. Mill used the term "entrepreneur" in his popular 1848 book, *Principles of Political Economy*, to refer to a person who assumes both the risk and the management of a business. In this manner, Mill provided a clearer distinction than Cantillon between an entrepreneur and other business owners (such as shareholders of a corporation) who assume financial risk but do not actively participate in the day-to-day operations or management of the firm.

Herein lies a central point—inventions are relatively risk-free, whereas innovations are not. You can be an inventor, go into your garage, and put something together to check out that your idea works. You can make a model or merely a sketch to start with. It is when economic transactions are committed that financial risks escalate and we enter the process of innovation, which hopefully ends up with an innovation that the entrepreneur comes onto the stage. The management of risk is therefore central to innovation and the reason why the laws of limited liability were so important. Society limited significantly the risk of poverty and removed the risk of imprisonment from the entrepreneur who thereafter only risked the equity of his enterprise. This unleashed huge amount of financial resources which fueled the revolution. However, there is more to the story that is of great importance to this book.

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[44]See Marx, K. (2004). *Capital: Critique of Political Economy, vol. 1*. London, Penguin Classics. p. 1152.

[45]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

[46]See Schumpeter, J. (1911). *Theorie der wirtschaftlichen Entwicklung (English translation: "The Theory of Economic Development", Harvard, 1934)*. Leipzig, Verlag von Duncker & Humboldt. p.

[47]See Sobel, R., S. (2008). Entrepreneurship. *The Concise Encyclopedia of Economics, 2nd edition*. D. R. Henderson. Indianapolis, IN, Liberty Fund, Inc.

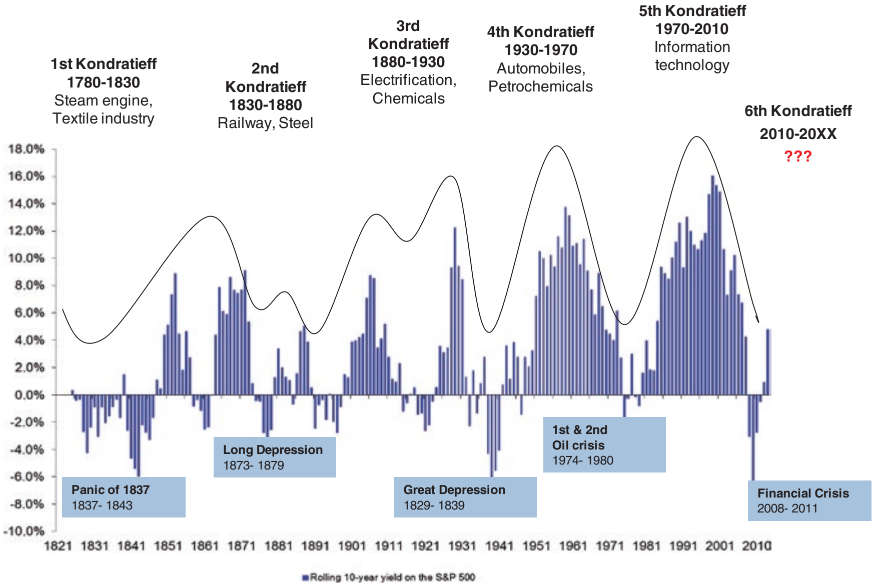

Fig. 1.1 The last six kondratiev cycles. Used with kind permissions from Global Capital Markets and Thematic Research Allianz Global Investors

First of all, I use the term "Industrial Revolution" in singular. However, it is important to be aware of the fact that there were quite clear successive waves of technical changes all revolutionary in their own way. Although there is no universally accepted precise description of these waves, they are typically referred to as Kondratiev (often also written Kondratieff) waves, or cycles, after the Russian economist Nikolai Dmitriyevich Kondratiev (1892–1938), and it is generally acknowledged that they typically last about 50 years. Their causes are, however, subject to discussion. Nonetheless, it was Jacob van Gelderen[48] (1891–1940) and Schumpeter[49] that first[50] saw technological change in a wide sense as a driver of these waves.

Allianz has presented the cycles as shown in Fig. 1.1. They have also highlighted the most important technical innovations. The explanations in Fig. 1.1 are commonly accepted across the literature. I am not going to speculate here about what will drive the next wave, but I do hope that environmental technology or

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[48]See van Gelderen, J. (1913). "Springvloed Beschouwingen over industrielle Ontwickkeling en prijsbeweging (Spring tide, Reflection on industrial development and price fluctuation)." *De Nieuwe Tijd* **184**(5 & 6).

[49]See Schumpeter, J. (1939). *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*. New York, McGraw-Hill Book Company. p. 461.

[50]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

society realigning toward a sustainable future will be the driver of one wave in the future and that must certainly be the case if we are to develop our societies in a sustainable direction. Figure 1.1 also shows something other important—new megatrends, as some call them, or cycles are born out of crises. It is not that the old technologies become obsolete per se; they have just lost their capabilities to drive significant growth and some even wither away almost completely depending on the new technologies such as the steam engine using in transportation.

If we look a little bit more on the first wave, it is easy—and common—to think that they just invented a steam engine and used it unchanged for decades. However, just like today, there were successive versions and significant improvements as shown in Table 1.1.

If we look at the coal consumption of steam engines, we see even bigger improvements, see Table 1.2. Clearly, innovation is nothing new.

Similar developments were also seen in the cotton industry, see Table 1.3. Here, we see the remarkable rise in productivity as measured by the number of operating hours required to process (OHP) 100 lbs of cotton due to process innovations. From handcraft in the eighteenth century until today, we see a 125,000 percent productivity increase or 1250 times improvement.

The question is how could such improvements take place and what were their implications?

If we consider typical industry life cycles and their characteristics today as shown in Table 1.4, it is clear that technological change certainly is very crucial. However, it is also evident that other forces are at play and that was also the case more than 100 years ago.

Table 1.1 Development of steam engine performance around 1800

Horsepower	Cost per horsepower (£)
2	89
10	40
20	30

Source von Tunzelmann (See von Tunzelmann, G. N. (1978). Steam Power and British Industrialization to 1860. Oxford, Oxford University Press. p. 356.) and used with kind permission of Oxford University Press

Table 1.2 Coal consumption in various types of steam engine in manufacturing applications

Engine	Approximately when	Coal per horsepower (lbs/horsepower)
Savery engine	Eighteenth century	30
Newcomen engine (mines)	1700–1750	20–30
Newcomen engine	1790	17
Watt low-pressure engines	1800–1840	10–15
High-pressure engines	1850	5

Source von Tunzelmann (See von Tunzelmann, G. N. (1978). Steam Power and British Industrialization to 1860. Oxford, Oxford University Press. p. 356.) and used with kind permission of Oxford University Press

Table 1.3 Labor productivity increases in cotton industry

Technology	OHP 100 lbs cotton
Manual spinning by Indians (Eighteenth century)	50,000
Crompton's mule (1780)	2000
100-spindle mule (c.1790)	1000
Power-assisted mules (c.1795)	300
Robert's automatic mule (c.1825)	135
Most efficient machines today (1990)	40

Source Jenkins (See Jenkins, D. T. e. (1994). The Textile Industries, Vol. 8. The Industrial Revolution in Britain. E. A. Wrigley and R. A. Church. Oxford, Wiley-Blackwell.) and used with kind permission from Wiley-Blackwell

Analysis of historical records from the Industrial Revolution reveals that there were other significant causes and effects in a self-reinforcing and mutually adjusting development cycle that were present in addition to the technical changes and laws of limited liability, which is already mentioned. Different people have different explanations, or at least different emphasis of factors in their explanations, of what took place when we discuss matters in greater details. Adam Smith witnessed the early stages of the Industrial Revolution as it unfolded in the 1760s and 1770s. Although the agrarian economy was huge in comparison with manufacturing in those days—in fact, as late as in 1900, 40 percent of Americans were employed in agriculture; today, it is less than 5 percent in most rich countries[51]—he focused in his *The Wealth of Nations* on technical change, capital accumulation, and division of labor leading to specialized skills as factors leading to industrialization and growth.[52] Almost all historians agree on the importance of these factors,[53] yet perhaps one of the most interesting discussions is provided by List, see Chap. 5.

Without going into each Kondratiev wave in detail, we find a number of interesting causes/effects that should certainly remind ourselves about what takes place today. First, the vast majority, then and now, of improvements are incremental improvement to existing products and processes and, as Smith also observed, are often made by workers who use machines in different types of workplaces.[54]

Second, the role of education was probably significant then as now. This is evident from the fact that Scotland provided an unusual high number of inventors (Watt and most of his assistants, Sinclair, Telford, MacAdam, Neilson, and many

[51]According to The Economist (2014d). *Special report on World Economy: The third great wave*. London, The Economist. p. 18.

[52]See Smith, A. (1981). *An Inquiry into the Nature and Causes of the Wealth of Nations, Volume I*. Indianapolis, IL, Liberty Fund. p. 543.

[53]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

[54]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

Table 1.4 The evolution of industry structure and competition over the life cycle stages denoted introduction, growth, maturity, and decline

	Introduction	Growth	Maturity	Decline
Demand	Limited to early adopters; high income, avant-garde	Rapidly increasing market penetration	Mass market, replacement/repeat buying. Customers are knowledgeable and price-sensitive	Obsolescence
Technology	Competing technologies, rapid product innovation	Standardization around dominant technology, rapid process	Well-diffused technical know-how; quest for technological improvements	Little product or process innovation
Products	Poor quality, wide variety of features and technologies, frequent design changes	Design and quality improvement, emergence of dominant design	Trend to commoditization. Attempts to differentiate by branding, quality, and bundling	Commodities the norm; differentiation difficult and unprofitable
Manufacturing and distribution	Short production runs, highly skilled labor content, specialized distribution channels	Capacity shortages, mass production, competition for distribution	Emergence of overcapacity, deskilling of production, long production runs, distributors carry fewer lines	Chronic overcapacity, reemergence of specialty channels
Trade	Producers and consumers in advanced countries	Exports from advanced countries to rest of world	Production shifts to newly industrializing and then developing countries	Export from countries with lowest labor cost
Competition	Few companies	Entry, mergers, and exits	Shakeout, price competition increases	Price wars, exits
Key success factors	Product innovation establishing credible image of firm and product	Design for manufacture, access to distribution, brand building, fast product development, process innovation	Cost efficiency through capital intensity, scale efficiency, and low input costs	Low overheads, buyer selection, signaling commitment, rationalizing capacity

Source Grant (See Grant, R. M. (2010). Contemporary Strategy Analysis: Text & Cases. Hoboken, NJ, John Wiley & Sons. p. 944.) and used with kind permission from Wiley others) at a time when Scotland had by far the best primary education system in Europe and some of the best universities. "It was not from Oxford or Cambridge, where the torch burnt dim, but from Glasgow and Edinburgh, that the impulse to scientific enquiry and its practical application came."[55] Today, having a good educational system is taken for granted to secure economic growth in the long run. Yet, many countries suffer from poor educational systems.

Last but not least, the emergence of railroads not only transformed transportation but also governance. In earlier eras, it had made sense for royal authorities to delegate power over the countryside to the nobility and the gentry. But now that any place was just a short ride away, it made more sense to concentrate power in the hands of an efficient central bureaucracy.[56] Today, Internet will have profound impact on government—although due to slow diffusion, the effects remain partly to be seen. Private industry, however, has adopted Internet technologies with greater speed and opened up for entirely new business opportunities such as those related to "big data" and "the cloud."

The sum of all these causes and effects, and more to be discussed later, is nothing short of a revolution. This goes to show that if we want the quest toward sustainability to be revolutionary, or relatively quick, we must approach it from multiple angles leaving no corners untouched or any sensible policies untried. We need a comprehensive approach. From the next section, this will become obvious.

1.2 Why Systemic Change Is Necessary

> As we shall see, apparent differences between people arise almost entirely from the action of the system they work in, not from people themselves.
>
> W. Edwards Deming

One of the easiest and most visual ways of illustrating complex, systemic effects is using a mathematical concept called fractals. Fractals can illustrate how simple principles—described mathematically—produce wildly different geometries depending on their context at hand. For example, in Fig. 1.2, we see three instances of the famous Mandelbrot[57] set—a fractal that is so complex that

[55]According to Ashton, T. S. (1963). The Industrial Revolution in Great Britain. *The Experience of Economic Growth*. B. E. Supple. New York, Random House.

[56]According to Micklethwait, J. and A. Woolridge (2014). "The State of the State: The Global Contest for the Future of Government." *Foreign Affairs* **93**(4): pp. 118–132.

[57]Benoît Mandelbrot was born in Warsaw in 1924 to a relatively wealthy Lithuanian Jewish family. When he was 12 years old, his family had the foresight to leave Poland and went to Paris. After World War II, he left France for the USA to escape the formalism of the French mathematical establishment. The stifling hold on mathematical imagination pushed Mandelbrot away from academia to work for IBM in New York. For more information, see Lesmoir-Gordon, N., W. Rood and R. Edney (2001). *Introducing Fractal Geometry*. Cambridge, Icon Books. p. 176.

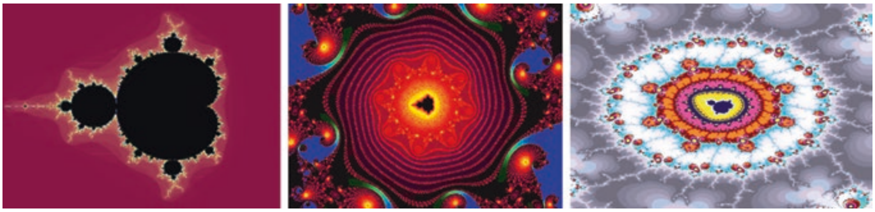

Fig. 1.2 Three instances of the Mandelbrot set. *Source* Wikipedia, the free encyclopedia

nobody has to date managed to calculate its exact area.[58] The one to the left is the classic one that the mathematician Benoît Mandelbrot (1924–2010) first published in 1980 together with many other fractals.[59] We may think that these three fractals are widely different, but in reality, they are three embodiments of the same principle found on different levels of scaling and artistic coloring.

What is startling is that these beautiful figures are generated by repeating the simple transformation

$$z \to z^2 - \mu \tag{1.1}$$

numerous times and only varying the constant μ and the step size of the variable z where $z = x + \mathrm{i}y$ and μ are *complex numbers.*[60] The coloring is an artistic expression of the various numerical values that are created, and it is different from the three pictures. Regardless of coloring, the point I am trying to make is this; unless we understand (a) the principles of society and (b) their potential impact in turning society toward a sustainable future, we can never expect to achieve a sustainable future.

Fractal geometry, however, can also provide much more insight that is useful for our further inquiries. First, by examining Eq. (1.1), we notice something obvious; z is a function of itself. In other words, fractal geometry is based on the notion of feedback, which is paramount in processes and systems. Second, fractals are self-similar, which is easiest to see from the figure and that must also any successful system in society be in order to induce large changes—we cannot have an elitist

[58]The closest approximation is 1.50659177, which is sufficient for most practical purposes. You might think this is only of academic interest, but it has also very real and tangible results. For example, the lengths of the common borders between Spain and Portugal, or Belgium and the Netherlands, as reported in these neighbors' encyclopedias, differ by 20 percent, or 987 km versus 1214 km for the Spain/Portugal border and 380 km versus 449 km for the Belgium/the Netherlands border. For more details, see Richardson, L. F. (1961). "The problem of contiguity: an appendix of statistics of deadly quarrels." *General Systems Yearbook* **6**: pp. 139–187.

[59]See Mandelbrot, B. B. (1980). "Fractal aspects of the iteration of z->lamda z(1−z) for complex lambda and z." *Non Linear Dynamics; Annals of the New York Academy of Sciences* **357**: pp. 249–259.

[60]A complex number z consists of a real number x and an imaginary number iy. It can be graphically plotted in a complex plane where, for example, the real number x is on the abscissa axis and the imaginary number iy is found on the other axis. Imaginary numbers occurs if we take the square root of a negative number. For example, $\pm 1i = \sqrt{-1}$.

system where some describe what is sustainably correct and what is not. Whether it is the baker, the welder, the clerk, the director, or the president, they must all through their behavior every day contribute in the correct direction. Third, z is what mathematicians would refer to as a complex number. Complex numbers exist on a wider dimension than the real numbers we use in ordinary life, but they are in fact more real than the real numbers because they can actually describe many real and natural phenomena, whereas real numbers are of limited usefulness. This is important because it implies the same story that Plato told about those people who sit watching the shadows of objects on the cave wall—it is the concepts that are real, and the real world is only a temporary embodiment. In other words, we must work on the deeply rooted concept to produce big effects. Fourth, from the third point, we understand that change is much more fundamental than we think—the change we seek cannot become a mechanistic administration of routines, practices, and environmental myths. To cause change we must be willing to change. Fifth, despite the huge variety of geometrical "elements" found in Fig. 1.2, they are in fact limited by themselves in the sense that there is a solution boundary for Eq. 1.1, and it is inherent in the system—it is not human made (as the Kyoto Protocol). In other words, we must change the system—which is the topic of this book in a wide sense.

A closely related topic called "the theory of strange attractors and of chaotic (or stochastic) evolution" serves as a mental map for understanding how the system changes over time. The theory of strange attractors and of chaotic (or stochastic) evolution evolved independently of fractals, but is being penetrated by them. According to Mandelbrot[61], while "… fractal geometry is concerned primarily with shapes in the real space one can see, at least through the microscope, … the theory of attractors is ultimately concerned with the temporal evolution is time of points situated in an invisible, abstract, representative space." It is in this invisible, abstract, and representative space the key aspects of social systems partly operate, but this space is fractal in nature, which is why I use fractal geometry as a metaphor here.

To understand the fractal attractor of our capitalist society, as it were, is beyond the scope of this book—however, we can understand it conceptually and that is important to truly understand the depth of change that is required for our society to become sustainable. To explain this better, consider the Lorenz attractor in Fig. 1.3, which was one of the first identified strange attractors. It was identified by Edward N. Lorenz (1917–2008) who set up and solved this set of differential equations:

$$\begin{aligned} \frac{\mathrm{d}x}{\mathrm{d}t} &= p(y - x) \\ \frac{\mathrm{d}y}{\mathrm{d}t} &= -xz + rx - y \\ \frac{\mathrm{d}z}{\mathrm{d}t} &= xy - bz \end{aligned} \tag{1.2}$$

[61]See Mandelbrot, B. B. (1980). "Fractal aspects of the iteration of z->lamda z(1-z) for complex lambda and z." *Non Linear Dynamics; Annals of the New York Academy of Sciences* **357**: pp. 249–259.

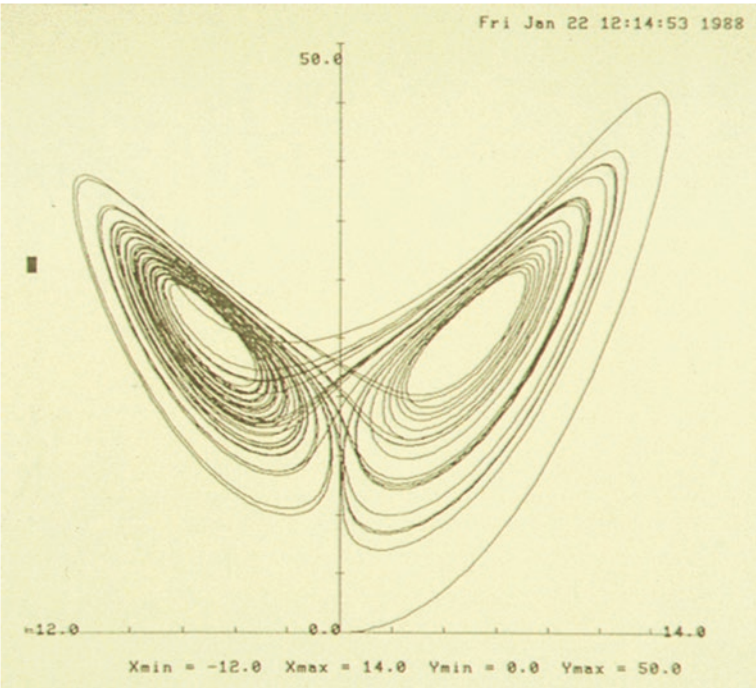

Fig. 1.3 The Lorenz attractor. *Source* Wikipedia, the free encyclopedia

In his original paper,[62] Lorenz used $p = 10$, $r = 28$, and $b = 8/3$. Later, many have explored other values, but the overall shape persists.

From Eq. 1.2, we notice that the time derivatives (for example, dx/dt, which is the time derivative of the variable x) are functions of the respective variable. This creates a feedback situation which creates the intriguing graph in Fig. 1.3. Figure 1.3 also highlights an important feature about strange attractors—one line *never* occurs twice, which has vast implications for this book. It implies something obvious, which is often acknowledged but in reality ignored—the future is never exactly like the past. It also implies that the performance of various policies and systems and so on within our global village can be similar—but only more or less similar. Conversely, many things may seem to be different, but they remain the same because they arise from the same underlying mechanism, the attractor. If we are to alter the path of our society, we must alter our attractor. What alters the attractor can be something apparently small, like the laws of limited liability, but the point is that this change will have a compounding effect that creates a flow of secondary changes which induces tertiary changes and so on. Then, we have a revolution. Otherwise, we have a lot of policy-making and no real changes—like

[62]See Lorenz, E. N. (1963). "Deterministic Nonperiodic Flow." *Journal of the Atmospheric Sciences* **20**(2): pp. 130–148.

today. Any policy enacted in contrast to the attractor will ultimately fail unless it changes the attractor. This is about understanding the attractor.

The question now becomes no longer how to internalize externalities, but more “how do we change the attractor of our global community toward a sustainable future?” To shed light upon this, we must discuss changes in complex systems which are done in Sect. 1.3. Finally, in Sect. 1.4, some of the main changes necessary to make are briefly discussed.

1.3 Change of Complex Systems

> It is not the strongest that survive, nor the most intelligent, but the ones most responsive to change.
>
> Charles Darwin

Change in social systems—or complex systems in general—are governed by the attractor of the system because the behavior of the system is predicated by the attractor of the system. The source of the change, however, is the complexity of the system because complex systems never rest completely. They cannot rest completely because when one variable does not fully control another, like in mechanical clockworks, all variables are free to change a little bit and this will inevitable cause change in the system even though we try to control all variables. In other words, complexity produces variation which in turn produces change. Change is therefore not the cause of anything but actually the result of something, a highly common misperception.

In a scientific sense, change is typically ignored in favor of the more easily measurable *rate of change* which is often understood as change per time unit where the change is measured as the difference between the start state and the end state using a particular variable or a set of variables. For example, acceleration is the change of speed per time unit, while speed is the change of distance per time unit. Unfortunately, the scientific interpretation is too narrow because it is “confined within a rule” and a “fixed law”—namely, that functions[63] are continuous and differentiable (so that the derivative, rate of change, can be estimated) and that time is a relevant reference.

To illustrate the mathematical aspect, in 1861, the mathematician Karl Theodor Wilhelm Weierstrass (1815–1897)—a person who delighted in finding the flaws in the arguments of others—identified a curve/function that was continuous but impossible to differentiate.[64] The curve consisted only of corners and the scientific community was shocked! Interestingly, in the process of refuting the ideas of the

[63]A function in mathematics is essentially an equation or a set of equations that describes the mathematical relationship between various variables. For example, a function f of x and y can be described as $f(x, y) = x + 2y + 3$.

[64]For more details, see Lesmoir-Gordon, N., W. Rood and R. Edney (2001). *Introducing Fractal Geometry*. Cambridge, Icon Books. p. 176.

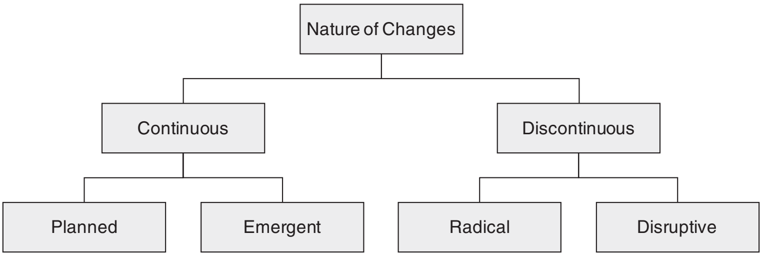

Fig. 1.4 Nature of changes

scientific community of the day, Weierstrass discovered the first mathematical fractal. Hence, fractals appear when we talk about change as mentioned earlier. The point is to recognize that change is a profound phenomenon that the vast body (except fractal geometry and attractors) of scientific knowledge treats too superficially. In a sense, we can say that science is more interested in measuring change than to understand it, and for science, this may be sufficient but not if we are to understand how we can change the attractor of a large, social systems like capitalism.

Nonetheless, mathematics has its right in the sense that there are two major types of changes in the world—continuous and discontinuous. Continuous changes represent various configurations of the same attractor, while the discontinuous changes represent bifurcation points from which new attractors start. The continuous can be divided further into planned and emergent. The planned is what we try for while the emergent arises slowly in ways that are unplanned. Planned can be divided into three subcategories: (1) continuous improvement, (2) technology-based innovation, and (3) market-based innovation. All three can arrive from or be the source of process innovations or product innovations, but this is another dimension discussed later because it only complicates the point I am trying to make here.

The planned can be managed, the discontinuous can be prepared for while the emergent can be nurtured, but they all result in various innovations. While innovations are sought, they have a tendency to either emerge or arise from discontinuities (the dotted lines in Fig. 1.4). In fact, most major innovations have been quite accidental (discontinuous). In fact, Royston M. Roberts (1918–1996) wrote a book[65] about accidental discoveries in science—and they are numerous and many are important. Likewise, in the business literature, we read about major innovations that were accidental and sometimes even unwanted by the corporations… in the beginning. For example, 3 M may be one of the corporations that have

[65]See Roberts, R. M. (1989). *Serendipity: Accidental Discoveries in Science*. New York, John Wiley & Sons. p. 288.

benefited the most from its "mistakes" as they have been skillful in learning from their mistakes and taking the opportunities. Examples include the Scotch™ masking tape (developed by Dick Drew in the 1920s despite being told to stop), the Post-it® Notes adhesive (developed by Spence Silver from a mistake), and 3 M's entire ceramic business that owes its existence to mistakes in developing a new abrasive grit.[66]

Later in this book, we will investigate more the nature of technological innovation and improvements, but the point here is to simply highlight the simple fact that we have to create a system in which we have all types of innovations working. An approach to legislate ourselves toward sustainability, in the sense that we have direct involvement of legislation in the innovation process, means that innovations must be planned to some extent and then, we miss the entire specter of emergent innovations and potentially also discontinuous innovations as well. To illustrate the importance of emergent innovations, it should be sufficient to highlight two stories from the real life.

The first is the importance of the container in marine transportation. Containerization reduced the port downtime from 12 days to 12 h,[67] cut the cost of loading cargo onto a ship from $5.83 per ton in 1956 to merely $0.16 per ton in 2005,[68] and hence revolutionized the marine transport industry. This was a discontinuous market innovation—something that legislation would never have the chance to capture.

The second is the story behind the personal computer (PC). The PC required no fewer than six separate strands of knowledge[69]:

1. Binary arithmetic;
2. The concept of Charles Babbage (1791–1871) of a calculating machine, in the first half of the nineteenth century;
3. The punch card, invented by Herman Hollerith (1860–1929) for the US census of 1890;
4. The audion tube, an electronic switch invented in 1906;
5. Symbolic logic, which was developed between 1910 and 1913 by Bertrand Arthur William Russell (1872–1970) and Alfred North Whitehead (1861–1947); and
6. And concept of programming and feedback that came out of abortive attempts during World War I to develop effective antiaircraft guns.

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[66]According to Brand, A. (1998). "Knowledge Management and Innovation at 3 M." *Journal of Knowledge Management* **2**(1): pp. 17–22.

[67]See Drucker, P. F. (1992). *Managing for the Future: The 1990s and Beyond*. New York, Truman Talley Books. p.

[68]See The Economist (2006b). *The physical internet: A survey of logistics*. London, The Economist. p. 18.

[69]See Drucker, P. F. (2002). "The Discipline of Innovation." *Harvard Business Review* **80**(August): pp. 95–102.

Although all the necessary knowledge was available by 1918, the first operational digital computer did not appear until 1946. The point is that much knowledge existed in small pockets that were not interconnected. In an emergent approach, this is much more likely to succeed than in a centrally driven, legislative approach. The former Soviet Union should be an instructive warning here.

Most successful, major innovations are market-oriented and hence continuous in nature. This view is supported by a study[70] by Donald Lehmann and Jacob Goldenberg and David Mazursky concerning success and failures. They studied 197 product innovations, of which 111 were successes and 86 were failures, and found that the successes had some, or all, of the following characteristics: (1) they were moderately new to the market, (2) based on tried and tested technology, (3) saved money, (4) met customers' needs, and (5) supported existing practices. The failures, in contrast, were based on (1) cutting-edge (untested) technology, (2) followed a "me-too" approach, and/or (3) were created with no clearly defined solution in mind. The typology of the failures rings symptoms from many environmental efforts. Without any empirical evidence, I will still claim that we probably already have enough knowledge and technology to solve our sustainability quest—what we lack is a systemic effort that puts it into the right context to make it a market-driven approach and produce a significant change.

However, a market-driven approach is not enough by itself. Here, the research of Everett M. Rogers (1931–2004) is of great importance to guide us in understanding what kind of innovations that have a fair chance of succeeding. He did not pioneer the field of diffusion of innovations, but he is certainly one of the major contributors over several decades of research spanning diverse areas such as from communication and technology adoption in general and to practical health problems including hygiene, family planning, cancer prevention, and drunk driving in particular. In Fig. 1.5, we see a fishbone diagram presenting the variables that determine the adoption rate of an innovation—with innovation it is important to realize that this model applies to products (material technology) and to methods (immaterial technology or knowhow). For this book, it can indeed serve as guidance toward what kind of changes and their characteristics can successfully bring humanity on the path toward sustainability.

As we see, there are five main types of variables. The first is "perceived attributes of innovations" which describes the actual innovation itself. The research[71] is conclusive on this; innovations that (a) provide significant relative advantages compared to ideas it supersedes (b) are compatible with peoples existing values,

[70]The study is quoted in Franklin, C. (2003). *Why Innovations Fail: Hard-won Lessons for Business*. London, Spiro Press. p. 232 and subsequently quoted by The Economist (2003). Expect the unexpected. *The Economist Technology Quarterly*: pp. 3.

[71]See for example;

- Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.
- Moore, G. C. and I. Benbasat (1991). "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation." *Information Systems Research* **2**(3): pp. 192–220.

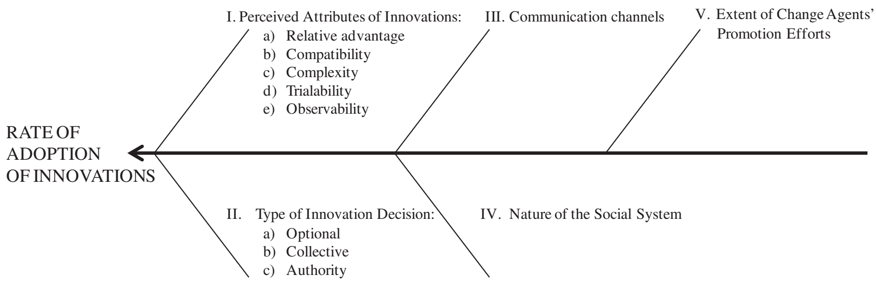

Fig. 1.5 Variables determining the rate of adoption of innovations

past experiences, and needs, (c) are trialable so they can be tested on limited basis and (d) are observable so that the results are visible to others will have higher adoption rate than others do. Innovations that are (e) complex in that they are relatively difficult to understand and use, however, face an uphill and slow adoption or even rejection. These results are intuitive, but nonetheless important; this type of variables account for as much as 49–87 percent of the rate of adoption.[72] Herein also lies one of the major challenges of working toward a sustainable future, the relative advantage of so-called preventive innovations is hard to argue because preventive innovations are to prevent a future problem, and hence, the effect of them is hard to demonstrate since it concerns the future and is consequently uncertain both in terms of timing and magnitude. A good example of this is health problems arising from lifestyle and how difficult it is to help people change their lifestyle and all the health campaigns necessary to impact just a few people. In our case, we have effects of highly uncertain consequences and in some perhaps distant future—clearly, a challenging case from an innovation point of view.

The second type of variable is what kind of innovation decision the innovation leads to. “Optional” refers to choices and decisions being made by the individuals independently of others in the system. “Collective” implies that the decision is made by consensus among the members in the system, whereas “authority” is the classic top-down decision. Experience shows[73] that the fastest adoption of innovation stems from authoritative process (depending on how innovative the authorities are), whereas “optional” is quicker than “collective” decisions.

When it comes to the third type of variable—the choice of communication channel—his research[74] shows that various channels have various effects in various stages of the innovation-decision process. In the current state of affairs, we have not even entered the process properly because we are still debating the need for change among others. At the same time, we have the Kyoto process going on

[72] See Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.

[73] According to Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.

[74] According to Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.

as if we were in the persuasion stage. Thus, when it comes to communication to rally the people for change toward sustainable development, we are in shambles. Because of this, we may in fact face rejection because progress in the process internationally has been faster than the innovation-decision process in many countries. This is one major reason in this book for trying to depoliticize the process by keeping issues such as social equity and local/regional issues out of the discussion. Also, for the same reason, we must avoid at all costs value-laden approaches, as discussed in Chap. 2.

The fourth type of variable—nature of the social system—can impede or facilitate the rate of adoption of innovation depending on the structure of the social system. Since the topic of this book is the global system, the structure of the social system is as complex as it gets. However, by finding a way through the economic system, the social system that must be managed is much less complex than more broad-based approaches with community involvement and so on.

The extent of change agent's promotional efforts is the fifth and final type of variable. The change agent typically plays up to seven roles in the process of introducing an innovation in a system[75]:

1. To develop the need for change.
2. To establish information exchange relationship.
3. To diagnose problems.
4. To create an intent to change in the client system.
5. To translate an intent into action.
6. To stabilize adoption and prevent discontinuance.
7. To achieve an internal relationship.

Yet, what separates good change agents from not so good change agents are some other factors:

(a) The more change agents contact the clients the better.
(b) The more change agents adopt a client orientation the better.
(c) The more change agents are able to cater the diffusion program toward the needs of the client the better.
(d) The more emphatic the change agent is toward the client the better.

This will be discussed more later, but what is sure is that with the insights from innovation diffusion researchers in mind, we can learn a number of things. For example, because there is no effective supranational organ in the world as long as the members of the Security Council in the United Nations have veto right and there are nobody to enforce solutions upon countries, the authoritatively approach will not work hence leaving the whole Kyoto approach and processes based on international treaties and legislation risky. Likewise, a "collective" approach will also not work because we will never reach consensus internationally. This leaves us with one approach—the "optional" which is essentially a market-based

[75]According to Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.

approach. We therefore need some other types of changes than what have been proposed thus far by governments and NGOs. Before we can outline them, we must discuss the party that both NGOs and governments alike interact with—"the corporation."

The word "corporation" has many possible interpretations—despite we often use it without clarifying what we mean. The one I find most useful for this book is the one found in *Webster's Encyclopedic Unabridged Dictionary of the English Language*[76] where corporation is defined as "an association of individuals, created by law or under authority of law, having a continuous existence independent of the existence of its members and powers and liabilities distinct from those of its members." Thus, a church is a corporation and so is a university as well as what we typically think of when we talk about corporation, namely limited liability enterprises. However, most of the issues discussed in this book are discussed in the context of the business world and less to a nonprofit context. This said, I believe that sustainable development must become an issue for all irrespective of whether they aim for profits, souls, or something else. Some,[77] however, argues that if a typical capitalistic corporation was a person, it would have been diagnosed as clinically insane. While this is to some extent true, we should remember what Max Weber (1864–1920) pointed out that the greater potential tyranny lay not with the economic bureaucracies of capitalism, but the state bureaucracies of socialism.[78] This is insight we should keep in mind.

Another issue about the corporation is its fundamental nature. According to the seminal paper[79] of professors Michael C. Jensen and William H. Meckling, "Contractual relations are the essence of the firm, not only with employees but also with suppliers, customers, creditors, etc." Furthermore, "It is important to recognize that most organizations are simply *legal fictions which serve as a nexus for a set of contractual relationships among individuals*" [original italics]. By "legal fiction," they mean the artificial construct under the law which allows certain corporations to be treated as individuals. From this, a number of implications follow. The most important implication for this book is that a corporation cannot be viewed as an individual with motivations and intentions. Therefore, Social Corporate Responsibility (SCR) is a fundamentally misleading term. In fact, they

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[76]See Webster (1989). *Webster's Encyclopedic Unabridged Dictionary of the English Language*. New York, Gramercy Books. p. 1854.

[77]In an award-winning documentary film called *The Corporation* (released in 2004), Mark Achbar, Joel Bakan, and Jennifer Abbott argue that like all psychopaths, a corporation (1) is singularly self-interested because it attempts to create wealth for its shareholders; (2) is irresponsible because it puts others at risk in order to achieve objectives harming employees, customers, and the environment; (3) insists that it is the best, or number one; (4) has no empathy and feels no remorse; and (5) relates to others only superficially. See The Economist (2004). The lunatic you work for. *The Economist*. **371:** pp. 68.

[78]See Weber, M. (1992). *Economy and Society: An Outline of Interpretive Sociology*. Berkely, University of California Press. p. 1470.

[79]See Jensen, M. C. and W. H. Meckling (1976). "Theory of the Firm: Managing Behavior, Agebcy Costs and Ownership Structure." *Journal of Financial Economics* **3**(4): pp. 305–360.

explain how a corporation in essence can be viewed as a market of contractual obligations, and as such, its behavior is akin to the behavior of a market, i.e., the outcome of complex (dis)equilibrium processes. This means that like in a market, the parties responsible are:

(a) Employees—the choices and decisions they make in their everyday work including contractual obligations between corporations and employees. Their minimum responsibility is to manage the contractual obligations of the corporation and do so within the law and the contractual obligations of the owners including the supervision of the CEO. The supervisory aspects of owners versus agents—leading employees—are a core question in agency theory and how this agency works is somewhat related to the law, as to what is legal or not, but apart from that, agency is another contractual relationship.
(b) Owners—by the contractual obligations they make and their supervision of the CEO. Their minimum responsibility is to act within the law.
(c) Government—by configuring how the market operates according to some legal standards for both (1) the corporation itself and (2) the markets the corporation exists in. The government therefore has the ultimate responsibility for corporate performance as long as the two other parties act within the law.

This means in turn that when we are to redirect the corporation and its sum of activities in the economy toward a sustainable future, we must essentially address these three parties in some way or the other. We cannot address the corporation itself—it is after all a legal fiction so that whatever we address the corporation, it will transfer its obligations to these parties in some fractional way or the other. If the corporation accepts an invoice for something, someone must pay for it in one way or the other.

So, does this mean that stakeholder theory is not useful? After all, some argue that it is important for organizations to think in terms of stakeholders. A stakeholder is "any group or individual who can affect or is affected by the achievement of the organization's objectives."[80] This is a shift away from "economic man" whose goal is to maximize the wealth of the corporation based on contractual and financial duties to shareholders[81] to "socially responsible man" whose goal is to ethically maximize the wealth of the corporation based on a variety of duties to stakeholders. This sounds good on paper, but in reality, it makes little sense.

However, being a legal fiction does not mean that the economic model of the corporation has to be the *modus operandi,* which has been highly and rightly criticized in the stakeholder theory literature,[82] because employees and the government (representing the people and the land in a wide sense) are very important

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[80]See Freeman, R. (1984). *Strategic Management: A Stakeholder Approach*. Boston, MA, Ballinger. p.

[81]See Brenner, S. and P. Cochran (1991). *The Stakeholder Theory of the Firm: Implications for Business and Society Theory and Research*. IABS Proceedings 1991.

[82]See Key, S. (1999). "Toward a new theory of the firm: a critique of stakeholder "theory"." *Management Decision* **37**(4): pp. 317–328.

stakeholders and part of the "contractual market" we call "the corporation." The contractual obligations are often of economic nature, but there are no limitations as to their nature, in general, and this is how society must provide suitable governance for corporations to operate within. Therefore, a socially responsible corporation is one in which all three parties listed above are socially responsible. If one of these fails, the corporation will fail in being socially responsible. However, regardless of their nature, their liabilities are limited due to the laws of limited liabilities.

A final issue is that what is legally right may not necessarily be morally right. This follows from the fact that a social unit of the size of a nation will always be more hypocritical than an individual. In fact, Reinhold Niebuhr (1892–1971) claims that "Perhaps the most significant moral characteristic of a nation is its hypocrisy."[83] These parties must therefore be judged according to the law and not individual morals. However, thanks to NGOs, consumer reports, newspapers, and the like corporations via their employees and owners are sometimes pressured to think about what is morally right as well for the sake of corporate branding and reputation. In an increasingly interconnected and increasingly affluent world, it is likely that these moral forces will increase in the future. However, in this book, they are ignored simply because they are not a part of the capitalist system per se. By ignoring these forces, the book essentially takes a conservative approach meaning that we have to foster sustainable development by improving the system without including moral forces of any kind. Put plainly, sustainability should not be pursued because it is morally right but because it makes rational sense for the business of all the players in the capitalist system. We have succeeded when Gordon Gekko realizes that a sustainable future is what he wants and is willing to accommodate it.

What must change for that to happen is the key question? While this book tries to give an answer, it is clear that no answer of today can be all exhaustive. We are likely to miss out important points. Nevertheless, some changes must be made, and next, we will look at the most important ones.

1.4 Ideas for Changes

> It is better to have enough ideas for some of them to be wrong, than to be always right by having no ideas at all.
>
> Edward de Bono

To change the system, we must, as argued earlier, impact the attractor of the system. Unfortunately, it is beyond human faculties to directly grasp the attractor of the capitalist system. However, it is clear it must be something very

[83] See Niebuhr, R. (1932). *Moral Man & Immoral Society: A Study of Ethics and Politics*. London, Westminister John Knox Press. p. 284.

fundamental. To be changeable, it must also be something that can be influenced by governments—otherwise, we end up with issues that are of very fundamental importance—such as the belief systems of people—that cannot be changed in any fashion unless they themselves see the need for change. Thus, we must not let the quest for the perfect hinder us in changing what we *can* change and then assess whether it is sufficient or not. We must think in terms of continuous improvement, and then at some point in time, we will reach the objective of sustainable societies.

Deeply rooted in capitalism is the principle of socializing risk. In fact, the primary idea of limited liability laws and subsequently shareholding was to "socialize risk."[84] That means that society assumes some of the risk of conducting business—the shareholder has a limited liability to the extent that they may lose their share capital but not more. Today, however, many have lost the essential understanding of the capitalist society. It is important to recall that Smith was very concerned about the moral issues relating to commerce and his contemporaries mostly saw him as a moral philosopher, and not as an economist. In *The Theory of Moral Sentiments* from 1759, he argues that self-love and sympathy, mediated by customs and institutions of civilized society, guide man to behave virtuously toward man.[85] In fact, he favors the marketplace mainly because the curbs it places on the mighty. The economic system is therefore an institution of civilized society, and the quintessence of his famous classic *An Inquiry into the Nature and Causes of the Wealth of Nations* from 1776, commonly referred to as *The Wealth of Nations*, is that self-interest and sympathy for man constrained by economic rivalry will lead to widespread prosperity. He argued that, "It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest," and "by pursuing his own interest he frequently promotes that of the society more effectually then when he really intends to promote it." This mechanism he termed the "Invisible Hand", and any order which arises spontaneously without intention or design can be regarded an instance of the Invisible Hand.[86] Sustainable development must become such an order—it cannot be managed by man because it is simply too vast and complex.

Crucially, there are at least three aspects of the Invisible Hand that are of importance here. The most basic are (1) governance of the economic system closely followed by (2) the measurement system and (3) taxation systems to change behavior. All these three must be tackled if we are to guide our society into a more sustainable direction. Briefly explained, governance must become clearer and legislation that protects the old and hinders the new must be changed because according to a study by the Organization for Economic Cooperation and

[84]See the through discussion in Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

[85]See The Economist (1999a). Introducing big government. *The Economist*. **353:** pp. 102.

[86]See Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

Development (OECD), political governance and corporate governance are "inseparable."[87]

> Subsidies and protectionism must be reduced so that the comparative advantages of countries can be better utilized for the good of all. This will also stabilize the world and make large-scale wars less likely. Players in the financial markets must be placed a curb on their size so that none become 'too big to fail'. Furthermore, the worst non-value-added/parasitic speculation must be outlawed, such as High-Frequency Trading (HFT); we cannot let the doctrine of maximizing liquidity become a religious tenet beyond questioning. Is there really no diminishing return on liquidity? Everything else in the realm of economics has a diminishing return—it would be remarkable if liquidity was the first exception…. This will greatly help also in dealing with short-termism and herding—phenomena that reinforces speculative behavior.

Such a move by governments may sound harsh but according to an OECD report, "… the major institutional investors, have been an important force working in favour of improved corporate governance worldwide."[88] Not only have they pushed for more rigorous laws and regulations, improved governance, attacked major corporations that do not comply, and forced the major auditing and consulting companies to separate their consulting and auditing businesses, but they themselves are also willing to pay a premium for well-governed companies. For example, institutional investors in the UK and the USA are willing to pay a 16–18 percent premium and 22 percent in Italy.[89] In fact, some[90] estimate that non-financial performance accounts for as much as 35 percent of institutional investors' valuation of public companies. This trend toward investing in green companies is also clearly illustrated by the fact that in 2003 when the first conference of the Investor Network on Climate Risk, the participants represented assets worth $600 billion, while only 2 years later—in 2005—the participants represented $2.7 trillion.[91] Serious investors like these will be aided by measures aiming at curbing speculative behavior, and all in all, we will all be better off. They will perhaps be even more aided by "energy accounting" as briefly described later.

When it comes to the accounting systems, we have only one real option, other than today's monetary system, and that is something that can be called "energy accounting" because (1) energy consumption is a vital indicator of socioeconomic development;[92] (2) today's energy costs are too low to have any real impact on

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[87]See Oman, C. (2001). *Corporate Governance and National Development*. Paris, OECD Development Centre. p. 47.

[88]See Oman, C. (2001). *Corporate Governance and National Development*. Paris, OECD Development Centre. p. 47.

[89]See Investor Relations Business (IRB) (2000). *Good governance pays off: institutions will pay a premium for an independent board*. Institutional Shareholder Services. p. 3.

[90]See Low, J. and T. Seisfeld (1998). "Measures that matter: Wall Street considers non-financial performance more than you think." *Strategy & Leadership* **26**(2): pp. 24–28.

[91]According to The Economist (2006a). *The heat is on: A survey of climate change*. London, The Economist. p. 24.

[92]See Olsson, L. E. (1994). "Energy-Meteorology: A new Discipline." *Renewable Energy* **5 Part II**: pp. 1243–1246.

business decisions in most of the economy; (3) energy consumption is to date the only consistent, apolitical, and relevant environmental impact measure we have; and (4) energy is what we are really pursuing causing emissions—why not address the underlying problem directly? Furthermore, pricing decisions are often not based on cost plus profit margin considerations, but increasingly market-based pricing has become the norm. This means that the energy aspect of pricing will most likely be minute. So, instead of raising energy costs by legislation, it is better to shift the focus of the economic system away from purely monetary terms and taxation of labor to also embrace energy consumption as basis for taxation. With taxation, we here mean not just corporate taxes but also value-added taxes and possibly also trade tariffs. We thereby not only avoid raising energy costs across the board and risk losing the raised energy costs in pricing decisions, but we will alter behavior away from products and processes with high energy consumption to products and processes with low energy consumption. The principles of energy accounting are close to the same as monetary accounting except the unit is no longer monetary but energy consumption as measured by kilowatt-hour (kWh) or kilojoule (kJ). However, unlike in the monetary world where costs and prices can be quite different thus sending distorted signals (from a cost perspective) to the next link in the supply chain, energy accounting will not be directly involved in any pricing decisions and hence provide a more correct information flow within the entire economy as to the environmental impact. Introducing energy accounting will, of course, be a significant political challenge, but it is really the only option we have *if* we want to add a more correct dimension to business decisions than monetary costs and revenues.

Governments must also demand more correct risk management for large-scale technological projects so that both the public is calmed down and correct risk management strategies are chosen for the sake of quality of decision-making. We cannot afford that technologically sound solutions, such as nuclear power—it is the only source of electric energy we have that is large scale and without direct greenhouse gas emissions—are avoided on the basis on incorrect risk assessments and low-cost solutions that make the public unsettled concerning the robustness of such technology with respect to natural disasters such as earth quakes and tsunamis.

Government must also promote educational efforts so that we can start to practice corporate cost management correctly. Today, there is often a huge discrepancy between actual costs and calculated costs simply because a large majority of companies fail to treat costs correctly.[93] The same applies to attitudes in society concerning consumer behavior and ethics—something I am sure Smith would welcome. This cannot be enforced—only promoted. Another area is of course corporate governance and its twin political governance. Corporations can no longer

[93]This is well documented in a number of publications following the landmark book Johnson, H. T. and R. S. Kaplan (1987). *Relevance Lost: The Rise and Fall of Management Accounting*. Boston, MA, Harvard Business School Press. p. 269.

argue solely out of their short-term self-interest anymore because most people do not share the idea that the sole responsibility of corporations is to maximize profits for its owners as Milton Friedman (1912–2006) argues.[94] In fact, studies show that corporations cannot obtain a legitimate decision-making role in society without first having demonstrated[95] (1) respect for fellow citizens, (2) commitment toward the community, and (3) exposure in the discussion.

However, if we realize that political governance is intimately linked with corporate governance, Friedman has a point *given* that there is sound political governance and the laws in the land are upheld. This means that political governance is a key area and a more careful reading of Friedman reveals that the heading of the article many refer to is a to-the-point formulation because in his book, *Capitalism and Freedom* from which he quotes in the end of the article, it reads "there is one and only one social responsibility of business—to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud."[96] In the book, he discusses this in broader terms. However, in countries where political governance is poor, it is ethically wrong for multinational corporations to take advantage of the situation—in that sense, the CSR movement is correct. This should, however, not be an excuse for politicians worldwide to bail out, and if they read this book, I hope to convey the fact that sustainable development is just as much a matter of political governance as corporate governance, if not much more. Furthermore, there is a great difference in relying on a solely political approach based on direct intervention and conformance and an approach relying on unanimity in following a market-based framework put in place and upheld by government.

All these issues, and more, will be discussed extensively in this book. Due to the complexity of the topic, it is not straightforward to discuss it. However, I have to the best of my abilities tried to organize it in a logical fashion for the general reader. Next, the organization of the book is outlined.

1.5 The Organization of the Book

The topic of the book is wide—covering a number of relatively technical issues such as risk management, finance, and innovation to broad issues like changing the entire economic system—reengineering capitalism. At some critical places, relatively deep discussions are provided to illustrate that current practices are not the only way and in fact an inferior way. This means that the book is a complex

[94]See Friedman, M. (1970). The social responsibility of business is to increase its profits. *New York Times Magazine*: pp.

[95]According to Saiia, D. H. and D. Cyphert (2003). "The Public Discourse of the Corporate Citizen." *Corporate Reputation Review* **6**(1): pp. 47–57.

[96]See Friedman, M. (2002). *Capitalism and Freedom*. Chicago, IL, University of Chicago Press. p. 210.

piece of work which is difficult to communicate well. However, after rewriting the draft of the book a couple of times, I realized that a suitable approach might be like this.

Chapter 2 contains a discussion on how we have approached the climate and sustainability issues so far—particularly the sustainability issues pertaining to the broad topics discussed in this book. I provide a detailed discussion on the ISO 14001 standard to illustrate how current practices work conceptually and how value-laden they are and hence susceptible to endless discussions if major issues are at stake. Then, I also provide a direct discussion on the Kyoto Protocol and the trading systems deriving thereof to show that the same conceptual weaknesses of the ISO 14000 standard even persist into an entirely different system. With a system resting on value-laden choices, I am 100 percent confident that discussions will be the end result when major issues become at stake.

The purpose of this chapter is, of course, not to belittle the great work done by many great scientists over the years. The message from this is actually more in the direction that the problems we are facing—climate change, sustainability, and so on—are not scientific problems per se, but rather systemic problems are related to the economic system. We have to realize that highly complex systems, such as the climate system of the Earth, cannot be measured, explained, and forecasted in clear-cut ways. The famous American photographer Ansel Adams (1902–1984) once quipped that

> There is nothing worse than a sharp image of a fuzzy concept".

This is not just true in photography, but in my opinion, it is a fundamental truth about knowledge and its limitations. We cannot expect science to tell us what to do. As far as I am concerned, we know enough to understand we are facing major future challenges and I also believe we know enough to make informed decisions. What we lack is a broad-based system that will ensure that humans in pursuit of self-interest will do so in the interest of the environment. Today, environmentalism is more or less a faith where we have a few faithful, a huge number of agnostics, and also quite many that basically do not care whatsoever. In fact, the fact that we have a term for it is sad. Thinking about environmental impact must become integral to all decisions in business and policy. Chapter 2 will clearly demonstrate that not only are we far from this today, but most likely we will never get there in the current *modus operandi*.

Then, in Chap. 3, I have to discuss some extremely basic issues concerning risk and uncertainty. Risk and uncertainty is not only important for policy makers, but risk and uncertainty is almost the fuel of the financial industries. Since the laws of limited liability were so crucial in socializing risk making investment personally much safer than before, it goes without saying that how the residual risk is managed in the financial industry is also of great importance. Risk and uncertainty is also closely linked to innovation, and innovation is one of the great drivers of change in society. Thus, risk and uncertainty is a very fundamental topic that I will try to discuss thoroughly without getting too technical.

Then, this discussion flows naturally into the world of Finance in Chap. 4. Finance today is not only a huge part of the problems, but also a huge part of the solution. Thus, understanding the financial world is vital justifying a quite long chapter for it. It should be noted that I try to keep the discussion on a conceptual level to avoid too many technicalities which will essentially derail the book. Therefore, this is not a review of the financial industry as such, but more a discussion on their methods, tools, and results—also on high level. Furthermore, I have chosen to divide the discussion into a number of subject areas that are contentious in the literature and in practice. For example, the alleged short-termism and herding of Finance are undisputable topics in this context. To write a book about how we can reengineer the capitalist system without discussion, these two topics in particular, but also Finance in general, would be a complete miss of the mark.

The discussion of Finance provides us with some of the tools necessary to discuss the capitalist system both as of today but not the least during the Industrial Revolution. It is particularly interesting to note what was different prior to the Industrial Revolution compared to after and what caused the difference. These causes can unfortunately not be directly transplanted to our time and altered to foster sustainable development. The entire context is different, but I believe that by understanding these causes, we can better understand the drivers we must impact today to realistically foster sustainable development. All this, and more, is found in Chap. 5 and to some extent in Chaps. 7 and 8.

In one way, the book could almost have ended here—except for a concluding chapter—but since we have already chosen to discuss Finance in some details, it is necessary to also discuss the other major drivers of change starting with how we measure performance. In Chap. 6, I therefore introduce a conceptually simple idea that would provide us all with correct information about energy effectiveness—energy accounting. The fact is that today, energy costs are just lumped into everything else but due to the fundamental importance of energy consumption and socioeconomic development, we cannot continue like this. The true cost of generating energy and using it is also missing today since much of the impact is external to the economic system and hence not assigned any costs whatsoever, and this is perhaps the most important reasons for explicating energy consumption and thereby energy efficiency.

Then, in Chap. 7, we look at technological development in a wide sense. Understanding how technological development takes place is fundamental, and in this chapter, it is discussed how. Borrowing from List's insight, for example, as to the importance of having supportive policies for infant industries during the Industrial Revolution, it is clear that technological development must be aided by something similar. It is outright naïve to believe that the market can by itself, under the current system, push the world toward sustainable development. The system must be reengineered to allow a market-based and effective approach to take hold of the entire society—not just the major polluters or idealists like today. Therefore, the chapter highlights just as much the development of technologies other than products, than to hammer more and more on the technology side.

From this chapter, as well as several other chapters, it becomes clear that sustainable development is more about making informed choices about policy based on what we know today than to pursue ever more sophisticated scientific models to provide us with even better information for making even more informed choices. There is a Chinese saying for this, "Even a long journey starts with a little step." Therefore, the role of the government receives much attention in this book. Today, governments point their fingers at corporations and corporations point back. This cannot continue, and from a historical perspective as well as from economic theory today, it follows that government must very often protect infant industries from the gales of competition. The government must therefore alter the rules of the game before we can expect any serious changes. The role of the government is therefore discussed at relative length in Chap. 8.

The final chapter is Chap. 9, which is a closure pointing to some of the main findings and tries to present it in a more intuitive way than facts and figures. Some final thoughts are also offered.

Chapter 2
The Quest so Far—And Why It Has Failed

The greatest obstacle to discovery is not ignorance—it is the illusion of knowledge.

Daniel J. Boorstin

So far, the quest has been characterized by either high-profile summits where all the countries in the world, more or less, adjourn to discuss our challenge based on work from researchers, academics and to some extent industry, or by a whole range of less profiled initiatives that are normally more practically oriented. These less profiled initiatives can generally be divided into five groups[1]:

I. Pollution Prevention, which is also known as waste minimization, green manufacturing, or environmentally responsible manufacturing. The common thread is to *encourage* efficient usage of resources. Legislation falls under this category as do the whole climate debate and the Kyoto treaty in its current trajectory of conformance.
II. Design for environment (DFE), which deals with how to minimize environmental burdens through design—eliminating the root of the problem at the outset so to speak.
III. Environmental management systems (EMS), which deals with the tools needed to manage, from an environmental perspective. Here, we can include the ISO 14001 EMS.
IV. Product stewardship. As with pollution prevention, this is essentially political or strategic in character. Legislation *can* fall under this category such as the Norwegian tack-back legislation of electronics which forces those that sell and produce electronics in Norway to take it back from their customers once the product has reached its end of life.
V. Environmental accounting is also referred to as life cycle accounting, total cost accounting, green accounting, and full cost accounting. The primary role of environmental accounting is to support environmental initiatives and policies by

[1]According to Wood, J. C. (1998). Environmental Impacts on Life Cycle Costs. *Handbook of Cost Management*. J. A. Edwards. Boston, MA, Warren, Gorham & Lamont: pp. D6-1–D6-30.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_2

> including the costs and benefits that are derived from the effects of the environment on the general ledger. This is therefore essentially a financial reporting and analysis of environmental aspects as they are manifested on the general ledger.[2]

In earlier publications,[3] I have discussed such initiatives from the assessment perspective—cost, energy consumption, and environmental impact—and linked it to design.[4] However, one thing that became apparent after several years of research culminating in my PhD was the difficulty of obtaining information except when it comes to information from the general ledger. This observation is the important input to this book. In this book, however, the assessment side is not discussed—here, the focus is on how to actually secure a more sustainable development by providing a basis for systematic work. The old maxim "what we measure is what we get" applies also in environmental issues but currently it does not work because there is no consistent information flow and the information that is there is often highly politicized and value-laden[5] causing debate and not focus on improvements.

But let us first step back to the beginning; in 1962, Rachel Carson published the landmark book *The Silent Spring*,[6] and it heralded a new time when Nature was no longer seen as unlimited and indestructible. Environmental consciousness became the new mantra for many. A huge amount of research into areas such as sustainable development, climate change, environmental conscious design, EMS, green design, bio-diversity, and pollution prevention have been undertaken since then in addition to the aforementioned high-profile summits around the world. Most of these initiatives have produced relatively minor results and many of them can be classified as cost-management initiatives because they could have been initiated by a normal, cost versus benefit analysis.

There has also been launched a large amount of environmental initiatives, and a couple of them have actually given very good results and been successful such as

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[2]For a thorough discussion, see Keoleian, G. A. and D. Menerey (1994). "Sustainable Development by Design: Review of Life Cycle Design and Related Approaches." *Air & Waste* **44**(May): pp. 644–668.

[3]See;

- Emblemsvåg, J. (1999). Activity-Based Life-Cycle Assessments in Design and Management. *The George W. Woodruff School of Mechanical Engineering*. Atlanta, GA, The Georgia Institute of Technology: pp. 600.
- Emblemsvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.
- Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[4]Also see Bras, B. and J. Emblemsvåg (1996). Designing For The Life-Cycle: Activity-Based Costing and Uncertainty. *Design for X*. G. Q. Huang. London, Chapman & Hall: pp. 398–423.

[5]See for example Liverman, D. M. (2009). "Conventions of climate change: constructions of danger and the dispossession of the atmosphere." *Journal of Historical Geography* **35**(2): pp. 279–296.

[6]See Carson, R. (1962). *The Silent Spring*. Boston, MA, Houghton Mifflin. p. 368.

the global effort to halt and stop the depletion of the ozone layer.[7] This effort, properly referred to as "The Montreal Protocol on Substances that Deplete the Ozone Layer," which is a protocol to the Vienna Convention for the Protection of the Ozone Layer, is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. According to analyses[8] performed by *The Economist,* this is the single most effective climate policy so far resulting in an effect that is almost equal to the sum of all other policies *combined*. The reason is that the ban is very effective both eliminating the chlorofluorocarbons (CFCs), which destroy ozone (and is also a very potent greenhouse gas) and costing relatively little. The cost of helping out developing countries phase out CFCs was just USD 2.4 billion all told from 1990 to 2010, whereas Germany alone spends about USD 21 billion per year on renewable energy transformation.[9]

Another successful initiative has been the effort in North America to stop acid rain. In fact, the US Environmental Protection Agency (EPA)[10] claims that the Acid Rain Program has the following:

1. Reduced SO_2 emissions by over 5 million tons from 1990 levels, or about 34 percent of total emissions from the power sector. Compared to 1980 levels, SO_2 emissions from power plants have dropped by 7 million tons, or more than 40 percent.
2. Cut NO_x emissions by about 3 million tons from 1990 levels, so that emissions in 2004 were less than half the level anticipated without the program. Other efforts, such as the NO_x Budget Trading Program in the eastern USA, also contributed significantly to this reduction.
3. Led to significant cuts in acid deposition, including reductions in sulfate deposition of about 36 percent in some regions of the USA and improvements in environmental indicators, such as fewer acidic lakes.
4. Provided the most complete and accurate emission data ever developed under a federal air pollution control program and made that data available and accessible by using comprehensive electronic data reporting and Web-based tools for agencies, researchers, affected sources, and the public.
5. Served as a leader in delivering e-government, automating administrative processes, reducing paper use, and providing online systems for doing business with EPA.
6. Resulted in nearly 100 percent compliance through rigorous emission monitoring, allowance tracking, and an automatic, easily understood penalty system for noncompliance. Flexibility in compliance strategies reduced implementation costs.

[7]See EPA, U. S. (2007). *Achievements in Stratospheric Ozone Protection; progress report*. Washington, DC, US Environmental Protection Agency, Office of Air and Radiation. p. 37.

[8]See The Economist (2014a). Curbing climate change. *The Economist*. **412**: pp. 22–26.

[9]According to analyses from The Economist (2014a). Curbing climate change. *The Economist*. **412**: pp. 22–26.

[10]See EPA, U. S. (2005). *Acid Rain Program 2004 Progress Report*. Washington, DC, US Environmental Protection Agency, Office of Air and Radiation. p. 27.

7. A 2005 study estimates that in 2010, the Acid Rain Program's annual benefits will be approximately $122 billion (2000 dollars), at an annual cost of about $3 billion—a 40-to-1 benefit-to-cost ratio.

However, when it comes to global issues that cannot be directly legislated in place, we have faced poor results. Why?

If we step back and investigate more what took place during the Industrial Revolution, we realize that legislation that socialized risk in the shape of limited liability laws partly won the day. I believe that there would have been a revolution of some kind irrespective of the technical marvels of the day simply because limited liability took away the risk of imprisonment and so on in case of bankruptcy, and this freed up capital that was already there. The technical marvels, of course, speeded up the transition but did not make a revolution on their own. This was fundamentally speaking a market-based approach—it was the Invisible Hand at its best, thus far.

The problem when it comes to our quest for a sustainable society is that we have not made a system in the bottom that facilitates a market-driven approach. Conformance to politically brokered treaties has been the mantra. With respect to the three aspects of the invisible hand mentioned in Chap. 1)—(1) governance of the economic system, (2) accounting systems, and (3) taxation systems—only taxation systems have been envisioned. Naturally, the bulk of the corporate world sees the quest toward a sustainable future as a cost and is consequently late adopters if not close to rejecters. There are, of course, some corporate leaders that see this as an opportunity such as Ray C. Anderson (1934–2011), Founder and CEO of Interface Flooring Systems who read Paul Hawken's book titled *The Ecology of Commerce*. It changed his life.[11]

Before continuing, I will show why the ISO 14000 standard cannot serve as accounting system as some believe and therefore will fail as link to the economic system. It will also become evident that such approaches are highly value-laden, and this is another problem. Then, we must investigate the root causes of the failure of the Kyoto process so that this can be rectified in a re-engineered capitalist system, which is the main topic of this book.

2.1 The Standardization Efforts and Why They Are Insufficient

> To every thing there is a season, and a time to every purpose under the heaven.
> King Salomon
>
> Ecclesiastes 3:1

The Coca Cola Company pioneered environmental analyses. In 1969, they studied the resource consumption and environmental releases associated with their

[11]According to Anderson, R. C. (1998). *Mid-Course Correction*. Atlanta, GA, The Peregrinzilla Press. p. 204.

beverage containers. In Europe, at the time, an analysis technique, later termed "Ecobalance," was developed. Both were basically an inventory analysis,[12] which is essentially an analysis of an audit. In 1972, Ian Boustead (1939–2011) calculated the total energy consumption of the production of various beverage containers.[13] This can be viewed as the beginning of Life Cycle Assessment (LCA), and it has largely consolidated in the ISO 14000 EMS Standard. There are other systems as well—one is proposed by Society of Environmental Toxicology and Chemistry (SETAC). The only real differences are the choices of impact categories and the weighting schemes. These, and similar approaches, I will refer to as conventional LCA approaches to distinguish them from other approaches such as activity-based LCA.[14]

To help understanding why these approaches have limitations and challenges, I will take you through the ISO 14000 LCA type. The environmental management part of the ISO 14000 standard is similar to the ISO 9000 standard—it is generic and sensible. The critical part is how measurements and improvements are done—hence, the focus on the LCA part here—because it illustrates the problems with all such value-laden approaches.

A conventional LCA consists of the following steps, which is outlined in the ISO 14040–ISO 14042 standards and in SETAC's "Code of Practice"[15]:

1. Goal definition and scoping,
2. Inventory analysis,
3. Impact assessment, and
4. Improvement Assessment (SETAC term) or Interpretation (ISO term).

I will now review each of these steps more in detail, and at the end of each section, a critique of them is presented.

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[12]According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

[13]See Boustead, I. (1996). "LCA—How it Came About, The Beginning in the UK." *International Journal of Life Cycle Assessment* **1**(3).

[14]This approach was developed by this author and first presented in the PhD dissertation at Georgia Institute of Technology and subsequently in this book; Emblemsvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.

[15]According to Consoli, F., D. Allen, I. Boustead and J. Fava (1993). *Guidelines for Life-Cycle Assessment: A 'Code of Practice'*. The SETAC Workshop, Sesimbra, Portugal, 31 March–3 April, Society of Environmental Toxicology And Chemistry (SETAC), Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

2.1.1 Goal Definition and Scoping

During this initial phase of the LCA, one is supposed to define the following:

1. "Goal," which shall unambiguously state the intended application, including the reasons for carrying out the study and the intended audience, i.e., to whom the results of the study are intended to be communicated.
2. "Scope," which describes the model of the systems to be studied. The scope should be defined well enough to ensure that the breadth and depth of a study are compatible with and sufficient to address the stated goal.
3. "Function and functional unit." The function is the performance characteristics of the system, while the functional unit is selected to measure "the performance of the functional outputs of the product system."
4. "System boundaries," which defines the unit processes, which will be included in the system to be modeled.
5. "Data quality," which must be defined by specific characteristics that describe both quantitative and qualitative aspects of data as well as the methods used to collect and integrate those data. There are five data quality indicators: (1) precision, (2) completeness, (3) representativeness, (4) consistency, and (5) reproducibility.
6. "Critical review process" is added in the end as a quality assurance measure.

These steps are sound and generic for just about any assessment method except one step, the definition of functions and functional units. A functional unit is defined as "the functional outputs of the product system whose primary purpose is to provide reference to which the input and output are normalized."[16] "For example, systems A and B perform functions *x* and *y* which are represented by the selected functional unit, but system A performs function *z* which is not represented in the functional unit. As an alternative, systems associated with the delivery of function *z* may be added to the boundary of system B to make the systems more comparable."

As we understand, the usage of functional units does not really make comparison possible, and how can we deal with say 20 systems with several important functions each, using functional units? In cases where there is no linear relationship between the function and the functional unit, like fuel consumption of a ship and the mass of cargo, the functional unit is also misleading as a basis for comparison. Add that during design various solution principles can involve various function structures, which effectively prohibit all comparison if functional units are required. Finally, the usage of functional units totally breaks down for consumer products, because the preference of customers cannot be approximated by a functional unit—we do not buy, e.g., a car based on transportation costs per driver

[16] See Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

mass. For example in one study, the ISO LCA is used to assess a toy manufacturer[17] and a significant problem is that they are unable to identify any functional units for the products. I therefore believe that functional units have limited usage, in general. Any method that relies on such concepts will not suffice.

2.1.2 Inventory Analysis

The inventory analysis whose purpose is simply to quantify inputs and outputs of a product system contains the following main issues:

1. "Data collection." The data can be site-specific or general; in any case, they must be collected for all unit processes within the system boundaries. Even qualitative data are allowed. As noted in the literature, this process may be resource intensive.
2. "Refining system boundaries." Based on the successes of the data collection, the system boundaries may have to be altered to better fit the available data set.
3. "Calculation" is simply a step to manipulate the data to make the amount of data manageable.
4. "Validation of data" is then employed to ensure the data quality. The purpose is to find areas where the data are insufficient so that better date can be gathered.
5. "Relating data to the specific system" by using the correct unit processes. The purpose is obviously to ensure that the right data are associated with the right unit processes. For each unit process, an appropriate reference flow shall be determined, or functional unit, for normalization purposes.
6. "Allocation" is employed when it is not possible to contain all the impacts and outputs inside the system boundaries. There are two ways out of this problem: (1) expanding the system boundaries to include all the inputs and outputs or (2) allocating the relevant environmental impacts to the studied system. The problem with option (1) is that it may make the whole analysis too complex. In the literature, we find procedures for doing this.

From the cost-management literature,[18] we know that allocations, i.e., in the sense of assignment of costs using estimations, can never become 100 percent correct and with the highly ambiguous procedures in conventional LCA I see no reason to assume that it will be a *lesser* problem. In fact, it will most likely be a *larger*

[17]See Emblemsvåg, J. and B. Bras (1998). *ISO 14000 and Activity-Based Life-Cycle Assessment in Environmentally Conscious Design and Manufacturing: A Comparison*. 1998 ASME Design Engineering Technical Conference, Atlanta, GA, American Society of Mechanical Engineers (ASME).

[18]See for example Cooper, R. (1990). "Five Steps to ABC System Design." *Accountancy* (November): pp. 78–81. and Kaplan, R. S. (1992). "In Defense of Activity-Based Cost Management." *Management Accounting*(November): pp. 58–63.

problem simply because of the fact that establishing causal relationships between product, functions, inputs, and outputs sound rather impossible. In fact, ISO states that the allocation procedures may vary the allocation factors from 0 to 100 percent. Then, what is the point?

ISO also prescribes the usage of unit processes. A unit process is defined as "the smallest portion of a product system for which data are collected when performing a life cycle assessment,"[19] or "the basic building blocks within the system boundaries."[20] The major problem with this approach is that if a company uses processes not modeled in any known software, then impact assessments are impossible (or they can in the best case be approximated crudely). Now, taken into account that there are more than eight million chemical compounds in commercial usage at the turn of the century, see the Beilstein and Gmelin databases, establishing unit processes seems a rather daunting, if not impossible approach. Another issue is that such an approach will become incredible bureaucratic and slow when updates are needed, which will probably be needed continuously.

2.1.3 Impact Assessment

The impact assessment consists of the following four steps:

1. "Category definition." Here, the environmental impact categories are defined by ISO in order to describe the impacts caused by the considered products or product system. Examples of typical impact categories include abiotic resource, biotic resources, land use, global warming, stratospheric ozone depletion, ecotoxicological impacts, acidification, and eutrophication.
2. "Classification." Classification is a qualitative step based on scientific analysis of relevant environmental processes during which the various inputs and outputs are assigned to the various categories. Since some outputs have to be accounted for in several categories and thereby double and triple accounting may be necessary. The environmental impacts also have to be scaled according to their geographical impact into four groups; local, regional, continental, and global. Throughout this process, there is an implicit assumption that "less is better."[21]

[19]According to ISO/TC 207/SC 5 (1996). *Environmental Management—Life Cycle Assessment—Principles and Framework*. International Organization for Standardization. p.

[20]According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

[21]See ISO (1997). *Environmental management—Life cycle assessment—Life cycle impact assessment*. International Standards Organization. p.

Table 2.1 An example of categorization and weighting factors

Environmental effect	Weights	Criterion
Greenhouse effect	2.5	0.1 °C rise every 10 years, 5 percent ecosystem degradation
Ozone layer depletion	100.0	Probability of 1 fatality per year per million inhabitants
Acidification	10.0	5 percent ecosystem degradation
Eutrophication	5.0	Rivers and lakes, degradation of an unknown number of aquatic ecosystems (5 percent degradation)
Summer smog	2.5	Occurrence of smog periods, health complaints, particularly among asthma patients and the elderly, prevention of agricultural damage
Winter smog	5.0	Occurrence of smog periods, health complaints, particularly among asthma patients and the elderly
Pesticides	25.0	5 percent represented an approximate reduction of ecosystem degradation
Airborne heavy metals	5.0	Lead content in children's blood, reduced life expectancy and learning performance in an unknown number of people
Waterborne heavy metals	5.0	Cadmium content in rivers, ultimately also impacts on people (see Airborne heavy metals)
Carcinogenic substances	10.0	Probability of 1 fatality per year per million people

3. "Characterization" whose aim is to model categories in terms of indicators. The model should be based on scientific knowledge where possible, but may have simplifying assumption and value choices.
4. "Valuation/weighing" is a step designed to overcome that fact that "comparison of these categories is not immediately possible."[22] By assigning weights to the various categories based on policies, goals, stakeholder opinions, and the like, a number that described the environmental impact is produced. Several approaches for this process are found in the literature.

In my opinion, the impact assessment step is a significant problem for the conventional LCA methods because it leads to political debate[23] as people disagree which emissions impact which impact categories and to what extent. In fact, consensus has not been reached for a single list thus far to my knowledge. This is probably also explaining the reluctance from a number of countries to ratify some agreements.

Consider Table 2.1, which shows a possible categorization of impacts and the associated weighting scheme. It is obvious that we will end up in never-ending discussions and political debate and ultimately no action if taxes associated with environmental impacts are to be imposed based on such a weighting- and

[22]A fact acknowledged by ISO (1997). *Environmental management—Life cycle assessment—Life cycle impact assessment*. International Standards Organization. p.

[23]According to Jensen, A. A., J. Elkington, K. Christiansen, L. Hoffmann, B. T. Møller, A. Schmidt and F. van Dijk (1997). *Life Cycle Assessment (LCA)—A guide to approaches, experiences and information sources*. Søborg, Denmark, dk-TEKNIK Energy & Environment. p.

categorization scheme. In fact, during the Kyoto meeting in December 1997, the delegates had enormous problems of agreeing upon just the greenhouse effect, which is just one out of roughly ten categories, and it did not stop there: The legislative environment in the US congress in 1997 was so bad that the Clinton administration did not even try to ratify the Kyoto treaty.[24] But disagreement is common among researchers as well if we go to details that have important consequences.

Regardless of the category definition, even if that happens to be the same, there are more than enough issues where people can misinterpret or simply go wrong:

1. After defining the categories, the next step of the impact categorization is classification. Due to the fact that various emissions can contribute to several categories, double, triple, etc., counting is needed. This requires that the practitioners have good understanding in the effects of every emission, because otherwise they will not be able to classify correctly.
2. An implicit assumption in the classification is "less is better" as mentioned earlier which in cases where compromises between various emissions must be made can lead to wrongful decisions.
3. The next step within the impact categorization is characterization, where one tries to assign the relative contribution of the relevant environmental processes. This is based on scientific knowledge, however, when that is not available one simply makes value choices. The result is that one mixes apples and pears whose result cannot be comparable, which is a major problem.[25]
4. The last step is the weighting or valuation. The purpose is to rank, weight, and possibly aggregate the results in order to arrive at the relative importance of the results. What completely ruins the credibility that might be left after the previous steps is now totally eradicated by allowing organizations and groups of stakeholders impact how the weights are chosen.
5. Throughout this process of impact categorization, they also try to establish a geographical area of impact. This is done by using highly ambiguous, subjective, and incomparable scales: "Global," "Continental," "Regional," and "Local." Global and continental are fairly accurate although incomparable. However, the two other scales are very inadequate in all respects, because it is inherently confusing, e.g., how local is local?

When all this is said, we should remember that the ISO 14000 standard, just like the ISO 9000 standard, is focusing on how a corporation can improve themselves and as such these issues are not that critical, but in order to tackle the issues discussed in this book they are disastrous. Achieving comparability is the key and without it there is no basis for measurement and improvement between corporations and ultimately nations.

[24]According to Meserve, J. (1998). *Environmental Legislation Going Nowhere Fast*. Washington. DC, AllPolitics. p.

[25]See the critique by Ayres, R. U. (1995). "Life cycle analysis: A critique." *Resources, conservation and recycling*(14): pp. 199–223.

2.1.4 Interpretation

Interpretation, or "improvement assessment," revolve around three issues to facilitate decision-making:

1. "Identification of significant environmental issues" in a prudent and justifiable manner which obviously is a necessity if a company should have any use of a LCA.
2. "Evaluation." The first element of this step is to conduct a qualitative check of the selection of data, processes, etc. to discuss the possible consequences of leaving out information. The second element is to apply a systematic qualitative or quantitative analysis of any implications of changes in the input data caused by data, methodological, and/or epistemological uncertainties. The last step (third) is to discuss the variations identified in relation to the goal and scope of the study. Check for completeness, sensitivity, and consistency as well as for uncertainty and data quality is only developed to a limited degree.
3. "Conclusions and recommendations" which is similar to any scientific or technical assessment, investigation or alike.

From this we understand that neither uncertainty analysis nor sensitivity analysis is well developed. In fact, some researchers say it flat out that "it is not possible to give a general rank of priorities of strategies and options for improvements."[26] From this we understand that whatever result may be left to interpret, it does not have much value for a corporation, or for anybody else for that matter.

2.1.5 Some Closing Remarks

As if the four aforementioned issues are not bad enough, the whole ISO 14000 standard is so loosely defined that the implementation can vary so much that two studies of the same case can in principle be incomparable. That can occur if only one of the following issues is occurring, in order of severity (the worst first):

1. The studies have different system boundaries, goals, and/or scope. This can be easily exemplified by the fact that when Interface Flooring Systems in La Grange, Georgia, USA, asked Exxon to assess the embodied energy, i.e., what we refer to energy content in Chap. 6, for some chemicals, Exxon came up

[26] See Hanssen, O. J. (1998). "Sustainable Product Systems—Experiences Based upon Case Projects in Sustainable Product Development." *Journal of Cleaner Production* **7**(1): pp. 27–41, which according to Christiansen, K., R. Heijungs, T. Rydberg, S.-O. Ryding, L. Sund, H. Wijnen, M. Vold and O. J. Hanssen (1995). *Report from Expert Workshop at Hankø, Norway on LCA in Strategic Management, Product Development and Improvement, Marketing and Ecolabelling and Governmental Policies*. Østfold Research Foundation. p. has developed 'one of the most comprehensive methods for Environmentally Sound Product Development'.

with negative embodied energy.[27] It does not take long to figure out why. By choosing the systems boundaries in certain ways, this is possible.
2. The functional units are chosen differently.
3. The software used in the two studies has different set of unit processes.
4. The impact categorization is different.
5. The implementation itself is different. That is, various factors are included in one of the studies which are not included in the other study based on the various critical reviews throughout the entire process.

The ISO 14000 standard basically leaves too many issues open to the practitioners.[28] This is of course very convenient from a political point of view, but it ruins comparability, benchmarkability, and finally *credibility*—particularly with respect to the topic in this book.

Finally, the framework is bureaucratic and there are substantial risks that it will never be used in the daily operations of a corporation. It serves best as a strategic tools to help companies improve themselves, locally, but as basis for becoming sustainable they will never work simply because they do not allow a systemic approach since they fail to establish consistency and comparability. Rolf Bretz of Ciba, for example, predicts that if comparability is not achieved, “LCA will be short-lived in the commercial world.” This he said more than a decade ago, when LCA was relatively hot, but today it is largely forgotten so it seems he was right.

Despite these shortcomings, the International Organization for Standardization (ISO) keeps pushing for even more standardization along the same lines and argues for “tackling climate change through standards” in the 2009 September issue of ISO Focus; The Magazine of the ISO. I believe that climate change, or sustainable development, cannot be tackled through standardization at all. The issues are much too complex for simple approaches like that.

Next, we investigate the climate change issues and how the international community has handled it thus far.

2.2 The Climate Change Effort and Why It Fails

> The secret of change is to focus all of your energy, not on fighting the old, but on building the new.
>
> Socrates

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change.[29] It was established by the

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[27]Personal communication with Director of Process Development Stuart Jones at Interface Flooring Systems in LaGrange January 13 1999.

[28]See Emblemsvåg, J. and B. Bras (1998). *ISO 14000 and Activity-Based Life-Cycle Assessment in Environmentally Conscious Design and Manufacturing: A Comparison*. 1998 ASME Design Engineering Technical Conference, Atlanta, GA, American Society of Mechanical Engineers (ASME).

[29]See http://www.ipcc.ch/organization/organization.shtml.

United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge on climate change and its potential environmental and socioeconomic impacts. In the same year, the UN General Assembly endorsed the action by WMO and UNEP in jointly establishing the IPCC.

The assessments of IPCC form the basis for the Kyoto treaty and for a number of high-profile summits where the governments around the world are to agree on cuts in carbon dioxide (CO_2) emissions. So far, the results are abysmal—why?

Without going into the scientific part of this in significant depth, for which I am unqualified, it should be mentioned that there not only exists serious counterarguments on the scientific side, see Sect. 2.2.2, but also on the socioeconomic side. In fact, one key problem[30] with the IPCC's report, sufficient by itself to declare the document "technically unsound," is the way the scenario-builders have based their projections of future output on national GDP estimates which have been converted to a common measure using market exchange rates. This procedure leads them to overstate the initial gaps in average incomes between rich and poor countries—because prices tend to be much lower in poor countries. Those gaps are in turn crucial for the IPCC's projections, because the method used in the scenarios assumes not only that the rich countries will continue to get richer but also, in most of the 40 scenarios considered, that the greater part of the (overstated) initial gaps between rich and poor will be closed by the end of the century.

This critique, also known as the Castle-Henderson critique, was subsequently published in the journal *Energy and Environment* (Vol. 14, No. 2–3) and the IPCC was invited to respond. The tragedy is that instead of taking this critique seriously from highly qualified people, IPCC chose to amass 15 authors to supply a response in which they defended previous work. This caused *The Economist*[31] to conclude that IPCC is "dangerous economic incompetent" explaining this incompetence by pointing to another obvious fact, "…that this horde of authorities is drawn from a narrow professional milieu." Later, in Sect. 2.2.2, we will see that this narrowness is also a problem for the climate scientific part as well.

In light from the diffusion of innovation discussion in Chap. 1 and Fig. 1.5, it is clear that we fail at decision type V both in establishing the need for change, a clear diagnosis and so on. Perhaps, more seriously, there is no agency that acts as a change agent and certainly not as a change agent in the sense that the agricultural extension service did with huge success, as discussed later. The whole change process is to take place in highly unconventional ways. The innovation decision process that the Kyoto process lends itself to is somewhere between the authoritative one and the collective one, but with no enforceable supranational organ authority becomes a hollow threat and a collective search for a solution take ages. From the

[30]According to Ian Castles of the National Centre for Development Studies at Australian National University, formerly the head of Australia's national office of statistics; and David Henderson of the Westminster Business School, formerly the chief economist of the OECD. See The Economist (2003a). Hot potato. *The Economist*. **366**: pp. 74.

[31]See The Economist (2003b). "Hot potato revisited." *The Economist* **369**(8349): pp. 78.

discussion in Chap. 1, it was concluded that only an optional-/market-based approach can stand the chance of succeeding but this is not chosen. Instead, it is highly political—even the summary part of the IPCC report is so politically laden that scientists are "angry at the deletions and astonished by the process."[32]

There are a number of parties calling for a carbon trading system, but the root cause for climate change is not carbon emissions per se—it is the quest for energy. This is one reason why this book tries to focus on the energy issues more than the emission issues. Emission is largely a choice due to economic constraints or costs and lack of political will, but the need for energy is not (unless we are to prevent emerging economies from rising, which is an intolerable line of argument). Another issue is that focusing on energy leaves out a lot of policy and can be handled in an accounting-like fashion as outlined in Chap. 6.

However, for the sake of argument, let us also review how the carbon trading system has worked so far and how it will work in the future. To help us on the way, it is useful to first explore a trading system that actually works, the SO_2 allowance-trading system in the U.S.

2.2.1 The SO_2 Allowance-Trading System

A landmark example of a cap-and-trade system that works well is the SO_2 allowance-trading system[33] which was established under Title IV of the Clean Air Act Amendments (CAAA) of 1990 in the USA. This system is a landmark example for several reasons[34]:

1. The SO_2 allowance-trading system in the USA was the first large-scale application of cap-and-trade to control pollution. For long, it was the largest and is to this day (2015) only superseded by the European Union (EU) Emissions Trading System (ETS) which was implemented in 2005.
2. The purpose of the program was to reduce the emissions in the USA by 10 million tons relative to 1980, when total US emissions were about 25.9 million tons. This goal was to be accomplished in two phases; from 1995 to 1999 and from 2000 and onwards and represented an approximate reduction of 50 percent from 1980 levels, or 17.5 million tons. The targets were met by 2007 even though electricity generation from coal-fired power plants increased 25 percent from 1990 to 2004.
3. The estimated costs were $6.1 billion, but they turned out to be less than $2 billion (although there are various estimates), and later estimates are as low as

[32]See The Economist (2014b). Inside the sausage factory. *The Economist*. **411**: pp. 69.

[33]This system is also known as the Acid Rain Program and the SO_2 cap-and-trade system.

[34]According to Chan, G., R. Stavins, R. Stowe and R. Sweeney (2012). *The SO2 Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation*. Cambridge, MA, Harvard Environmental Economics Program. p. 39.

$0.5 billion.[35] Moreover, the health benefits, however, were estimated at more than $50 billion per year by 2010.
4. This was achieved without extensive price volatility and compliance was close to perfect. This was largely achieved by transparent data systems, public access to information and strict and certain penalties for non-compliance.

In this program, the allowances were distributed for free due to prior regulatory benchmarks associated with emissions per unit of heat. According to theory,[36] at the time the initial distribution of allowances including, specifically, how many allowances a given firm holds at the outset will have approximately no effect to the ultimate outcome. What matters to corporation's decisions to trade or abate are marginal abatement costs, and these costs are generally unaffected by the initial allocation of allowances. Later economic analyses have, however, elucidated the relative merits of free allocation and actions of allowances in cap-and-trade programs and three conclusions are relevant for the SO_2 allowance-trading system[37]:

1. Unless the overall emission cap is very stringent, the sum of the market value of allowances is likely to substantially exceed the total abatement costs incurred to meet the cap causing recipients of free allowances to be overcompensated for their actual compliance costs resulting in windfall profits. This problem increases with size of the cap-and-trade market.
2. If there is no price regulation, emitters can easily pass on the bill of compliance to the customers. In many US states, however, there are cost-of-service regulations causing emitters to look for more cost-effective solutions and not merely pass the bill to customers.
3. An action of allowances is more economically effective for society although for the emitters the abatements costs remain the same. In a sense, this represents a general principle of shifting taxation from social "goods" to social "evils" such as pollution.

All these three conclusions are violated in the global carbon market—(1) the system is much bigger than the US SO_2 allowance-trading system, (2) there are no price regulatory bodies so the temptation to pass the costs on to customers is huge, and (3) the allocation of allowances is very questionable. Before seriously criticizing the system, however, it is useful to first investigate it.

[35] See for example EPA, U. S. (2011). *The benefits and Costs of the Clean Air Act from 1990 to 2020: Final Report*. Washington, DC, US Environmental Protection Agency, Office of Air and Radiation. p. 238.

[36] See Montgomery, W. D. (1972). "Markets in licenses and efficient pollution control programs." *Journal of Economic Theory* **5**(3): pp. 395–418.

[37] See Chan, G., R. Stavins, R. Stowe and R. Sweeney (2012). *The SO2 Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation*. Cambridge, MA, Harvard Environmental Economics Program. p. 39.

2.2.2 The Emissions Trading System

The global carbon market is more properly known as the emissions trading system (ETS) because carbon is just one of several greenhouse gases (GHGs) and not the one with highest global warming potential either. Therefore, a whole set of gases have been assessed with respect to their global warming potential and they all fall under this ETS. It is therefore more correct to talk about emissions with global warming potential. So much for definitions, if we step back and look at how the system came about it will be easier to understand how it works.

The origins of the international concern about climate change is traceable to the publication of the Mauna Loa[38] series which showed an increase in atmospheric carbon dioxide and this was linked to the rise of consumption of fossil fuels and what this might mean in terms of global temperatures. For an excellent overview of the whole story written by insiders review the accounts of Diana Liverman[39] and David Demeritt.[40] This publication series and a number of other simplistic publications "were enough to provoke a small but influential group of scientists to build the case for institutions and policies to coordinate research and responses to the risks of climate change. In turn, this led to a series of meetings and reports between 1985 and the Rio Summit in 1992 laid the scientific groundwork for an international agreement on climate change."[41] The rest of the story is more or less as described earlier in this book.

To build the case, these scientists and others produced three key narratives that have been used internationally to rally politicians, the public, and other scientists around the world for global warming and climate change[42]: (1) "dangerous climate change" must be avoided, (2) the responsibility for climate change is common although somewhat differentiated, and (3) the market—using cap-and-trade

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[38]The location of Mauna Loa has made it an important location for atmospheric monitoring by the Global Atmosphere Watch and other scientific observations. The Mauna Loa Solar Observatory (MLSO), located at 3400 m, has long been used for observing the sun. The NOAA Mauna Loa Observatory (MLO) is located in the proximity. From its location high above local human-generated influences, the MLO monitors the global atmosphere, including the greenhouse gas carbon dioxide. Measurements are adjusted to account for local outgassing of CO2 from the volcano. For more information see page 95 in Rhodes, J. M. and J. P. Lockwood, Eds. (1995). *Mauna Loa Revealed: Structure, Composition, History, and Hazards*. Geophysical Monograph Series (Book 92). Washington DC., American Geophysical Union. p. 348.

[39]See Liverman, D. M. (2009). "Conventions of climate change: constructions of danger and the dispossession of the atmosphere." *Journal of Historical Geography* **35**(2): pp. 279–296.

[40]See Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

[41]According to Liverman, D. M. (2009). "Conventions of climate change: constructions of danger and the dispossession of the atmosphere." *Journal of Historical Geography* **35**(2): pp. 279–296.

[42]According to Liverman, D. M. (2009). "Conventions of climate change: constructions of danger and the dispossession of the atmosphere." *Journal of Historical Geography* **35**(2): pp. 279–296.

system—is the most cost-efficient way to reduce the danger. They are therefore embedded in international climate agreements such as the 1992 United Nations Framework Convention on Climate Change and the 1997 Kyoto Protocol. The problem is that science has become political[43] because these three narratives do not stand up to scientific scrutiny.[44] In many ways, they suffer from the same conceptual problems as the ISO 14000 system discussed earlier in that there are too many value-laden judgments causing debate. The worst, however, is that in order to win support from politician and the public, the IPCC intentionally makes the scientific advice more certain than what it is, which the climate sceptics use against them.[45] In fact, in one study[46] where they studied paleoclimate data from 19,000 to 23,000 years ago, the results suggest a lower probability of imminent extreme climatic change than previously thought. In fact, despite considerable efforts over the last 32 years, the uncertainty of the initial estimates of 3 ± 1.5 °C remains. In other words, climate study is an area of doubt and uncertainty.

It is important to understand that science rests upon a process of selection[47] and what is crucial to understand is that it is a narrow selection which means that results obtained through scientific processes should be viewed as true within limits and then we must judge whether these limits have practical consequences or not with respect to reality. The term "theoretically laden facts" introduced by Lev Semjonovitsj Vygotsky (1896–1934) is therefore extremely relevant,[48] and also the simple fact that of all the "inexorable laws of Nature" before 1900 only Newton's law of gravity have stood the test of time.[49] In other words, the scientific process is a process of continuous improvements, sometimes changed by radical innovations, where improved theories replace outdated ones—and we are, of course, not at the end of this process (if it will ever come). It is therefore plainly naïve to believe that the climate models we have today of such a hugely complex topic as climate change are so correct that there is negligible room for debate and hence will form a clear basis for a huge volume of economic transactions that will

[43]See Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

[44]For an excellent review see Liverman, D. M. (2009). "Conventions of climate change: constructions of danger and the dispossession of the atmosphere." *Journal of Historical Geography* **35**(2): pp. 279–296.

[45]See Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

[46]See Schmittner, A., N. M. Urban, J. D. Shakun, N. M. Mahowald, P. Clark, U., P. J. Bartlein, A. C. Mix and A. Rosell-Melé (2011). "Climate Sensitivity Estimated from Temperature Reconstructions of the Last Glacial Maximum." *Science* **334**(9 December): pp. 1385–1388.

[47]See the classic work of Merz, J. T. (1915). *Religion and Science, A Philosophical Essay*. London, William Blackwood and Sons. p. 192.

[48]See Vygotsky, L. S. (1988). *Thought and Language*. Cambridge MA, The MIT Press. p. 285.

[49]See Merz, J. T. (1915). *Religion and Science, A Philosophical Essay*. London, William Blackwood and Sons. p. 192.

be respected internationally. The belief in the infallibility of science is tantamount to rising science to the level of becoming an ideology based on the rhetoric of objectivity. The trouble with this rhetoric is that it suggests that "…science somehow stands above and outside the fray as a uniquely privileged vehicle to Truth."[50] In fact, Demeritt[51] has identified a number of potentially contentious judgments, assumptions, and practices:

1. Anthropogenic climate change is a global-scale, environmental (as opposed to political or economic) problem.
2. It is caused by the universal physical properties of GHGs (as opposed to underlying political structures or moral failings).
3. These objective entities have universal meanings that can be discovered scientifically by experts.
4. The best way to understand global warming scientifically is to model it mathematically.
5. An important objective of climate science should be the construction of more complex, comprehensive, and physically reductionist models.
6. Model simulations provide the basis of future climate predictions.
7. Rational policy is (or should be) founded on general circulation model (GCM) projections about the regional-scale impacts of climate change.
8. The regional scale is the most meaningful one for policy making.
9. Model parameterizations adequately simulate the climate system variability, or soon will.
10. Modelers should focus first on (what they perceive to be) the most likely outcomes, as opposed to the most extreme.
11. Experts are best placed to decide the legitimacy and credibility of these practices.

The sum of this is that "a socially contingent form of scientific knowledge is being shaped by an emergent international policy regime that, in turn, is being constructed and legitimated by this same body of scientific knowledge."[52] This is a self-reinforcing system without check and balance and this is very troublesome. This results in low credibility and hence opening up for fossil-fuel industry to debunk it scientifically, but we also risk groupthink and ultimately erroneous decisions with huge consequences. This said, it should be noted that "Even Exxon Mobil, *bête noire* of the climate-change activists, has now withdrawn funding

[50]According to Rorty, R. (1990). *Objectivity, Relativism, and Truth: Philosophical Papers, Vol. 1*. Cambridge, Cambridge University Press. p. 236.

[51]A highly interesting paper on this is Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

[52]A highly interesting paper on this is Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

from the CEI[53] and appears to accept the need for controls on carbon emissions."[54] However, whether this is due to reputational risks or new insight is unclear to me.

This is a prime reason for writing this book—I also believe that we go in the wrong direction. Not that I reject climate change; on the contrary, change is inherent in Nature and climate along with it—to believe something else would not only be naïve but also in plain contrast to geological- and historical records. The extent of human impact, however, is another thing which is why I try to argue that it is better to focus on what we know to have impact on sustainability instead of betting everything on a contentious issue. This said, I believe that climate research is important because the climate is a complex adaptive system and complex systems have bifurcation points after which dramatic and irreversible effects can take place. We therefore need climate research not only for long-rang planning purposes but also to be sure that we do not develop our societies on an irreversible and destructive path.

If we expand our thought a little, we can investigate the so-called logistics equation from population biology as an example:

$$x_{n+1} = r \cdot x_n \cdot (1 - x_n) \tag{2.1}$$

where

x_n is a number between 0 and 1 and represents the population at year n. Hence, x_0 represents the initial population (at year 0)

r is a positive number and represents a combined rate for reproduction and starvation.

By creating a program where this equation is iterated[55] upon itself (x_{n+1} in the first iteration is set to x_n in the second iteration and so on) hundreds of times, the bifurcation diagram in Fig. 2.1 is produced. In general, a bifurcation diagram shows the long-term solution of a system as a function of the variables that constitute the so-called attractor,[56] and in this case it represents all possible population

[53]Competitive Enterprise Institute (CEI) is an organization that casts doubt on the science of climate change and campaign against greenhouse-gas reductions, see The Economist (2007). *Cleaning up: A special report on business and climate change*. London, The Economist. p. 32.

[54]According to The Economist (2007). *Cleaning up: A special report on business and climate change*. London, The Economist. p. 32.

[55]An iteration is the mathematical equivalent of a feedback loop.

[56]Unfortunately, there are no universally accepted definitions for attractors, but an attractor can be defined as subset—due to a contraction—of an abstract mathematical space called phase space that describes a dissipative dynamical system by representing all possible states of the system with each possible state of the system corresponding to one unique point in the phase space. A dissipative dynamical system is characterized by the presence of some sort of internal 'friction' that tends to contract phase-space volume elements and hence induce attractors. Therefore, an attractor can be thought of as the long-term behavior of a complex system. There are three types of attractors; (1) fixed point attractors, (2) periodic attractors and (3) strange attractors—also known as fractal attractors, see Ilachinski, A. (1996). *Land Warfare and Complexity, Part I: Mathematical Background and Source Book (U)*. Alexandria, VA, Center for Naval Analyses. p. 231.

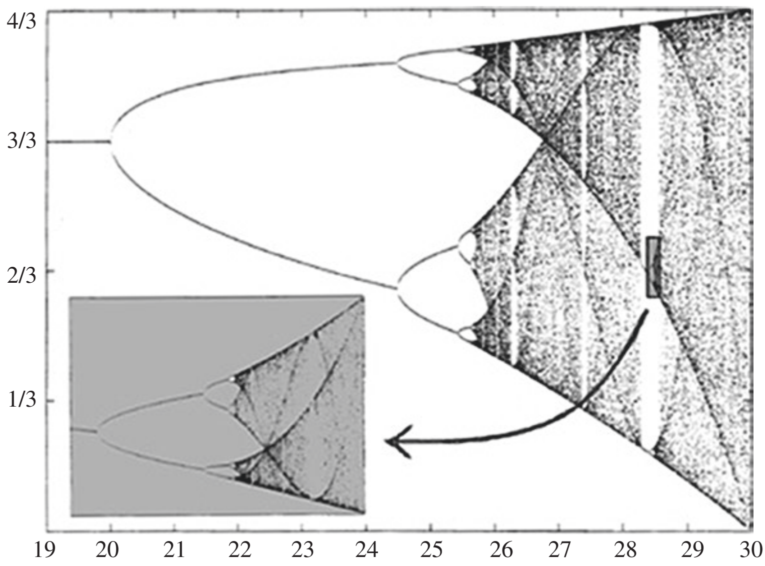

Fig. 2.1 Change in a population governed by the logistics equation whose growth is a strange attractor. *Source* Wikipedia, the free encyclopedia

growth scenarios over time as the combined rate for reproduction and starvation is changed. The resulting figure is a strange attractor, or fractal attractor—the fractal itself is commonly known as the Feigenbaum fractal. The points shown in Fig. 2.1 where the lines split are so-called *bifurcation point*.

Before, we can discuss what bifurcation points are, we must first introduce what Ilya Prigogine (1917–2003) called *dissipative structures*[57] to highlight two apparently contradictory tendencies in all living systems—points of instability where order and structure can emerge. These emerging orders and structures arise in living systems, as well as in social systems, because there is internal "friction" which leads to irreversibility in the system. When a system is forced to change for whatever reasons, it consequently cannot go back to its initial state due to friction which results in dissipation of old structures into the breakdown or breakthrough to new, emergent structures. Hence, a dissipative structure can be likened to an island of order in a sea of disorder and it describes the paradoxical coexistence of change and stability, according to Prigogine. For students of innovation, political science, history, and so on, this should be familiar… This is common throughout our world, which is one of the reasons I find complexity theory so interesting to better understand our areas of study and link it toward real life. With this in mind, bifurcation points can be explained.

[57]See Prigogine, I. and I. Stengers (1989). *Order Out of Chaos*, Bantam Doubleday Dell Publishing Group. p.

Bifurcation points are states at "…a threshold of stability at which the dissipative structure may break down or break through to one of several new states of order"[58] resulting sometimes in evolution or other times in revolution. This process of change via self-organization and attractor bifurcation will create a heavy strain on existing structures and hence push toward the dissipation process. Even the amplifying feedback ("things go out of control"), which always has been considered destructive, appears to be a source of new order and complexity because "stress" is increasingly alleviated via multiple cycles of bifurcation and dissipation and a more relaxed state occurs. Thus, dissipative structures become a source of order.

A very important point about bifurcation points is indeterminacy. Indeterminacy is a key characteristic at the bifurcation points, according to Prigogine,[59] because at the bifurcation point several potential paths or changes exist for the system, but which path it will take depends on past history and various external conditions and can never be predicted for long. Furthermore, minute fluctuations in the environment can cause great changes in the dissipative structure at the bifurcation point. Thus, the dissipative structure can only be predicted over a short-time span. This is, of course, another reason for the climate scientists to be a little less sure—it is only destructive to the cause of sustainability, because there are a number of contentious judgments, assumptions, and practices to debate and hence open up for the commercial interests of the fossil-fuel industry or even the climate research industry if you like.

With all these contentious issues surrounding the climate research and hence the importance of gasses with global warming potential, including carbon dioxide, it is clear that a cap-and-trade system is based on shaky and uncertain foundations. On top, it is complicated further by introducing sinks and carbon equivalents hence making it even more value-laden than it could have been. This is perhaps one of the reasons why Larry Lohmann sees strong conceptual similarity between the trade of derivatives in financial markets and trading carbon equivalents in the ETS.[60] His arguments are compelling and in Table 2.2 I have attempted to summarize some of them to show how similar it is. In Chap. 4, I have expanded on how financial markets work so here it suffices to highlight the similarities. These similarities are interesting because we all know how well the financial markets fared in 2008. Do we want to take the same risk with our environment? Obviously not, and we cannot repeat the same mistakes all over again.

The ETS is complex and beyond this book to discuss in all facets, but some are crucial to note. First, due to the foundations of the ETS and possibilities of offsets, it is hard to determine whether the ETS actually promotes sustainable development or not. In fact, Deutsche Bank claims[61] that any minimal shortfall in carbon

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[58]See Capra, F. (1996). *The Web of Life*. New York, Anchor Books, Doubleday. p. 347.

[59]See Capra, F. (1996). *The Web of Life*. New York, Anchor Books, Doubleday. p. 347.

[60]See Lohmann, L. (2010). "Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes." *New Political Economy* **15**(2): pp. 225–254.

[61]According to Lohmann, L. (2010). "Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes." *New Political Economy* **15**(2): pp. 225–254.

Table 2.2 Similarities between derivatives in financial markets and ETS

Areas of similarity	Financial markets	Emission trading system
Basis for trade	• Derivatives mostly devoid of reality. Packaging and repackaging of securities makes it impossible to understand what the trade is about	• Great confusion as to what the market is trading in. It can be viewed as a commodification of climate benefits/'costs'
Market value	• Set at some initial level, but over time achieve unrealistic trading values compared to real economy	• Governments decide supply levels, set scarcity levels, and either sell or give away commodities to large industrial polluters
Background for valuation	• Heavy usage of models to create commodities and price them	• Heavy usage of models to create commodities
Offsets	• Trading of equivalences in the shape of derivatives	• Polluters can invest in cheaper measures with equivalent effect according to models instead of reducing GHG emissions
Speculation	• Speculation is rampant and is an important factor in short-termism and herding	• By 2008, about 80 carbon investment funds were largely oriented toward speculation
Traders	• Financial institutions	• The same financial institutions, specialist financial institutions, and energy companies

In June 2008, the nominal value of various derivatives was 683 trillion USD—many times global economic output, see Bank of International Settlements (2008). "Statistical Annex; Table 19: Amounts outstanding of over-the-counter (OTC) derivatives." *BIS Quarterly Review*(December): pp. A103
See Cochran, I. T. and B. Leguet (2007). *Carbon Investment Funds: The Influx of Private Capital*. Paris, Caisse des dépôts et consignations, Département développement durable. p. 36
See Cochran, I. T. and B. Leguet (2007). *Carbon Investment Funds: The Influx of Private Capital*. Paris, Caisse des dépôts et consignations, Département développement durable. p. 36
For example in the 70s most currency exchange was for financing international purchases of goods and services, after 2000 the figure was less than 0.1 percent, according to Hart, K. (2001). *Money in an Age of Inequality*. Knutsford, Texere Publishing. p. 340
See Environmental Data Services (2004). "Editorial." *The ENDS Report*(July): pp. 3
According to Lohmann, L. (2010). "Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes." *New Political Economy* **15**(2): pp. 225–254

permits that might appear through 2020 can be met via existing fossil-fired installations; even if circumstances change, the most that could happen would be that some new gas-fired plant gets built ahead of new coal-fired plant.

Second, ETS gives polluting industries additional incentives for delaying structural changes not only because it gives them the alternative of buying or being given bankable pollution permits but also because it relies on prices that cannot be set 40 years in advance.[62]

[62]According to Lohmann, L. (2010). "Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes." *New Political Economy* **15**(2): pp. 225–254.

Third, because the carbon credits were given away for free to polluters, there are significant opportunities for windfall profits, profits that occur unexpectedly due to fortuitous circumstances, and because there is no price regulation as in the SO_2 allowance-trading system, the cost of compliance is suspected to be passed on to customers. Several studies confirm this, for example:

1. The level of windfall profits is significant across many countries, with the estimated level in the five countries (Germany, United Kingdom, Spain, Italy, and Poland) included in one study[63] to be between 23 and 71 billion euros, in total, during the second period of the EU ETS (2008–2012)—based on an EUA price of 21–32 €/t CO2 and a range of pass-through assumptions.
2. The total magnitude of windfall profits is difficult to discern as the evidence was here only shown for a few products in three sectors. However, if we would apply the here discovered full cost-pass-through rates to all products in the refineries and iron and steel sectors, it can be calculated that the total amount of windfall profits would equal € 14 billion between 2005 and 2008. This implies a substantial transfer of money from consumers to the energy intensive industry.[64]

In a market-based system, there are only two principal alternatives[65]: (1) cap-and-trade and (2) taxation. With cap-and-trade system largely malfunctioning[66] concerning climate change on global scale, we are left with taxation as an option. This view is also held by Financial Times which stated that "…carbon markets leave much room for unverifiable manipulation. Taxes are better, partly because they are less vulnerable to such improprieties."[67] The issue of taxation will be discussed in Chap. 8, but the point is to realize that the ETS is complex, value-laden and susceptible to manipulation, rent-seeking and creating wind-fall profits that has nothing to do with improvements. Basically, cap-and-trade system for carbon dioxide and other GHGs simply does not work or is at least highly questionable. A better solution must be found, and later in this book some suggestions will come.

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[63]See Point Carbon Advisory Services (2008). *EU ETS Phase II—The potential and scale of windfall profits in the power sector: A report for WWF*. Oslo, Thomson Reuters Point Carbon. p. 29.

[64]According to de Bruyn, S., A. Markowska, F. de Jong and M. Bles (2010). *Does the energy intensive industry obtain windfall profits through the EU ETS? An econometric analysis for products from the refineries, iron and steel and chemical sectors*. Delft, CE Delft. p. 73.

[65]According to Chan, G., R. Stavins, R. Stowe and R. Sweeney (2012). *The SO^2 Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation*. Cambridge, MA, Harvard Environmental Economics Program. p. 39.

[66]As of 2007 it was concluded that "the carbon market is working, but not bringing forth as much innovation as had been hoped for" by The Economist (2007). *Cleaning up: A special report on business and climate change*. London, The Economist. p. 32.

[67]See Financial Times (2007). Carbon markets create a muddle. London. **April 27th**: pp.

2.3 Some Final Reflections

Judge a tree by its fruit
and not by its leaves.

Euripides

When all this is said, there is one final remark to make—one that is not scientifically rooted or empirically proven, but one that everybody who has worked in industry will realize. If something is to stand the scrutiny of real life, it has to be simple, robust and in this context also provide standardized and consistent information. The approaches chosen by ISO and IPCC are in a sense scientifically rooted, but therein also lay their greatest weakness—they invite too much debate and valuations and this will be their undoing in the end. Only scientists deeply steeped in the ideology of science fails to see this.

Let me just mention that in the USA, they have spent more than 50 years just trying to come up with a formula to divide corporate tax revenues among individual states without succeeding.[68] What makes anybody believe that reaching meaningful, global agreements on the environment will be any easier? In fact, I believe that it will be far more difficult. Even if we ignore the practicalities of reaching agreements, the fundamental problem is that these approaches pretend to be much more reliable and objective than what they are. However, science is not value-free—not even hardcore science such as physics.[69]

Two telling tales we all have heard about are instructive: the tales of Galileo Galilei (1564–1642) and Sir Isaac Newton (1642–1727). Those of us with an education in engineering and natural science may believe that we know their stories from standard textbooks we have read in physics/mechanics, but we do not—at least I did not.

Science is a product of the curiosity born by the works of significantly people like Nicolaus Copernicus (1473–1543), Galileo, René Descartes (1596–1650), and not to mention Sir Isaac Newton. They presented an explanation to the many mysteries of those days that the Church did not seem to provide answers for. The Jesuit Thomas Corbishley (1903–1976) notes, however, that "the Church has never been hostile to scientific advance, and the tension between Church and Science can be attributable to, on one hand, the way scientific discoveries were presented to oppose the religious truths and, on the other hand, some theologians being nervous about its possible repercussions in their domain. In fact, hostility has often originated from the side of science."[70] It is easy to dismiss this because it comes from a Jesuit, but what did really take place?

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[68]See The Economist (2014c). *Special report: companies and the state*. London, The Economist. p. 16.

[69]For a thorough and compelling review, see Cartwright, N. (2002). *How the Laws of Physics Lie*. Oxford, Clarendon Press. p. 221.

[70]See Corbishley, T. (1997). Christianity: The Catholic Church since the Reformation. *Encyclopedia of the World's Religions*. R. C. Zaehner. New York, Barnes & Noble Books.

In school, we were taught that the Church was solely at fault, however, by reading what really took place we get a much more nuanced picture actually more in line with what Corbishley says. This is well documented by Paul Karl Feyerabend (1924–1994), a philosopher of science.[71] A highly interesting sourcebook is also *A History of European Thought In The Nineteenth Century*, *Vol. 3* written by John Theodore Merz (1840–1922) and first published in 1903. His work forms the basis for our understanding of philosophy on a number of subjects prior to 1900 so it is time well spent reading (it is surprisingly readable too-perhaps because Merz was a chemist and not a philosopher).

Recall that Galileo presented the idea that the Earth was rotating around the Sun and that the whole universe followed inexorable laws (the heliocentric worldview or the Copernican System of Cosmology) and not everything rotating around the Earth (the geocentric worldview) as the Church held to be true at the time. He had support from his observations with the telescope but he was unable to explain how the clouds in the sky could follow the Earth if it was rotating around the Sun in high speed to keep its orbit. Therefore, when the matter was investigated by the Roman Inquisition in 1615, they concluded that it could be supported as only a possibility, not an established fact.[72] In retrospect, it is obvious that Galileo was right because later more physics was discovered that allowed us to explain why the clouds did not float away in space as the Earth rotated around the Sun. However, at the time, with the arguments presented in 1615, it is unquestionable that the Church had a more scientific approach than Galileo since they rejected a hypothesis that could not explain all observations. Also, Galileo used an instrument that was poorly understood at the time to support his findings.

Feyerabend suggests along the lines of other scholars that the *real* reason for Galileo coming into trouble was that he violated the rules of patronage vis-á-vis his powerful patron Pope Urban VIII. A final source for Galileo's misfortune that Feyerabend lists is his temper. He was easily irascible and full of contempt for people not up to his standards. These two factors are, of course, not unimportant in a politicized atmosphere that could easily existed in this case particularly when Galileo defense presented in *Dialogue Concerning the Two Chief World Systems* appeared to attack Pope Urban VIII and hence alienated him and the Jesuits who had both supported Galileo up until this point.[73] He was subsequently tried by the Inquisition, found "vehemently suspect of heresy", forced to recant, and spent the rest of his life under house arrest. During his house arrest, however, he was urged by people from the Church to finish his work which shows that it was not necessarily what he said that was the problem but more that it lacked complete scientific foundation at the time or maybe even the way he said it…

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[71]See Feyerabend, P. (2011). *The Tyrrany of Science*. Cambridge, Polity Press. p. 153.

[72]See Pantin, I. (1999). "New Philosophy and Old Prejudices: Aspects of the Reception of Copernicanism in a Divided Europe." *Studies in history and philosophy of science* **30**: (2): pp. 237–262.

[73]See Hilliam, R. (2004). *Galileo Galilei: Father of Modern Science*. New York, Rosen Publishing Group. p. 112.

The story of Galileo is not unique, however. Before the twelfth century another issue was at stake—was the Earth flat? There were plenty of references in the Bible suggesting that it was flat. However, based on the evidence the Church changed position. So, the Church has not be alien to new arguments as many claims—is has only exercised skepticism.

However, the best example is possibly Newton's law of gravity. Newton's law of gravity was presented in 1687 in his masterpiece *Philosophiæ Naturalis Principia Mathematica*. Using geometric methods, however, gave the startling result that the solar system would fall apart despite the fact that ancient Babylonian records indicated that the solar system had remained stable considerable time.[74] Newton observed that the solar system did not fall apart, and then concluded that the Almighty once in a while gave the planets a jolt to get them back into position. Hardly, a very scientific proposition, yet, Newton is proclaimed as one of the greatest in history of Science and rightfully so.

I do not tell these tales to belittle these great scientists—it should more serve as a warning against making science an ideology that is infallible and perfect. Science has its flaws and it is work in progress—always. As Bertrand Russell so eloquently phrased it:

> Although this may seem a paradox, all exact science is dominated by the idea of approximation.

Then, does this approximation reduce the validity? In many cases, the answer is no, like Newtonian mechanics, for which this author has formal training at university level, but where is the borderline? Is trying to model such a hugely complex system such as the climate of the Earth a valid approach or is it deceptive? Many believe it is deceptive and with just cause as argued in the previous section. Just because a model can produce nice graphs and a massive output of numbers does not validate it. If the fundamentals are questionable—trying to model a hugely complex system without reference cases—a layer of advanced technology on top does not correct its fundamental shortcomings.

There are numerous examples of how people can be duped by someone saying something the right way even though the content is outright nonsensical or inaccurate to say the very least. The problem is that people mix the right way of expression as evidence of sincerity and truthfulness.[75] Take for example the essay Alan Sokal, a professor in physics at New York University, presented in the journal *Social Text* where he suggested a link between quantum mechanics and postmodernist philosophy of the kind popular in cultural studies. The essay, however, was a hoax, which Sokal announced in another journal *Lingua Franca*. Needless to say, the editors (and the reviewers) of *Social Text* appeared rather silly. Although Sokal

[74]See Feyerabend, P. (2011). *The Tyrrany of Science*. Cambridge, Polity Press. p. 153.

[75]See Mercer, N. (2006). *Words and Minds; How we use language to think together*. London, Routledge. p. 206.

blatantly violated the Griceian[76] maxim of quality in communication, as well as partly violated the others maxims, his actions raise interesting question concerning the quality of researchers ability to judge truth content. In this case, the community subscribing to *Social Text* was duped, but what about those cases where it is the other way around. In fact[77]:

> People offering new and interesting ideas to members of a community, but doing so in ways that do not correspond with the communicative ground rules of the communities, may find that their ideas are ignored or rejected simply because they are not presented in the right kind of language.

Sounds like a basis for Galileo's misfortune…. Furthermore, Albert Einstein in fact compared the scientific method to a game[78]:

> One may compare these rules [related to the scientific method] with the rules of a game in which, while the rules are arbitrary, it is their rigidity alone which makes the game possible. However, the fixation will never be final. It will have validity only for a special field of application.

This said, science has amassed enough knowledge today for our societies to start the journey—what is missing is a more productive context that can unlock human ingenuity, just like the laws of limited liability did in the past. This process cannot start, however, by proclaiming that some scientists are right and others are wrong. We must use science where it applies correctly for enlightenment and not for debate which will stifle action toward sustainability. Therefore, the approaches today are too ambitious because they require a level of scientific infallibility and perfection that is impossible to achieve in foreseeable future. Yet, largely due to the politics of science,[79] this is the path pursued.

This book tries to argue that we should rather focus on what can be realistically managed and then institute policies accordingly. It is better to be approximately right than exactly wrong.

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[76]See the maxims in Grice, H. P. (1991). *Studies in the Way of Words*. Cambridge, MA, Harvard University Press. p. 394.

[77]See Mercer, N. (2006). *Words and Minds; How we use language to think together*. London, Routledge. p. 206.

[78]See Einstein, A. (1950). *The Theory of Relativity & Other Essays*. New York, MJF Books. p. 75.

[79]See Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

Chapter 3
Risk and Uncertainty—Crucial Issues in Finance and Innovation

Management is a practice rather than a science… and the ultimate test of management is performance.

Peter F. Drucker

Central in the capitalist system is the management of risk. It is important for technology development because lack of trust can be a significant barrier to the successful commercialization of innovations that are costly, technologically sophisticated, or potentially harmful to human health and the environment.[1] It is also important for the financial industry as they try to anticipate future earnings and the like. To properly manage risks is not just important for investors to avoid losses, but it is important for society to continue accepting socialization of risks, which is crucial for the legitimacy of limited liability. Thus, there is a moral obligation to behave in trustworthy ways for those who want to invest and innovate in addition to managing risk.

Risk management today has come a long way since its early days, but there is still much to improve. Concerning this book, there are particularly two areas where risk management needs to improve and that is financial risk management (FRM) and risk management of high-impact, low-probability (HILP) events, commonly referred to as disasters because they are both unexpected, rare and often with disastrous consequences. Therefore, for simplicity, I refer to the risk management of HILPs as disaster risk management (DRM).

Improving DRM practices is crucial for sustainable development because today trust has eroded significantly away from a technology such as nuclear power, which according to some is the only viable solution for large-scale energy production that at the same time will reduce CO_2 emissions. Trust has eroded generally as well, as discussed in Chap. 9. In fact, ecologist Patrick Moore, known as one of the five founders of Greenpeace, has over the last years been a vocal advocate for

[1]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_3

nuclear power because "And it was obvious to me—it's been obvious to me all along—that wind and solar can't really change that [the reliance on fossil fuel] very much. But what can change it, is nuclear power, plus hydroelectricity where it is available, and there's still a lot of potential hydroelectric power in the world[2]". He also points out a striking fact; we use nuclear medicine produced in nuclear reactors without any public outcry—all technology can be used for good or evil. Clearly, we do not reject nuclear power on the basis that it is nuclear per se but rather on the fact that there have been some very unfortunate accidents which have scared the public. Therefore, it is vital to give technology a more correct profile as to the understanding of risk, and this is discussed further in Sect. 7.2.

Likewise, FRM is important to improve simply to restore basic trust in the financial world which has been severely eroded over the last decades as one financial crisis has slid into another. The erosion of trust in the financial world may seem like completely out of the blue concerning the topic of this book, but the fact is that sound financial management is crucial to fuel the sustainability revolution just like it did for the Industrial Revolution as discussed in Chap. 1. This is discussed more in Chaps. 4 and 5.

First, however, a brief introduction to risk and its cousin uncertainty is necessary because in the literature and among practitioners, there is considerable confusion. In fact, risk and uncertainty are often used interchangeably. For example, for auditors "risk is uncertainty."[3] It may be that distinguishing between risk and uncertainty makes little sense for auditors, but the fact is that there are many fundamental differences as explained next. We first discuss risk from traditional perspectives, and we look at the sources of risks. Then, the concept of uncertainty is explored in Sect. 3.2.

3.1 Risk

> A brave man runs no more risk than a coward.
>
> Lord Horatio Nelson

The word "risk" derives from the early Italian word *risicare*, which originally means "to dare." In this sense, risk is a choice rather than a fate, as Peter L. Bernstein (1919–2009) points out in his highly acclaimed book *Against the Gods: the Remarkable Story of Risk*.[4] Other definitions also imply a choice aspect. Risk as a general noun is defined as "exposure to the chance of injury or loss; a hazard

[2]See Murphy, G. (2008). "A Conversation with Patrick Moore: Why Former Greenpeace Leader Supports Nuclear Energy." *EIR Science & Technology*(16 May): pp. 58–63.

[3]According to Friedlob, G. T. and L. L. F. Schleifer (1999). "Fuzzy logic: application for audit risk and uncertainty." *Managerial Auditing Journal* **14**(3): pp. 127–135.

[4]See the highly acclaimed book by Bernstein, P. L. (1996). *Against the Gods: the Remarkable Story of Risk*. New York, John Wiley & Sons. p. 383.

or dangerous chance" by *Webster's Encyclopedic Unabridged Dictionary of the English Language*.[5] Along the same token, in statistical decision theory[6] risk is defined as "the expected value of a loss function." Thus, various definitions of risk imply that we expose ourselves to risk by choice, which also includes *not* choosing or making a decision.

Risk is *measured*, however in terms of "consequences and likelihood"[7] where likelihood is understood as a "qualitative description of probability or frequency," but frequency theory is dependent on probability theory.[8] Thus, risk is a probabilistic phenomenon as it is defined in most of the literature. Note that risk is not consequences *multiplied* by likelihood. This is because multiplication implies a risk neutral decision-maker.[9] This insight again emphasizes the choice/decision aspect of risk, which must be remembered when we discuss uncertainty later on.

Note that it is important to distinguish between the *concept of probability*, *measures of probability,* and *probability theory*. Unfortunately, this is rarely done properly. Consequently, there is much dispute about the subject matter of probability.[10] From its linguistic roots, probability can best be defined as a "degree of belief," but it is vital to understand that it can be *measured* in several ways out of which the classical probability calculus is the best known. For simplicity and generality, the definition of risk found in Webster serves the best—the "exposure to the chance of injury or loss; a hazard or dangerous chance"—while I suggest measuring risk in terms of "degree of impact and degree of belief."

It is important to emphasize that "risk is not just bad things happening, but also good things not happening"[11]—a clarification that is particularly crucial in business context because many companies do not fail from primarily taking "wrong actions," but from not capitalizing on their opportunities, i.e., the loss of an opportunity. As Peter Ferdinand Drucker (1909–2005) observes, "The effective business

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[5]See Webster (1989). *Webster's Encyclopedic Unabridged Dictionary of the English Language*. New York, Gramercy Books. p. 1854.

[6]See for example Hines, W. W. and D. C. Montgomery (1990). *Probability and Statistics in Engineering and Management Science*. New York, John Wiley & Sons, Inc. p. 732.

[7]This is a very common way of measuring risk found in countless literature, such as:
- Standards Australia (1999). *AS/NZS 4360:1999—Risk Management*. Sydney, Standards Australia. p. 44.
- Robbins, M. and D. Smith (2001). *BS PD 6668:2000—Managing Risk for Corporate Governance*. London, British Standards Institution. p. 33.

[8]According to Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

[9]This insight is from Hubbard, D. W. (2009). *The Failure of Risk Management: Why It's Broken and How to Fix It*. Hoboken, NJ, John Wiley & Sons, Inc. p. 281.

[10]According to Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

[11]According to Jones, M. E. and G. Sutherland (1999). *Implementing Turnbull: A Boardroom Briefing*. City of London, The Center for Business Performance, The Institute of Chartered Accountants in England and Wales (ICAEW). p. 34.

focuses on opportunities rather than problems."[12] Thus, risk management is ultimately about being proactive to avoid losses in a wide sense.

So far, I have not said a word about uncertainty. Uncertainty comes into play because "the source of risk is uncertainty."[13] This derives from the fact that risk is a choice rather than a fate and occurs whenever there are one-to-many relations between a decision and possible future outcomes. This brings us to the discussion of uncertainty.

3.2 Uncertainty

> We demand rigidly defined areas of doubt and uncertainty.
>
> Vroomfondel
> in *Hitchhiker's Guide to the Galaxy*

Uncertainty as a general noun is defined by *Webster's Encyclopedic Unabridged Dictionary of the English Language*[14] as "the state of being uncertain; doubt; hesitancy." Thus, there is neither loss nor gain *necessarily* associated with uncertainty; it is simply *the not known with certainty*—not the unknown. If it was unknown, we could not contemplate it and hence not speak of it.

Some define uncertainty as "the inability to assign probability to outcomes," and risk is regarded as the "ability to assign such probabilities based on differing perceptions of the existence of orderly relationships or patterns."[15] However, such definitions are too simplistic for a number of reasons. The important realization comes from the fact that uncertainty and complexity are intertwined and as an unpleasant side effect, imprecision emerges. Lotfi A. Zadeh formulated this fact in a theorem called the *Law of Incompatibility*[16]:

> As complexity rises, precise statements lose meaning and meaningful statements lose precision.

Since all corporations experience some degree of complexity, this theorem is crucial to understand. With *complexity* we refer to the state in which the cause-and-effect relationships are loose, for example, operating a sailboat. A mechanical

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[12]See Drucker, P. F. (1986). *Managing for Results: Economic Tasks and Risk-Taking Decisions*. New York, HarperInformation. p. 256.

[13]According to Peters, E. E. (1999). *Complexity, Risk and Financial Markets*. New York, John Wiley & Sons. p. 222.

[14]See Webster (1989). *Webster's Encyclopedic Unabridged Dictionary of the English Language*. New York, Gramercy Books. p. 1854.

[15]See for example Gilford, W. E., H. R. Bobbitt and J. W. Slocum jr. (1979). "Message Characteristics and Perceptions of Uncertainty by Organizational Decision Makers." *Academy of Management Journal* **22**(3): pp. 458–481.

[16]Quoted by McNeill, D. and P. Freiberger (1993). *Fuzzy Logic*. New York, Simon & Schuster. p. 320.

clock, however, in which the relationship between the parts is precisely defined, is *complicated*—not complex. From the Law of Incompatibility, we understand that there are limits to how precise decision support both can and *should be* (to avoid deception), due to the inherent uncertainty caused by complexity. In fact, *increasing the uncertainty* in decision-support material to better reflect the *true* and inherent uncertainty will *lower the actual risk*.[17]

Furthermore, Nobel laureate Kenneth Joseph Arrow warns us that "[O]ur knowledge of the way things work, in society or in Nature, comes trailing clouds of vagueness. Vast ills have followed a belief in certainty."[18] Basically, ignoring complexity and/or uncertainty is risky, and accuracy may be deceptive. Thus, striking a sound balance between meaningfulness and precision is crucial, and possessing a relatively clear understanding of uncertainty is needed since uncertainty and complexity are so closely related.

Another important source for uncertainty is, of course, the future. No one can tell the future, and it is from this interpretation of uncertainty that many believe that the only distinction between risk and uncertainty is that risk involved loss whereas uncertainty does not.[19]

The essence of word meaning is that it constitutes a generalized reflection of reality,[20] and from this, we realize that uncertainty describes the meaningfulness of information. To develop a more operational measure uncertainty, we can therefore use quality as defined by Genichi Taguchi (1924–2012). Taguchi stated[21] that quality is the loss a product causes to society after being shipped, other than losses caused by its intrinsic functions. Furthermore, Taguchi asserted that there were two types of losses: (1) loss caused by variability of function and (2) loss caused by harmful side effects. Hence, good quality means that a service, product, process, or whatever "performs its intended functions without variability and causes little loss through harmful side effects, including the cost of using it." From this, I would like to offer a very general definition of quality—quality is a measure of the consistency of something around its target as approximately measured by the standard deviation. Similarly, uncertain becomes a measure of information quality, and statistically speaking uncertainty can be approximated by the famous sigma (σ)—or the standard deviation.

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[17]This is exemplified by Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[18]See Arrow, K. J. (1992). I Know a Hawk from a Handsaw. *Eminent Economists: Their Life and Philosophies*. M. Szenberg. Cambridge, Cambridge University Press: pp. 42–50.

[19]See for example Hubbard, D. W. (2009). *The Failure of Risk Management: Why It's Broken and How to Fix It*. Hoboken, NJ, John Wiley & Sons, Inc. p. 281.

[20]According to Vygotsky, L. S. (1988). *Thought and Language*. Cambridge MA, The MIT Press. p. 285.

[21]See Taguchi, G., S. Chowdhury and Y. Wu (2005). *Taguchi's Quality Engineering Handbook*. Hoboken, NJ, John Wiley & Sons. p. 1662.

With this in mind, researchers[22] identify two main types of uncertainty: fuzziness and ambiguity. Definitions in the literature differ slightly but are more or less consistent with the following. Fuzziness occurs whenever definite, sharp, clear, or crisp distinctions are not made. Other words can be vagueness, cloudiness, haziness, unclearness, indistinctness, and shapelessness. Ambiguity results from unclear definitions of the various alternatives (outcomes). These alternatives can either be in conflict with each other, or they can be unspecified. The former is ambiguity resulting from discord—where we can also think of words such as dissonance, incongruity, discrepancy, and conflict—whereas the latter is ambiguity resulting from non-specificity bringing words such as variety, generality, diversity, equivocation, and imprecision to mind. The ambiguity resulting from discord is essentially what probability theory focus on, because "probability theory can model only situations where there are conflicting beliefs about mutually exclusive alternatives."[23] In fact, neither fuzziness nor nonspecificity can be conceptualized by probability theories that are based on the idea of "equipossibility", because such theories are "digital" in the sense that degrees of occurrence is not allowed—it either occurs or not. Put differently, *uncertainty* is a too wide concept for probability theory, because probability theory is closely linked to equipossibility theory.[24] In fact, just as the majority of theories developed in the history of science and the arts ignore complexity, so does probability theory. It was simply not in their mind and a phenomenon not yet understood at that time. Therefore, in probability theory, uncertainty has no meaning, and I think this is one of the reasons why there is a big confusion on the topic among practitioners as well as many academics which results in many fruitless debates in my opinion.

Just consider this: There is nothing uncertain about rolling a *balanced* dice. You know that you will either get 1, 2, 3, 4, 5, or 6. That's it. You even know that because it is balanced, there is no tendency to get one number more frequent than any other number so that the probability of obtaining 1 is 1/6, and so it is for all six numbers. Just because you cannot tell the exact outcome—1, 2, 3, 4, 5, or 6—in advance does not mean that it is uncertain. It means that it is probabilistic. There is not a shred of complexity at work—all options are known, and the entire solution space is known. Nothing is uncertain in itself.

Researchers have discussed the various methods used in risk analysis and classified them as either "classical" (probability-based) or "conceptual" (fuzzy set-based). They find that[25]:

[22]See Klir, G. J. and B. Yuan (1995). *Fuzzy Sets and Fuzzy Logic: Theory and Applications*. New York, Prentice-Hall. p. 268.

[23]See Klir, G. J. (1991). "A principal of uncertainty and information invariance." *International Journal of General Systems* **17**: pp. 258.

[24]See Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

[25]See Kangari, R. and L. S. Riggs (1989). "Construction risk assessment by linguistics." *IEEE Transactions on Engineering Management* **36**(2): pp. 126–131.

> … probability models suffer from two major limitations. Some models require detailed quantitative information, which is not normally available at the time of planning, and the applicability of such models to real project risk analysis is limited, because agencies participating in the project have a problem with making precise decisions. The problems are ill-defined and vague, and they thus require subjective evaluations, which classical models cannot handle.

To deal with both fuzziness and nonspecific ambiguity, however, Zadeh invented *fuzzy sets* which is "the first new method of dealing with uncertainty since the development of probability"[26]—and the associated *possibility theory*. Fuzzy sets and possibility theory handles the widest scope of uncertainty.

Similar ideas, however, seem also to have been absorbed by a type of probability theory denoted "subjective probability theory."[27] This is explained in detail in Sect. 3.4, and for simplicity, I use the term "classic probability theory" to separate it from subjective probability theory. First, however, we must add another element to the discussion on risk and uncertainty—intuitive risk judgments typically referred to as "risk perception."

3.3 Risk Perception

> If you think predicting the future is risky, try ignoring it.
>
> The Economist

A major development in the study of risk perception was achieved by the discovery of a set of mental strategies, or heuristics, that people employ to make sense out of an uncertain world. Although these rules are valid in many circumstances, they can lead to significant and persistent cognitive biases which which have serious implications for risk management.[28]

First of all, note that the term "cognition" is widely used but defined in countless ways depending on which domain that uses it. Broadly speaking, it can be defined as[29] "…the domain of thought and inference, marking the contrast with perceptual experiences and other mental phenomena such as pain and itches." More recently, "cognition" has been perceived as "…the domain of representational states and processes studied in cognitive psychology and cognitive sciences." These are phenomena involved in thinking about the world, using language, guiding, and controlling behavior. Here, the work of Daniel Kahneman

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[26]According to Zadeh, L. A. (1965). "Fuzzy Sets." *Information Control* **8**: pp. 338–353.

[27]See for example Roos, N. (1998). *An objective definition of subjective probability*. 13th European Conference on Artificial Intelligence, John Wiley & Sons.

[28]See Kahneman, D., P. Slovic and A. Tversky, Eds. (1982). *Judgment Under Uncertainty: Heuristics and Biases*. New York, Cambridge University Press. p. 544.

[29]This definition is from Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

and Amos Tversky (1937–1996) is paramount, and their Prospect Theory suggests, and empirical results confirm, that people tend to make different choices under different conditions. When people are in a position of gain, they become increasingly risk averse and unwilling to accept gambles because they wish to hold on to their gains. However, when people are in a position of loss and as losses increase, they become more risk seeking because they have not very much to lose. Unfortunately, this asymmetrical behavior is not captured by economic and financial theories.

The prospect of loss or gain is undoubtedly important, but there are other factors at work too, such as:

1. Personality. Our innate dispositions, feelings, biases, and characteristics that tend to manifest themselves in preferences, sensitivities, habits, and reactions are crucial.[30] This will in turn decide whether a specific situation is perceived as a threat or an opportunity. An important part of evaluating this is a person's sensation seeking. This aspect of personality comprises of four elements: (1) thrill and adventure seeking, (2) experience seeking, (3) lack of inhibition, and (4) susceptibility of boredom. This is relevant as to managing financial risks as we have all heard about "rouge traders."
2. Organizational culture—with the maxim that "culture eats strategy for breakfast" we understand that this is important. The importance of perceptions, including risk perceptions, is even found in Edgar Schein's authoritative definition on organizational culture; "A culture is a pattern of shared basic assumptions that was learned by a group as it solves its problems of external adaption and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems".[31] For the sake of good order, the culture in the context of that maxim refers to the sum of national culture and organizational culture.
3. National cultures also have big impact on risk perception and also the ability to manage risk. This is evident from Geert Hofstede's definition on national culture as "…the collective programming of the mind that distinguishes the members of one group or category of people from others."[32]
4. Gender and age also impact risk perception. On an average, women are more risk averse than men, and more experienced managers are more risk averse

[30]See Fenton-O'Creevy, M. and E. Soane (2001). The subjective perception of risk. *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. J. Pickford. London, Prentice Hall: pp. 25–30.

[31]See Schein, E. H. (2004). *Organizational Culture and Leadership*. San Francisco, Jossey Bass. p. 452.

[32]For an excellent discussion, see Hofstede, G., G. J. Hofstede and M. Minkov (2010). *Culture and Organizations: Software of the Mind: Intercultural Cooperation and Its Importance for Survival*. London, McGraw-Hill. p. 561.

than younger ones.[33] Furthermore, evidence suggests that successful managers take more risk than unsuccessful managers.

In the context of risk perception, it is uncertainty rather than risk that is the issue. This highlights the importance of managing uncertainty as something distinct from managing risk—too often the two are mixed, and we fail to separate the choice issues (risk) from the information quality issues (uncertainty). This is a particular importance in the discussion of HILP events where uncertainty is by far a greater problem concerning decision-making than the risks themselves. This can be exemplified by Table 3.1 where we see how experts rate risks compared to laypeople—a rank of 1 represents the most risky activity or technology. We see easily how nuclear power stands out as a significant challenge concerning risk perception. Understanding risk perception and handling it wisely will be crucial to develop policies and technologies that can have large impact on development.

An answer to this apparent contradiction between the fact-based, expert version and the perception of laypeople was first proposed by Chauncey Starr (1912–2007), who in 1969 posed the seemingly simple question "how safe is safe enough?"[34] To find an answer, he developed an approach in which he separated societal activities into two broad groups—"voluntary activities" and "involuntary activities." In the case of "voluntary" activities, the individual uses his own value system to evaluate experiences, whereas "involuntary" activities differ in that the criteria and options are determined by a controlling body and not the individual. His studies then led him to conclude that the public is willing to accept "voluntary" risks roughly a 1000 times greater than "involuntary" risks. While debating the details of his approach and the number 1000 is no problem—later studies have shown that there are more factors involved such as familiarity, control, catastrophic potential, equity, and level of knowledge[35]—the general idea that risk means different things to different people is important for our discussion and for public policy. A telling tale is the Three Mile Island nuclear reactor accident in the USA in 1979. Although nobody was killed and few if any latent cancer fatalities are expected, no other accident in US history has produced such costly societal impacts.[36] Policies neglecting the effect of accidents and major failures are therefore bound to fail.

Indeed, work by Paul Slovic and his colleagues suggest that the perception of risk can be decomposed into mainly two factors: (1) fear—how much do we dread the outcome and (2) control—the extent to which we feel in control of events.

[33]See MacCrimmon, K. R. and D. A. Wehrung (1986). *Taking Risks: The Management of Uncertainty*. New York, The Free Press. p. 400.

[34]See Starr, C. (1969). "Social Benefit versus Technological Risk." *Science* **165**(3899): pp. 1232–1238.

[35]See Slovic, P., B. Fischhoff and S. Lictenstein (1979). Facts and Fears: Understanding Perceived Risk. *Proceedings of the General Motors Symposium on Societal Risk Assessment*. R. C. Schwing and W. A. Albers. Warren, MI, Plenum Press: pp. 181–216.

[36]See Slovic, P. (1987). "Perception of Risk." *Science* **236**(4799): pp. 280–285.

Table 3.1 Ordering of perceived risks for 30 activities and technologies calculated based on geometric mean within each group

Activity or technology	League of women voters	College students	Active club members	Experts
Nuclear power	1	1	8	20
Motor vehicles	2	5	3	1
Handguns	3	2	1	4
Smoking	4	3	4	2
Motorcycles	5	6	2	6
Alcoholic beverages	6	7	5	3
General (private) aviation	7	15	11	12
Police work	8	8	7	17
Pesticides	9	4	15	8
Surgery	10	11	9	5
Firefighting	11	10	6	18
Large construction	12	14	13	13
Hunting	13	18	10	23
Spray cans	14	13	23	26
Mountain climbing	15	22	12	29
Bicycles	16	24	14	15
Commercial aviation	17	16	18	16
Electric power (non-nuclear)	18	19	19	9
Swimming	19	30	17	10
Contraceptives	20	9	22	11
Skiing	21	25	16	30
X-rays	22	17	24	7
High school and college football	23	26	21	27
Railroads	24	23	29	19
Food preservatives	25	12	28	14
Food coloring	26	20	30	21
Power mowers	27	28	25	28
Prescription antibiotics	28	21	26	24
Home appliances	29	27	27	22
Vaccinations	30	29	29	25

Source Slovic, Fischhoff et al. (see Slovic, P., B. Fischhoff and S. Lictenstein (1979). Facts and Fears: Understanding Perceived Risk. *Proceedings of the General Motors Symposium on Societal Risk Assessment*. R. C. Schwing and W. A. Albers. Warren, MI, Plenum Press: pp. 181–216) and used with kind permissions from Springer Science + Business Media New York

Naturally, high degree of fear and a feeling of no control—such as a nuclear accident—is the worst. For most people, the fear of loss without any measure of control will probably win over the prospect of winning. This is important for public policy because when the science and innovation system, see Chap. 7, is to be configured for sustainable development policy makers must take into account the perceptions of risk and not just clinical expert numbers such as the number of people killed or saved—otherwise, they run the risk of facing large public opposition when diffusing innovations.

It should also be noted that here we have a significant difference between now and during the Industrial Revolution. Then, an acceptable balance between technological benefits and social costs was found via trial and error over time.[37] Today, the speed of diffusion of innovations is too high for trial and error leaving us in a state of uncertainty as to the impacts of technological risks, and hence, the perception of risks is no longer based on experience from trial and error and formal knowledge is often wanting or not easily accessible for laypeople. This represents a significant challenge both to the legislative process as well as the science and innovation system as discussed later. However, one apparent way of handling public risk perceptions better is by changing the way we analyze the risks of new technologies as discussed later in this chapter.

Before we continue, an important technical discussion concerning probability and our understanding of it is warranted. It is important because there is considerable confusion about it and various interpretations of probability are inherent in various approaches—FRM being one of the worst—so to understand the limitations of these approaches, we must understand the technical issues of probability. Those with a more relaxed attitude concerning probability can, of course, skip the next section.

3.4 Probability, Subjective Probability, or Possibility?

> Objectivity is inter-subjective agreement.
>
> Arne Næss

For the crux of the difference between classic probability theory and possibility theory can be understood by considering the Venn diagram in Fig. 3.1. The two outcomes *A* and *B* in outcome space *S* overlap, i.e., they are not mutually exclusive. The probability of *A* is in other words dependent on the probability of B and vice versa. This situation is denoted non-specific ambiguity.

In classic probability theory, we look at *A* in relation to *S* and correct for overlaps so that the sum of all outcomes will be 100 percent (all exhaustible). In theory,

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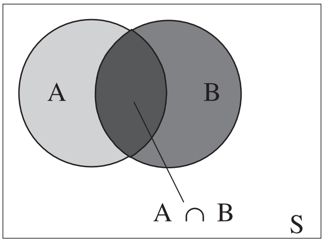
[37] According to Starr, C. (1969). "Social Benefit versus Technological Risk." *Science* **165**(3899): pp. 1232–1238.

Fig. 3.1 Two non-mutually exclusive outcomes in outcome space S



this is straightforward, but in practice, calculating the probability of $A \cap B$ is problematic in cases where A and B are interdependent and the underlying cause-and-effect relations are complex. Thus, in such cases, we find that the larger the probability of $A \cap B$, the larger may the mistake of using classic probability theory become.

In possibility theory, however, we simply look at the outcomes in relation to each other, and consequently, S becomes irrelevant and overlaps do not matter. The possibility of A will simply be A to $A + B$ in Fig. 3.1. Clearly, possibility theory is intuitive and easy, but we pay a price—loss of precision (an outcome in comparison with outcome space) both in definition (as discussed here) and in its further calculus operations (not discussed here). This loss of precision is, however, more true to high levels of complexity. Also, it is important that risk management approaches do not appear more reliable than they are because then decision-makers can be lead to accept decisions they normally would reject, a problem Bernstein highlighted and the 2008 Financial Crisis illustrated.[38]

This discussion clearly illustrates that "[classic] probabilistic approaches are based on counting whereas possibilistic logic is based on relative comparison."[39] The estimate itself concerning relative comparison is established mathematically by relative (pair-wise) comparison, and Analytical Hierarchy Process (AHP) is a supreme tool that results in internal consistency not possible to achieve in any other way.[40] There are also other differences between classic probability theory and possibility theory, which is beyond the scope of this book.

It should be noted that several places in the literature the word "probability" is used in cases that are clearly "possibilistic." This is probably more due to the fact that "probability" is a common word—which has double meaning[41]—one reflect-

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[38]See Bernstein, P. L. (1996). *Against the Gods: the Remarkable Story of Risk*. New York, John Wiley & Sons. p. 383.

[39]See Dubois, D., J. Lang and H. Prade (1994). Possibilistic logic. *Handbook of Logic in Artificial Intelligence and Logic Programming: Volume 3: Nonmonotonic Reasoning and Uncertain Reasoning* D. M. Gabbay, H. C. J. and J. A. Robinson. Oxford, Oxford University Press: pp. 439–513.

[40]See Emblemsvåg, J. and L. E. Kjølstad (2006). "Qualitative risk analysis—some problems and remedies." *Management Decision* **44**(3): pp. 395–408.

[41]See Bernstein, P. L. (1996). *Against the Gods: the Remarkable Story of Risk*. New York, John Wiley & Sons. p. 383.

ing an actual usage of classic probability theory and calculus, and one reflecting the sloppy daily usage of the word.

Subjective probability theory is somewhere in between classic probability theory and possibility theory in that it relaxes the "all exhaustive" condition of classic probability but maintains counting. However, in this book, we need not distinguish between possibility theory and subjective probability theory because the main difference between those theories lies in the exact mathematical calculus, but the difference in calculus is of no interest because at the end of the day, we can use the powerful Monte Carlo methods in which these distinctions disappear since it is a numerical mathematical approach.

In modern decision theory,[42] subjective probability is regarded as "…the quantified opinion of an idealized person."[43] The derived probability is subjective in the sense that different individuals are allowed to have different probabilities for the same event. This approach therefore provides a rigorous subjective interpretation of probability that is applicable to unique events and is embedded in a general theory of rational decision [44]and relates well with risk perception.

There is only one language with absolute correctness and that is mathematics,[45] so quantitative measures of risk and uncertainty are preferable to qualitative ones. Qualitative ones can in many cases be converted to quantitative ones by using AHP,[46] so the important distinction is not quantitative versus qualitative risk analyses—it is between absolute and relative measures of probability, or basically between all exhaustive (classic) and relative (subjective) probabilities. Therefore, classic probability calculus may prove deceptive in risk analyses because it assumes all exhaustiveness, which is hard to achieve in many cases. This is not to say, however, that probability theory should be discarded altogether—I simply claim that classic probability theory needs to relax its all exhaustive condition and admits its subjective nature to be useful in real life resulting in subjective probability theory which is what this book relies on. However, ordinal scales should be avoided as some[47] points out and correctly so, but biases are less prone to creep

[42]According to Tversky, A. and D. Kahneman (1974). "Judgment under Uncertainty: Heuristics and Biases." *Science* **185**(4157): pp. 1124–1131.

[43]See Savage, L. J. (2003). *The Foundations of Statistics*. New York, Dover Publications Inc. p. 310.

[44]According to Tversky, A. and D. Kahneman (1974). "Judgment under Uncertainty: Heuristics and Biases." *Science* **185**(4157): pp. 1124–1131.

[45]According to Vygotsky, L. S. (1988). *Thought and Language*. Cambridge MA, The MIT Press. p. 285.

[46]See for example Emblemsvåg, J. and L. E. Kjølstad (2006). "Qualitative risk analysis—some problems and remedies." *Management Decision* **44**(3): pp. 395–408.

[47]See Hubbard, D. W. (2009). *The Failure of Risk Management: Why It's Broken and How to Fix It*. Hoboken, NJ, John Wiley & Sons, Inc. p. 281.

into the analysis by using AHP for calculating the subjective probabilities in an internally consistent way based on the entire belief system of the individual.[48]

Furthermore, by using AHP it is also possible by using Monte Carlo methods to include uncertainty analysis into the subjective probability analysis.[49] This is not possible by using psychological calibration training as some[50] advocate.

The necessity of the subjective nature of probability can easily be fathomed by considering the enormous variety of risks that corporations face and most translates into financial outcomes in one way or the other and many are not mutually exclusive. Examples of risks include as follows[51]:

- Operational risks:
  (a) Machinery breaks down.
  (b) Product defects increase.
  (c) Weather destroys plant.
  (d) Inventory obsolesces.
- Input risks:
  (a) Input prices increase.
  (b) Labor strikes.
  (c) Key employees leave.
  (d) Supplier fails.
- Tax risks:
  (a) Income tax increases.
  (b) Industrial revenue bonds end.
  (c) Sales tax increases.
- Regulatory risks:
  (a) Environmental laws change.
  (b) Stricter antitrust enforcement.
  (c) Price supports end.
  (d) Import protection ceases.

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[48]Unfortunately, for subjective probabilities to be considered adequate, internal consistency is not enough. The judgment must be compatible with the entire web of beliefs held by the individual, see Tversky, A. and D. Kahneman (1974). "Judgment under Uncertainty: Heuristics and Biases." *Science* **185**(4157): pp. 1124–1131.
However, since the scoring using AHP is based on beliefs, and AHP allows a mathematical consistency check, I believe using AHP is the best we can obtain.

[49]See Emblemsvåg, J. (2010). "The augmented subjective risk management process." *Management Decision* **48**(2): pp. 248–259.

[50]See Hubbard, D. W. (2009). *The Failure of Risk Management: Why It's Broken and How to Fix It*. Hoboken, NJ, John Wiley & Sons, Inc. p. 281.

[51]This compilation is from Meulbroek, L. (2001). Total strategies for company-wide risk control. *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. J. Pickford. London, Prentice Hall: pp. 67–73.

- Legal risks:
  (a) Product liability.
  (b) Restraint of trade changes.
  (c) Shareholder lawsuits.
  (d) Employee discrimination lawsuits.
- Product market risks:
  (a) Customer loss.
  (b) Product obsolescence.
  (c) Competition increases.
  (d) Product demand decreases.
- Financial risks:
  (a) Capital costs increases.
  (b) Exchange rates change.
  (c) Inflation.
  (d) Covenant violation.
  (e) Default on debt.

There are many aspects of risk management to improve with respect to all the risks in a corporation, but that is beyond the scope of this book. Here, we rather focus on two types of risk management—(1) financial risk management and (2) risk management of events with high impact but low probability of occurrence (HILP)—that are important for sustainable development because they both have direct impact on the outcome of cases. They also have strong influence on risk perceptions and hence degree of public understanding and acceptance of new technologies.

Before we leave this topic and moves on, there is a final issue that must be discussed. While the theory discussed so far seems quite straightforward, in reality different risk analysis approaches may impact the identification of risk sources.[52] In fact, three independent consulting companies performed a risk analysis of the same hydroelectric power plant and reached widely different conclusions.[53] Decision-makers have also taken risks they otherwise would not have taken due to the risk management process.[54] Part of this problem lies naturally in the fact that risk analysis is just as much an art as a science. However, there is also an inherent problem in the approaches themselves—risk, uncertainty, and knowledge are intermingled and not treated well. By augmenting the risk management process, the situation can be improved as discussed next.

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[52]See Emblemsvåg, J. and L. E. Kjølstad (2006). "Qualitative risk analysis—some problems and remedies." *Management Decision* **44**(3): pp. 395–408.

[53]As reported by Backlund, F. and J. Hannu (2002). "Can we make maintenance decisions on risk analysis results?" *Journal of Quality in Maintenance Engineering* **8**(1): pp. 77–91.

[54]According to Bernstein, P. L. (1996). *Against the Gods: the Remarkable Story of Risk*. New York, John Wiley & Sons. p. 383.

3.5 Augmenting the Risk Management Process

> There are risks and costs to a program of action, but they are far less than the long-range risks and costs of comfortable inaction.
>
> John F. Kennedy

The augmented risk management process is shown in Fig. 3.2. It is organized into five steps as indicated by a number, title, and color band (grayish or white) where each step consists of three parallel processes: (1) the actual risk management process, (2) the information management process to reduce the uncertainty in the risk management process, and (3) the knowledge management (KM) process to improve the usefulness of the model. These steps and processes are explained in detail in other publications to which the interested reader is referred.[55] The purpose here is to basically argue that a complete risk management process must include more than the traditional risk management process.

Compared to traditional risk management approaches, the most noticeable difference is that explicit relations exist between risk, uncertainty, and knowledge. To reduce the problems of inconsistent risk estimates, AHP is used to provide logically consistent probability guesstimates, in particular. Furthermore, AHP can be used to provide relative consequence guesstimates, as well.

The added benefit of using the matrix system inherent in the AHP system is that Monte Carlo methods can be used to model the impact of uncertainty on both probability and consequence guesstimates, and also trace the drivers of uncertainty in the risk analysis. This is vital for improving model quality and also being able to assess reliability of the risk analysis.

The most difficult part is the knowledge management (KM) part because how this can be done in real life is a major field of research, and some even propose seven schools of knowledge management.[56] Furthermore, even reputed scholars of the field question the management of knowledge… It is difficult.

In the augmented risk management process, the approach concerning KM is very simple thus far. We simply try to identify relevant knowledge in all steps and that is done by first realizing that knowledge is either directly available or it is tacit, and the various types of knowledge may interplay as suggested by the SECI process, which is presented later in Chap. 7. Tacit knowledge can be either implicit or really tacit.[57] Tacit knowledge is often the most valuable because it is a foundation for building sustainable competitive advantage, but it is unfortunately less

[55]See Emblemsvåg, J. (2010). "The augmented subjective risk management process." *Management Decision* **48**(2): pp. 248–259.

[56]See Earl, M. (2001). "Knowledge management strategies: toward a taxonomy." *Journal of Management Information Systems* **18**(1): pp. 215–233.

[57]According to Li, M. and F. Gao (2003). "Why Nonaka highlights tacit knowledge: a critical review." *Journal of Knowledge Management* **7**(4): pp. 6–14.

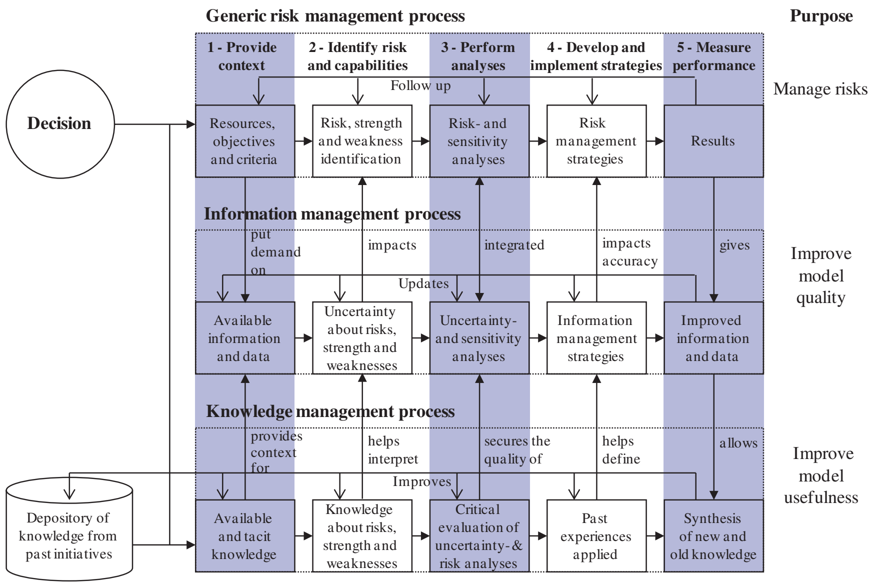

Fig. 3.2 The augmented risk management process

available.[58] Residing in the mind of people, as much tacit knowledge as possible should be transferred to the organization and hence become explicit knowledge, as explained later. Typical procedures and systems of knowledge that can be used include[59]:

1. Knowledge mapping—a process by which an organization determines "who knows what" in the company.
2. Communities of practice—naturally forming networks of employees with similar interests or experience, or with complementary skills, who would normally gather to discuss common issues.
3. Hard-tagging experts—a knowledge management process that combines knowledge mapping with a formal mentoring process.
4. Learning—a post-incident assessment process where lessons learned are digested.
5. Encouraging a knowledge-sharing culture—values and expectations for ethical behavior are communicated widely and effectively throughout the organization.
6. Performance monitoring and reporting—what you measure is what you get.

[58] See Cavusgil, S. T., R. J. Calantone and Y. Zhao (2003). "Tacit knowledge transfer and firm innovation capability." *Journal of Business & Industrial Marketing* **18**(1): pp. 6–21.

[59] See Neef, D. (2005). "Managing corporate risk through better knowledge management." *The Learning Organization* **12**(2): pp. 112–124.

7. Community and stakeholder involvement—help company leaders sense and respond to early concerns from these outside parties (government, unions, non-governmental or activist groups, the press, etc.), on policy matters that could later develop into serious contentions or incidents.
8. Business research and analysis—search for, organize, and distribute information from internal and external sources concerning local political, cultural, and legal concerns.

The point here is merely that we must have a conscious relationship toward certain basic steps such as identifying what we know, evaluate what takes place, learn from it, and then increase the pool of what we know. How this (and possibly more steps) should be done most effectively is a matter for future work. Currently, we do not have a tested solution for the KM challenge, and a software solution would also be highly beneficial. Risk and uncertainty analyses can, however, be very effectively performed using AHP and Monte Carlo methods.

This concludes the introduction to risk and uncertainty and I hope that both the distinction between the two has become clear and its importance for various types of risk management. Next, the world of Finance is explored where risk is actually traded on a huge scale.

Chapter 4
Realigning Finance to Its Original Purpose

> *All men seek one goal; success and happiness. The only way to achieve true success is to express yourself completely in service to society. First, have a definite, clear, practical ideal – a goal, an objective. Second, have the necessary means to achieve your ends – wisdom, money, materials, and methods. Third, adjust your means to that end.*
>
> Aristotle

Financial considerations always win in society—almost. Yet, the financial industry does at its core only two simple things[1]: (1) It can act as an economic time machine, helping savers transport today's surplus income into the future, or giving borrowers access to future earnings now, and (2) it can act as a safety net, insuring against floods, fires, or illness. Depending on how these transactions play out, Finance determines loss and gain, what is economically viable or not and financial considerations serve as basis for management of all economic resources. Ultimately, they determine winners and losers, and because of this, Finance has a huge impact on the behavior of people.[2] It is as Voltaire said;

> When it comes to money, everybody is of the same religion.

This has, unfortunately, also become a problem for capitalism in general because it becomes tempting for executives to present rosy pictures of past performance as the financial markets review these figures with great rigor. Finance in most countries has also been prone to bubbles and bursts and as such Finance has terrorized these countries.[3] Echoing sentiments along the same lines Nassim Taleb

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[1]According to The Economist (2014f). The slumps that shaped modern finance. *The Economist*. **411**: pp. 47–52.

[2]See for example Shields, M. D. and S. M. Young (1989). "A Behavioral Model for Implementing Cost Management Systems." *Journal of Cost Management for the Manufacturing Industry*(Winter): pp. 17–27.

[3]According to The Economist (2014f). The slumps that shaped modern finance. *The Economist*. **411**: pp. 47–52.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_4

wrote[4], "Indeed, the tragedy of capitalism is that since the quality of the returns is not observable from past data, owners of companies, namely shareholders, can be taken for a ride by the managers who show returns and cosmetic profitability but in fact might be taking hidden risks." These hidden risks are not factored into any calculations or risk management tools—it is a matter of trust or even ignorance.

Most people lost much of whatever trust was there in the financial industry due to the 2008 Financial Crisis, but most of this industry is today still in service to society—luckily. However, some financial institutions and mavericks have become totally self-serving, and we can question their role in society. It is easy to think that this is ethically questionable and an inescapable by-product of capitalism. It is not—questionable behavior is intrinsic to human nature, and not specific to capitalism. These people operate under laws of limited liability; thus, society have assumed some of their risks—for this they owe society to behave in certain ways—according to the rules and norms in society. Society should in return also impose useful laws and regulations so that the market does not tilt in favor of questionable behavior.

In addition, a challenge that has been increasingly discussed in financial literature over the last decades are two behavioral elements found in the financial markets; (1) short-termism and (2) herding. It is not easy to find ways to overcome these two behaviors due to the ancient reality that Hippocrates describes:

> Life is short, the art long, opportunity fleeting, experiment treacherous, judgment difficult.

The purpose of this chapter is to shed more light onto the role of financial markets, how they manage risk and what their challenges are. Much of what is discussed seems to be completely forgotten by many executives, politicians, and even finance people. We will consequently shed some light onto these commonly mentioned problems in the financial industry, how they relate to the topic of this book and explore possible solutions. First, however, some basics on the financial markets must be introduced, and then we must explore how risks are managed.

4.1 Market Fundamentals

> Money … is not of the wheels of trade; it is the oil which renders the motion of the wheels smooth and easy.
>
> David Hume

The consequence of the laws of limited liability is that risk is socialized; that is, society assumes some of the risk of conducting business to create a good environment for economic growth which in turn means employment, taxes, and so on. For the investor, limited liability means that there is a limit to the liability the investor

[4]In Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. London, Allen Lane. p. 366.

exposes himself to. Without limited liability "…each and every investor purchasing one or more share of a corporation would be potentially liable to the full extent of his personal wealth for the debt of the corporation."[5] Limited liability is in other words a contract between investor (owner) and society which means that risks are shared which is why it is often referred to as "socialization of risk". This sharing of risks places accountability onto both parts. Theodore Roosevelt (1858–1919) eloquently addressed government's part of the deal in the State of the Union Address on December 3 in 1901[6] as follows:

> Great corporations exist only because they are created and safeguarded by our institutions; and it is therefore our right and our duty to see that they work in harmony with these institutions.

Today, the corporate responsibility of this bargain has been embedded in the mantra of maximizing shareholders value, which broadly speaking means to maximize the return on investment for the shareholders within the confinements of laws and regulations. What this really means is not straightforward to understand in real life because shareholder value is difficult to influence directly. Apparently at odds with this mantra is the notion of the so-called Corporate Social Responsibility (CSR), which has become a hotly debated issue at times. In this book, I have chosen to ignore CSR along the lines of Friedman because we cannot rest our quest toward sustainable development on a foundation so relatively shaky even though it has real effects as mentioned earlier concerning reputation and stock prices. The approach advocated here is therefore conservative in the sense that whatever we can achieve without thinking about CSR will be strengthened even further when that effect comes into play.

Anyway, shareholder value is usually broken down into components who relate to value drivers, and a widely used model comprises of seven drivers of shareholder value giving some guidance to managers[7]:

1. Revenue.
2. Operating margin.
3. Cash tax rate.
4. Incremental capital expenditure.
5. Investment in working capital.
6. Cost of capital.
7. Competitive advantage period.

From these seven drivers, it is not intuitively clear why share price should be *the major* focus for many in the equities markets unless they are buying or selling at the moment. The question is, whether constantly buying and selling is really the approach for the "intelligent investor" to borrow the title of a landmark book by

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[5]From Jensen, M. C. and W. H. Meckling (1976). "Theory of the Firm: Managing Behavior, Agebcy Costs and Ownership Structure." *Journal of Financial Economics* **3**(4): pp. 305–360.

[6]Quoted in *Bill Moyers Journal*, September 19, 2008.

[7]See Bender, R. and K. Ward (2008). *Corporate Financial Strategy*. Oxford, Routledge. p. 406.

Benjamin Graham (1894–1976) which many in today's financial markets seem to either have never read or at least completely forgotten.

More than 200 years of experience is clear on two things concerning the behavior of the intelligent investor—he relies on (1) dividends and (2) time diversification. The intelligent investor and his practices will be discussed later, but the purpose here is to show that just buying and selling shares is actually both ineffective and in contrast to all statistically significant experience. I do not think you will find any serious research supporting the behavior of mainstream Finance today.

The 2008 Financial Crisis clearly illustrated that the financial industry is unable to hold this contract both technically in the sense that its instruments are too complex for them to manage but also ethically in that executives and others willfully made unethical calls. The contract is broken, as it were, and we must find measures to re-establish it and make sure it will not be broken in the future.

First, the financial industry must realize that they have special, moral obligations since there is a cap on their liabilities and some are considered "too big to fail" so they are bailed out by their governments. Furthermore, the financial industry have virtually unlimited supply of "materials" and can therefore easily create house of cards as it were. This means that there must be some measure of conservatism—"better safe than sorry," should be the mantra and not "greed is good" as Gordon Gekko claimed. I have no belief that merely stating this would have any effect—it must be built into the system as discussed later, which is why all the talk about CSR is probably derailing real efforts because it becomes only lip service. However, an obvious step in the right direction is to limit the size of any financial institution so that they can be held fully accountable without any problems for society at large. This basically means to re-institute the Glass-Steagall Act of 1933 or something equivalent.

Second, the technical aspects of the financial industry cannot become so complex and convoluted that nobody understands how it work and as such we become victims of our own complexity. World-renowned investor Warren Buffet warned against derivatives in his letter to the shareholders in the annual report of Berkshire Hathaway in 2002 stating that "derivatives are financial weapons of mass destruction, carrying dangers that, while now latent, are potentially lethal". He was proven right in 2008.

Derivatives are one of the three main categories of financial instruments, the other two being stocks and debt (bonds and mortgages). The latter two are easy to understand and do not hold any technical risks as to their meaning and definitively not on the same magnitude as derivatives. Derivatives, however, can be so complex that they hold inherent technical risks which are why they were likened to "financial weapons of mass destruction" by Buffet.

A derivative is a financial contract whose value is derived from the performance of some underlying market factors, such as interest rates, currency exchange rates, and commodity, credit, or equity prices. Derivative transactions include an assortment of financial contracts, including structured debt obligations and deposits, swaps, futures, options, caps, floors, collars, forwards, and various combinations thereof.[8] Note that the underlying does not have to be sold or bought—the majority of transactions are cash-settled and for options a premium is due.[9]

The true regulatory challenge of derivatives is that they can be used both for managing risks such as forwarding prices for a farmer and for speculation or simply taking risks without hedging positions (pure betting).[10] To understand this better, we must introduce a number of facts about derivatives markets. First, the financial risks of derivatives are typically divided into three types:

1. Market risk which typically can be divided into (a) interest rate risks, (b) currency risks, and (c) commodity risks.
2. Credit risk, or counterparty risk, which can typically be divided into (a) credit line (how much the bank is willing to lend you), (b) concentration risk (the amount of exposure you have toward any given counterparty), and (c) settlement risks (the final payment settlement can be disrupted or partly incomplete).
3. Liquidity risk which can typically be divided into (a) cash flow risks (revenues and costs do not match producing temporary or permanent situations of lack of cash), (b) funding risks (lack of funding altogether regardless of timing), and (c) market liquidity risk.

The truth is that in this market they trade risk itself… So, for example, liquidity risk means the risk of being stuck in a certain risk position subject to the three aforementioned subareas of that particular risk.

Second, an important aspect of any financial market, also derivatives, is to ensure that it is liquid. Liquidity is “an indicator of how likely one is to be able to sell or to buy the instrument at a particular point in time.”[11] In a liquid market, investors can take new positions easily whenever they want, whereas in an illiquid market they can get stuck in positions for some time, which can induce significant losses. Therefore, the cost of financial transactions is strongly related to liquidity, and experience[12] shows that banks usually fail due to illiquidity triggered by contractual payment obligations. As a saying in the market goes, “there is a price for buying, a price for selling and a price for selling quickly.” Typically, liquidity is far better in exchange-traded instruments than in over-the-counter (OTC) instruments. Furthermore, the OTC market is far less transparent. Despite this, the volume in

[8]This definition is provided by Office of the Comptroller of Currency, U.S. Department of the Treasury.

[9]See Taylor, F. (2010). *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. London, Financial Times/Prentice Hall. p. 432.

[10]How derivatives can both serve for good and for speculation is explained very well by Taylor, F. (2010). *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. London, Financial Times/Prentice Hall. p. 432.

[11]According to Taylor, F. (2010). *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. London, Financial Times/Prentice Hall. p. 432.

[12]See Goodhart, C. A. E. (2008). “The regulatory response to the financial crisis.” *Journal of Financial Stability* **4**(4): pp. 351–358.

the OTC markets is staggering. In June 2009, the total outstanding volume in the OTC derivatives market was $604.62 trillion,[13] and typically, they say that the OTC market is about 80 percent of total market.[14] It was distributed across the assets classes like this:

- Interest rates (73.0 percent).
- Foreign exchange (8.0 percent).
- Credit Default Swaps (CDS) (5.3 percent).
- Equity (1.0 percent).
- Commodities (0.5 percent).
- Other unallocated data (11.2 percent).

At yearend 2013, the notional value of all outstanding contracts was about $700 trillion according to the Bank for International Settlements.[15] Debt and derivatives are therefore the biggest areas of interest for the financial markets. Stocks are actually quite small in comparison (but they are important for companies and the topic of this book which is why the main focus is on stocks).

Third, derivatives are typically said to offer highly geared positions. Compare the OTC market in June 2009 with the US real GDP in yearend 2009, which was $14.58 trillion,[16] or indeed the entire world, which was $73.24 trillion.[17] The interesting question is, how come the market for trading risk is more than 8 times the Gross World Product (GWP) in 2009? One explanation of this is gearing, which is one of the major problems of this market with respect to sustainable development. The underlying is so little worth compared to the trade of risk that why should financial markets worry about the underlying today and even less more in a relatively distant future, which for many actors in this market can be just a year down the road or even shorter?

This brings us to an extremely important point—the financialization of society, as Gautam Mukunda[18] calls it. Financialization is the increase in the influence of financial markets, institutions, and elites over both the economy and the other institutions of society including government. Indeed, Bain & Company estimates that total financial assets in recent years is almost 10 times larger than the value of the global output of products and services and that it is likely to grow another

[13]Source: Bank for International Settlements (BIS).

[14]This 80/20 heuristic is provided by Hodgson, B. (2010). Central Clearing and the OTC Market. *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. F. Taylor. London, Financial Times/Prentice Hall: pp. 239–262.

[15]Quoted by The Economist (2014g). *Special report on International Banking: Shadow and substance*. London, The Economist. p. 16.

[16]Source: US Bureau of Economic Analysis.

[17]Source: Earth Policy Institute on-line at www.earth-policy.org.

[18]See Mukunda, G. (2014). "The Price of Wall Street's Power." *Harvard Business Review* **92**(6): pp. 70–78.

50 percent by 2020 as emerging markets grow.[19] Essentially the many have come to be at the risk of the wealthy, few. Interestingly, a study from International Monetary Fund (IMF) concludes that while a strong financial system is crucial to the development of a country, once private sector credit level reaches about 80–100 percent of GDP it actually inhibits growth and increases volatility.[20] In the Unites States in 2012 the credit sector level was 184 percent of GDP. Financialization undermines economies in two, major ways[21]:

1. Larger and more complex financial systems may be more prone to crashes—a point several notable economists also share such as Hyman Minsky (1919–1996), Charles Kindleberger (1910–2003) and Raghuram Rajan, who famously in 2005 argues that the risks of financial instability was much larger than anticipated. He was right.
2. An overdeveloped financial system may significantly misallocate resources. As far back as in 1984, Nobel laureate James Tobin (1918–2002) observed that "very little of the work done by the securities industry…has to do with the financing of real investment." Human resources will consequently also be misallocated, but the worst is that as financialization increases, investments in real assets will be crowded-out by investments in financial assets simply due the market preferring short-term and liquid assets, according to studies from Özgür Orhangazi.

David Hume (1711–1776) once observed that "Money … is not of the wheels of trade; it is the oil which renders the motion of the wheels smooth and easy." The problem is that "money" has become self-serving and forgotten that they actually serve a role in greasing the wheels. Today, the grease has become more important than the wheels… This is something to think about because this is what happens when special interests win the day as discussed more later.

Forth, the time horizon for derivatives is varying a lot. Some trades are as short as milliseconds, whereas other can have maturity dates 75 years down the road. Of course, the longer the time frame, the larger the risks and the more expensive the derivative. Most derivatives have less than 2 year maturity.[22]

Fifth, most derivatives are triggered if there is a move in an exchange rate, an equity or bond price. An important type of derivatives that are trigger otherwise is credit default swaps (CDS)—they are triggered by a legal trigger and are inherently more risky. In many ways, they can be thought of someone insuring the neighbor's car and receiving the payments if she collides! In other words, CDSs

[19]Quoted by Christensen, C. M. and D. van Bever (2014). "The Capitalist's Dilemma." *Harvard Business Review* **92**(6): pp. 60–68.

[20]Referred to by Mukunda, G. (2014). "The Price of Wall Street's Power." *Harvard Business Review* **92**(6): pp. 70–78.

[21]See Mukunda, G. (2014). "The Price of Wall Street's Power." *Harvard Business Review* **92**(6): pp. 70–78.

[22]According to Taylor, F. (2010). *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. London, Financial Times/Prentice Hall. p. 432.

enable the separation and transfer of credit risk between two parties, without transferring ownership of the underlying asset itself. They were heavily involved in the 2008 Financial Crisis as one of the main culprits, and prime assignee for the title Financial Weapons of Mass Destruction.

Sixth, this market invites to a number of tactics that have advantages and disadvantages. For example, short-selling—selling something you do not own—sound bizarre for most laymen, is that possible? Nonetheless, it is widely accepted[23] that short-selling provides valuable liquidity to underlying markets, can help the market to flush out over-valued financial assets and creates the ability to hedge derivatives exposure. At the negative side, in times of high volatility shorting can create instability.

Therefore, I hope this short introduction of the fundamental aspects of the financial markets illustrates its complexity and that this market is not straightforward to regulate. The goal of such regulation is "…to avoid financial and social risks at an acceptable cost,"[24] and if we simply ban everything that is not completely safe then we will lose much liquidity and hence raise the cost of financing which in turn will be negative for long-term investments such as investments toward sustainability… After the 2008 Financial Crisis, regulation has been a huge topic, but I will not attempt to join it—I am simply not in the position to offer any advice on regulation. I think the answer to it lies at a deeper level because regulators will always be too late—it takes years to consider and implement new legislation but only months to bring new financial innovations. The solution must be built into the very fabric of the system. I think the solution is already found on the globe as will be discussed in Sect. 4.5, and it is remarkably simple and rugged.

Next, we explore approaches toward investing to show that it does not have to be like it is today. There are alternatives that not only are used today, but they actually produce superior performance.

4.2 Managing Financial Risks

> Thinking first of money instead of work brings on fear and blocks every avenue of success.
>
> Henry Ford

I wonder what Hume would have been thinking if he had witnessed the foreplay to the financial crisis in 2008. In his time, money rendered trade "smooth and easy."

[23]According to Salomons, E. (2010). Regulation in the Derivatives Market. *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. F. Taylor. London, Financial Times/Prentice Hall: pp. 361–378.

[24]According to Salomons, E. (2010). Regulation in the Derivatives Market. *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. F. Taylor. London, Financial Times/Prentice Hall: pp. 361–378.

The problem this time was that it got too smooth and too easy and control was lost. The financial crisis of 2008 clearly indicated that this is an area with great needs for improvements.

One of the key issues in Financial Risk Management (FRM) is that the models they have used have failed spectacularly. In an entertaining and insightful book,[25] Nassim Taleb ascribes this to the existence of "Black Swans," and he identified two types:

I. The narrated Black Swans, those that are present in the current discourse and that you are likely to hear about on television.
II. The Black Swan that nobody talks about since they escape models.

The first type is likely to be overestimated, while the second to be severely underestimated, Taleb claims. This is probably true. The first type includes for example nuclear power where the public and some politicians use the three most famous cases—(1) the Fukushima Daiichi nuclear disaster (2011), (2) the Chernobyl disaster (1986), and (3) Three Mile Island accident (1979)—to discredit the nuclear energy in a populist way as discussed in Chap. 7. The second is the root to the financial crisis in 2008 as mentioned before, and this will be expanded on next.

The central problem of probability and information theory[26] is that (1) information is costly to obtain, (2) information is costly to store, and (3) information is costly to manipulate and retrieve. In other words, uncertainty is costly in itself and also costly to reduce. From this, four broad ways of managing risks by investors can be identified:

1. Assume the future is somewhat similar to the past. From this, the statistically driven approaches of mainstream FRM arise. A special case is those investors that study the patters of price and volume and place their investments based on their analyses of trends thereof. These are referred to as momentum investors[27] since they rely on the momentum in the market of price/volume changes. As such, they just ride the bandwagon of existing trends, but they are essentially mainstream in their philosophy concerning risk and investment, which is why I have lumped them together with the other major group of players—those who rely on the efficient market hypothesis of Eugene Fama, that is, the notion that information in the market is known at the same time by all participants. Information is therefore symmetric, and prices already incorporate all known information about an asset.
2. Put an effort into identifying relevant information (past performance, future expectations, plans, strategies, etc.) and base decisions on such fundamentals.

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[25] See Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. London, Allen Lane. p. 366.

[26] According to Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. London, Allen Lane. p. 366.

[27] See Greenwald, B. C. N., J. Kahn, P. D. Sonkin and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300.

From this, value investing arises. Because it concerns corporations in details, it is by some[28] referred to as a micro-fundamentalist approach. Some micro-fundamentalist approaches go with the broad market and use forecasting in the traditional sense. I therefore find these approaches more similar to FRM than to value investors. Only a small part of investors are therefore value investors.

3. Put an effort into understanding the macroeconomic situation and how that will impact the market and from that, base decisions on buying and selling securities. This is also referred to as macro-fundamentalist approach[29] since they start with the big picture and then zoom in for the investment.
4. Ignore uncertainty risks and go with the guts. Needless to say, this approach does not constitute any method or approach per se so it will not be discussed any further in this book. From a risk management perspective, this is akin to the "accept risk" strategy (the three other are risk prevention, risk mitigation, and transfer).

Understanding the conceptual difference between these broad approaches, however, is crucial for understanding how the financial markets must be realigned to support sustainable development. Since both momentum investing and macro-fundamentalism is using a toolkit more similar to FRM than to value investing, I will limit my discussion to FRM and value investing as two extremes in the investment world knowing all too well that there are many other investment approaches in various shades and colorings in usage by practitioners. The financial industry is a large and diverse industry also in their approaches. However, for me there is a significant conceptual difference between managing risk as uncertainty, relying heavily on statistical methods and then forecast performance in the hope of foretelling the future contra searching for value in each case and then actively manage risk by understanding the risk, taking the right risks and have contingency plans/margins of safety in case of surprises.

All these things are important to keep in mind when we discuss the management of risks, particularly financial risks due to the intense trading environment and large sums of money swapping hands in minutes with all the problems attached as discussed later in this chapter.

4.2.1 Mainstream Financial Risk Management

Financial Risk Management (FRM) was once synonymous with the management of a corporation's insurance interests, but since the 1970s, the emergence of new financial markets in derivatives has greatly expanded the number and size of

[29] See Greenwald, B. C. N., J. Kahn, P. D. Sonkin and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300.

[28] See Greenwald, B. C. N., J. Kahn, P. D. Sonkin and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300.

opportunities available to corporate risk managers.[30] In the course of a decade (from mid-1970s to the mid-1980s), an entirely new financial market emerged—the derivatives market. The market's goal was not to trade assets but risk itself.[31] The concepts are not new. In fact, the US Securities Exchange Act of 1934 defines a security as:

> Any note, stock, treasury stock, bond, debenture, certificate of interest or participation in any profit-sharing agreement or in any oil, gas, or other mineral royalty or lease, any collateral trust certificate, preorganization certificate or subscription, transferable share, investment contract, voting-trust certificate, certificate of deposit, for a security, any put, call, straddle, option, or group or index of securities (including any interest therein or based on the value thereof), or any put, call, straddle, option, or privilege entered into on a national securities exchange relating to foreign currency, or in general, any instrument commonly known as a "security"; or any certificate of interest or participation in, temporary or interim certificate for, receipt for, or warrant or right to subscribe to or purchase, any of the foregoing; but shall not include currency or any note, draft, bill of exchange, or banker's acceptance which has a maturity at the time of issuance of not exceeding nine months, exclusive of days of grace, or any renewal thereof the maturity of which is likewise limited.

Furthermore, as mentioned before, there are broadly three categories of securities:

1. Debt securities such as banknotes and bonds.
2. Equity securities, e.g., common stocks.
3. Derivatives, such as forwards, futures, options, and swaps.

Before we continue, it is important to put this in context. When we talk about mainstream FRM approaches, we talk essentially (out of simplicity) about approaches such as (1) modern portfolio theory, (2) options theory, and (3) Value at Risk (VaR). These tools, however, are the current end-results of a long way of mathematical development involving people like Blaise Pascal (1623–1662), Pierre de Fermat (1601–1665), John Graunt (1620–1674), Edward Lloyd (1648–1713), Edmund Halley (1656–1741), Jacob Bernoulli (1655–1705), Abraham de Moivre (1667–1754), Daniel Bernoulli (1700–1782), Francis Galton (1822–1911), John von Neumann (1903–1957), Oskar Morgenstern (1902–1977), Harry Markowitz, Fischer Black (1938–1995), and Myron Scholes as Bernstein explains.[32] Some of these people provided basic knowledge, whereas three of them made the actual breakthrough building blocks of today's approaches[33]:

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[30] According to Pickford, J., Ed. (2001). *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. London, Prentice Hall. p. 325.

[31] According to Brown, G. W. (2001). Seeking security in a volatile world. *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. J. Pickford. London, Prentice Hall: pp. 101–108.

[32] See Bernstein, P. L. (2001). The enlightening struggle against uncertainty. *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. J. Pickford. London, Prentice Hall: pp. 5–10.

[33] See Bernstein, P. L. (2001). The enlightening struggle against uncertainty. *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. J. Pickford. London, Prentice Hall: pp. 5–10.

- In 1738, Daniel Bernoulli greatly enriched probability theory by introducing the notion of "utility theory." This established a method for defining the value or attractiveness of different outcomes.
- In the late 1800s, Francis Galton noted that, over time, there is an average to which extremes always will return—there was a "regression to the mean." Later on, this was proved to exist in a vast array of situations including stock markets and economic cycles.
- In 1952 as a young graduate student at the University of Chicago named Harry Markowitz provided a solid mathematical foundation to the strategy of diversification in investments for which he was awarded a Nobel Prize in Economics in 1990.

What Markowitz realized[34] was that he could create a two-dimensional surface of expected returns (E) on one axis and variance (V) on the other axis. This surface will represent all possible portfolios, but on the frontier of the surface, we find all feasible portfolios that give the investor the best combinations of either minimum V for given E or maximum E for given V or less. This so-called efficient frontier essentially represents the trade-off between risk (as measured by variance or standard deviation) and expected return faced by an investor when forming his portfolio. From this insight, modern portfolio theory was born, and it was an important underpinning of the famous capital asset pricing model (CAPM) of William F. Sharpe,[35] John V. Lintner[36] (1916–1983), and Fisher Black.[37] This model has long shaped the way academics and practitioners alike think about average returns and risk.[38]

The Markowitz model treats expected returns, standard deviations (the square root of variance), and correlations as population parameters. However, in practice, population parameters are unavailable. Instead, statistical estimates must be used. The estimation errors introduced can distort the optimization results, and some researchers have shown that even small estimation errors can result in large deviations from optimal allocations in an optimizer's results.[39] Indeed, there are a number of empirical contradictions of CAPM[40] and tests do not support its most basic prediction namely that average stock returns are positively related to market betas (β). Hence, stock risks and prices, are multidimensional.

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[34]See Markowitz, H. (1952). "Portfolio Selection." *Journal of Finance* **7**(1): pp. 77–91.

[35]See Sharpe, W. F. (1966). "Capital asset prices: a theory of market equilibrium under conditions of risk." *Journal of Finance* **19**(3): pp. 425–442.

[36]See Lintner, J. V. (1965). "The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets." *Review of Economics and Statistics* **47**(1): pp. 13–37.

[37]See Fisher, B. (1972). "Capital market equilibrium with restricted borrowing." *Journal of Business* **45**(3): pp. 444–455.

[38]According to Fama, E. F. and K. R. French (1992). "The cross-section of expected stock returns." *Journal of Finance* **47**(2): pp. 427–466.

[39]See for example Michaud, R. O. (1989). "The Markowitz Optimization Enigma: Is 'Optimized' Optimal?" *Financial Analysts Journal* **45**(1): pp. 31–42.

[40]See Fama, E. F. and K. R. French (1992). "The cross-section of expected stock returns." *Journal of Finance* **47**(2): pp. 427–466.

Before we go on, it is crucial to make a note on the theoretical underpinnings this shift in reality entailed, but was lost in the tools. Insurance is based on statistical analyses of events that trigger losses, but because these events are by nature random, this is correct usage of the statistical theories. In the financial markets, however, this random nature is not present either due to herding, short-termism, or simply because companies actually have strategies devised to capture returns not by chance (random) but by design (the strategy and its implementation). Furthermore, Markowitz talked about "fixed probability beliefs,"[41] which implies two things: (1) he envision subjective probabilities since he used the term "beliefs," and (2) he relies his work on the frequency interpretation of probability since he requires "fixed" probability beliefs. The first thing is a useful relaxation of classic probability theory, which is good as argued earlier. The second is more problematic because it means that inherent in the theory is a limitation that can introduce serious mistakes if the system is undergoing change, which the stock market inevitably does. For example, in periods of rapid growth or in recessions when corporations are actively implementing strategies, this limitation may introduce real-life consequences.

Despite this, the definition of risk that Markowitz offered in 1952[42] is still in use today, and he defines risk as the variance of any asset's return (yield being the expected return) only that today standard deviation, being the square root of variance, is used instead. Over the years, this has expanded, and "increasingly sophisticated tools have evolved to measure market risk, credit risk, insurance risk and, while still being regarded as 'under development', operating risk."[43] Furthermore, they claim that in banking "too many risk measurement frameworks rely on a set 'multiple of standard deviation' as the solvency standard." The problem is essentially that all these tools rely on standard deviations in one way or the other, and the more complex the tools become, the more difficult it becomes to understand their implications. In aggregating the risk distributions, risks are grouped into four areas based on the risk drivers and the nature of the risk distribution. The objective is to reduce the problems related to the incomparable nature of some of these risks[44]:

1. Credit risk. This arises from changes in the value of assets and off-balance sheet exposures due to volatility in default rates or credit qualities. This is typically a non-normal risk.
2. Market risk. This arises from changes in the value of financial assets and liabilities due to volatility in market prices (interest rates, currencies, equities, commodities).

[41]See Markowitz, H. (1952). "Portfolio Selection." *Journal of Finance* **7**(1): pp. 77–91.

[42]See Markowitz, H. (1952). "Portfolio Selection." *Journal of Finance* **7**(1): pp. 77–91.

[43]According to Garside, T. and P. Nakada (2000). "Enhancing risk measurement capabilities." *Balance Sheet* **8**(3): pp. 12–17.

[44]According to Garside, T. and P. Nakada (2000). "Enhancing risk measurement capabilities." *Balance Sheet* **8**(3): pp. 12–17.

3. Insurance risk. This arises from volatility of insurance claims around the expected level of claims. This is also typically a non-normal risk.
4. Business and operational risk. This captures all of the risks not covered in the first three categories. Business risk arises from changes in volumes, margins, or costs resulting from changes in general business conditions (such as demand, competition, and regulation). Operational risk arises from one-time losses due to events such as fraud and systems failure. Note that this does not just cover "operations" such as processing and IT and that to form part of an effective risk management framework must cover legal- and other people-related risks.

Using standard deviations, covariations (resulting in the famous beta (β) of stocks) and the like undoubtedly produce mathematically pleasing tools, but the underlying assumptions of this approach simply do not correspond with reality.[45] With respect to the discussion in Chap. 3, it is evident that the foundations have been altered as to the true meaning of risk and management of risks. Mainstream FRM is therefore not managing risks per se but rather responding to after the fact information and then projecting this information into risks in the future under essentially a *ceteris paribus* assumption (all other things being equal or constant), which is rarely the case. It is, of course, possible to make more fancy models where some of the assumptions also become the part of the projection as well, but this will in reality also be a product of past information of some kind. Forecasting is invariably a product of the past. Thus, the standard deviation is really a measure of the uncertainty the market faces in pricing.

For those that face business risks, operational risks, and equity risks, this is clearly a problem since these risks are related to the real, physical world. However, for those in the financial markets buying and selling risk itself—or uncertainty as I would argue—it is less problematic except for the quality of using the past in projecting future uncertainty. In Sect. 4.2.2, we discuss a completely different set of investing principles that put a premium in detailed individual analyses that does not suffer from these problems and also provides superior performance.

From Chap. 3, we also remember that risk management is never about minimizing risks, but to rather take the *right* risks which we have comparable advantages in handling. Investing in a stock with a small standard deviation does not mean that we take the right risk but rather that we invest in a stock the market believe to be less uncertain, which is something we can only know by conducting a detailed, individual assessment of the stock which is rarely done by mainstream FRM practitioners.[46] With respect to the augmented risk management process discussed in Chap. 3, this means that the whole knowledge perspective is missed. The quality of the whole risk management process is therefore highly questionable, which

[45]According to Madden, B. J. (2003). *CFROI Valuation: A Total System Approach to Valuing the Firm*. Oxford, Butterworth-Heinemann. p. 356.

[46]According to many sources in the literature including Madden, B. J. (2003). *CFROI Valuation: A Total System Approach to Valuing the Firm*. Oxford, Butterworth-Heinemann. p. 356.

probably partly explains the relative poor performance FRM practitioners as discussed later.

This sorry state of FRM has been commented by many, but it means that investors using these tools actually have no good tools to manage risks and certainly not for investing. Performance is certainly a testament to this ascertainment, which will be shown later in this chapter. In the insightful words of one of the premier investors of the world, Warren Buffet[47]:

> Diversification serves as a protection against ignorance. If you want to make sure that nothing bad happens to you relative to the market, you should own everything. There is nothing wrong with that. It's a perfectly sound approach for somebody who doesn't know how to analyze businesses.

Nevertheless, the insight of Markowitz has had many practical consequences over the years. For example, it lead to the steady demise of the conglomerates in the West due to the simple fact that an investor can more easily and cheaply diversify their portfolio in the stock market than by diversifying the corporation itself.[48] In Asia, however, there are numerous examples of conglomerates doing well, and even in the USA, one of the most valuable corporations in the world—General Electric—is a conglomerate. This is an issue that I do not intend to settle here; I just merely wanted to show that the theory has implications outside the financial markets and into the real world.

Markowitz acknowledged that his approach could not protect against systemic risks and market risks. This inability to handle systemic and market risks coupled with the systemic complexity of mainstream finance laid the groundwork for the 2008 disaster. As Jean-Pierre Landau, Deputy Governor of The Bank of France, explained in 2009[49]:

> Increases in complexity did not come with more diversity. On the face of it, market participants looked more and more different in their legal status, investment strategies, and business objectives. It has now become apparent that, behind these veils of diverse colors, there was a profound uniformity in the approach to risk, its measurement, its management, as well as in the drivers of risk appetite. This uniformity had very destabilizing consequences.

The mantra that was followed blindly was that of diversification, which in finance refers to "reducing non-systematic risk by investing in a variety of assets. If the asset values do not move up and down in perfect synchrony, a diversified portfolio will have less risk than the weighted average risk of its constituent assets, and

[47]See Outstanding Investor Digest (1996). Berkshire Hathaway's Warren Buffett & Charlie Munger "If the Business and the Manager Are Right, You Should Probably Forget the Quote." **XI**(3 & 4).

[48]See Knight, R. F. and D. J. Pretty (2001). The real benefits of corporate diversification. *Financial Times Mastering Risk—Volume 1: Concepts; Your Single-Source Guide to Becoming a Master of Risk*. J. Pickford. London, Prentice Hall: pp. 92–96.

[49]Landau, J.-P. (2009). Introductory remarks. *The macroeconomy and financial systems in normal times and in times of stress*. Gouvieux-Chantilly, Bank of France, Deutsche Bundesbank and Bank of International Settlements: pp. http://www.bis.org/review/r090806c.pdf.

often less risk than the least risky of its constituent."[50] There are two basic types of diversification that investors can revert to: (1) time diversification and (2) the width of the portfolio.

Time diversification is a contentious issue and hotly debated due to two possible ways of measuring returns—annualized returns versus cumulative returns—which depend on how we measure risk and the perception of risks. Javier Estrada[51] provides an excellent summary:

> …time diversification refers to the relationship between risk and the holding period. Supporters of time diversification believe 1) that the risk of an asset, particularly stocks, decreases with the holding period; 2) that the longer the holding period, the lower is the probability that a riskier (more volatile) asset underperforms a less risky (less volatile) assets; and 3) that investors should gradually decrease their exposure to riskier assets as their holding period shortens. Critics of time diversification disagree with 1; agree with 2) but find the argument incomplete as far as the relationship between relative risk and the holding period is concerned; and agree with 3) but for reasons unrelated to the relationship between risk and the holding period.

Cumulative return studies make obviously no sense unless the holding period is the same. Furthermore, annualized returns provides consistent results with return-adjusted risks (risks per unit of return), suggesting that time does diversify risk. Indeed, Estrada[52] found that on average across the 19 countries in the sample, stocks provided investors with an annualized real return of 4.7 percent, 3.8 percentage points higher than that of bonds (0.9 percent). This finding is based on careful analysis of the Dimson-Marsh-Staunton dataset, which covers 19 countries over 110 years. In the same study, Estrada also found that although the spread between the highest and lowest cumulative returns steadily increases with the holding period, the increase in spread typically resulted in an increase in the *upside* potential. Hence, it is beyond doubt that time diversifies risks. In the words of Bernstein[53] [italics as in the original]:

> If diversification is the prime method for improving the trade-off between risk and return, then diversification over time is just as important as diversification across asset groups at any given moment. Just as none of us can ever be sure that any given single asset or even asset group is *the best* place to be at any particular moment, what assurance can we have that any particular moment is *the best* time to hold any particular asset of asset group?

The consequence of this is that long-term thinking is not only good for the environment but also for Finance. Yet, short-termism is rampant as argued in Sect. 4.3. Why? Another question is, what is long-term and what is short-term? Let us continue by discussing the time horizon.

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[50] According to O'Sullivan, A. and S. M. Sheffrin (2006). *Economics: Principles in Action*. Upper Saddle River, NJ, Pearson Prentice Hall. p. 592.

[51] See Estrada, J. (2013). "Stocks, Bonds, Risk, and the Holding Period: An International Perspective." *The Journal of Wealth Management* **16**(2): pp. 25–44.

[52] See Estrada, J. (2013). "Stocks, Bonds, Risk, and the Holding Period: An International Perspective." *The Journal of Wealth Management* **16**(2): pp. 25–44.

[53] See Bernstein, P. L. (1976). "The Time of Your Life." *Journal of Portfolio Management* **2**(4): pp. 4.

Various studies have various estimates for when stocks always outperform bonds or at least inflation. A study[54] conducted by the Federal Reserve Bank in Kansas City concludes that "…long-term investors in U.S. stocks did very well provided they could invest in stocks continuously for at least 26 years. They not only enjoyed higher average returns than bond investors, which was expected, but they also had higher returns than bond investors 100 percent of the time—regardless of the month or the year when they started the investment." Other studies indicate fewer years. One study[55] finds that "…a 15-year holding period is required to ensure a 95 percent probability that stocks will outperform the risk-free rate of return," that is bonds whereas Estrada[56] states that "…the lowest return steadily increases with the holding period, eventually turning positive in many countries at investment horizons of 20 or 30 years." It is clear that such time horizons, irrespective of study, are incompatible with many investor's expectations—the average holding period for NYSE listed stocks between 1950 and 1970 was approximately six years, whereas today it is under one year[57]—and as Bernstein[58] wrote as early as in 1976:

> …goaded by their clients, they are now tending to downgrade the powerful *time* diversification by trying to decide which are the most and which are the least attractive moments to hold certain assets, within time parameters that may as short as months or even weeks. Do they understand that they have simply swapped one kind of specific risk for another?
>
> Only time will tell.

Time did tell and loudly so by the 2008 Financial Crisis, and risks were indeed swapped…

Herein lies perhaps the answer to short-termism as well. Their clients want higher return than what the time diversification can offer. They want to outperform the equity market, which so many uses as yardstick for excellence including popular management books such as *In Search of Excellence*[59] and *Good to Great*.[60] The problem is that the tools they use cannot achieve this because a portfolio of stocks, for example, can be considered fully diversified if there are more than 30 stocks (the width of the portfolio), according to their own beliefs, which means it

[54]See Shen, P. (2005). "How Long Is a Long-Term Investment?" *Economic Review*(First quarter): pp. 5–32.

[55]See Li, B., B. Liu, R. Bianchi and J. J. Su (2012). "Stock Returns and Holding Periods." *JASSA The Finsia Journal of Applied Finance*(2): pp. 43–48.

[56]See Estrada, J. (2013). "Stocks, Bonds, Risk, and the Holding Period: An International Perspective." *The Journal of Wealth Management* **16**(2): pp. 25–44.

[57]According to data from NYSE and quoted by Mortimer, I. and M. Page (2013). *Why Dividends Matter*. Investment Research Series. London, Guinness Atkinson Funds. p. 11.

[58]See Bernstein, P. L. (1976). "The Time of Your Life." *Journal of Portfolio Management* **2**(4): pp. 4.

[59]See Peters, T. J. and R. H. Waterman Jr. (1982). *In Search of Excellence: Lessons from America's Best-Run Companies*. New York, HarperTrade. p. 360.

[60]See Collins, J. (2001). *Good to Great: Why some companies make the leap… and others don't*. New York, Random House Business Books. p. 324.

will by default move like the general market. To be more precise, 95 percent of the benefits of diversification are captured with a 30-stock portfolio. This is a common belief held by virtually all investment professionals.[61] It is based on research on NYSE-traded stocks during 1926–1965.[62] Newer research based on data from January 1986 to June 1999, however, is probably more realistic for today's more volatile situation, and this research shows that "fifteen-stock portfolios, on average, achieve only 75–80 percent of available diversification, not the 90 percent-plus typically believed. Even 60-stock portfolios achieve less than 90 percent of full diversification."[63] Nonetheless, the point is that most investments professionals should realize that their approach is bound to follow the market more or less, yet they act as it will not.

Buying and selling is one thing, but an even greater puzzle is why they do not settle for corporations that pay reasonable dividends every year, year after year, and hold on to these stocks for the opportunity to sell at premium levels down the road. After all, Graham and David LeFevre Dodd (1895–1988) wrote in their landmark book *Security Analysis: Principles and Technique* first published in 1934 that

> The prime purpose of a business corporation is to pay dividends regularly and, presumably, to increase the rate as time goes on.

The question is; are they right? Based on several studies, it is clear that dividends unequivocally matter a lot. In one study,[64] the components of total equity returns of US stocks from 1802 to 2002 are examined and the finding is that dividends plus their real growth accounted for fully 5.8 percentage points of the 7.9 percent total annualized return. Another study[65] looked at the same topic from a more global perspective and found that from 1900 to 2005 the real returns across 17 countries averaged approximately 5 percent, while the average dividend yield of those countries for the same period was 4.5 percent. Another study[66] shows how 100 USD invested at the end of 1940 would have been worth about 174,000 USD at the end of 2011 if dividends were reinvested, whereas the exclusion of dividends the value would have been only 12,000 USD. The most compelling finding of this study, however, is that "the importance of dividends to total returns increases dramatically in low growth

[61]According to Surz, R. J. and M. Price (2000). "The Truths About Diversification by the Numbers." *The Journal of Investing*(Winter): pp. 1–3.

[62]Conducted by Fisher, L. and J. H. Lorie (1970). "Some Studies of Variability of Returns on Investments in Common Stocks." *Journal of Business* **43**(2): pp. 99–134.

[63]According to Surz, R. J. and M. Price (2000). "The Truths About Diversification by the Numbers." *The Journal of Investing*(Winter): pp. 1–3.

[64]See Arnott, R. D. (2003). "Editor's corner: Dividends and the Three Dwarfs." *Financial Analysts Journal* **59**(2): pp. 4–6.

[65]See Dimson, E., P. Marsh and M. Staunton (2008). Chapter 11—The Worldwide Equity Premium: A Smaller Puzzle. *Handbook of the Equity Risk Premium*. R. Mehra. Amsterdam, Elsevier: pp. 467–514.

[66]See Mortimer, I. and M. Page (2013). *Why Dividends Matter*. Investment Research Series. London, Guinness Atkinson Funds. p. 11.

decades—which are defined by some combination of sluggish economic growth, rising inflation, increasing oil prices, and high unemployment. In low growth periods such as the 1940s and 1970s, dividends accounted for over 75 percent of total returns."

Thus, when investors use typical FRM tools, it is clear that outperforming the market is at best short-term luck, but it can seem like being controllable. This is probably due to an important psychological phenomenon referred to as the Illusion of Control (IoC), which refers to situations where the decision-maker act as if they exert control over processes that are in fact determined by chance mechanisms. It was Ellen Jane Langer who in 1975[67] introduced the concept, and she stated that the illusion is most likely to occur in situations where, although chance determined outcomes, cues are present that are more typically associated with outcomes determined by skill. These include factors such as competition, choice, familiarity, cognitive activity, and involvement. Sequences of successes or failures will significantly impact this phenomenon. While research is not conclusive, a recent study[68] suggests that experiencing an increasing rate of success can create the false impression of learning the correct strategy. This seems to be an intuitively correct suggestion because it also partially explains why people take more risks as they face successes through the hype of bull markets.

The point, however, is that finance is just as much about psychology as numbers and logic. Coming from a different perspective—that of cognitive biases—Werner De Bondt and Richard Thaler found evidence to suggest that the stock market over-reacts to a long series of bad news which could produce predictable mispricing of stocks traded on NYSE.[69] This gave them the impetus to introduce the term "behavioral finance". Not surprisingly, they met resistance from the defenders of the traditional doctrine arguing that this is not a problem as long as the marginal investor, that is, the investor making the specific investment decision at hand, is rational. What this mean, however, has rarely been spelled out and the fact is that data say otherwise.

Nobel laureate Eugene Francis Fama has another way of looking at it.[70] His conclusion after reviewing this literature is that "subjected to scrutiny, however, the evidence does not suggest that market efficiency should be abandoned. Consistent with the market efficiency hypothesis that the anomalies are chance results, apparent overreaction of stock prices to information is about as common as underreaction." That said, in a convincing argument Thaler agrees that it is time to end the term "behavioral

[67]See Langer, E. J. (1975). "The Illusion of Control." *Journal of Personality and Social Psychology* **32**(2): pp. 311–328.

[68]See Ejova, A., D. J. Navarro and P. H. Delfabbro (2013). "Success-slop effects on the illusion of control and remembered success-frequency." *Judgment and Decision Making* **8**(4): pp. 498–511.

[69]See De Bondt, W. F. M. and R. H. Thaler (1985a). "Does the Stock Market Overreact?" *Journal of Finance* **40**(3): pp. 793–808.

[70]See Fama, E. F. (1998). "Market efficiency, long-term returns, and behavioral finance." *Journal of Financial Economics* **49**(3): pp. 283–306.

finance" simply because it is redundant, and he lists a series of compelling evidence from the market[71] (and I have added some more as indicated by references):

1. Volume—standard models predicts that participants will trade very little because everybody is rational and information cannot be asymmetric, i.e., you cannot know something I do not know. About 700 million shares a day at NYSE can hardly indicate little trade and hence rationality.
2. Volatility—prices should change only when news arrives, but stock and bond prices are more volatile that an efficient market would predict. This is also supported by the work of Robert James Shiller, which in 1981 published a paper[72] titled "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" This caused quite a lot of controversy but his general conclusions are considered to be correct even today, and together with Eugene F. Fama and Lars Peter Hansen, he jointly received the 2013 Nobel Memorial Prize in Economic Sciences, "…for their empirical analysis of asset prices."
3. Dividends—in an efficient market, dividend policy should be irrelevant,[73] yet why do most large companies pay cash dividends and why do stock prices rise when dividends are initiated or increased? Neither question has any rational answer…
4. The equity premium puzzle—the equity premium in the USA and elsewhere has been huge. For example, a dollar invested January 1, 1926, in Treasury Bills would be worth about 14 dollars in 1999, while a similar investment in equities would be worth 2000 dollar. Although equities are riskier than Treasury Bills, a seven percent a year return differential is too much to be explained by risk alone.[74] The explanation today for this phenomenon is called "Myopic Loss Aversion," which refers to the tendency for decision-makers to weigh losses more heavily than gains and despite the fact that decision-makers that claim to be long-term actually exhibit short-term behavior concerning gains and losses.[75]
5. Predictability—in an efficient market, future returns cannot be predicted on the basis of existing information. Yet, everybody agrees today that stock prices are partly predictable[76] on the basis of past returns. Although there is significant

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[71]See Thaler, R. H. (1999). "The End of Behavioral Finance." *Financial Analysts Journal* **55**(6): pp. 12–17.

[72]See Shiller, R. J. (1981). "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends." *The American Economic Review* **71**(3): pp. 421–436.

[73]This is shown by Modigliani, F. and M. H. Miller (1958). "The Cost of Capital, Corporate Finance, and the Theory of Investment." *The American Economic Review* **48**(3): pp. 655–669.

[74]See Mehra, R. and E. C. Prescott (1985). "The Equity Premium: A Puzzle." *Journal of Monetary Economics* **15**(2): pp. 145–161.

[75]See Benartzi, S. and R. H. Thaler (1995). "Myopic Loss Aversion and the Equity Premium Puzzle." *Quarterly Journal of Economics* **110**(1): pp. 73–92.

[76]See Fama, E. F. (1991). "Efficient Capital Markets II." *Journal of Finance* **46**(5): pp. 1575–1617.

controversy to be solved whether this is due to mispricing or risk, no one has been able to specify an observable risk measure that can explain current data patterns.[77]

6. Performance—there are many studies documenting the underperformance of mutual fund managers and pension fund managers relative to passive investment strategies.[78] Furthermore, good performance in one year does not indicate good performance the following year, and skills in mutual fund management are nonexistent.[79]

Clearly, the behavioral aspects of Finance are significant and perhaps even more important than numbers and logic. This means that for society to approach sustainable development, the behavioral aspects of Finance must be taken carefully into account. We must also take into account that investors also trade for other reasons.

Investors obviously buy assets and sell them to make profits, but there are at least two more reasons often mentioned for why investors trade[80]: (1) to rebalance their portfolio for risk sharing (hedging) and (2) to speculate on their private information (speculation). This private information is whatever that is not public—everything from inside information to hunches. Hedging typically generates negatively autocorrelated returns, whereas speculation typically generates positively autocorrelated returns. They also find that while hedging typically results in reversed returns afterward, speculation typically leads to little degree of reversed returns and in fact continuation.[81] Others have studied the consequences of speculative trading in the context of the Chinese financial market, which is very interesting due to its ban of short sales and the existence of A and B class shares for control purposes, and they conclude that speculation can help explain a significant fraction of the price differences between the dual-class shares.[82] In other words, speculations can lead to bubbles or it becomes a significant contributor. If we add fear and greed, two common human traits, the case is obvious…

In fact, as researchers that have studied the markets for years state in a paper in Harvard Business Review, "In our attempt to maximize returns to capital, we

[77]See Lakonishok, J., A. Shleifer and R. W. Vishny (1994). "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance* **49**(5): pp. 1541–1578.

[78]See Malkiel, B. G. (1995). "Returns from Investing in Equity Mutual Funds 1971 to 1991." *Journal of Finance* **50**(2): pp. 549–572.

[79]See Carhart, M. M. (1997). "On Persistence in Mutual Fund Performance." *Journal of Finance* **52**(1): pp. 57–82.

[80]According to Llorente, G., R. Michaely, G. Saar and J. Wang (2002). "Dynamic Volume-Return Relation of Individual Stocks." *The Review of Financial Studies* **15**(4): pp. 1005–1047.

[81]This finding is also supported by others including Stickel, S. E. and R. E. Verrecchia (1994). "Evidence that Trading Volume Sustains Stock Price Changes." *Financial Analyst Journal* **50**(6): pp. 57–67.

[82]See Mei, J., J. A. Scheinkman and W. Xiong (2009). "Speculative Trading and Stock Prices: Evidence from Chinese A-B Share Premia." *Annals of Economics and Finance* **10**(2): pp. 225–255.

reduce returns to capital".[83] This is the result of how most investors resolve what they refer to as "The Capitalist's Dilemma", which is "Doing the right thing for long-term prosperity is the wrong thing for most investors, according to the tools used to guide investments." Ironically, the actual return on capital for many venture capital investors over the last decade is close to zero percents which is a far cry from the 25 percent return they were promised. This is a paradox William Sahlman fittingly calls "capital market myopia".[84]

The fact is that most investors and executives have inflated expectations concerning returns than what reality warrants. It is vital for sustainable development that investors and executives alike have realistic expectations concerning returns. Today, there is a real danger in under-investment, simply because many corporations with their investors and executives are living in the past and have erroneous estimates of the cost of capital.[85] The fact is that for 449 corporations in the S&P Index that were publicly listed from 2003 through 2012, only 9 percent of earnings were funneled back to the corporation itself in the shape of either investments or higher incomes for employees.[86] The rest was used externally as discussed later.

I have so far eluded an obvious definition—investment. So far, it has been taken for granted but in the next section it will actually make sense as Graham and Dodd once defined[87]:

> An investment operation is one which, upon thorough analysis, promises safety of principal and a satisfactory return. Operations not meeting these requirements are speculative.

Based on the augmented risk management process outlined in Chap. 3, it is clear that investment as defined by Graham and Dodd actually complies fully. "Thorough analysis" must encompass not only expected economic values, risks but also their uncertainties and more importantly their interpretation into knowledge. This is the most serious deficiency of FRM—it is purely numerical and statistical as if non-quantifiable knowledge did not matter. It largely ignores risks and focuses mostly on uncertainty. Furthermore, by fully diversifying the portfolio, it is sure that none, or just a very few, of the investments are actually researched properly and hence understood. This is essentially speculation, but it does not stop there. Typically, mainstream finance people buy when a stock advances and they sell when it declines, yet "if true investment has one fundamental principle, it is

[83]See Christensen, C. M. and D. van Bever (2014). "The Capitalist's Dilemma." *Harvard Business Review* **92**(6): pp. 60–68.

[84]According to Christensen, C. M. and D. van Bever (2014). "The Capitalist's Dilemma." *Harvard Business Review* **92**(6): pp. 60–68.

[85]This point is highlighted also by Dimson, E., P. Marsh and M. Staunton (2000). "Risk and Return in the 20th and 21st Centuries." *Business Strategy Review* **11**(2): pp. 1–18.

[86]See Lazonick, W. (2014). "Profits without prosperity." *Harvard Business Review* **92**(9): pp. 46–55.

[87]See Graham, B. and D. L. Dodd (1951). *Security Analysis: Principles and Technique*. London, McGraw-Hill Book Company. p. 770.

likely to be the opposite of that one."[88] Can there really be any doubt of that? It is self-evident… Who would buy food when prices rise and stop buying when they fall?

Before we discuss some practices in the financial markets in greater detail, we should realize that there are investors that follow an entirely different approach to investing which is discussed in the next section. They do not try to diversify, they actually *invest* based on knowledge as Graham prescribes, and they can therefore take the *right* risks and they do well—some outperform the market significantly and have done so for years. Because they take the right risks, even though their exposure is greater and they are less liquid, they actually face less risk. Investment is about taking the right risks—not eluding specific risks and swapping it for systemic risks they cannot handle.

4.2.2 Value Investing

The most famous value investor is by far Warren Buffet whose investment performance is simply impressive for which he has earned the honors title of "The Oracle from Omaha." He started with 100 dollars in 1956 and in mid-2004 his net worth was about 42.9 billion dollars.[89] Also in the academic literature, there is considerable evidence for claiming that value investing produce superior returns, what is controversial is *how*.[90] People have distilled Buffet's practices into the following key questions[91]:

- Business questions:
  1. Is the business simple and understandable?
  2. Does the business have a consistent operating history?
  3. Does the business have favorable long-term prospects?
- Management questions:
  4. Is management rational?
  5. Is management candid with its shareholders?
  6. Does management resist the institutional imperative?

[88]According to Graham, B. (2005). *The Intelligent Investor*. New York, HarperCollins Publishers. p. 269.

[89]According to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[90]See Lakonishok, J., A. Shleifer and R. W. Vishny (1994). "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance* **49**(5): pp. 1541–1578.

[91]I have taken the liberty to somewhat explicate some of the questions, and see for example Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

- Financial questions:

  7. What is the return on equity (ROE)?
  8. What are the business' "owner earnings"?
  9. What are the profit margins?
  10. Has the business created at least one dollar of market value for every dollar retained?

- Value questions:

  11. What is the intrinsic value of the business?
  12. Can it be purchased at a significant discount to its value to secure a margin of safety?

To understand where these questions come from, it is useful to investigate the sources of influence upon Buffet. These influential people are as follows[92]:

1. Benjamin Graham. Buffet considers Graham to be the one individual, after his father, who had the most influence on his investment life,[93] and several investment tactics were adopted from him:

   (a) The margin of safety approach. Margin of safety is by Buffet considered of being "the three right words."[94] Stocks should be bought when they are traded at values significantly lower than their intrinsic value. Buying cheap stock is not ideal.[95]
   (b) Determine the intrinsic value of the investment object through proper research and then either paying a fair price or a bargain price if the corporation has temporary problems or the general market falls.[96] With intrinsic value, we should understand "that value which is determined by the facts" as Graham expressed it.[97] These facts included corporate assets, its earnings and dividends and any future definitive prospects. The future earning power is, of course, the most important for future performance, but it is also most uncertain, which is why it is in fact given less relative importance. This is another conservative streak of many value investors as discussed later.

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[92]According to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[93]According to Lenzner, R. (1993). "Warren Buffet's Idea of Heaven: 'I Don't Have to Work With People I Don't Like'." *Forbes*(October 18): pp. 43.

[94]See Berkshire Hathaway Annual Report 1990, p.17.

[95]See Davis, L. J. (1990). "Buffett Takes Stock." *New York Times Magazine*(April 1): pp. 61.

[96]According to Peter S. Lynch in his foreword to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[97]See Graham, B. and D. L. Dodd (1951). *Security Analysis: Principles and Technique*. London, McGraw-Hill Book Company. p. 770.

(c) Speculation is a consequence of people's greed and fear so the importance of thinking independently is critical through what Charlie Munger, Buffets longtime companion, called "the psychology of misjudgment."

2. Philip Arthur Fisher (1907–2004). Buffett once said that "he is 85 percent Graham and 15 percent Fisher."[98] However, this statement was made in 1969 and over the years Buffet became more like Fisher so today he might have said 50/50, something that many believe is attributable to the influence of Charlie Munger. Clearly, Fisher had an important influence too and his contributions to Buffet are three investment tactics[99]:

   (a) Scuttlebutt is important so throughout the years Buffet developed an extensive network of contacts who assists him in evaluating potential investment opportunities. He talks with customers, vendors, and former employees. More specifically, Fisher developed an approach consisting of 15 points to help him evaluate possible investments, which he presents in his classic *Common Stocks and Uncommon Profits*, first published in 1958.[100] These points touches core issues and essentially reveals what a good investment should look like, and they are as follows:

      (i) Does the company have products or services with sufficient market potential to make possible a sizable increase in sales for at least sev eral years?
      (ii) Does the management have a determination to continue to develop products and processes that will still further increase total sales poten tials when the growth potentials of currently attractive product lines have largely been exploited?
      (iii) How effective are the company's research and development efforts in relation to its size?
      (iv) Does the company have an above-average sales organization?
      (v) Does the company have a worthwhile profit margin?
      (vi) What is the company doing to maintain or improve profit margins?
      (vii) Does the company have outstanding labor and personnel relations?
      (viii) Does the company have outstanding executive relations?
      (ix) Does the company have depth to its management?
      (x) How good are the company's cost analysis and accounting controls?
      (xi) Are there other aspects of the business, somewhat peculiar to the industry involved, which will give the investor important clues as to how outstanding the company may be in relation to its competition?

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[98]According to http://www.valuewalk.com/philip-fisher-resource-page/.

[99]According to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[100]For details concerning the 15 points, see Fisher, P. A. (2003). *Common Stocks and Uncommon Profits and Other Writings*. Hoboken, NJ, John Wiley & Sons. p. 292.

(xii) Does the company have short-range or long-range outlook in regard to profits?

(xiii) In the foreseeable future will the growth of the company require suf ficient equity financing so that the larger number of shares then out standing will largely cancel the existing stockholder's benefit from this anticipated growth?

(xiv) Does the management talk freely to investors about its affairs when things are going well but "clam up" when troubles and disappoint ments occur?

(xv) Does the company have a management of unquestionable integrity?

Fisher also offered a set of ten Don't for investors in the same book.

(b) Focus on just a few investments at a time. In Fisher's view, buying stocks without taking the time to develop a thorough understanding of the business was far more risky than having limited diversification. Fisher typically owned stocks in no more than ten corporations at a time and three to four corporations constituted perhaps 75 percent of his portfolio's worth.

(c) Outstanding corporations had quality management with unquestionable integrity and honesty. The above-average managers can implement the corporation's long-term plans while at the same time focus on daily operations and keep good relations with employee representatives.

3. John Burr Williams (1900–1989). He is best known for "The Theory of Investment Value" which was published in 1938 based on his PhD thesis. He was among the first to articulate the theory of discounted cash flow (DCF)-based valuation, and in particular, dividend-based valuation. From him, Buffet obtained a methodology for calculating intrinsic value, which is a cornerstone in value investing. Note that DCF is also used in mainstream finance. A question often debated is not DCF per se but what discounting factor to use for which there is considerable disagreement.

From these investment tactics, a whole array of corollaries can be deducted starting with the notion that there is no fundamental difference between buying stocks and buying a corporation, as Buffet believes[101]—and it is one of his bedrock principles. As Graham wrote in *The Intelligent Investor*, first published in 1949, "Investing is most intelligent when it is most businesslike,"[102] and Buffet concurs and highlights that these nine words are "…the nine most important words ever written about investing."[103] Therefore, selling and buying does not follow the ordinary approaches of mainstream Finance of buying when it rises and selling when it falls, which is really extremely illogic from a value investment perspective, but logic from a speculative perspective exploiting the momentum or

[101]According to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[102]See Graham, B. (2005). *The Intelligent Investor*. New York, HarperCollins Publishers. p. 269.

[103]Quoted by Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

psychology in the market. Fisher puts up three reasons for selling, and only three, provided that the purchase in the first place was made according to his 15 points[104]:

1. The investment was a mistake in the sense that the judgment of the investor was poor.
2. The investment deteriorates. Typically, there are two reasons for that (1) deteriorating top management and (2) the prospects for increasing its markets. Bad fortune may also occur from time to time.
3. The investment has poor future growth potential. This can occur after the business cycle has peaked, new technologies are disrupting the corporation and the like. Essentially, the investment has exhausted itself and growth slows down significantly.

With this mindset it follows that the best investments may never be sold—the investor will only harvest dividends and/or increase his investment worth via rising stock prices and occasional stock splits. Fisher, for example, never sold his Motorola shares first bought in 1955.

Therefore, Buffet does not care what the general stock market has done recently or believe they will do in the future.[105] Instead, Buffet puts great emphasis on understanding the investment case itself. In fact, he emphasizes the importance of understanding the investment case so much that his choice of discounting factor amounts to the risk-free rate of return.[106] He therefore manages risk by choosing investments with an in-built margin of safety—not by modeling. "Thus, investment can be grounded largely on the time-tested principle of insurance—which combines an adequate safety factor in each individual commitment with a wide diversification of risk," Graham wrote.[107]

From the discussion in Chap. 3, it is clear that this is really risk management because explicit choices are made as to actively manage risk, whereas mainstream Finance in the equity markets essentially try to manage risk by avoiding it via diversification or by raising discounting factors by allegedly trying to pick the best investments. The more advanced practitioners may even enter the derivatives market to manage the financial risk itself on top of managing the equities. However, the risk of the equity is still not addressed. Thus, as noted before, mainstream FRM approaches are really confusing uncertainty with risk and the price they pay is relatively poor performance.

Before we continue, it is important to highlight another aspect. Like all approaches, value investing has its various flavors depending on the practitioner.

[104] See Fisher, P. A. (2003). *Common Stocks and Uncommon Profits and Other Writings*. Hoboken, NJ, John Wiley & Sons. p. 292.

[105] According to Peter S. Lynch in his foreword to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[106] See Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[107] In Graham, B. (2005). *The Intelligent Investor*. New York, HarperCollins Publishers. p. 269.

Table 4.1 Approaches to value investing

Approach	Classic	Mixed	Contemporary
Well-known practitioners	• Graham • Tweedy, Browne • Schloss & Schloss • Heine • Heilbrunn • Klarman	• Gabelli • Neff • Price • Royce • Greenblatt • Whitman	• Buffett • Greenberg • Ruane, Cuniff
Key characteristics	• Diversified portfolio • Tangible assets • Cursory research • Unpresentable • "Wounded ducks" • In the shadows	• Replacement value • Sufficient research • Private market value • Catalyst • Relative value • Bland • Normalized earnings • Temporarily offstage	• Concentrated portfolio • Intense research • Franchise value • Attractive but not sexy • Owning the business • "Wounded eagles" • Hiding in plain site

Source Greenwald, Kahn, Sonkin, and van Biema and used with kind permission from John Wiley & Sons

See Greenwald, B. C. N., J. Kahn, P. D. Sonkin, and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300

This is evident from reading the book *Value Investing: From Graham to Buffett and Beyond*, which provides an excellent overview of the field, and in Table 4.1, an overview is provided of various approaches to value investing as well as their most well-known practitioners and their characteristics. Clearly, there are different approaches to value investing while staying true to the fundamental principles.

So, how does value investing really work? One interpretation[108] is that value investing benefits from the misjudgment of mainstream Finance, and as such they overinvest in stocks that are underpriced and underinvest in stocks that are overpriced and in this way they outperform mainstream Finance in the market. Another interpretation is that value investment is fundamentally riskier and higher returns follows thereof.[109] Some researchers[110] set out to empirically test which of these interpretations are true, if any. They studied portfolios formed every year starting at the end of April 1968, with at least five years of past performance, using returns

[108]Offered by several academics including:

- De Bondt, W. F. M. and R. H. Thaler (1985a). "Does the Stock Market Overreact?" *Journal of Finance* **40**(3): pp. 793–808.
- Haugen, R. A. (1998). *The New Finance: Case Against Efficient Markets*. Upper Saddle River, NJ, Prentice Hall. p. 160.

[109]This argument is most forcefully argued by Fama, E. F. and K. R. French (1992). "The cross-section of expected stock returns." *Journal of Finance* **47**(2): pp. 427–466.

[110]See Lakonishok, J., A. Shleifer and R. W. Vishny (1994). "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance* **49**(5): pp. 1541–1578.

data from the Center for Research in Security Prices (CRSP) and accounting data from COMPUSAT covering stocks of both the New York Stock Exchange (NYSE) and American Stock Exchange (AMEX), and they found that:

1. Value investing strategies (buying out-of-favor stocks) outperformed strategies focusing on so-called glamour stocks—defined as stocks with high growth in the past and high expected future growth—with 10–11 percent per year. Glamour stock strategies are typically what would be supported by mainstream finance unless manual considerations are made.
2. Market participants tend to consistently overestimate future growth rates of glamour stock as would be predicted by mere extrapolation of past growth data. The fact that the market learns slowly over time about its likely mistake indicates that it cannot be as efficient as commonly argued by its proponents[111]—if it was, the lack of growth rates, as forecasted, should be detected quickly and corrected. However, this is not the case, and value investors can typically exploit this to their benefit.
3. Value strategies are no riskier than glamour strategies even though the standard deviations are somewhat higher. This claim is substantiated by the facts that the value strategies outperformed the glamour strategies in both extreme good states and extreme bad states and on average. This illustrates that standard deviation is not really a measure of risk but rather a measure of the uncertainty the market faces in pricing the stock relative to the market. Since uncertainty can be thought of a measure of information quality, we see the obvious link to value strategies—value investors spend time and resources obtaining more information so even though the stock may seem uncertain from what is available information in the market, they reduce this uncertainty and can make better decisions.

Similar studies have been carried out for a variety of countries (Japan, UK, German, France, Switzerland) and for a variety of time series. Yet, the results are more or less the same. Clearly, value strategies outperform glamour strategies. Period.

When the logic is so obvious—particularly when performance in real-life supports the logic—it is fascinating how the huge equities markets are dominated by allegedly professional institutional investors, with billions and billions in their portfolio, using FRM techniques and in more than 90 percent of the cases[112] in most years they underperform compared to the S&P 500 Index. Are they dumb? These people are highly educated and intelligent, so there must be something else at work.

[111]See for example Fama, E. F. and K. R. French (1992). "The cross-section of expected stock returns." *Journal of Finance* **47**(2): pp. 427–466.

[112]According to Mizrahi, C. S. (2008). *Getting Started in Value Investing*. Hoboken, NJ, John Wiley & Sons. p. 190.

I believe, and others[113] as well, that we are into the behavioral aspects of organizational life. First, the fact is that regardless of the size of an investment fund, they also compete for customers. Choosing glamour stocks may seem more prudent, and if they fail, they have an easier life explaining what went wrong than if they invested in a relatively unknown stock perhaps with temporary problems. Second, a better documented problem is that the increasingly shorter investment horizons demanded by their clients essentially makes it harder to succeed with investments.[114] Value investing strategies typically take three to five years[115]—the longer the better—but with average holding periods today in the financial markets shorter than one year, it becomes too risky for money managers personally with respect to their careers. This means that value investors implicitly harvest the effects of time diversification as well. Third, there are a number of policy restrictions that institutional investors and their investors place on themselves. Typically, this has to do with sector, geography, cash levels, and size of investment object.[116] Finally, not only are their valuation techniques very different as argued so far, but they also emphasize various value elements of equities differently as conceptually illustrated in Fig. 4.1.

Mainstream Finance typically put premium on future growth potential and little on assets, whereas value investors are much more conservative and have virtually opposite emphasis. As some authors[117] put it, the valuation method of value investors "puts more emphasis on information about the firm that is solid and certain, and it values the company's future prospects with more realism and less optimism than is customary on Wall Street." By putting so much emphasis on what is essentially unknown or at the very least very uncertain, mainstream Finance and by extension institutional investors expose themselves to more risks—meeting uncertainty with ignorance is perhaps the pinnacle of riskiness—than value investors. Furthermore, mainstream Finance fails to exploit the powerful time diversification effects as they trade frequently. At least, had they been disciplined/smart enough to allow time diversification work in their advantage there might have been hope.

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[113] See for example Lakonishok, J., A. Shleifer and R. W. Vishny (1994). "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance* **49**(5): pp. 1541–1578.

[114] See for example:

- De Long, J. B., A. Schleifer, L. H. Summers and R. J. Waldman (1990). "Noise trader risk in financial markets." *Journal of Political Economy* **98**(4): pp. 703–738.
- Schleifer, A. and R. W. Vishny (1990). "The New Theory of the Firm: Equilibrium Short Horizons of Investors and Firms." *The American Economic Review: Second Annual Meeting of the American Economic Association* **80**(2): pp. 148–153.

[115] See for example Lakonishok, J., A. Shleifer and R. W. Vishny (1994). "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance* **49**(5): pp. 1541–1578.

[116] See Mizrahi, C. S. (2008). *Getting Started in Value Investing*. Hoboken, NJ, John Wiley & Sons. p. 190.

[117] See Greenwald, B. C. N., J. Kahn, P. D. Sonkin and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300.

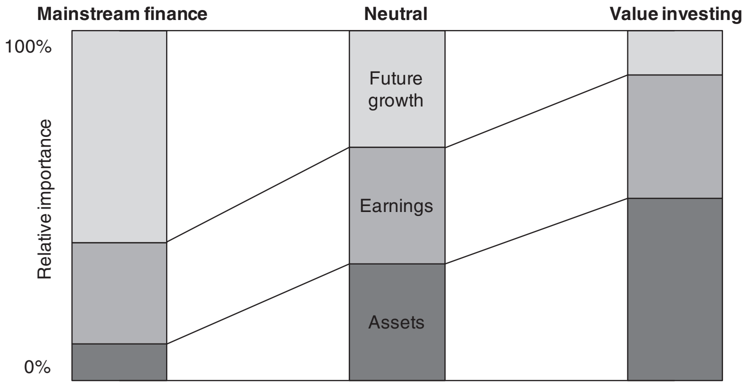

Fig. 4.1 The emphasis of various investors on the value elements in corporations

Since this is not a book on financial analysis or investment, I will refrain from a technical discussion on valuation techniques. However, there are three books that interested readers should read and in the following order:

1. Value Investing: From Graham to Buffet and Beyond.[118] This is a very readable introduction to the valuation techniques in value investing.
2. Security Analysis: Principles and Technique.[119] This is the landmark book of Benjamin Graham and David Dodd that every financial analyst should know.
3. CFROI Valuation: A Total System Approach to Valuing the Firm.[120] The CFROI valuation method is perhaps the most sophisticated approach in the market today.

From this list, it is evident that the author of this book is not impressed by mainstream Finance techniques—I can find no rational basis for their application except habit and the behavioral aspects of investing, i.e., it is what everybody does; hence, they cannot be accused of making a wrong decision.

What is truly interesting to take away from the review of mainstream Finance and value investing is that there are approaches in the investment world, i.e., value investing, that does *not* lead to herding, short-termism, and the like that we are soon to explore. Value investing is true investing, and if more investors used this approach, we would probably have financial markets that better served our quest toward sustainable development. Not to mention all the funds that are squandered away today due to the speculative nature of mainstream Finance that could have

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[118]See Greenwald, B. C. N., J. Kahn, P. D. Sonkin and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300.

[119]See Graham, B. and D. L. Dodd (1951). *Security Analysis: Principles and Technique*. London, McGraw-Hill Book Company. p. 770.

[120]See Madden, B. J. (2003). *CFROI Valuation: A Total System Approach to Valuing the Firm*. Oxford, Butterworth-Heinemann. p. 356.

been redeployed productively into the hands of business-like investors. The problem, however, is that as long as everybody believes that the current *modus operandi* is the way it should be, then they keep putting more funds into the hands of these speculators and they are allowed to continue their destructive path wasting billions of dollars every year, year after year. Of course, much of this is notional value, or paper value, but that real value is also lost is beyond any doubt. Next, we continue to discuss some dysfunctional aspects of the financial industry in greater depth.

4.3 Short-termism

> Life is short, the art long, opportunity fleeting, experiment treacherous, judgment difficult.
>
> Hippocrates

For humanity to approach something that might rightfully be labeled as "sustainable development," we must make sure that short-term speculation does not jeopardize long-term efforts. In fact, researchers point out that "short-termism has been identified as a significant barrier to achieving corporate sustainability, both in Australia and globally."[121] The CFA Centre for Financial Market Integrity and the Business Roundtable Institute for Corporate Ethics co-sponsored a "Symposium Series on Short-Termism" from September 2005 where leaders from the corporate, issuer, analyst, asset and hedge fund manager, institutional investor, and individual investor communities met. One of the major insights of the symposia participants "…confirm what the academic research suggests, namely that the obsession with short-term results by investors, asset management firms, and corporate managers collectively leads to the unintended consequences of destroying long-term value, decreasing market efficiency, reducing investment returns, and impeding efforts to strengthen corporate governance."[122] When this is said, I think it is important to stress that taking the longer view must not become an excuse for "…failing to grasp the nettle" because long-termism has not been a guarantee of success either.[123] Indeed, as we shall see later, much of the problem lies with the boards themselves.

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[121]See Atherton, A., J. Lewis and R. Plant (2007). *Causes of Short-termism in the Finance Sector*. Sydney, University of Technology, Institute for Sustainable Futures, Total Environment Center. p. 17.

[122]See CFA Centre for Financial Market Integrity/Business Roundtable Institute for Corporate Ethics (2006). *Breaking the Short-Term Cycle: Discussion and Recommendations on How Corporate Leaders, Asset Managers, Investors, and Analysts Can Refocus on Long-Term Value*. Charlottesville, VA, CFA Institute. p. 19.

[123]According to The Economist (2014e). Schumpeter: The tyranny of the long term. *The Economist*. **413**: pp. 65.

Before we continue, the term "short-termism" should be defined. In the literature, the term is defined in several ways. One "technical" definition provided by the finance industry itself is that short-termism refers to the "…excessive focus of some corporate leaders, investors, and analysts on short-term, quarterly earnings and a lack of attention to strategy, fundamentals, and conventional approaches to long-term value creation."[124] More, generically, we could say that short-termism is "…the pursuit of immediate gratification at the expense of long-term thinking."[125] One of the worst cases of short-termism in recent years is Albert J. Dunlap—nicknamed "Chainsaw Al"—who destroyed Scott Paper (to the cheering of Wall Street) while netting $100 million for 18 month's work as CEO.[126] If thinking longer than the next quarter, not to mention the next year, proves to be difficult in the financial markets, we can only start contemplating the problems of funding major environmental project regardless of industry whose time frame may stretch into decades!

One might argue that this is only a problem in the corporate world of profit seeking, but it is not. There are major societal trends that come into play as well. For example, we have the short cycles of re-election in the political sphere, and since corporate governance is closely related to political governance,[127] the political short-termism will ultimately seep into the corporate world and vice versa. On an even more fundamental level, each and every one of us feels more comfortable making decisions that have a short time frame than a longer time frame. There are also other decision effects that promote the short term over the long term.[128] For example, we prefer recent information over prior information[129]—a tendency that fuels short-termism in itself.

The short-termism of the financial markets and the societal trends of short-termism is most likely at constant interplay. In an insightful paper,[130] Andrei Schleifer and Robert W. Vishny provide a compelling explanation for the interplay between the financial markets and corporations, and how short-termism is in fact

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[124]See CFA Centre for Financial Market Integrity/Business Roundtable Institute for Corporate Ethics (2006). *Breaking the Short-Term Cycle: Discussion and Recommendations on How Corporate Leaders, Asset Managers, Investors, and Analysts Can Refocus on Long-Term Value*. Charlottesville, VA, CFA Institute. p. 19.

[125]See Wellum, J. M. (2006). "*Short-termism" and some significant challenges to the capital markets*. Toronto, Work Research Foundation. p. 14.

[126]See Useem, J. (2002). Tyrants, statesmen, and destroyers. *FORTUNE*. **146**: pp. 50–55.

[127]See Oman, C. (2001). *Corporate Governance and National Development*. Paris, OECD Development Centre. p. 47.

[128]See March, J. G. (1994). *A Primer on Decision Making: How Decisions Happen*. New York, The Free Press. p. 298.

[129]According to Kahneman, D. and A. Tversky (1982). Intuitive Prediction: Biases and Corrective Procedures. *Judgment Under Uncertainty: Heuristics and Biases*. D. Kahneman, P. Slovic and A. Tversky. London, Cambridge University Press: pp. 414–421.

[130]See Schleifer, A. and R. W. Vishny (1990). "The New Theory of the Firm: Equilibrium Short Horizons of Investors and Firms." *The American Economic Review: Second Annual Meeting of the American Economic Association* **80**(2): pp. 148–153.

due to rational behavior on the part of the market participants and executives in corporations.

Their starting point is the observation that arbitrage (trading based on knowledge that the price of an asset is different from its fundamental (intrinsic) value) is cheaper for assets that cannot stay mispriced for long, i.e., short-term assets, than for assets that can (long-term assets). Moreover, their argument is based on another key observation which concerns the fact that managers of firms are typically averse to severe underpricing of their equity because they risk getting fired or facing a (hostile) takeover. Any investment that raises the cost of arbitrage of their equity will therefore be avoided since this will lead to mispricing for longer time, and consequently, the short-term horizon of the arbitrageur will shape the behavior of executives toward short-termism. The important fact is that this is not just due to the time value of money, but longer time horizons also bring other costs—(1) the fundamental value may fall resulting in a real loss for the investor (referred to fundamental risk) and even longer time horizons for eliminating the mispricing, and (2) the mispricing may get worse resulting in what is called "noise trader risk". These risks raise the costs of arbitraging long-term assets relative to short-term assets. Since outside investors do not know whether the arbitrageur is skillful or not, they will worry that he takes risks without earning extra returns. The outside investor will therefore limit his supply of funds to this arbitrageur,[131] which induces additional costs to the arbitrageur. These credit constraints will in turn introduce an opportunity cost for the arbitrageur since his funds might be tied up. The longer it takes for the mispricing to be eliminated, the larger the opportunity costs. Due to the increased costs of funding, the smart arbitrageur will try to convince his investors about his skills so he will try to earn good returns—and fast. If the arbitrageur is unlucky, he will be forced to think more and more short-term. Demonstrating his talent by going for long-term assets is thus expensive and risky.

In this way, the capital markets leads to short-termism in the first instance. However, in the second instance, this process means that as more arbitrageurs flock to short-term assets, the shorter will the mispricing exist and hence reduce their risks and make it possible to trade even faster. The process is therefore self-reinforcing, and the link to high-frequency trading (HFT) is obvious—which is discussed more later. The point here is that John Maynard Keynes (1883–1946) was right when he feared that[132] smart money does not flock to long-term arbitrage; it requires a lot of patience and patience is costly. Importantly, this is not due to individual choices but it is inherent in the system and exacerbated by FRM tools as is evident from the discussions earlier in this chapter.

[131]See Stiglitz, J. E. and A. Weiss (1981). "Credit Rationing in Markets with Imperfect Information." *American Economic Review* **71**(3): pp. 393–410.

[132]According to Schleifer, A. and R. W. Vishny (1990). "The New Theory of the Firm: Equilibrium Short Horizons of Investors and Firms." *The American Economic Review: Second Annual Meeting of the American Economic Association* **80**(2): pp. 148–153.

Any remedies must therefore attack the root of the system. During the "Symposium Series on Short-Termism," an array of recommendations was put forward for financial markets only.[133] However, many of them also seem pertinent for the industry in general, such as:

1. End the practice of providing quarterly earnings guidance. If there are any companies with strategic needs for providing earnings guidance, they should adopt guidance practices that incorporate a consistent format, range estimates, and appropriate metrics that reflect overall long-term goals and strategy.
2. Support corporate transitions to higher quality, long-term, fundamental guidance practices, which will also allow highly skilled analysts to differentiate themselves and the value they provide for their clients.
3. Align corporate executive compensation with long-term goals and strategies and with long-term shareowner interests. Compensation should be structured to achieve long-term strategic and value-creation goals.
4. Endorse corporate leadership in communicating long-term strategic objectives and related performance benchmarks rather than in providing quarterly earnings guidance.
5. Encourage companies to provide more meaningful, and potentially more frequent, communications about strategy and long-term vision, including more transparent financial reporting that reflects a company's operations.
6. Encourage greater use of plain language in communications instead of the current communications dominated by accounting and legal language.
7. Endorse the use of corporate long-term investment statements to shareowners that will clearly explain—beyond the requirements that are now an accepted practice—the company's operating model.

These must also be addressed on the path toward sustainability, at least for publicly listed companies because they are continuously exposed to the financial markets. However, they fail to address the underlying problem of the system creating short-term arbitrage as discussed earlier. If holding periods were enforced, this would raise the cost of capital, which is not good for long-term investments. We must also not forget that arbitraging generally serves the useful social function of bringing asset prices quicker toward their fundamental value.[134] The problem must be tackled in a completely different way, which is discussed in Chap. 8.

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[133]See CFA Centre for Financial Market Integrity/Business Roundtable Institute for Corporate Ethics (2006). *Breaking the Short-Term Cycle: Discussion and Recommendations on How Corporate Leaders, Asset Managers, Investors, and Analysts Can Refocus on Long-Term Value*. Charlottesville, VA, CFA Institute. p. 19.

[134]According to Schleifer, A. and R. W. Vishny (1990). "The New Theory of the Firm: Equilibrium Short Horizons of Investors and Firms." *The American Economic Review: Second Annual Meeting of the American Economic Association* **80**(2): pp. 148–153.

Most corporations, however, are small- and medium-sized corporations and many or not traded on stock exchanges. For these, as well as for many large corporations, a good place to start in their daily operations would be to avoid:

1. Choosing very high discounting factors or short payback times, which produced essentially the same effect in this respect, and/or
2. focusing only on financial metrics. Both of these have been discussed before.

There are also many other avenues of improvement that must be made including various societal factors such as laws and regulations. These avenues are, however, beyond the scope of any single industry except that they must be supported. This is discussed later in Sect. 4.4.

There are also industry-specific initiatives that should be explored. For example, the real-estate industry should address building codes. The importance of building codes can hardly be overstated as "the operating costs of a school can consume the equivalent of its capital costs every 4–5 years and remain in service for a century."[135] Furthermore, concerning the environmental performance, we find that "In the USA, buildings use one-third of our total energy, two-thirds of our electricity, and one-eighth of our water and transform land that provides valuable ecological resources."[136] Thus, building codes should be revised to ensure lowest possible operating costs and environmental impact for a longest possible period. This is now a part of the scope of the LEED program.

The LEED program represents the efforts of a coalition including the US Green Building Council (GBC) to establish a nationwide standard for constructing so-called green buildings. So far, LEED has been voluntary, but the federal government is adopting it as a standard.[137] More specifically, "an analysis by NRDC and the US GBC estimated that 18.5 percent of public sector construction had applied for certification; another NRDC study cited in the New York Times put the percentage at 16.5 percent. By contrast, the percentage of non-public projects applying was only about one percent." Too often, unfortunately, the investment costs of buildings are overemphasized at the expense of life-span performance, and from the data on the penetration of LEED in the real-estate industry, it may appear that LEED must be made mandatory to truly become effective.

In Norway, for example, it is quite common to choose materials and solutions that are only slightly cheaper in order to end up with a sales price within certain market segment despite the fact that the durability and quality of these materials and solutions are inferior. In other words, the importance of a certain market segment (final sales price) is more important than durability, quality, and ultimately value. Take, for example, the fact that a ceramic roof that cost about 25 percent more than

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[135]See Government Asset Management Committee (2001). *Life Cycle Costing Guideline*. Sydney, New South Wales Government Asset Management Committee. p. 15.

[136]According to US Green Building Council (2005). *LEED® for New Construction & Major Renovations*. Washington DC, U.S. Green Building Council. p. 78.

[137]According to Northbridge Environmental Management Consultants (2003). *Analyzing the Cost of Obtaining LEED Certification*. Arlington, VA, The American Chemistry Council. p. 13.

the most commonly sold roofing may have an expected life span that is more than twice as long—20 years for the cheaper roof compared to at least 50 years for the more expensive roof. However, most real-estate companies consistently chose the cheaper roof to keep the construction cost of the building as low as possible.

It is obvious that when lowest construction cost is the criteria in industry, sustainability will be a hard case to crack. The building codes must be revised to focus on lowest life-cycle cost for a defined quality level. Subsequently, the design of the buildings must be changed so that the lowest possible life-cycle cost is attainable.[138] Indeed, maybe the whole life cost should become an important funding criterion? Maybe even warranty periods should be significantly extended?

The building code is further exacerbated by the high demand for return, but there is also another element to it. Some believe that higher return on investment is a natural consequence of the steadily stricter environmental rules and legislation that are coming into place, but this is not based on fact. In reality, the law is very conservative,[139] in the sense that old technology is often given much more leeway that new technology by being exempted from certain requirements or by being given generous transition arrangements. Take all the old coal-fired power plants, for example. Despite much more environmentally friendly technology is available, very few have actually been closed due to poor environmental performance—and those that have been closed or are scheduled for closure have been under intense scrutiny for many years if not decades. Therefore, the fact that the environmental legislation is moving rapidly forward in many countries, can hardly provide an excuse for short-termism and high discounting factors. Those that really run a risk in today's legislative environment are those companies that have underinvested for years so that their assets are severely outdated. Ironically, such lack of investments may be the direct consequence of short-termism and high discounting factors. Why should they get away with it?

A final element in the work against short-termism is education—and education in a wide sense. Such education must not only concern the financial aspects, which is the focus here, but virtually every aspect of the corporate system in which short-termism is prevalent or dangerous. An obvious starter would be to educate people in Finance about what returns can be realistically achieved over time and also how to invest correctly using value investing principles. The education must encompass the causes, problems, and remedies of short-termism. It should ideally be integrated into existing courses taught in our educational system because it is important to realize that just as the causes of short-termism cannot be identified in isolation, the solutions cannot be found in isolation.

An extreme type of short-termism is HFT, which is discussed next. This is not proper short-termism because it is due to exploitation of computerization of trade. It is a subset of algorithmic trading (AT) due to the fact that computers act based

[138]An approach for how this can be achieved is presented in Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[139]According to see Bradbrook, A. J. (1994). "Environmental Aspects of Energy Law—The Role of the Law." *Renewable Energy* **5**, **part III**(5–8): pp. 1278–1292.

on algorithms designed and implemented by humans. In other words, AT is the generic term that refers to strategies that use computers to automate trading decisions. AT does, however, not necessarily have to be HFT—it can be more than that. Hence, a separate section on HFT is warranted.

4.4 High-Frequency Trading

> Perfection of means and confusion of goals seem – in my opinion – to characterize our age.
>
> Albert Einstein

High-frequency trading (HFT) refers to trading strategies that are characterized by their reliance on speed differences relative to other traders to make profits based on short-term predictions and also by the objective to hold essentially no asset inventories (zero net assets) for more than a very short period of time.[140] With "very short" we typically understand milliseconds[141]—in this way, they can perhaps be viewed as an extreme form for momentum traders. Typically, the computer/robot of the HFT identifies a trend of a rising price on an asset, buys and sells almost at the same time and cashes in some profit. Depending on how events unfold, these traders "…spot trends before other investors can blink, changing orders and strategies within milliseconds. High frequency traders often confound other investors by issuing and then cancelling orders almost simultaneously."[142] Essentially, they tease out information from the slower investors and this information leakage helps the HFTs exploit slower investors.[143] In this way, the high-frequency trader becomes an intermediary between slower traders, and in so doing, they produce a number of side effects that researchers evaluate like this[144]:

1. HFT strategies introduce microstructure noise: In order to profit from intermediation, HFTs buy shares from one trader at a cheap price and sell it more dearly to another trader, generating price dispersion where before there was only a single price. Moreover, HFTs' additional intermediation increases the volume of trade. The additional volume is neither driven by fundamentals nor

[140]See Cartea, A. and J. Penalva (2012). "Where is the Value in High Frequency Trading?" *Quarterly Journal of Finance* **2**(3): pp. doi:10.1142/S2010139212500140.

[141]See Duhigg, C. (2009). Stock Traders Find Speed Pays, in Milliseconds. *The New York Times*. New York: p. 24 July.

[142]See Duhigg, C. (2009). Stock Traders Find Speed Pays, in Milliseconds. *The New York Times*. New York: p. 24 July.

[143]See Stewart, J. B. (2009). Barclays Suit Sheds Light on Trading in Shadows. *The New York Times*. New York: p. B1, 24 July.

[144]See Cartea, A. and J. Penalva (2012). "Where is the Value in High Frequency Trading?" *Quarterly Journal of Finance* **2**(3): pp. doi:10.1142/S2010139212500140.

is it noise trading. Far from it, the extra volume is a consequence of trades which are carefully tailored for surplus extraction.

2. Market participants react to the presence of HFTs by adjusting asset demand and supply functions, leading to an additional market distortion in the form of an exacerbated price impact of initial liquidity trades (the ones that generate a temporary order imbalance). Thus, the burden of HFT rent extraction is primarily borne by liquidity demanders who face a double burden: The direct cost from the trading surplus extracted by the HFT, and the indirect cost of a greater price impact. Furthermore, this effect is increasing in the size of the liquidity need.
3. The effect of HFTs on the market's liquidity providers is ambiguous. On the one hand, they suffer increased trading costs from HFT surplus extraction. On the other hand, the increased market impact of the initial liquidity trades implies increased profits from higher liquidity discounts. Nevertheless, despite the a priori negative definition of HFTs as pure rent extractors, it is possible for the second effect to be dominant so that HFTs lead to an increase in overall liquidity provision in the market.
4. Standard measures of market liquidity, especially volume-based ones, may lead to erroneous conclusions: HFTs may not increase liquidity, and yet we obtain substantially higher trading volumes—the European Securities and Markets Authority (ESMA) estimates that HFT accounts for more than a fifth of European share trading by value.[145] In fact, liquidity traders face overall lower sales revenue and higher costs of purchase, suggesting that liquidity is better measured through total cost of trade execution.

This has attracted an increasing amount of attention both from market participants and regulators particularly after the so-called Flash Crash on May 6th of 2010. On that day, 16 trading accounts classified as HFT traded over 1,455,000 contracts, accounting for almost a third of the volume that day, yet the positions changes so rapidly that the HFT rarely held more than 3000 contracts long or short on that day.[146] Furthermore, although the HFTs did not directly cause the Flash Crash, they contributed to it by demanding immediacy ahead of other market participants. Immediacy absorption activity of HFTs results in price adjustments that are costly to all slower traders, including the traditional market makers. The HFTs, however, seem to be making handsome profits with double digit Sharpe ratios (ordinary investors typically have Sharpe ratios of 1–2).[147] This may explain why close to half of the traded stock market volume in the USA in 2014 was HFT.[148] Note that

[145]See The Economist (2014b). A bigger bang. *The Economist*. **411**: pp. 63–65.

[146]See Kirilenko, A., A. S. Kyle, M. Samadi and T. Tuzun (2010). "The Flash Crash: The Impact of High Frequency Trading on an Electronic Market." *SSRN-id2433211*(October 1).

[147]See Aldridge, I. (2010). How Profitable Are High Frequency Strategies? *The Huffington Post*, www.huffingtonpost.com: pp. July 26.

[148]According to The Economist (2014c). Free exchange: Frequent but inefficient. *The Economist*. **413**: p. 66.

a Sharpe ratio measures return per unit risk so that a ratio of 2 means that the average annualized return on the strategy twice exceeds the annualized standard deviation of strategy returns. The extremely high Sharpe ratio is not only secured by providing profits. These traders also largely avoid risks due to the very short holding periods—so short that the probability of substantive changes in the fundamental value of the asset during the period is insignificant.[149]

Perhaps, the most serious effect of HFTs is that they simply reduce the value of the stock market as a forum for providing a way for investors to convert their equity into cash (and vise versa) quickly and at a reasonable price.[150] This is due primarily to the adverse effect of HFTs on prices (costs of execution). This value reduction would, in a more general framework, be passed on to the firms raising capital in equity markets.

The controversy surrounding HFTs is by no means settled. They are under tough scrutiny by, for example, New York Attorney General Eric T. Schneiderman who has sued Barclays for fraud in its operations of a so-called dark pool that secretly catered to HFTs.[151] Proponents focus on the ability of HFT to provide liquidity in the market, whereas skeptics are more aligned with the view presented in this section. In fact, the European Commission proposed an upgrade of the Markets in Financial Instruments Directive (MiFID 1) which was implemented in 2007, and the new MiFID 2 will force all asset classes into the open and promote transparent markets. The ESMA will implement this new regime in 2017, and some insiders estimate that the effect will be profound.[152]

Reading about HFT, a statement from Stephen Hawking in the context of Artificial Intelligence (AI), which in a sense can be thought of the next generation within robotics, comes to mind[153]:

> One can imagine such technology [i.e. AI] outsmarting financial markets, out-inventing human researchers, out-manipulating human leaders, and developing weapons we cannot even understand. Whereas the short-term impact of AI depends on who controls it, the long-term impact depends on whether it can be controlled at all.

Indeed, the fact that circuit-breakers are our last line of defense against the actions of these traders should be worrying because that means we have created a system that does not contain itself via feedback loops that works. Again, we do not fix the problem but rather find a way of managing it, which has been the approach historically, as discussed later.

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[149]See Cartea, A. and J. Penalva (2012). "Where is the Value in High Frequency Trading?" *Quarterly Journal of Finance* **2**(3): pp. doi:10.1142/S2010139212500140.

[150]See Cartea, A. and J. Penalva (2012). "Where is the Value in High Frequency Trading?" *Quarterly Journal of Finance* **2**(3): pp. doi:10.1142/S2010139212500140.

[151]See Stewart, J. B. (2009). Barclays Suit Sheds Light on Trading in Shadows. *The New York Times*. New York: p. B1, 24 July.

[152]See The Economist (2014b). A bigger bang. *The Economist*. **411**: pp. 63–65.

[153]Published in The Independent on Tuesday 20 May 2014.

From controls, we know that high-performing systems such as a jet fighter are aerodynamically instable and cannot be flown manually. The Spitfire, which was one of the best fighter planes in World War II, however, was aerodynamically stable as was all airplanes at the time before advanced controls. With a system as complex as the modern financial system, it may seem a little naïve that it can be controlled like a jet fighter, which calls for a more conservative approach, i.e., like the Canadian banking system as discussed later. Thus, we must go back to the purpose of the financial system to find guidance as to what should be the advice concerning many of today's practices.

Fundamentally speaking, I also question the current lore that "the more liquidity, the better." With a notional value of the financial markets roughly 10 times the real economy as measured by the Gross World Product; is there really no diminishing return on liquidity—like everything else in the economic sphere? For a layman like myself, their whole operation seems to be at odds with what financial markets should be about—providing liquidity in a fair way for a large variety of legal purposes so that those that need capital can get access to it without unreasonable costs. In fact, I would argue that HFT simply exploits others while offering nothing or very little in return. The liquidity they supposedly offer is more or less fictitious—they trade so quickly that nobody in the real world can benefit from this allegedly liquidity. Needless to say, this can hardly be in line with sustainable development so I would argue that regulators should find a suitable way of regulating their activities either via MiFID 2 or something else. Financial markets that operate in a fair way are extremely important, and whatever stands in the way for that must be rooted out. As far as I can understand, HFT offers nothing of real value—except bloated volumes that may look good in some quarters.

4.5 Herding

> If everyone is thinking the same, no one is thinking!
>
> George S. Patton

First of all, "herding" as a term is borrowed from the animal kingdom signifying the apparent mindless, yet loosely coordinated, movement of a herd—sometimes under the pressure of predators; think of a large flock of birds or a shoal of fish—or sometimes apparently without any reason. In its most general term, it can be defined as "…behavior patterns that are correlated across individuals."[154] A more specific definition for the financial industry is that herding arise when "…a group of investors *following* each other into (or out of) the same securities

[154] According to Devenow, A. and I. Welch (1996). "Rational herding in financial economics." *European Economic Review* **40**(3): pp. 603–615.

over some period of time [original italics]."[155] In the literature, which is extensive, the mechanism behind herding is described in two polar views as either "rational" or "non-rational." In real life, the herding is probably somewhere in between, that is, partly rational or non-rational—or "near-rational" as it is labeled. In fact[156],

> The non-rational views centers on investor psychology and holds that agents behave like lemmings, following one another blindly and foregoing rational analysis. Less crazy investors are assumed to be able to profit handsomely therefrom. The rational view centers on externalities, optimal decision-making being distorted by information difficulties or incentive issues. The intermediate view holds that decision-makers are near-rational, economizing on information processing or information acquisition costs by using 'heuristics', and that rational activities by third-parties cannot eliminate this influence.

While the mechanisms behind herding are interesting reading in itself, the focus here is on the consequences for industry in general. Because what is clear is that herding is more than an academic phenomenon or something for special interests, it is very real and common.[157] Combined with short-termism and a tendency of investors to overreact,[158] we have a recipe for bubbles and busts under certain circumstances.

The financial crisis of 2008 was a testimony to this although its underlying causes are much deeper than mere herding of investors and the like,[159] as discussed at the end of this section. What is clear, however, is that the industry played a major role both as victim but also as villain, as it were. It should also be made clear that this is not just the works of practitioners, but also of teaching and research institutions. Particularly, business schools have failed in their education of practitioners and researchers.[160] Indeed, even the Chairman of the Federal Reserve in the USA admits that he never saw it coming.[161] In fact, just three days before the crisis began, J.P. Morgan—arguably the US premier financial institution,[162] projected that the US GDP growth rate would accelerate during the first half of 2009.

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[155]See Sias, R. W. (2004). "Institutional Herding." *The Review of Financial Studies* **17**(1): pp. 165–206.

[156]According to Devenow, A. and I. Welch (1996). "Rational herding in financial economics." *European Economic Review* **40**(3): pp. 603–615.

[157]See for example Hwang, S. and M. Salmon (2004). "Market stress and herding." *Journal of Empirical Finance* **11**(4): pp. 585–616.

[158]According to De Bondt, W. F. M. and R. H. Thaler (1985b). "Does the Stock Market Overreact?" *Journal of Finance* **40**(3): pp. 793–805.

[159]See The Economist (2009). *Greed—and fear: A special report on the future of finance*. London, The Economist. p. 24.

[160]See Podolny, J. M. (2009). "The Buck Stops (and Starts) as Business School." *Harvard Business Review* **87**(6): pp. 62–67.

[161]See Greenspan, A. (2013). "Never Saw It Coming: Why the Financial Crisis Took Economists by Surprise." *Foreign Affairs* **92**(6): pp. 88–96.

[162]According to Greenspan, A. (2013). "Never Saw It Coming: Why the Financial Crisis Took Economists by Surprise." *Foreign Affairs* **92**(6): pp. 88–96.

Such "intellectual herding," or groupthink, is not any better than for example the herding of sales and purchase found in the financial markets and real-estate markets. Put simply, if a business partner uses a discounting rate of 15 percent, it does not necessarily translate into 15 percent for another company even though the rationale behind the 15 percent is some external benchmark like average return in the stock market (which is much lower over time, as shown earlier).

The lack of critical thinking concerning economic evaluations is a very common problem particularly when statistical analyses are involved. For example, two economists, Deirdre McCloskey and Stephen Ziliak studied to what degree papers in the highly respected journal *American Economic Review* failed to separate statistical significance from plausible explanations of economic reality.[163] Their findings are depressing: first, in the 1980s, 70 percent of the papers failed to distinguish between economic and statistical significance, and second, in the 1990s, more than 80 percent failed! This is particularly a finding that researchers must address because the number among practitioners is probably even worse, and if researchers (and teachers) cannot understand it correctly, we can hardly expect practitioners to develop the understanding via any other means that trial and error. On top of it, financial risk management relies heavily on statistics as shown. The link is fairly obvious…

Part of this herding has in fact a rational explanation in that too much trust was put in the tools of mainstream Finance. These tools made economists and investors believe that a sophisticated global system of financial risk management could contain market meltdowns.[164] However, irrespective of that, the herding was also fueled by plain greed and subsequent fear. In fact, the chairman and CEO of Citigroup, Charles Prince, expressed fears of a bubble in 2007 but in a now-famous remark explained that there could be no relaxation in fear of losing market share; "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing." One could believe that Mr Prince talked about the party game where chairs are removed and as the music stops you have to find an available chair, because when the music that Mr Prince talked about stopped almost all the chairs were removed. The combination of greed, fear, and naïve trust in the system proved catastrophic.

The immediate lesson from this is that herding leads to outright wrong economic decisions even in the light of contrarian evidence. Nowhere can this be more important than in the realm of sustainable development because the very long-term nature of sustainable development. To face the rampant short-termism and herding in our society and to counter this development, decisions must be based on facts. In light of the 2008 Financial Crisis, industry and its researchers

[163]See The Economist (2004). Signifying nothing? *The Economist*. **370**: pp. 63.

[164]According to Greenspan, A. (2013). "Never Saw It Coming: Why the Financial Crisis Took Economists by Surprise." *Foreign Affairs* **92**(6): pp. 88–96.

should be at the hub of the problems and therefore possibly the closest to start finding remedies. However, as we see from the discussion so far about mainstream Finance, their tools and thinking leads inevitably to lemmings-like behavior because it is not based on facts and understanding.

It is no wonder that, Graham introduced the term "Mr Market" to describe the erratic price movements of the market—one day he is euphoric and another day he is depressed. When he is euphoric, he is willing to pay more for stocks than their worth, and when he is depressed, he sells for less than their intrinsic value. Therefore, Graham described Mr. Market as bipolar.[165]

Here, again, value investors stand out from the crowd—they exploit Mr. Market because they have not fallen under his spell as it were. Their tactics of buying when the market fall and selling when it rises means that these investors are actually acting independently of the vast majority of the market (exploiting Mr. Market). Therefore, once adequate facts are established about an investment opportunity, the supreme virtue of an investor is courage.[166] Going with the herd is intuitive for social animals like humans, but if we truly are to change our approach, we need courage. How, governments can encourage this kind of value investing is therefore an interesting question.

However, the worst culprits are elsewhere and have largely left the scene without any tomatoes in their faces as will be evident from the next section.

4.6 Learning from Canadian Banking

> To make the worker responsible for his job and for that of the work group is also the best – and maybe the only – way to restore the supervisor to health and safety.
>
> Peter F. Drucker

We need to look at the custodians of the banking system—the politicians. The robustness and the performance of the financial system—out of which the banking system is a large part—are at their helm. To help us understand this better, Charles W. Calomiris and Stephen H. Haber published an insightful paper[167] on why banking systems succeed and fail. They studied the banking systems in 117 countries that have population in excess of 250,000, that are not current or former communist countries, and that have banking systems large enough to report data on private credit from commercial banks for at least 14 of the 21 years from 1990 to 2010:

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[165] According to Mizrahi, C. S. (2008). *Getting Started in Value Investing*. Hoboken, NJ, John Wiley & Sons. p. 190.

[166] According to Graham, B. (2005). *The Intelligent Investor*. New York, HarperCollins Publishers. p. 269.

[167] See Calomiris, C. W. and S. H. Haber (2013). "Why Banking Systems Succeed—and Fail; The Politics Behind Financial Institutions." *Foreign Affairs* **92**(6): pp. 97–110.

1. Only 34 of those countries (29 percent) avoided crises entirely between 1970 and 2013.
2. 62 (53 percent) had one crisis.
3. 19 (16 percent) had two crises.
4. One (1 percent) had three crises.
5. One (1 percent) had four crises.

They argue that all modern banking is best thought of as a partnership between the government and a group of bankers and that partnership is shaped by the institutions that govern the distribution of power in the political system. Hence, a country does not choose its banking system; it gets the banking system it deserves! This is because all governments face three inherent conflicts of interest concerning the banking system:

1. Governments supervise and regulate banks while looking to them as source of government finance.
2. Governments enforce the credit contracts that discipline debtors of behalf of banks while relying on those debtors for political support.
3. Although governments must spread the pain among creditors in the event of bank failures, they must also simultaneously look to the most significant group of those creditors—bank depositors—for political support.

This Game of Bank Bargains, as they call it, is managed by the rules set by the countries' political institutions as those rules determine which interest groups are being included in the government–banker partnership and who are excluded. This means that debates about banking are often framed erroneously—the focus should not be on more or less regulation but rather on the goals that give rise to the regulation and the way these goals are shaped by political bargains.

The records show clearly that broad-based interest bargaining produced a far more stable and less crisis prone systems than bargaining in which special interest groups had disproportionate say. To prove their point, they convincingly discuss both England versus Scotland and most notably USA versus Canada.

The banking system in the USA has been highly crisis prone producing no less than 14 major crises in the past 180 years. Canada, in contrast, has experienced only two brief, mild bank-liquidity crises in the 1830s—they largely escaped the 2008 Financial Crisis altogether. Yet, Canada and the USA share a huge number of similarities in terms of location, culture, and so on. Add to that Canada's open, export-based economy which makes the country more vulnerable to changing market conditions than the US economy. To add to the laurels, the Canadians have achieved all this with little government intervention.

The authors attribute this not to the conventional explanation of large, nationwide banks but to the quality and stability of their political institutions which have been virtually immune to special interests. For more than 150 years, the Canadian parliament has carried out periodic legislative reviews and recharterings of their banks. Up until 1992, this process occurred every ten years—thereafter it occurred every five years. Mindful of the power of their parliament, Canadian bankers follow the dictum “Pigs get fat, hogs get slaughtered.” Thus, banks that failed were not bailed out. Liabilities were limited—not as is most countries were “too big to fail” has become the mantra resulting in cases where executives after first being bailed out receive hefty bonuses for merely surviving their own folly.

Furthermore, banking in Canada is not used to hide political agendas of favored political constituencies such as securing affordable housing to the less privileged. The Canadians rather gave people in need financial support directly from the government instead of lowering the underwriting standards of the banks, which was done in the USA causing the huge collapses of Freddie Mac and Fannie Mae. It turns out that using capitalist systems toward certain social ends is dangerous. They close off their article with an insightful quote from George Bernard Shaw:

> The reasonable man adapts himself to the world: the unreasonable one persists in trying to adapt the world to himself. Therefore, all progress depends on the unreasonable man.

With this in mind, it is interesting to go into more depth to how the Americans solved banking crises. Here, *The Economist* gave a very interesting review from which we can learn a number of things.[168] From 1792 to 1929, the Americans experienced five major slumps from which *The Economist* identifies two major trends in financial evolution.

The first is that modern finance with central banking, deposit insurance, and stock exchanges are not products of understanding and strategy but have been put together at in times of turbulence trying to fight the fire. If we go back to the topic of this book, it is clear that finance today cannot proceed as in the past. This is evident from the fact that finance has moved from crash to crash and evidently without solving the root causes since crashes repeat themselves with consequences reverberating for decades. With such a track record, it is very likely that our quest toward sustainability will be due to happenstance and not through design. This will not suffice and fresh thinking aiming for addressing the root causes is clearly called for.

The second is just as alarming. The response to every crisis follows a predictable pattern. It starts with blame. New parts of the financial system are vilified; a new type of bank, investor, or asset is identified as the culprit and then banned or regulated out of existence. It ends by entrenching public backing for private markets; other parts of finance deemed essential are given more state support. It is an approach that seems sensible and reassuring. It was first tried out by Alexander Hamilton (1755–1804) in the crisis of 1792 when the first bank bailout took place in fear of having a financial system lingering for years such as the result of the 1720 crisis in France. However, it is corrosive—insulating investors from risk in an ever-increasing degree. Risks are no longer limited; they are removed and subsidized. Walter Bagehot (1826–1877), the highly respected editor of *The Economist* between

[168] See The Economist (2014f). The slumps that shaped modern finance. *The Economist*. **411**: pp. 47–52.

1860 and 1877, would have been angry at the bailouts today, and he argued that financial panics occur when the "blind capital" of the public floods into unwise speculative investments. Yet, well-intentioned reforms have made this problem worse—an evil circle which must be broken by placing risk back where it belongs as they have done in Canada. The size of the problem can be illustrated by the fact that IMF estimates that the world's largest banks benefitted from implicit government subsidies worth $630 billion in the year 2011–2012 alone. Then, debt becomes unnecessary cheap leading to more lending, more leverage, and a higher probability of a new crisis in the future. This is old news, and it seems to be inherent in the system based on an analysis of the causes in crisis after crisis the last 200 years. Maybe it is time to learn and do something new?

With the discussion of the ETS in mind from Chap. 2, it is obvious that the ETS is mired in special interests from certain countries and industries and from that perspective is doomed to fail the test of time. The lesson from this is that the road toward sustainability cannot be paved by special interests of *any* kind—not even allegedly environmental interests. Environmental interests have become an industry themselves and are therefore susceptible to special interests. The approach we seek must be thoroughly disinterested in special interests, thoroughly broad-based, and any market participant must be small enough to be expendable for the greater good—only this will provide sustainable effects throughout value chains, industries, and countries. Then, what is left is to guide the system toward sustainability, which will be discussed later. For now, we focus on avoiding booms, busts, and perverted financial interests.

An interesting aspect of this lesson is that it also has implications for the stewardship of stocks as well, which is discussed next.

4.7 The Stewardship of Stocks

> For if one were to offer men to choose out of all the customs in the world such as seemed to them the best, they would examine the whole number, and end by preferring their own; so convinced are they that their own usages far surpass those of all others.
>
> Herodotus,
> The Histories, 420 BC

A basic truth of life is that most people do not intentionally destroy their livelihood, their family, their neighborhood, or whatever is close to them. Poverty can, of course, alter this to some extent because the poor is sometimes forced to make destructive, short-term decisions just to survive from one day to another. This is why the socioeconomic dimension of sustainability is perhaps just as important as what we discuss in this book, but finance and the corporate world can also make significant contributions here as Jeffrey Gates argues in his *Ownership Solution* book.[169] His thesis is that "people are likely to become better stewards of all those systems which they are a part—social, political, fiscal, cultural and natural—as they gain a personal stake in the economic system, with all the rights and responsibilities that implies."

This may seem to be at odds with the discussions concerning short-termism and herding, but the problem with the financial markets is that their tools can just as well be used for speculation as for useful transactions.[170] Furthermore, most trades are focusing on trading in derivatives and not in the "underlying"; hence, they have little understanding of the real economic impact of their dealings. The point is that the financial markets in general cannot serve as prudent stewards of physical assets—they do not have the tools and in many cases they also lack the inclination; just think of many scandals in recent decades. Thus, we must try to bring the general population more onto the field as stewards and that means, as Gates points out, they must become a part of the ownership structure. In other words, we are talking about broad-based ownership.

Furthermore, there is an impressive amount of statistics worldwide showing that wealth (physical as well as financial) is becoming increasingly concentrated, indicating that we are going in the wrong direction. At the same time, it is also true that more adult Americans own stocks and stock mutual funds that ever before.[171] In other words, society is becoming increasingly polarized. These trends led former President of Federal Reserve Bank of New York William J. McDonough to issue in October 11th in 1995 the following warning: "Issues of equity and social cohesion [are] issues that affect the very temperament of the country. We are forced to face the question of whether we will be able to go forward together as a unified society with a confident outlook or as a society of diverse economic groups suspicious of both the future and each other."[172] A year later, in the Human Development Report 1996, the UNDP used terms such as "grotesque inequalities" to describe the rising levels of inequalities globally.[173]

There are significant social–political connotations in this, which will not be discussed here, but as mentioned a few pages earlier—finance and the corporate world can also contribute. This starts by executives realizing that involvement of employees actually leads to improved corporate performance. While this has

[169]See Gates, J. R. (1998). *The Ownership Solution: Toward A Shared Capitalism For The 21st Century*. Reading, MA, Addison-Wesley. p. 388.

[170]See Taylor, F. (2010). *Mastering Derivatives Markets: A Step-by-Step Guide to the Products, Applications and Risks*. London, Financial Times/Prentice Hall. p. 432.

[171]Gates provide a thorough discussion on this to which people are referred to for more information, see Gates, J. R. (1998). *The Ownership Solution: Toward A Shared Capitalism For The 21st Century*. Reading, MA, Addison-Wesley. p. 388.

[172]Quoted by Cassidy, J. (1995). Who Killed the Middle Class. *The New Yorker*. New York: p. 113.

[173]See UNDP (1996). *Human Development Report 1996*. New York, United Nations Development Programme (UNDP). p. 229.

been debated for some time, the evidence is quite clear and favoring so-called Employee Stock Ownership Programs (ESOP):

1. Academic studies[174] are quite conclusive in that for publicly traded companies there are "…significant differences in operating performance generally favoring the ESOP firms. Most notable are the findings that in comparison with public non-ESOP companies, public ESOP companies generally have lower risk (significantly higher betas, significantly lower unsystematic risk), manage growth more conservatively and have higher return on assets. This supports the arguments in favor of incentive alignment and the value of the 'ownership culture'."
2. The success lean practices have had on a large number of corporations, most notable Toyota, is well documented,[175] and lean practices are heavy on employee involvement albeit not necessarily ownership.

ESOPs are not something esoteric and strange—it can be viewed as a special case of a mutual ownership model and such ownership models have been around since Roman times.[176] These ownership structures are based on the notion of collective self-help and can take many forms such as consumer cooperatives, tenants in housing cooperatives, farmers in an agricultural cooperatives, and savers/borrowers in a building societies or friendly societies. Such ownership models were flourishing in the nineteenth century. For example, in the UK in 1892, approximately 80 percent of the seven million male industrial workforces were members of at least one society.[177] In many ways, an ESOP can be thought of as a capitalist version of older mutual ownership models. Finally, it should be noted that historically there have been five communities—and mutual ownership models in total: (1) common and customary ownership, (2) community ownership, (3) cooperative and mutual ownership, (4) charitable ownership, and (5) municipal and state ownership. In recent years, i.e., after the Industrial Revolution, the joint-stock company emerged and it dominates today. However, forgetting about these older ownership models might be a serious mistake in our quest for a sustainable future.

In Leviticus 25, we can also read about how the ancient Hebrews redistributed land back to their original owners every jubilee, i.e., every 50 years. This is undoubtedly an original way of avoiding the dangers of large concentrations of ownership, but it is highly unlikely to work in the modern world to say the least. However, it is an important historical fact, and it goes to show how societies

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[174] See Stretcher, R., S. Henry and J. K. Kavanaugh (2006). "The ESOP Performance Puzzle in Public Companies." *The Journal of Employee Ownership Law and Finance* **18**(4).

[175] There are scores of books on Toyota, but perhaps the most important is the first major book; Womack, J. P., D. T. Jones and D. Roos (1990). *The machine that changed the world*. New York, Rawson Associates. p. 323.

[176] See Woodin, T., D. Crook and V. Carpentier (2010). *Community and mutual ownership: A historical review*. York, Joseph Rowntree Foundation. p. 58.

[177] According to Woodin, T., D. Crook and V. Carpentier (2010). *Community and mutual ownership: A historical review*. York, Joseph Rowntree Foundation. p. 58.

throughout the ages have grappled with ownership and found useful solutions for them. It is clear that our quest toward a sustainable future must entail original thinking also on ownership and particularly concerning how risk is to be managed in society. The laws of limited liability were critical for the Industrial Revolution, but with today's hollowing out of limited liability for the financial industry, in particular, we must ask ourselves how to rebuild the societal contract also for the fat cats of Finance who are deemed "too big to fail".

Anyway, according to the National Center for Employee Ownership (NCEO) 2014 statistics indicate that "…approximately 28 million employees participate in an employee ownership plan. These numbers are estimates, but are probably conservative. Overall, employees now control about 8 percent of corporate equity" in the USA. In addition, we have all the pension funds. Global pension assets totaled $31.5 trillion or 39.5 percent at the end of 2011 according to TheCityUK estimates based on OECD data.[178] These funds are, however, mostly passively managed and hence cannot fill the roles as an owner—they are more to be likened with a classic rentier. So, this means that the portion of ESOPs is still low—certainly if we think of it on a global scale where many countries have no ESOPs at all. This is the case even though they are associated with a number of benefits[179]:

1. To provide the employees of the company with a benefit, stock ownership in the company.
2. To provide existing shareholders of closely held corporations with a tax-advantage method for transferring ownership of the company to the employees.
3. To capture the incentive effects of ownership in employee motivation.
4. To ward off potential or actual takeover attempts.
5. To replace an existing defined contribution plan that is more expensive.
6. To allow retiring owners to divest their shares by selling to the ESOP.
7. To obtain low-cost, tax-advantaged financing for expansion or other corporate use.

From a theoretical point of view, the agency issue should also become better in an ESOP context. Nevertheless, there is an obvious puzzle between what is actually taking place (relatively low ESOP adoption) compared to the benefits reported from the frontlines. Is it simply due to ignorance or greed or the hunger for power? This is something that demands more research, but it is clear that ESOPs is definitively something that should be discussed in the context of sustainable development—particularly from the social perspective but also from the systemic issue since effective resource usage and less inequalities is beneficial from both the environment and people at large.

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[178] See Maslakovic, M. (2012). *TheCityUK Fund Management 2012*. Financial Markets Series. London, TheCityUK Research Centre. p. 14.

[179] See Logue, J. and J. S. Yates (1999). "Worker Ownership American Style: Pluralism, Participation and Performance." *Economic and Industrial Democracy* **20**(2): pp. 225–252.

How employees can become a part of the ownership solution in a corporation is clearly an interesting point, but an equally interesting point is the current mantra of tying executive compensation to stock ownership. While this should in principle be a good thing because, as the logic goes; as owners of stocks the executives would have a stake in the development of their corporation in which they own stocks, and hence work harder for the benefit of the corporation as a whole particularly if the values of the stocks is significant. However, when this idea is coupled with two more issues, we get a dysfunctional system:

1. Corporations can buy back their shares.
2. The enormous focus on meeting earnings targets.

William Lazonick has studied how stock buybacks works in reality.[180] He studied 449 corporations in the S&P Index that were publicly listed from 2003 through 2012. In that period those corporations used 54 percent of their earnings—a total of USD 2.4 trillion—to buy back their stock, all almost through the open market. Dividends consumed another 37 percent of their earnings, which left only 9 percent for investments and higher incomes for employees. He further investigated the payment structure of the 500 highest paid CEOs in US public corporations. According to these corporation's proxy statements, these executives received on average USD 30.3 million each per year.

There are several possible explanations of this. However, if we used the principle of parsimony, which is often used in science, we should look for the simplest solution that provides a sensible answer for all evidence involving the fewest number of assumptions.[181] Then, we get an explanation that is not very flattering for the capitalist system. Lazonick convincingly shows that the system, as it is rigged today, is designed for value *extraction* and not value *creation*. Until the late 1970s, the typical approach was retain-and-invest, whereas during the 1980s, it became downsize-and-distribute in the name of maximizing shareholder value. Executives were to be incentivized to maximize shareholder value by making stock-based pay a large component of executive compensation, and with Wall Street's expectations of ever higher quarterly Earnings Per Share (EPS), executives turned to the option of making large stock repurchases to "manage" the stock prices. Particularly, repurchases in the open market is damaging and also the by far most common approach (as opposed to tender offers which can be beneficial when the stock price is below intrinsic value, but this is very small in volume in comparison with the open-market repurchases). Rule 10b-18 of the Securities Exchange Act limits the volume to 25 percent of the average daily trading volume of the last four weeks, but this is hard to enforce in reality without special investigations. Nonetheless, ExxonMobil bought USD 300 million a day for the period of 2003–2012 and

[180]See Lazonick, W. (2014). "Profits without prosperity." *Harvard Business Review* **92**(9): pp. 46–55.

[181]See Bothamley, J., Ed. (1993). *Dictionary of Theories*. London, Gale Research International, Inc. p. 637.

Apple Computer bought up to USD 1.5 billion in a single day—both cases was never investigated.

These repurchases has three effects. First, to directly influence the price in the market to thereby manage the market value of the corporation and therefore create a number of other indirect, apparently beneficial, effects such as reducing volatility. Essentially, this system allows price manipulation on a large and systemic scale. Second, an important by-product is the fact that executives earn more. Even the investors and owners of the corporation retain far less than the executives. The ultimate loser is the ongoing business of the corporation which retains only 9 percent of earnings and has thus relatively little to invest in capabilities and capacities for the future. Third, this leads to misallocation of capital[182] as cash that could have gone to Research & Development (R&D) is diverted to securing the first two effects. In this sense, they have the same impact as short-termism in that capital for growth becomes limited.

To illustrate how dysfunctional the system is, Roger L. Martin tells the tale of John Chambers, the CEO of Cisco Systems since 1995, as an illustration of the problem. In his case, he oversaw a steady decline in stock price from $34.08 to $24.85 from November 2009 through June 2014. Yet, due to the dysfunctional system, he actually netted USD 53 million, whereas the shareholders lost about 20 percent of their value. In fact, the Financial Crisis was not all that bad for many executives due to the compensation system.[183]

One thing is that the corporation loses out in this system causing several people to warn corporate America about its lack of investment for the future in innovation and manufacturing capabilities,[184] but this is a perversion as to the very intent of socializing risk. Society did not limit investor's liabilities to fuel greed and short-sightedness. The intent was to give investors a better chance of succeeding in running their corporations over time and at the same time capping their risk so that failing investors should not end up in permanent problems where family fortune and so on would be at risk. Today, however, the system seems to be rigged in such a fashion that many of the fat cats take absolutely no risk in their quest to enrich themselves at the expense of everybody else—even the investors. Not even the buccaneers pirating the seas under the protection of the English Crown had so low risks. They could get shot or sink in a storm…

Current practices of extracting value from corporations—as opposed to creating value—are also in stark contrast to one of the most innovative corporations in history—IG Farben AG. IG Farben was founded on December 25, 1925, as a merger of BASF (27.4 percent of equity capital), Bayer (27.4 percent), Hoechst including Cassella and Chemische Fabrik Kalle (27.4 percent), Agfa (9.0 percent),

[182]One study shows that a doubling in stock repurchases leads to an 8 percent fall in R&D spending, see The Economist (2014e). Schumpeter: The tyranny of the long term. *The Economist*. **413**: p. 65.

[183]See Martin, R. L. (2014). "The Rise (and Likely Fall) of the Talent Economy." *Harvard Business Review* **92**(10): pp. 41–47.

[184]See for example Pisano, G. P. and W. C. Shih (2012). *Producing Prosperity: Why America Needs a Manufacturing Renaissance*. Boston, MA, Harvard Business Review Press. p. 256.

Chemische Fabrik Griesheim-Elektron (6.9 percent), and Chemische Fabrik vorm. Weiler Ter Meer (1.9 percent).[185] IG Farben had nazi-friendly executives prior and during World War II, and 13 were found guilty of war crimes for its involvement in Holocaust producing, for example, the infamous Zyklon B gas used in the extermination camps. However, as a machine for innovation in the chemicals industry, its performance cannot be disputed, which is why I find it relevant to mention here. The R&D level of IG Farben was far greater than in any other firm in the world with expenditures for R&D between 1925 and 1939 just over 7 percent of turnover.[186] Indeed, IG Farben spent more on R&D than in payments in dividends in this period. Its output in terms of patents was also impressive[187] having more than a third of all the patents of the 30 largest firms in the leading industrialized world (Great Britain, USA, France, and Germany), and prior to World War II, it registered twice as many patents as any other firm in the world for the whole period of 1791–1930, and out of 117 major technical advances from 1790 to 1955, they held 30 (UK had 15). During its heyday, IG Farben was the largest chemical company in the world and the fourth largest overall industrial corporation, after General Motors, US Steel, and Standard Oil of New Jersey according to Wikipedia. Clearly, its success was largely due to its focus on R&D with large financial resources committed.

So, for all the talk and rhetoric about the importance about innovation and long-term corporate success, it is clear that actions and words do not match for most corporations and their shareholders today, but it might be another symptom of the financialization of society as mentioned earlier.

Next, we investigate how finance can be realigned to its original purpose.

4.8 Avenues for Solutions

Normality is a statistical illusion.

Stephen Zander

Lack of trust can be a significant barrier to the successful commercialization of innovations that are costly, technologically sophisticated, or potentially harmful to human health and the environment if managed incorrectly.[188] To properly manage

[185] See Tammen, H. (1978). *Die I. G. Farbenindustrie Aktiengesellschaft (1925–1933): Ein Chemiekonzern in der Weimarer Republik (in German)*. Berlin. p. 468.

[186] See Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 256.

[187] According to Delorme, J. (1962). *Anthologie des brevets sur les matières plastiques: Fabrication et transformation, Vols 1–3*. Paris, Amphora.p.

[188] According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

risks is not just important for investors to avoid economic loss, but it is important for society to continue accepting socialization of risks. It is important for the legitimacy of limited liability. Thus, there is a moral obligation to take this seriously for those who want to invest, and "the need is to make the *whole* system as a whole more stable, not so much enhance risk awareness amongst *individual* banks"[189] The same applies to the financial market as a whole, and this we must hold together with the insight from William Edwards Deming (1900–1993) stating that:

> As we shall see, apparent differences between people arise almost entirely from the action of the system they work in, not from people themselves.

This means that the seven remedies that were presented in the "Symposium Series on Short-Termism" are insufficientbecause they do not change the system per se—they are touching the surface. The question is, what *systemic* variables should be focused on?

First of all, we have to realize that the financial industry is not a unified lot—there are all sorts of actors. Consequently, if we limit ourselves to the grand distinctions used here, we see that they can fulfill various roles in our quest toward sustainability. Finance can serve well in a role of lowering the cost of capital using a whole array of instruments, and if we manage to get the wheels turning in the direction of sustainability where business people can do well by doing good, the herding and momentum trading of mainstream Finance can actually be beneficial to some extent. After all, low cost of capital is important to make economic considerations for the long-term investment viable. The problem these days, however, is to get to that point at all.

Value investing has many characteristics that make it a more interesting approach toward sustainable development. First of all, the approach is based on understanding the fundamentals of an investment case. This is a basic prerequisite if sustainable development is going to become a reality. Second, value investors tend to find many suitable investment objects in corporations with relatively small market capitalization (small caps).[190] Interestingly, the very same companies are probably at the helm of sustainable development in that:

1. they often do not have sunk costs in old technologies and will therefore be more aggressive in developing the new whatever it is,
2. can take greater risks since they do not have big institutional investors as shareholders (due to policies and size issues in these large funds that makes dealing with small caps economically unattractive due to costs and risks), and
3. like so often in business history, majors were once small, grew up shaping the new waves of innovation and in so doing displaced the old and outdated

[189] According to Goodhart, C. A. E. (2008). "The regulatory response to the financial crisis." *Journal of Financial Stability* **4**(4): pp. 351–358.

[190] According to Greenwald, B. C. N., J. Kahn, P. D. Sonkin and M. van Biema (2001). *Value Investing: From Graham to Buffet and Beyond*. Hoboken, NJ, John Wiley & Sons. p. 300.

corporations in its days. Yet, after a while the same corporations are displaced by new and upcoming corporations—and the circle of life is complete.

Therefore, it is more likely that value investing holds the key to finance's role in kicking off sustainable development than mainstream Finance.

Given these initial thoughts, it is clear that finance must fundamentally speaking be based on, and operate within, broad-based interests of society—otherwise risk is not socialized throughout society but rather transferred to groups unaware of their risk position—typically the poor, the ignorant, or other investors. In an increasingly interconnected and informed society, this is less likely to stand the scrutiny of public opinion.

Therefore, one way of thinking of financial markets and policies related to them is to view it as a constitutional issue demanding more than simple majority to change. An important part of the lesson from Canada is that the system was implemented at a time when Great Britain had to hinder large populations of French decent as well as natives in Canada to succeed in special interest campaigns. This historical context is not possible to replicate in any given country; however, the effect of it can be somewhat replicated, perhaps—make it difficult to change the core of the banking system including making regulatory amendments, interpretations, and the like. Today, this is akin a constitutional issue in most countries typically requiring at least 2/3 majority in both chambers (if there are two). Furthermore, it must outside the reach of the bureaucracy to change underwriting standards, etc. In other words, the system must be broad-based, change very slowly, and be predictable—so that hogs get slaughtered even though there are good personal relations, which can be a significant problem in smaller countries.

A natural extension of the financial system conservatism is to abolish the "too big to fail" notion of some institutions. Lifting all banking issues to almost a constitutional level will undoubtedly help abolishing such notions. Basically, governments must keep their hands off to rescue failing institutions and rather spend money on softening the problems for ordinary citizens and thereby let investors, shareholders, and executives take the heat—deservingly. This will send powerful signals to future generations of investors, shareholders, and executives that "you will not be bailed out of your own folly." This is the risk all other limited liability companies face—why should the fat cats of Finance be treated any differently?

An easy way to make this work is to also limit financial institutions—explicitly making them "small enough to be expendable"—and governments should ban the most destructive practices such as HFT. Limiting the financial institutions can be done effectively in two ways—without entangling regulators into huge and administratively complex and expensive codes with loopholes and being constantly too late:

1. Limit their size. The Glass–Steagall Act of 1933 did this and something equivalent must be restored. Some researchers[191] suggest limiting the size of com-

[191]See Johnson, S. and J. Kwak (2010). *13 Bankers: The Wall Street Takeover and the Next Financial Meltdown*. New York, Pantheon E-books.p.

mercial banks to never more than 4 percent of GDP and no more than 2 percent of GDP for investment banks. This would reduce the size of the biggest banks and prevent them from becoming too big to fail.

2. Limit their leverage and hence increase their ability to absorb losses before failing. Limiting leverage is an idea Nobel laureate Jean Tirole[192] also supports to counter the moral hazard of bankers behaving recklessly anticipating bailouts. In fact, if bank leverage were capped at 3:1 so that equity constituted 25 percent of total liabilities, then it would have no impact on banks abilities to make loans while vastly improving the stability of the financial system.[193]

Ironically, the so-called shadow banking system manages to operate successfully in the voids the banks have left due to stricter regulations with leverage far less than 3:1—indeed some must operate with 1:1 due to regulations. The Financial Stability Board (FSB) defines shadow banking as "credit intermediation involving entities and activities outside the regular banking system," and the volume is staggering and growing—approximately 25 percent of all financial assets are found in the shadow banking system.[194] Since the sort of shadow banking activities that worried regulators in the past and gave shadow banking a bad reputation—off-balance sheet transactions—has largely atrophied due to regulations, regulators are now generally positive to this development because if they fail the systemic consequences are negligible. One might be tempted to think that mainstream banks and financial institutions in general have grown too large and too costly for their own good so limiting their size and leverage might be a good cure in lieu of good management. Jamie Dimon, the CEO of JP Morgan Chase, issued the following explanation in his letter to the shareholders for why banks must wake up[195]:

> We really should not call them "shadow" banks – they do not operate in the shadows. They are non-bank financial competitors, and there is a wide set of them. They range from many-market trust funds and asset managers, mortgage real-estate investment trusts and mortgage servicers and middle-market lending funds to PayPal and clearing houses. Many of these institutions are smart and sophisticated and will benefit as banks move out of certain products and services. Non-bank financial competitors will look at every product we price, and if they can do it cheaper with their set of capital providers, they will.

To add more regulation than what is already done in the aftermath of the 2008 Financial Crisis is perhaps not the first avenue to investigate simply due to the enormous complexity of the system. Incremental steps seem reasonable. However, I think the most important is to start in the right end and start questioning the goals that give rise to the regulation in the first place and the way these goals are shaped

[192]According to The Economist (2014d). It's complicated. *The Economist*. **413**: p. 72.

[193]According to Admati, A. and M. Hellwig (2013). *The Bankers' New Clothes: What's Wrong with Banking and What to Do about It*. Princeton, NJ, Princeton University Press. p. 416.

[194]See The Economist (2014g). *Special report on International Banking: Shadow and substance*. London, The Economist. p. 16.

[195]Quoted in The Economist (2014g). *Special report on International Banking: Shadow and substance*. London, The Economist. p. 16.

by political bargains as pointed out by Calomiris and Haber.[196] Capping the problem as outlined above also sounds intuitively smart—maybe the amount of regulations and red tape could be greatly reduced by imposing simple and robust rules on the financial industry that cannot be meddled with?

This leads us to the potentially most touchy of all issues—the quality of government. I am not thinking of dictatorships versus democracies or something like that. I am primarily thinking about the quality of democratically elected governments, their bureaucracies, and agencies. Francis Fukuyama has offered some intriguing discussions to the problems using the US Forest Service as a telling tale of the sources of political dysfunction in the USA[197]:

> The creation of the U.S. Forest Service at the turn of the twentieth century was the premier example of American state building during the Progressive Era. … The Forest Service, in contrast [to patronage], was the prototype of a new model of merit-based bureaucracy. … At the time, the idea that forestry professionals, rather than politicians, should manage public lands and handle the department's staffing was revolutionary, but it was vindicated by the service's impressive performance. Several major academic studies have treated its early decades as a classic case of successful public administration. Today, however, many regard the Forest Service as a highly dysfunctional bureaucracy performing an outmoded mission with the wrong tools.

So what happened? It lost its autonomy, and today it operates under multiple and often contradictory mandates from congress and the courts.[198] This has swollen its size and therefore costs but with poorer and poorer results. Unfortunately, this is far from a special case. It has become the norm in most Western countries, if not all.

The fact is that governments today are giving into voters who are not just conspicuous consumers but also conspicuous in their demand of ever more services from governments. The swelling of the US Government from 26 percent of national income in 1956 to 39 percent of national income in 1982 where non-defense spending had more than doubled is a telling example.[199]

Personally, I believe that this is due several factors including media and special interests focus on single cases normally presented without context or understanding, and politicians respond by giving in to stay in office. Media and special interests have become particularly influential due to the apathy concerning politics in the general population leaving the media and special interests as the only players on the field with some politicians. Naturally, those that can outspend others win

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[196]See Calomiris, C. W. and S. H. Haber (2013). "Why Banking Systems Succeed—and Fail; The Politics Behind Financial Institutions." *Foreign Affairs* **92**(6): pp. 97–110.

[197]See Fukuyama, F. (2014). "America in Decay: The Sources of Political Dysfunction." *Foreign Affairs* **93**(5): pp. 5–26.

[198]According to Fukuyama, F. (2014). "America vin Decay: The Sources of Political Dysfunction." *Foreign Affairs* **93**(5): pp. 5–26.

[199]Offered by Friedman, M. (2002). *Capitalism and Freedom*. Chicago, IL, University of Chicago Press. p. 210.

the day. In any case, the result is short-termism also in politics.[200] The Australian cycle is more compressed than most, and in 2000, Prime Minister John Howard acknowledged that "short-termism (is) forced on national politics by the maximum parliamentary term of three years."[201] Regardless of underlying causes, I believe that the following is a very good synthesis of the malaise[202]:

> The result is a toxic mixture: dependency on government, on the one hand, and disdain for government, on the other hand. The dependency forces governments to overexpand and overburden themselves, while the disdain robs governments of their legitimacy and turns every setback into a crisis. Democratic dysfunction goes hand in hand with democratic distemper.

The question, however, that comes to the mind is that how can this happen in a democracy? A dictatorship is easy to explain due to the lack of free speech and so on, but a democracy? The answer lies in the process of institutionalization. Samuel Huntington (1927–2008) describes an institution as having "…stable, valued and recurring patterns of behavior."[203] This stability, however, is also the source to its decay. One reason is cognitive—people see the world in certain ways and tend to stick to that view even when they are faced with contradictory evidence. Another is special interests and insiders as discussed many times so far in this book. It is interesting to note that in Washington alone there were about 13,700 lobbyists spending USD 3.5 billion in 2009 trying to persuade the government. In 1971, the same numbers were about 175 lobbyists.[204] Clearly, something must be worth paying for.

In fact, Mancur Olson (1932–1998) argued[205] that in times of peace and stability, democracies tend to accumulate ever-increasing numbers of interest groups. Instead of pursuing wealth-creating economic activities, these groups use the political system to extract benefits or rents for themselves. These rents are collectively unproductive and costly to the public as a whole. But the general public has a collective-action problem and cannot organize as effectively as, for example, the banking industry or corn producers to protect their interests. The result is the steady diversion of energy to rent-seeking activities over time, a process that can be halted only by a large shock such as a war or revolution. This sound very plausible—the political

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[200]See Jay, D. (2004). "Devil in lack of planning detail." *The Australian*(24 June): p. 48.

[201]See Australian Financial Review (2000). "Politics of myopia hurt us all in the long run." (April 8): p. 20.

[202]See Micklethwait, J. and A. Woolridge (2014). "The State of the State: The Global Contest for the Future of Government." *Foreign Affairs* **93**(4): pp. 118–132.

[203]See Huntington, S. P. (2006). *Political Order in Changing Societies*. New Haven, CT, Yale University Press. p. 240.

[204]The numbers are from Fukuyama, F. (2014). "America in Decay: The Sources of Political Dysfunction." *Foreign Affairs* **93**(5): pp. 5–26.

[205]See Olson, M. (1984). *The Rise and Decline of Nations: Economic Growth, Stagflation and Social Rigidities*. New Haven, CT, Yale University Press. p. 288.

system in many countries seems to be mired in special interests cases whereas the major, long-term cases are hardly attended to.

When a country is not even able to make the forest service work, what makes us believe that we can make the quest toward sustainability successful? Do we need a major shock? This is actually the best argument in favor of an indirect approach as advocated in this book—a direct approach trying to "manage" sustainability is destined to fail as discussed in Chap. 2 but which is also intuitive from this discussion. Our environmental degradation is therefore to a large extent due to political degradation from special interest nationally and grid-locked globally due national interests essentially being special interests on a larger scale. Therefore, the situation cannot be remedied unless we address our attention to the fundamental issues first. We must find a way to curb special interests—not just in the financial industry and industry at large but also in political processes. A huge topic like sustainability will therefore eventually trigger major changes in government and politics that must be solved.

When it comes to stock ownership, it is clear that a number of improvements in regulation can be made. First, governments could ban day-trading on stocks and introduce holding periods on stocks to make sure investors have intentions behind their actions other than managing risks for the sake of risk itself or to purely speculate. The investopedia describes day traders as "an investor who attempts to profit by making rapid trades intraday. A day trader often closes out all trades before the market close and does not hold any open positions overnight." The key is rapid buying and selling and as such is simply speculation. The laws of limited liability were not passed to allow pure speculation, and as such day traders are parasitic with respect to the socialization of risk. They want to have the advantages of limited liability but not contribute toward society. Why should they be allowed to do so? Just because something *can* be done, does not mean that it *should* be done.

By banning day-trading for equities, the holding period is at least 24 h, but is that enough to prevent speculation and rash behavior possibly including herding, or to put it differently, to promote real investing in stocks and not just placement of money with speculative intentions? With what we know from value investing compared to mainstream Finance, it is tempting to suggest holding periods of at least one week to force investors to take a business-like, ownership-oriented perspective on their investments. Even if something like that scared off many so-called investors, those that were left would be the real investors and they would probably do a much better job.

Note that this concerns the actual trade of the equities and not derivatives concerning equities or derivatives in general. The trade in risk (derivatives) is fundamentally different than trading equities—at least it should be. Trade in the underlying should be based on purposeful investing, whereas trading in risks concerns positions and since things change constantly on that level, trade should also be allowed to take place quickly. Otherwise we run the risk of a highly illiquid market. This said, HFT should be banned—it does not even serve the purpose of liquidity and even if it does the cost of HFT is simply not worth the benefits. With a financial economy roughly ten times greater than the real economy, liquidity should not be a problem. Perhaps, it is even excessive. Hence, banning HFT cannot be anything but positive.

Second, the massive volume of stock repurchases at the open market is highly damaging. Not only is this highly special interest oriented in itself, but it is outright dysfunctional and even perverted usage of the stock markets for self-serving actions by some executives and investors alike. There are countermeasures, however[206]:

1. Open-market stock repurchases must be banned completely, as it was in the original version of Securities Exchange Act of 1934. With only 9 percent earnings retained the main purpose of the stock market for the corporation as an entity—provide funds for corporate investments—is in question, and this cannot continue. Unless, executives begin to rein themselves someone else must stop them using a complete ban as countermeasure.
2. Rein stock-based compensation. It is clear that the system is dysfunctional when even decline in stock prices leads to increased executive pay because boards of directors is afraid that executives will leave a sinking ship, as it were. Also, studies[207] show that today's system keeps ratcheting up salaries simply because the same consultants are used across corporations and salaries are to be "competitive." This can be achieved by introducing rules for how executives can sell stocks after exercising stock options—for example, introducing holding period could be very effective to prevent speculation.
3. Transform the composition of board of directors to better reflect the socialized level of risk. Employees should, for example, have a position in the board with numbers according to the size of the corporation.

Unionization have historically been a contentious issue, particularly in some countries such as USA, but it could be legislated that all corporations above a certain size are to have a local employee organization who could nominate one person for the board of directors. Such an organization need not be linked to some big, national union as such. The point is that employees should have a formal say in things along the lines of all other with capital in the corporation.

Third, authorities should also promote broad-based ownership of stocks via ESOPs. This will not only improve corporate governance in itself, with beneficial economic by-products, but it will also make it more difficult to exploit employees, bend rules, and behave irresponsibly in general. It will also be an acknowledgment of the fact that capital is more than just financial capital. Today, we find at least five types of capital discussed in the literature:

[206]According to Lazonick, W. (2014). "Profits without prosperity." *Harvard Business Review* **92**(9): pp. 46–55.

[207]According to Lazonick, W. (2014). "Profits without prosperity." *Harvard Business Review* **92**(9): pp. 46–55.

1. Natural—the total sum of the ecological system that support life.[208]
2. Physical—the total sum of physical assets capable of producing income.[209]
3. Financial—the total sum of financial assets capable of producing income.[210]
4. Intellectual—crudely, defined as the collective "brain power" of the corporation.[211] The intellectual capital is divided in many ways. The way used by the pioneering corporation Skandia[212] is to divide intellectual capital into human capital, customer capital, and structural capital. Another way[213] is to simply divide it into human capital and structural capital.
5. Social—the stocks of accumulated material and immaterial resources that can be accessed via social relationships.[214]

Extensive research[215] points to a problematic fact from the perspective of equitable distribution among people; the value from innovation are increasingly being captured by capitalists (equity owners) rather than wage earners. This is due to the simple fact that private financiers typically provide equity rather than debt financing for innovations because collateral is hard to find in a start-up.[216] ESOPs will help the employees get a bigger chunk of their innovative abilities than today. Employees will therefore also be more business-like in their thinking and not become these old-fashion unions that resemble almost a paramilitary group fighting management.

ESOP systems could also help pension funds, and similar players become more active owners under the assumption that pension fund managers and employees will have similar interests. The practicalities of ESOPs must be further investigated—for example:

- Should limited liability corporations above a certain size have mandatory ESOPs by law? The argument being that capital is more than financial capital,

[208]Definition is from Hawken, P., A. B. Lovins and L. H. Lovins (1999). *Natural Capitalism—The Next Industrial Revoluion*. London, Earthscan Publications, Ltd. p. 396.

[209]Definition is based on Bannock, G., R. E. Baxter and E. Davis (1999). *Dicitonary in Economics*. London, Profile Books. p. 439.

[210]Definition is based on Bannock, G., R. E. Baxter and E. Davis (1999). *Dicitonary in Economics*. London, Profile Books. p. 439.

[211]See Crainer, S. and D. Dearlove, Eds. (2001). *Financial Times Handbook of Management*. London, Financial Times Prentice Hall. p. 784.

[212]See Skandia (1994). Visualizing Intellectual Capital in Skandia, www.skandia.se: pp. Intellectual capital supplement.

[213]See for example Roos, J., G. Roos, N. C. Dragonetti and L. Edvinsson (1998). *Intellectual Capital: Navigating in the New Business Landscape*, Macmillan Business. p. 208.

[214]Definition is from Baker, W. E. (2000). *Achieving Success Through Social Capital: Tapping the Hidden Resources in Your Personal and Business Networks*. San Francisco, Jossey Bass Wiley. p. 256.

[215]See for example West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[216]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

and due to the imperfect socialization of risk in the current system, ESOPs are believed to increase the corporate governance simply due to the transparency ESOPs will give.

- Should there be a cap on the ESOPs or a minimum requirement? If employees want, can they demand up to 34 percent ownership and thereby, under most jurisdictions, be able to prevent changing stock ownership agreements and the like?

Fourth, the damaging combination of short-term, self-reinforcing arbitraging, herding, and tools that supports these activities must be attended to. The strange thing is that this takes place despite the fact that value investing and similar approaches produce better results and are probably much more in line with sustainable development since understanding fundamentals is highly rated and speculation not. Outlawing certain approaches for investing does not sound like a good approach. What can be done is to limit the information these approaches feed upon, as many have said when they argue for limiting reporting to quarterly reporting. This might work for corporate stress and misallocation of highly paid personnel, but the basic information from the stock exchanges will still be there to feed upon every second, every minute, every hour, and every working day.

Fifth, corporate boards are not working,[217] and this must be fixed. Corporate boards are important overseers in the capitalist system, but today, they are dysfunctional in many corporations exacerbating the problems discussed in this chapter and the next. Just consider these facts[218]:

1. 34 percent of 772 directors surveyed by McKinsey in 2013 agreed that they fully comprehend their corporation's strategies.
2. 47 percent of 604 c-suite executives and directors around the world surveyed by McKinsey and Canada Pension Plan Investment Board (CPPIB) in March 2014 stated that the corporate board was most responsible for the overemphasis on short-term financial results and underemphasis on long-term value creation. Shockingly, 74 percent of the directors of boards surveyed agreed to the same statement.

Some directors hide themselves behind the fiduciary duty of loyalty to the corporation and prudence in decision-making. However, there is nothing suggesting that this means that their role is pressuring management to maximize short-term shareholder value to the exclusion of other interests.[219] With such poor results and no ability to solve the problems, a whole new industry has arisen—the activist funds.

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[217]This bold statement comes from Barton, D. and M. Wiseman (2015). "Where Boards Fall Short." *Harvard Business Review* **93**(1/2): pp. 98–104.

[218]This bold statement comes from Barton, D. and M. Wiseman (2015). "Where Boards Fall Short." *Harvard Business Review* **93**(1/2): pp. 98–104.

[219]According to Barton, D. and M. Wiseman (2015). "Where Boards Fall Short." *Harvard Business Review* **93**(1/2): pp. 98–104.

The activist funds are an offshoot of hedge funds, but they are small in numbers. According to Hedge Fund Research,[220] there are about 8000 hedge funds but only 71 that qualify as an activist fund—in other words, only one percent. Yet, in 2014, they raised $14 billion of new cash, or roughly one-fifth of all inflow to hedge funds. Despite small in numbers, they yield disproportionate power in the boardroom of big corporations because ownership in the USA has polarized.

The good part of this is that they can help passive investors impact the boardroom and ultimately dispose CEOs, directors, and subpar people in key positions. However, their performance (89 percent) measured since the end of 2008—though better than hedge funds (50 percent)—is still worse than the S&P 500 Index (159 percent) after fees have been deducted. An even better part is that, while in the 1980s, they were called corporate raiders and associated with asset stripping in Gordon Gekko style, two studies[221] indicates that they on average actually improve operating performance, lead to more R&D spending and increased returns to shareholders. However, there are significant risks as many other points at.

Undoubtedly, the poor performance of the boards has provided an opportunity for activist funds,[222] and there is a relatively broad consensus as to the importance of strengthening corporate governance.[223] Ironically, 50 percent of current directors who responded to McKinsey's September 2014 survey agreed that regularly communicating the corporation's long-term strategy and performance to key long-term shareholders would be one of the most effective ways to alleviate the pressure to maximize short-term returns and stock price.[224]

Why does this seem to be so difficult? One primary reason—again—is a patchwork of regulations, a mix of private and public policymakers and no consensus as to what constitutes successful corporate governance.[225] While charging the boards of being weak is relatively simple, as shown above, we must also find the root cause(s) as well (not just ask how to fix it…). An important clue comes from Michael Dell, who took Dell private on September 12, 2013, when he wrote in the Wall Street Journal that[226]:

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[220]Quoted by The Economist (2014a). Activity funds; An investor calls. *The Economist*. **414**: pp. 17–20.

[221]See The Economist (2014a). Activity funds; An investor calls. *The Economist*. **414**: pp. 17–20.

[222]According to Barton, D. and M. Wiseman (2015). "Where Boards Fall Short." *Harvard Business Review* **93**(1/2): pp. 98–104.

[223]See CFA Centre for Financial Market Integrity/Business Roundtable Institute for Corporate Ethics (2006). *Breaking the Short-Term Cycle: Discussion and Recommendations on How Corporate Leaders, Asset Managers, Investors, and Analysts Can Refocus on Long-Term Value*. Charlottesville, VA, CFA Institute. p. 19.

[224]According to Barton, D. and M. Wiseman (2015). "Where Boards Fall Short." *Harvard Business Review* **93**(1/2): pp. 98–104.

[225]See Subramanian, G. (2015). "Corporate Governance 2.0." *Harvard Business Review* **93**(3): pp. 96–105.

[226]See http://www.wsj.com/articles/michael-dell-going-private-is-paying-off-for-dell-1416872851.

> Privatization has unleashed the passion of our team members who have the freedom to focus first on innovating for customers in a way that was not always possible when striving to meet the quarterly demands of Wall Street.

Therefore, personally I believe that the rise of the activist funds is really a sign of systemic sickness—as many other relatively recent "innovations" in the financial industry. The industry has completely lost the focus of their purpose, and huge sums of money are diverted to speculation and purely financial returns without any relation to the real world. Risk was not socialized to turn the financial world into a self-serving circus. Therefore, returning to the basics is probably a good way to start at least if the American system is any representative[227]:

1. Boards should have the right to manage the company for the long term. Ending earnings guidance would be good, as many points out, and bringing back staggered boards so that continuity and stability in the boardroom can be brought back. In 2002, 60 percent of boards in corporations traded at the S&P 500 Index were staggered—only 18 percent were staggered in 2012. Also, boards must become better protected from frivolous litigations, but held accountable by corporate law experts and not juries of various compositions.
2. Boards must have the best possible people in the boardroom irrespective of age and term limits. This means that there must be meaningful director evaluations and shareholders must be granted proxy access.
3. Boards must give shareholders an orderly voice. Today, shareholders and boards are at odds with each other. This seems to be completely in contrast with the purpose of directors of representing shareholders.

Education might help, but not focusing on the financial industry alone. The financial industry is a product of our society. With political short-termism on the rise, and instant gratification throughout society, what makes us believe that the financial industry can change its course out of the blue? Political leadership is required, and the first step here is not to solve the problem as such, but rather defining the problem. I will leave this for now and get back to it in Chap. 8 where the role of the government is explored.

There are probably many more practicalities to address, but they seem to be all solvable if we are to use the extent of ESOPs in the USA as a guide. So far, it is clear that realigning the financial industry toward a greener invisible hand is indeed possible, but to be truly effective, we must change the measures of success also—at least complement them—because as the old maxim goes; "what we measure is what we get." This is discussed in Chap. 6, whereas in the next chapter, the greater aspects of capitalism will be discussed, and based on the discussion on finance in this chapter, some policy changes will be discussed in Chap. 8.

[227]See Subramanian, G. (2015). "Corporate Governance 2.0." *Harvard Business Review* **93**(3): pp. 96–105.

Chapter 5
Reengineering some Capitalist Cornerstones

The untrammeled intensification of laissez-faire capitalism and the spread of market values into all areas of life are endangering our open and democratic society.

George Soros

Some environmentalists call for an abolition of capitalism altogether, but this does hardly seem to be the way with the collapse of communism and an array of problems to solve in the aftermath. It is better to take what works and try to reengineer the rest, which is the topic of this chapter and the book at large. To argue the case, I start by outlining our response so far to what we can call the "economic problem" and put it into a historical context trying to learn from the Industrial Revolution. Note that a major element of reengineering capitalism lies in realigning the financial industry, which is one of the cornerstones of Capitalism, as discussed in the last chapter.

5.1 The Economic Problem and Political Economy

> The solution to the economic problem of society is … always a voyage of exploration into the unknown …
>
> Friedrich A. Hayek

Economics can be defined as "the study of how scarce resources are allocated to satisfy alternative, competing human wants."[1] The purpose of economics is to solve the economic problem, which concerns how to allocate resources—to choose. It arises from the fact that:

1. Our material wants are virtually unlimited.
2. Economic resources are scarce.

[1]See Wonnacott, P. and R. Wonnacott (1990). *Economics*. New York, John Wiley & Sons. p. 804.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_5

The degree of choice in the market will greatly influence the resource allocation, and there are several economic doctrines that have historically tried to solve this issue. The one, however, that fueled the Industrial Revolution was capitalism, and often referred to as Industrial Capitalism in the context of the Industrial Revolution and the years that followed, and this doctrine is still alive and well today albeit with some adjustments.

In capitalism, the free market is the mantra, and Adam Smith was the champion. However, it was François Quesnay (1694–1774) from whom the idea of universal free trade originated.[2] In 1776, Smith published his classic book commonly referred to as *The Wealth of Nations*. He argued that "It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest." Furthermore, "by pursuing his own interest he frequently promotes that of the society more effectually then when he really intends to promote it." This mechanism he termed the "Invisible Hand". In fact, any order which arises spontaneously without intention or design can be regarded as an instance of the Invisible Hand.[3] Consequently, Smith generally argues against government interference in the operations of the private market and thereby promoted *laissez-faire*—French for "leave it alone"—policy. Smith's work has largely stood the test of time[4] although it has been modified significantly as argued soon. First, however, it is important to recall that Smith was very concerned about the moral issues relating to commerce—in fact, his contemporaries mostly saw him as a moral philosopher, and not as an economist. In *The Theory of Moral Sentiments* from 1759, he argues that self-love and sympathy, mediated by customs and institutions of civilized society, guide man to behave virtuously toward man.[5] Therefore, Smith is very considerate about commoners and he probably favors the marketplace mainly because the curbs it places on the mighty. The economic system is an institution of civilized society, and the quintessence of Smith is that self-interest and sympathy for man constrained by economic rivalry will lead to *widespread* prosperity. Where the capitalist doctrine is prevalent, the market can operate freely (within constraints) using capital, and it is commonly referred to as *capitalism*. Depending on the constraints, we have a whole array of versions of capitalism.

So far, so good—while the vivid images of the butcher and the baker in mind Smith are fundamentally right on the individual level, but he confused the principles of private economy with those of national economy on a number of issues and as such made many simplifications and outright mistakes that make it difficult to apply

[2]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

[3]According to Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

[4]According to Wonnacott, P. and R. Wonnacott (1990). *Economics*. New York, John Wiley & Sons. p. 804.

[5]See The Economist (1999b). The key to industrial capitalism: limited liability. *The Economist*. **353**: pp. 97–98.

his thinking in real life. Therefore, Friedrich List commented extensively on Smith and his school in his landmark work—*National System of Political Economy*—first published in 1841 as a volume with four books. Here, he conducts a highly interesting study of European economy from the Late Middle Ages to his time.

He conclusively shows how Great Britain came from literally nothing and became *great*. The secret was threefold; first, she opened up to learn from the best; second and subsequently, she increasingly started to protect her infant industries; and finally, she arrived as a strong proponent of free trade—to cover her tracks, as it were.[6] In fact, William Pitt (1708–1778) clearly saw how Smith's thinking could be used to manipulate other nations from following the path of England to greatness and as such kicking away the ladder for the rest. It should be noted that the same approach is exercised today by the developed world in imposing "good policies" and "good institutions" upon the emerging economies and the poor world and thereby "kicking away the ladder"[7]—a term List used about English policy. The intentions are probably better today than what England's intentions were—it was considered an English State secret—whereas today, I think it is partly rich countries' naiveté about what poorer countries need in combination with general lack of historical knowledge as to our own path toward wealth. The scary part of this in relation to sustainable development is that lack of social economic development on the part of naïve enforcement of "good policies" and "good institutions" might be that the underdeveloped and emerging countries will spend much longer time developing onto a level where their inhabitants can afford to take a long-term view—human, economic, and environmental.

His first volume is dedicated to the economic history of many countries, and he uses Great Britain as a benchmark of sound policy, as it were. This volume is extremely interesting and contains a lot of historic fact anybody interested in economic history should read. Here, a very brief excerpt is provided to highlight the historical context from which the Industrial Revolution sprang.

The history of modern economy actually starts with the Italian city-states. Venice, Genoa, and Florence were the three premier states in the twelfth and thirteenth centuries possessing all the elements of national economical prosperity. They were far more advanced than anybody else in Europe in just about every aspect. For example, the annual revenue of Florence city government at the time was 300,000 gold gulden which was more than that of Great Britain and Ireland combined under Queen Elizabeth more than 200 years later. Yet, the Italian city-states tumbled in the course of history. They lacked national union and the power that comes with it. Instead, war, lukewarmness, and treachery on the behalf of the leaders of the Italian league, formed in 1526, were the direct cause of the subjugation of Milan and the fall of the Tuscan Republic. From this period, the downfall

[6]As pointed out by Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

[7]As pointed out by Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

of Italian industry and commerce can be dated and largely at the hands of King Charles V. He introduced nobility by patent and the idea that it was disgraceful of nobility to carry on commerce and manufacturing. With despotic and oligarchic rule, lack of adaptability, destruction of the freedom, and energies of the people, the roots of power and prosperity died away and other nations rose and surpassed them. As Charles-Lois de Secondat Montesquieu (1689–1755), better known simply as Montesquieu, wrote in *De l'esprit des lois*:

> A nation which has fallen into slavery strives rather than to retain what it possesses than to acquire more; a free nation, on the contrary, strives rather to acquire than to retain.

While there is some obvious learning from the failure of the Italian republics such as the importance of freedom, the rule of law, adapting to new circumstances, and ultimately leadership, List also points at a less obvious fact—the misuse of the term "freedom." The term "free trade" is used without the important distinction between freedom of internal trade within a state and freedom of trade between separate nations. Again, Montesquieu wrote in *De l'esprit des lois* words of wisdom:

> Commerce is never subjected to greater restrictions than in free nations, and never subjected to less ones than in those under despotic government.

The positive aspects of the Italian republics such as knowledge about bookkeeping, banking, and a number of handcrafts and industries did not fall into oblivion, however. The Hansas (meaning "league" in the Low German dialect) was formed in 1241 between Hamburg and Lübeck and a century later counted 85 cities in northern Europe. They picked up the development and went further. They quickly comprehended the force a confederation of individual industries in their member cities could pose. They also realized that by passing a Navigation Law that gave their own merchant vessels monopoly of trading Hanseatic goods, they could secure their standing further. On top of that, they created their own powerful navy that not only defended their merchant vessels but also to subdue kingdoms in their trade efforts. In 1250, at the invitation of King Henrik III (1207–1272), the Hansa established "The Steelyard" in London producing various goods. In fact, at the time of King Edward II (1284–1327), the English were so inexperienced in commerce that the Hansa managed to monopolize all trade of the kingdom. The English supplied the Hansa factories with wool, tin, hides, butter, and other mineral and agricultural products and received manufactured articles in return.

Then, King Edward III (1312–1377) came. He realized that after a hundred years of the foundation of The Steelyard in London, it was perhaps more beneficial for England to make her own woolen cloth than to export raw materials and import woolen cloth as before. So, he started to attract Flemish weavers by granting them special privileges, and as soon they had produced a considerable amount of cloth, Edward III issued a law prohibiting wearing foreign cloth. In attracting this special competence, Edward III was aided by the foolishness, as List puts it, of continental rulers. At both the Flanders and the Brabant, the rulers made it difficult for the weaving industry to prosper and emigration to England became a sensible choice. In fact, in 1413, the English woolen industry had made such progress that Hume wrote[8]:

> Great jealousy prevailed at this time against foreign merchants, and a number of restrictions were imposed on their trade, as, for instance, that they were required to lay out in the purchase of goods produced in England the whole value which they realized from articles which they imported into it.

Notwithstanding that the king was later compelled under Hansa pressure to remove this early attempt at protecting an infant industry, it appears that the woolen industry in England had been greatly promoted by this temporary protection. The extent of Hansa influence on England can perhaps be best illustrated by the fact that all the coins in circulation in England were that of the Hansa. The Hansa was referred to as the "Easterlings"—in contradistinction to the Dutch and the Belgians—and from this, the term "sterling" came and hence the "pound sterling". The currency of England was consequently Hanseatic!

Then came some disastrous decisions under King Henrik VIII (1491–1547) where the causes of the rising prices of all articles of food in London were wrongly attributed to the foreign manufacturers. So, he expelled 15,000 Belgian artificers. Needless to say, the Hansas were very pleased. England was not the only country to issue such foolish policies. There were made significantly worse mistakes elsewhere and here are perhaps much worse.

First, the Spanish Inquisition not only drove much industry into exile, but also effectually prevented foreign manufacturers from settling down in Spain. The gold they had from South America was used to buy what they needed as long as it lasted. Thus, not only did they inhibit their own industrial development, but they were instrumental in building Dutch and British industries.

Second, the German nobility occupied themselves mainly with warfare and hunting throughout the Middle Ages. Agriculture and manufacturing industry were opposed and even oppressed. Apart from coastal areas, the Swiss Confederation, and the Seven United Provinces, most of the Germanic areas were in a poor state of affairs. Thus, List writes[9]:

> Thus, we see even to the beginning of the eighteenth century in Germany, barbarism in literature and language, barbarism in legislation, State administration and administration of justice; barbarism in agriculture, decline in industry and of all trade upon large scale, want of unity and of force in national cohesion; powerlessness and weakness on all hands in dealing with foreign nations.
>
> One thing only the Germans had preserved; that was their aboriginal character, their love of industry, order, thrift, and moderation, their perseverance and endurance in research and in business, their honest striving after improvement, and a considerable natural measure of morality, prudence, and circumspection.

[8]See David Hume, *History of England*.

[9]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

It was Austria and Prussia that first started to promote manufactures in the Germanic areas. King Frederick II of Prussia (1712–1786)—also referred to as Frederick the Great—was known for his military victories in the Seven Year's War, but List highlights his wise policies in promoting the interests of agriculture, industry, trade, the literature and science. Yet, it took well into the 1800s before the Germans realized that they had to protect their infant industries. In fact, desperation was so great in German industry that in 1819, a private union of 5000 to 6000 manufacturers and merchants were founded with the object to abolish internal tariffs of the various German states while at the same time establishing a common trade and customhouse system for the whole of Germany.

Third, the Methuen Treaty from 1703 between Portugal and England permitted the import of Portuguese wine at a third of the duty levied upon wines from other countries, but in return, Portugal admitted English cloth at the same rate of import duty which had been charged upon such goods prior to the year 1684. The result of this was the industries in Portugal were outcompeted and ruined, and the yearly export from England to Portugal became about 1 million sterling greater than the import from Portugal.

Fourth, the successors to Jean-Baptiste Colbert (1619–1683) managed to dismantle more or less what he had built through the revocation of the Edicts of Nantes. Colbert instituted sound policies for rebuilding French industry and succeeded to a large degree—although much of it was through force which was necessary due to an apathetic population after years of despotic rule. At the time of his death, there were 50,000 looms in France, fisheries were flourishing, and there was an extensive merchant fleet. The result of these reversals of policies caused by Colbert's successors was that about half a million of the most industrious, skillful, and thriving inhabitants of France were banished. To make matters worse, these people transplanted their industries and capital in Switzerland, Prussia, and also to Holland and England.

Fifth, the Eden Treaty was a similar treaty as the Methuen Treaty except it was between France and England with equally ruinous results for France. Similar types of treaties the English practiced in the colonies as well. They bought colonial produce from them, whereas England supplied them with manufactured goods. From 1835 to 1839, the import of sugar from the East Indies to England quadrupled and the import of coffee even more. It seems to me that for some hundred years, England was the only country whose rulers realized that spending money on building the nation is good business—also for themselves. All the other countries paid dearly for their mistakes, and as an example, we can look at Poland. Poland and England was at roughly the same level at some point, but Poland chose an agricultural path, whereas England industrialized and that made all the difference.

In fact, it was not until Queen Elizabeth (1533–1603) that England stood up and abolished the privileges of the Hansa permanently. This abolishment resulted in a war whereby Queen Elizabeth seized 60 Hansa vessels which were engaged in contraband trade with Spain and the general assembly in Lübeck decided to harass all export from England.

This was a risky game of Queen Elizabeth because we have to remember that the Hansa had fought England's navy battles. The sea power of England was very limited, but as List points out, the Hansa could have avenged this policy due to their superior powers but lacking their "…ancient courage, their mighty spirit of enterprise, the power inspired by freedom and by co-operation" they did not fight back effectively. In 1630, they were dissolved. Apart from these internal causes, their downfall was caused by other nations rising and playing their game in controlling trade via navigational laws. However, the greatest weakness of the Hansa was that they followed the maxim recommended by all theoretical economists at the time of List—they "bought only in the cheapest market." They left things to themselves ("*Laissé faire et laissé aller"*) so to speak.

They never promoted the interests of their own industries, and the German aristocracy had no interest in maritime trade so instead of promoting a powerful union between the Hansa cities and the German inland, the Hansa cities bought and sold until the rest of Europe had awakened and joined the game. The Dutch came first and then the British took over. Unlike the Hansa, and later the French, however, both the Dutch and the British supported piracy to harass other nation's trade, so trade was associated with many dirty tricks those days. As List points out[10],

> Had the English left everything to itself – 'Laissé faire et laissé aller' as the popular economical school [of Smith] recommends – the merchants of the Steelyard would be still carrying on their trade in London, the Belgians would still be manufacturing cloth for the English, England would have still continued to be the sheep-farm of the Hansards, just as Portugal became the vineyard of England, and has remained so till our days, owing to the stratagem of a cunning diplomatist.

The Germans followed the thinking of Smith, which List refers to above, in the famous passage from the *Wealth of Nations* in which Smith writes:

> Restrictions on trade imposed on the behalf of the internal industry of a country are mere folly; every nation, like every individual, ought to buy articles where they can be procured the cheapest; in order to attain the highest degree of national prosperity, we have simply to follow the maxim of letting things alone (Laissé faire et laissé aller').

Smith and his school was one of the few that actually believed that leaving things to their natural course would be a good solution. Montesquieu also found the *laissez-faire* policy questionable already before it was invented writing in *De l'esprit des lois* published in 1748:

> If the State imposes restrictions on the individual merchant, it does so in the interest of commerce, and his trade is nowhere more restricted than in free and rich nations, and nowhere less so than in nations governed by despots.

Also more recently, the Great Depression indicated major flaws of the *laissez-faire* policy probably unnecessarily prolonging the depression. *The General Theory of Employment, Interest and Money,* or simply *General Theory* therefore

[10]See List, F. (2005a). *The National System of Political Economy—Volume 1: The History*. New York, Cosimo Classics. p. 142.

came timely in 1936 where Keynes argued that the government has the duty to intervene and put the unemployed back to work. Keynes' main objective was to modify and improve the economic system.[11]

A well-known example of employing the ideas of Keynes is Roosevelt's The National Industrial Recovery Act (New Deal) in 1933, but the *intended* effect, was at best limited.[12] In fact, the US Supreme Court overturned the whole law in 1935 for being "unconstitutional." In Scandinavia, Keynes' ideas formed the basis for various policies of countering business cycles in the 1970s. However, it is clear that such practices eroded competitiveness and was largely left out of politics in the 1980s. It therefore appears that to politically and legislatively control and regulate the economy beyond a certain point is damaging and futile in the long run. The Scandinavian model today, however, has overcome these problems it seems.

In fact, if we look at how the Norwegian oil industry arose, it is almost directly from the English playbook List documents (open to learn, protect to establish infant industries, open up, preach the gospel, and expand to grow further). In the 1960s, the oil sector was widely open for foreign companies. Then, when the Ekofisk oil field was discovered by Philips Petroleum Company in late 1969, the Norwegian government realized that this industry will be of national interest and hence established Statoil in 1972. In February 1972, Shell and Esso (Exxon) discovered the Brent oil field on British side and they believed that it stretched into the Norwegian sector and what became the Statfjord field. Thus, some blocks of the Statfjord field were licensed in August 1973 to Mobile, Statoil, Shell, Esso, Conoco, and four other minor corporations, and in March 1974, the first productive well was found. After 30–40 years of innovation and building competence, the Norwegian oil and marine industry is market-leading within its segments. Naturally, expanding internationally became the new focus for the last decade or so. Similar arguments can also be established for Japan, Korea, the Asian Tigers, and China. Therefore, it can be argued that neither *laissez-faire* policy nor Keynes has been successfully applied in real life. Those countries that have succeeded have largely followed the path of building productive powers as argued by List. This is a critical point which we will discuss later.

Another response to the *laissez-faire* policy was provided by Karl Heinrich Marx (1818–1883). He devised a theory, presented in *Das Kapital* (The Capital), that became a cornerstone of both the former Soviet Union, and as such, he is probably the single most influential economist of all time. Marxism derives from a thorough historic analysis that (correctly, in my opinion) showed that workers always were exploited. This exploitation was unjust because "labor is the sole source of value," and only workers labored according to Marx. Thus, the workers were the only ones entitled to the fruits of production. Since the capitalists did not accept this conclusion, the workers were to take their rightful place by revolution. Ironically, Marx

[11]See Wonnacott, P. and R. Wonnacott (1990). *Economics*. New York, John Wiley & Sons. p. 804.

[12]See The Economist (1999a). FDR and the New Deal. *The Economist*. **353**: pp. 51.

believed that Hegel's process[13] of thesis—antithesis—synthesis would end with the Marxist system, but no economic system has probably undermined itself as swiftly as the Marxist system with huge human and environmental costs in the process. Marxism is therefore a socially irresponsible system, in my opinion.

In terms of environmental issues, it is important to identify an important lesson from *the results* of Marxism. A command style approach toward sustainability is unwise. This does not mean that promoting legislation is unwise because even a free market also constraints as argued before. What it *does* mean is that we must avoid rules and regulations that prohibit the constructive ingenuity of the marketplace. In fact, the way environmentalists and others eagerly tell people what is green and what is not probably stalls innovation of new and better products because companies become more aware of what is "green" than what is "better."[14] The fact is that nobody knows what is "green," i.e., has low environmental impact, because we have not agreed upon a generic, reliable, and comparable framework for assessing environmental impact.[15]

Clearly, extreme solutions to manage the economy can be disastrous, and without reviewing the entire historical narrative of List, it is sufficient to stop here at the fall of the Hansa and the beginning of the rise of the Dutch and its subsequent fall as England finally arose. History has a tendency to repeat itself… The financial system largely came out of learning from its disasters,[16] see Chap. 4. The challenging part this time is that we must learn from what went well, which is why I put much emphasis on understanding what went well prior and during the Industrial Revolution if we are to avoid many crises before our society can be rightfully labelled as "sustainable."

So, if we proceed from the historical account to the analysis, in his fourth book, List provides the following list of British policies that resulted not only in their economic greatness and world domination, but these policies were closely interwoven with the Industrial Revolution as well:

1. Always to favor the importation of productive power, in preference to the importation of goods.
2. Carefully cherish and to protect the development of the productive power.

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[13]Any system (thesis) will eventually undermine itself, cause its own destruction, and thereby give place for an opposite system (antithesis). The antithesis will undergo a similar process, and the new system will be the synthesis of the two preceding systems. Hegel believed that this is how history progresses. Marx was a firm believer in this process too, which is called Hegelian dialectic. For more information, see Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

[14]See Scarlett, L. (1998). "The Green Hand of Progress." *Journal of Commerce* (January 13).

[15]For a thorough discussion Emblemsvåg, J. (1999). Activity-Based Life-Cycle Assessments in Design and Management. *The George W. Woodruff School of Mechanical Engineering*. Atlanta, GA, The Georgia Institute of Technology: pp. 600.

[16]See The Economist (2014a). The slumps that shaped modern finance. *The Economist*. **411**: pp. 47–52.

3. To import only raw materials and agricultural products and to export nothing but manufactured goods.
4. To direct any surplus of productive power to colonization and to the subjection of barbarous nations.
5. To reserve exclusively to the mother country the supply of the colonies and subject countries with manufactured goods, but in return to receive on preferential terms their raw materials, and especially their colonial produce.
6. To devote especial care to the coast navigation; to the trade between the mother country and the colonies; to encourage seafisheries by means of bounties; and to take as active part as possible in international navigation.
7. By these means to found a naval supremacy and by means of it to extend foreign commerce and continually to increase her colonial possessions.
8. To grant freedom of trade with the colonies and in navigation only so far as she can gain more by it than she loses.
9. To grant reciprocal navigation privileges only if the advantage is on the side of England, or if foreign nations can by that means be restrained from introducing restrictions of navigation in their own favor.
10. To grant concessions to foreign independent nations in respect of import of agricultural products, only in case concessions in respect of her own manufactured products can be gained thereby.
11. In cases where such concessions cannot be obtained by treaty, to attain the object of them by means of contraband trade.
12. To make wars and to contract alliances with exclusive regard to her manufacturing, commercial, maritime, and colonial interests. To gain by these alike from friends and foes: from the latter by interrupting their commerce at sea and from the former by ruining their manufactures through subsidies which are paid in the shape of English manufactured goods.

The zeal of which Britain followed these policies can perhaps be best illustrated by how she handled Indian cotton and Chinese silk. She bought silk and cotton and sold it to continental Europe and used the proceeds to build British industry and competitiveness. The English themselves, however, had to buy more expensive cloth with lower quality. Later, after building an effective industry, they ruled the international silk trade as their production constituted up to 90 percent of global production.

Before we continue to discuss the insight of List, it is worth noting that the narrative thus far clearly shows the importance of defending infant industries and building a context for their success both in terms of competence and skills but also access to raw materials and market. It also most clearly shows the need for sensible laws and enforcement. From his historical account, List highlights what history teaches us and the fact is that regardless of how industrious, thrifty, inventive, and intelligent individual citizens might be, they cannot make up for lack of free and sensible institutions. Individuals derive the greater part of their productive powers from the social, municipal, and political institutions and conditions under which they are placed. Therefore, List appoints the rule of law in England securing an elementary level of freedom as its ultimate advantage over other nations at the time in addition to breeding of sheep and to the woolen manufacture. The continental

Europe was plagued by despotism, whims of princes and rulers, and outright foolishness as listed earlier. Indeed, even Marx noted that Britain had a bourgeois aristocracy in that landlords invested in transport infrastructure unlike anywhere else.[17]

List, therefore, has a completely different twist to political economy than do Smith. Smith has problems in defending much of his work as to practical cases of his days. Fundamentally, Smith speaks of what is called the "cosmopolitical economy," that is the science which teaches how the *entire* human race may attain prosperity. His work must therefore be read with an ideal state in mind because in practical political situations, the cosmopolitical school ignores wars, nationalities, and their special interests and conditions. He therefore followed to some extent what is called the Physiocratic school which Quesnay founded and had considerable influence upon France. They taught that "the well-being of the individual is dependent altogether on the well-being of the whole human race." Smith did in fact allegedly intend to dedicate his great classic to Quesnay.[18] The Physiocrats, however, went to the extreme of claiming that agriculture was the sole source of wealth with their maxim that "the soil alone yields nett revenue."[19]

This is in contrast to "political economy" which is the science as to how the inquiry of a given nation can obtain (under the existing conditions of the world) prosperity, civilization, and power by means of agriculture, industry, and commerce. In the current state of the world, and certainly at the time of List, political economy provides more realistic advice than cosmopolitical economy, which List demonstrates thoroughly throughout his writings. However, a cosmopolitical outlook is probably more in the spirit of sustainable development than political economy. The central question thus becomes how do we bridge the ideal with real-life limitations?

This is particularly a pertinent question in the context of sustainable development—there is literally tons of literature describing very ideal approaches to sustainable development, but I know from my own working experience that the pursuit of the perfect too quickly can ruin the good. List has therefore a more realistic approach, and today's world is far from perfect—just as in the days of List.

This said, List does not disagree with Smith as to what is the ideal solution; however, he sees the naiveté of applying Smith's cosmopolitical thinking into the real world. Also, Edmund Burke (1727–1797) declared to Smith in confidence that "…that a nation must not be governed according to the cosmopolitical systems, but according to knowledge of their special national interests acquired by deep research."[20] The result is that Smith and his school have "fallen into the opposite extreme to the errors of the so-called mercantile system," as List puts it.

[17]See Freeman, C. (2002). "Continental, national and sub-national innovation systems—complementarity and economic growth." *Research Policy* **31**(2): pp. 191–211.

[18]According to T. and J. Allman who in 1825 published *Life of Smith*.

[19]According to List, F. (2005c). *The National System of Political Economy—Volume 3: The Systems and the Politics*. New York, Cosimo Classics. p. 124.

[20]Quoted by List, F. (2005c). *The National System of Political Economy—Volume 3: The Systems and the Politics*. New York, Cosimo Classics. p. 124.

Mercantilism was an economic theory and practice dominant in Europe from the sixteenth to the eighteenth century whereby state power was augmented at the expense of rival national powers. This was achieved through governmental regulation of national economy aiming at accumulating monetary reserves through a positive trade balance, especially of finished goods.[21] An important aspect of mercantilism was its building of overseas colonies, trade wars, trade monopolies, and other negative practices that both Smith and List agreed on.

However, List's solution to the problem was not free trade, which he demonstrates did nothing good to those that tried it except the very poor nations or the very powerful. In fact, List realized that to allow freedom of trade, the less advanced nations would have to first be raised by intentional measures to a stage of cultivation to which the English nation had been lifted. One of these intentional measures is protection. However, protection was not the main approach—in fact, exaggerated protection is detrimental. List therefore developed what he called "The Theory of the Powers of Production" to describe how to build capital in a country so that modest protection would make sense. List therefore writes in Book 2:

> It may in general be assumed that that where any technical industry cannot be established by means of an original protection of forty to sixty per cent and cannot continue to maintain itself under a continued protection of twenty to thirty per cent the fundamental conditions of manufacturing power are lacking.
>
> The causes of such incapacity can be removed more or less readily; to the class more readily removable belong want of internal means of transportation, want of technical knowledge, of experienced workmen, and of the spirit of industrial enterprise; to the class which is more difficult to remove belong the lack of industrious disposition, civilization, education, morality, and love of justice on the part of the people; want of sound and vigorous system of agriculture, and hence of material capital; but especially defective political institutions, and want of civil liberty and of security of justice; and finally, want of compactness of territory, whereby it is rendered impossible to put down contraband trade.

List acknowledges the greatness of Smith in that he introduced the natural law, or doctrine, of the division of labor. Unfortunately, as List shows, Smith never carried out a thorough investigation of the essential nature and character of this doctrine or followed it to its logical consequences. The reason for this is probably that Smith had essentially a transaction and market view concerning himself with exchangeable values thereby failing to take into account the productiveness of labor in a production sense (relying on skills and judgment)—something that List was extremely concerned about. List provided the following example to explain the difference[22]:

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[21]See LaHaye, L. (2008). Mercantilism. *The Concise Encyclopedia of Economics online*, Liberty Fund.

[22]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

> Let us suppose the case of two fathers of families, both being landed proprietors, each of whom saves yearly 1000 thalers and has five sons. The on puts out his savings at interest, and keeps his sons at common hard work, while the other employs his savings in educating two of his sons as skilful and intelligent landowners, and in enabling the other three to learn a trade after their respective tastes; the former acts according to the theory of values, the latter according to the theory of productive powers. The first at his death may prove much richer than the second in mere exchangeable value, but it is quite otherwise as respect productive powers. The estate of the latter is divided into two parts, and every part will by the aid of improved management yield as much total produce as the whole did before; while the remaining three sons have by their talents obtained abundant means of maintenance. The landed proprietor of the former will be divided into five parts, and every part will be worked in as bad manner as the whole was heretofore. In the latter family a mass of different mental forces and talents is awakened and cultivated which will increase from generation to generation, every succeeding generation possessing more power of obtaining material wealth than the preceding one, while in the former family stupidity and poverty must increase with the diminution of the shares in the landed property.

It might be tempting to argue that this is just a simple example, but the fact is that in the Middle Ages, the yield of wheat of an acre of land in England was fourfold, and in 1840, it was tenfold to 20-fold, and in addition to that, five times more land was cultivated. In many European countries with similar quality of soil as England, the yield in 1840 did not exceed fourfold the yield hundreds of years earlier. A striking example is Poland. Lacking a vigorous middle class, Poland fell behind and this was due to the lack of the establishment of an internal manufacturing power. The aristocracy preferred to export paltry fruits of serf labor to foreign markets and obtained in return cheap and fine goods made by foreign countries. Consequently, the productive power of Poland did not develop, and compared to England, it fell behind significantly. In fact, Montesquieu argues that Poland would have been better off by giving up all foreign commerce altogether and rather tried to establish manufacturing power for herself and consumed her own raw materials and means of subsistence.[23]

In short, Smith's focus on exchangeable values renders his theory to "dead materialism," as List calls it, and after "boundless cosmopolitanism," this is the second main defect of Smith's work. The problem is that the focus on the mere exchange of values means that Smith does not take into account the mental and political, present and future interests, and the productive powers of the nation. Furthermore, because his economic thinking was essentially narrow and that of an individual merchant focusing on exchange of values, his thinking really did not end up becoming the antithesis to mercantilism, which Smith strongly criticized, but becoming a restricted version of mercantilism. This conclusion was not only reached by List, but also by Louis Say (1774–1840), the brother of Jean-Baptiste Say (1767–1832) who was a follower of Smith more extreme than the master.

This also meant that Smith and List had different understanding of the very foundation of capitalism—capital. Smith and his school of thought did not limit capital merely to material capital but included also all mental and social means of

[23]See Montesquieu, C. (1758). *De l'esprit des lois*.

and aids to production. However, as List points out, this wider usage of the term capital was essentially lost in their arguments and the word "capital" as used by Smith and his followers more in the sense "…taken by rentiers or merchants in their book-keeping and their balance-sheets, namely, as the grand total of their values of exchange in contradistinction to the income accruing therefrom." List, in contrast, adopted the term "capital" but distinguished between mental and material capital; between material, agricultural, manufacturing and commercial capital; and between private and national capital. This different understanding of capital leads to the differences pointed out earlier. For Smith, building up national capital was more or less an exercise in saving like a private rentier, while for List, building up national capital meant building the productive powers of the nation.

List also shows that there is a fundamental difference between dividing the labor of one person as to produce various objects, like a hunter that goes hunting, prepares arrows, clothes, etc., on the one hand, and several persons divide the work of a single object on the other hand. The former does not further production, whereas the latter does as it leads to specialization through division of labor and increased productivity. Smith is, of course, thinking about the latter type of dividing work, but he is missing a vital point. Division of labor also necessitates a union of laborers—cooperation and organization—and not just between laborers but also across the economy. List therefore sees the rise of industry as a vital force in improving agriculture, whereas Smith failed to discuss, and perhaps understand, this. Not only did List argue this very well, but also an article published in The Times in 1883 titled "Manufacturers and Agriculture" refers to statistical surveys that prove convincingly that diversified industries are best for the state and the individual industries themselves. List himself used the case of Poland versus England where he found that land of equal agricultural quality was 10–20 times more valuable in England than in Poland. Therefore, division of labor and union of labor did not only apply to a company, or an industry, but also to an entire nation and indeed humanity. Smith failed to see this, and it constitutes the third, and final, main defect of Smith's work, according to List. In fact, the importance of division of labor and confederation of the productive forces is seen by List as being so important that he raises it to the status of natural law.

Like Smith, the famous theory of David Ricardo (1772–1823) is based on the same fallacy of ignoring the mental capital inherent in material capital. It is as if everything is just given… As List humorously quipped, in response to Ricardo's claim that rent paid from land is based on the natural fertility inherent in the land, "All Canada in its original state (inhabited merely by hunters) would yield in meat and skins scarcely enough income to pay the salary of a single Oxonian professor of political economy."

The most critical type of division of labor, however, List argues is the division between mental work and material work. Both are dependent on each other, and he states that[24]:

[24]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

> The more the mental producers succeed in promoting morality, religion, enlightenment, increase of knowledge, extension of liberty and of perfection of political institutions – security of persons and property within the State, and the independence and power within the State, and the independence and power of the nation externally – so much greater will be the production of material Wealth. On the other hand, the more goods that the material producers produce, the more will mental production be capable of being promoted.

From this insight, he concludes something I believe we today should take notice of[25],

> It is possible for a nation to possess too many philosophers, philologers, and literati, and too few skilled artisans, merchants, and seamen. This is the consequence of highly advanced and learned culture which is not supported by a highly advanced manufacturing power and by and extensive internal and external trade.

To raise the productive powers of a nation is therefore a systemic effort. List was not the first to point this out—Antonio Serra (late sixteenth century) of Naples wrote as early as 1613 about political economy in Venice where he discusses various indirect means of acquiring precious metals and that included qualifications of the people, nature and circumstances of locality, form of government, public order, municipal liberty, political guarantees, and the stability of laws.[26] Unlike Serra, however, List had a more scientific approach to the topic probing it much more widely and thoroughly, and List explicitly mentions "rich sources of productive power" as being (with my personal interpretation behind those which may appear strange or old fashion):

1. The Christian religion. I believe that we must here keep in mind that he probably refers to Protestantism because what rings true in this is what Max Weber (1864–1920) almost 100 years later referred to as "the protestant [work] ethic"[27] which influenced large numbers of people to engage in work in the secular world, developing their own businesses, engage in trade and accumulate wealth for investment, and as such became an important force behind the unplanned and uncoordinated emergence of modern capitalism. List also explicitly refers to the importance of the Reformation in the rise of England.
2. Monogamy. I believe that he thinks of the solidity of families in bringing up their children and laying the foundation for the next generation.
3. Abolition of slavery and vassalage. I suspect that this is to reflect the degree of freedom in society because he is very clear in a number of passages concerning the importance of personal freedom and want of fear, the problem of despotisms, and so on.

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[25]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

[26]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

[27]See Weber, M. (2001). *The Protestant Ethic and the Spirit of Capitalism*. London, Routledge. p. 320.

4. Hereditability of the throne. I believe that this is essentially a proxy for stability and national alignment in his time, and at the time, it was also the state of national development. He is, however, very clear on the fact that an economic system can function well under a number of different governmental systems. For example, he contrasts the problems in the democratic Southern States of America, i.e., the Confederate States later on, with the relative good economic development found under an absolute monarchy in Russia.[28] This we can also witness today with China being autocratic and doing a lot better than most democratic countries economically speaking.
5. Invention of printing of the press.
6. The postal system. The postal system has been vital in securing the information flow in society, and I believe this is what List thinks about.
7. Money weights and measures.
8. The calendar.
9. Watches.
10. Police. I believe he thinks of rule of law and eradication of the chronic lack of personal safety in the streets, and so on, many other countries suffered from at the time.
11. The principle of freehold property. I believe this is essentially the same as property rights in a more modern context.
12. Means of transportation.

In addition to this list, it is vital to keep in mind that List put premium on manufacturing industries which the others did not. In fact, he claims that all great rulers—Edward III, Elizabeth, Frederick the Great, George Washington (1732–1799), and Napoleon Bonaparte (1769–1821)—put significant incentives, including protecting infant industries, to build manufacturing. Just like the Stone Age did not end due to lack of stones, agriculture did not end by the hands of manufacturing and so shall not manufacturing end by modern-day service industries. For example, in 1900, some 40 percent of Americans worked in agriculture and just over 40 percent of the typical household was spent on food; today, less than 5 percent work in agriculture and the cost of food has dropped steeply too.[29] What happens is that productivity increases due to a number of factors so less resources are necessary to produce the same and more resources can be applied to build the future. Generally speaking, increasing productivity is also environmentally friendly.

Therefore, it not the bodily exertions of people that produce the greatest wealth effects, but skills and judgment applied on solving problems of various sorts. Hence, I think it is also fair to say that the Industrial Revolution took hold in Britain first probably because of relatively superior legislation and leadership setting the wheels in motion for manufacturing industries, which gave new

[28]See List, F. (2005c). *The National System of Political Economy—Volume 3: The Systems and the Politics*. New York, Cosimo Classics. p. 124.

[29]See The Economist (2014b). *Special report on World Economy: The third great wave*. London, The Economist. p. 18.

technologies for a rising agriculture and manufacturing industries that in turn supported an even greater population which in turn could produce even more which was used to build infrastructure, educate people, and increase the wealth of rich and poor alike; a self-reinforcing, revolutionary economy was created which lifted the entire society. This is what we have to repeat today but in the context of sustainable development.

Before continuing, it should be noted that List's analysis corresponds very well with many modern-day analyses as well. For example, writing about the cotton industry in England, William Mass and William Lazonick state that[30]:

> By the 1870s cotton industries around the world could readily purchase British plant and equipment and even British engineering expertise. But no other cotton industry in the world could readily acquire Britain's highly productive labour force; no other industry in the world had gone through the century-long developmental process that had produced the experienced, specialized and cooperative labour force that Britain possessed.

With reference to the chapter about finance, there is actually one thing both Smith and List agree on—the role of commerce. Both acknowledged the productive role of commerce, but pointed out that, its role is very different than that of agriculture and manufacturing. The latter two actually produces something—tradable goods—whereas commerce brings about the exchange of these goods. From this, they find that "…commerce must be regulated to the interests and wants of agriculture and manufacturing, not vise versa."[31] Today, however, I find it to be the opposite and therein lie a root to the problem. Those responsible for trading and investing have little understanding of the actual process of producing the goods they trade or the corporations they trade/invest in,[32] which means that many critical decisions are made without sufficiently understanding the consequences. Needless to say, this can hardly be the path toward sustainable development.

We also have other issues that are at odds with the principle of the Invisible Hand. That sympathy of man is wanting should come as no surprise from what has been discussed thus far. More surprising to many, however, is that economic rivalry is also lacking. Examples include the following:

- *Protectionism* reduces/prevents market access by, for example, imposing tariffs on trade. Thus, goods and services are not produced as effectively as possibly, yielding higher environmental impact and costs. Note that I am not discussing protection of infant industries but general protectionism where it should not be. List did not support protectionism per se—he argued for protecting infant industries, which is something completely different. I think also that it is important to highlight that protective duties do not necessarily translate into higher prices—the critical issue is how the protection is used. If it is used to basically build

[30]Quoted by Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

[31]This statement is from List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

[32]See Graham, B. (2005). *The Intelligent Investor*. New York, HarperCollins Publishers. p. 269.

support under failing industries, it is not beneficial, of course. However, as John Bowring (1792–1872) documents in a report in 1840 to Foreign Secretary Henry John Temple, the 3rd Viscount Palmerston (1784–1865) on the German Zollverein (customs union), the Germans under relatively high protective tariffs not only produced goods of better quality than imported ones but also cheaper.[33] Thus, protection can work beneficially if it is used to build "productive powers," to use List's term.

- *Subsidies* of raw materials, goods, and services cause perverted usage of resources and often prevent poor countries from benefiting from their cost advantage. For example, the USA spent in the 1990s more on building logging roads than the American logging industry earns from timber sales.[34] Thus, not only does the USA lose money, but lower timber prices are also a subsidy which gives higher consumption of timber. Similar situations are found all around the world concerning a huge variety of natural resources; at the turn of the millennium, the world spent at least $650 billion annually—equivalent to 9 percent of all government revenues.[35] In 2013, some $550 billion was spent alone on subsidies for fossil fuels.[36] In fact, "The extraordinary complexity of the various 'taxes' and 'subsidies' affecting the oil industry is revealing in itself—eloquent testimony to politicians' desire to meddle, and to obscure the true cost of their meddling."[37]
- *Dumping* is an attempt of gaining/protecting market shares and/or getting rid of overproduction, by selling goods and services with loss or unsustainably low margin. Dumping is essentially a subsidy of the consumer, which also increases resource consumption and slows down/prevents industry restructuring. Many countries today engage in such activities, but this has been common throughout history and it has often been used to crush infant industries by leading nations, which is another argument for protecting infant industries explicitly. England, for example, repeatedly did so in an attempt to quell infant industries in North America; according to List, goods manufactured in England could be obtained much cheaper in North America than in England—even below production cost.[38]

That economic rivalry is missing to some extent is a problem by itself, but the aforementioned practices—and others not discussed—also lead to major misallocation of resources that in turn yields unnecessary and possibly high impact on the

[33]See List, F. (2005c). *The National System of Political Economy—Volume 3: The Systems and the Politics*. New York, Cosimo Classics. p. 124.

[34]See Roodman, D. M. (1999). *The Natural Wealth of Nations: Harnessing the Market and the Environment* New York, Routledge. p. 304.

[35]See Brown, L., C. Flavin, H. French, J. Abramovitz, S. Dunn, G. Gardner, A. Mattoon, A. P. McGinn, M. O'Meara, M. Renner, D. Roodman, P. Sampat, L. Starke and J. Tuxill (1999). *State of the World 1999*. New York, Worldwatch Institute/W.W. Norton & Company. p. 259.

[36]According to The Economist (2015). *Special report: Let there be light*. London, The Economist. p. 12.

[37]According to The Economist (2001). Big Oil and its subsidies. *The Economist*. **358**: pp. 82.

[38]See List, F. (2005b). *The National System of Political Economy—Volume 2: The Theory*. New York, Cosimo Classics. p. 245.

environment and costs to society. Another problem is that lacking economic rivalry often protects the wealthy against the poor due to the mechanisms behind political and legislative processes,[39] which will be discussed later. Thus, lack of economic rivalry is ultimately lack of sympathy for man, and it will no doubt be a major source of friction in our path toward sustainable development, and it highlights the importance of the social side of sustainable development. This is discussed further later, but first, we look at "the environmental problem" to understand better how the system must be reengineered.

5.2 The Environmental Problem in Brief

> If you think that today's environmental requirements seem like a light breeze, you should get ready for the storm of tomorrow.
>
> Percy Barnevik
> Former President and Chief Executive Officer at ABB

The world economy is largely capitalistic albeit in various colors. Hence, when reengineering capitalism, we must assume relatively free markets with some governmental interventions. In these free markets, the fundamental issue of choice is everlasting. Both the environmental problem and the economic problem are rooted in decision-making—choosing. The choices derive from the fact that:

1. Our material wants are virtually unlimited.
2. Real resources are scarce.
3. Virgin material and/or previously processed material are input to a transformation process aiming at satisfying our material wants whereby waste is created.

By comparing the three points above with the economic problem, we see that there are only two differences. First, while the economic problem is related to *economic resources*, the environmental problem is related to *real resources*. Hence, how real resources are measured becomes critical:

- In the economy, resources are measured as costs, which are represented by money. The economic problem is therefore closely linked to the monetary system, which is discussed later.
- In nature, resources have *no* common measure, and as long as no agreed upon, generic, comparable and reliable environmental impact measure exists, environmental management will be ineffective and inefficient as discussed before. Furthermore, because "what you measure is what you get" and "performance measurement systems drive behavior," environmental issues are only attended sporadically.

[39] See Bradbrook, A. J. (1994). "Environmental Aspects of Energy Law—The Role of the Law." *Renewable Energy* **5**, **part III**(5–8): pp. 1278–1292.

Second, in the "economic problem" formulation, it is implicitly assumed that resources are abundant, whereas in the "environmental problem," it is recognized that resources are converted in a process that lead to less and less virgin material and more and more waste. When this is said, it should be mentioned that what is waste in one process can be input material for another process. The common assumption that as resources are converted more and more waste is created typically at the expense of virgin material is not necessarily true in the long run.

Economically, waste is only interesting to the extent it drives costs, whereas environmentally speaking waste is regarded as one of the main causes of environmental impact through the conversion processes. Thus, we have incongruent process boundaries between the economic system and a system supposed to deal with environmental issues.

Third, the economic system is created to deal with the "economic problem" and is inherently relatively shortsighted due to its transaction orientation—the transaction concerns only the exchange of cash for goods or services and supporting transactions to secure this primary transaction. The "environmental problem," however, largely lacks a system for its representation. This is exacerbated by the fact that environmental issues are not transaction-oriented but rather take the life cycle view. In other words, while the exchange of cash for a transaction takes seconds, the environmental consequence of the transaction may last for a lifetime. This is perhaps the single most challenging aspect of sustainable development—how to take the longer view although the economic transaction takes seconds.

What this means for our quest to reengineer capitalism will be discussed later. First, we must study the monetary system since it is so integral in capitalism and due to the fact that a similar system is completely missing in the environmental domain.

5.3 The Monetary System

> The most effective way to destroy a society is to destroy its money.
>
> Vladimir Iljitsj Uljanov (a.k.a. Vladimir Lenin)

The main purpose of the monetary system is to ease transactions as Hume said: "Money… is not of the wheels of trade; it is the oil which renders the motion of the wheels smooth and easy." In fact, this property of money is so advantageous that in lieu of *official* money, *local* "money" tends to emerge. We can find many examples of this throughout history such as:

1. In the early colony of Quebec, playing cards were used as "money."[40]
2. In the World War II Prisoner-Of-War (POW) camps, cigarettes were used as "money."[41]

[40]See Wonnacott, P. and R. Wonnacott (1990). *Economics*. New York, John Wiley & Sons. p. 804.

[41]See Radford, R. A. (1945). "The Economic Organization of a POW Camp." *Economica* (November): pp. 189–201.

The POWs, however, faced two problems associated with their crude monetary system. Firstly, the POWs realized that they could remove strands of tobacco before "spending it." Over time, this lead to a distinction between "good" cigarettes, which were smoked, and "bad" cigarettes, which were used as "money." This undermined the system as it opened up for debasing the cigarettes in various ways. Sir Thomas Gresham (1519–1579) described such processes in Gresham's Law, which popularly can be stated as "bad money drives out good." One possible way of preventing this is that a piece of money has the same value no matter what—old or new, clean or dirty, and so on. Secondly, the supply of money varied greatly, which caused price fluctuations and the like. Price stability was therefore not obtained, which violates an important economic goal.

In modern monetary system, such problems are overcome by using *uniform* money (a one dollar bill is worth one dollar regardless of appearance, smell, feel, and so forth) and by controlling the supply of money, which is done by a central bank. This is possible because the society (the general public, commercial banks, and the central bank) has agreed upon a certain monetary base. Thus, central banking is arguable one of the greatest innovations in society.[42]

Clearly, anything can be used as money provided it makes transactions easier than without the money (bartering). Thus, the measurement system we use is an important premise behind our economic system, because the monetary system enables society to reward economically oriented behavior, and it is needed for economic transactions in unforeseeable future. Hence, the undersigned still believes that the lessons from the economic and the monetary system are indispensable for developing system toward sustainability. The need for comparability and consistency is therefore obvious for developing a system toward sustainability:

- Without comparability, managers cannot choose between various alternatives.
- Without consistency, managers cannot trust the numbers.
- Without consistency and comparability, we cannot have an effective flow of information in society as to environmental performance.

Hence, consistency and comparability is crucial for industry and for environmental management in general as discussed in Chap. 2 as well.

Here, the lessons from money are indispensable. "Money is what renders trade smooth and easy" we just learned, and what we seek is something that would render trade *sustainable* as well. As shown, the economic and the environmental problems are similar—although some crucial difference exist. Nonetheless, money has several indispensable characteristics that an environmental measurement system needs, see Table 5.1. We have discussed comparability, uniformity, and generality, but what about abstractness and consistency?

[42]This is also argued by List, F. (2005c). *The National System of Political Economy—Volume 3: The Systems and the Politics*. New York, Cosimo Classics. p. 124.

Table 5.1 Characteristics of money versus current efforts and what we must improve

Characteristic	Money	Current efforts
Comparability	Money makes it possible to assess and compare any product, service, and process with each other. This enables economically motivated decision-making, e.g., chose the product with lowest cost	There is no comparable index or similar to support our quest toward sustainability
Uniformity	Money is worth the same regardless of appearance, usage, for what purpose it was used, and so forth	Today's efforts are value laden and politics erodes uniformity
Generality	Money can be used to measure the economic value of any economic resource	Today's efforts are targeted toward perceived environmental problems such as global warming. Thus, generality is missing
Abstractness	Money is a measure of wealth but is not wealth in itself. This is important to ensure both supply and uniformity	Current efforts measure environmental impact in relation to the actual environmental problems—so it is everything but abstract
Consistency	The central bank issues money, which is worth the same regardless what practitioners do	Today's efforts are easy to manipulate, but even if we assume that manipulation will not take place, there is little consistency

First, abstractness is apparently difficult to comprehend or simply ignored in environmental management literature because it is fixed on *actual* environmental problems, see, e.g., the discussion on impact categorization in the ISO 14000 standard and the work leading up to it.[43] The problem with actual environmental problems—and impact categories—is that they are per definition incomparable. This is *one* of the reasons why environmental approaches cannot produce comparable results.[44] The beauty with abstractness lies in the fact that it removes the monetary system away from physical limitations and problems to something that has essentially no practical problems.

This is clear if we look at the history of gold and silver coins; gold and silver coins obviously had an inherent value, but therefore an inherent limitation—the supply of gold and silver and the risk of forgery. Weight was another practical problem as well. Today, we have come so far as to just use electronic transactions which is a monetary system reduced to its pure purpose—transacting information

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[43]In ISO (1997). *Environmental management—Life cycle assessment—Life cycle impact assessment*. International Standards Organization.p.

[44]See Emblemsvåg, J. and B. Bras (1999). "LCA Comparability and the Waste Index." *International Journal of Life Cycle Assessment* **4**(No. 5, September): pp. 282–290.

smoothly and easily. This is crucial for sustainable development since the majority of corporation's environmental footprint and social impact are not within their direct control but lie upstream with suppliers or downstream with customers using the product.[45] Without effective information flow, effective environmental management becomes impossible for most corporations and certainly for a state.

Therefore, if we are to make our society sustainable, it is information flow and decisions based on this information flow that matters. When I buy a mobile phone, I should be able to compare one type from another and make a choice concerning environmental profile. What the actual environmental impact will be is of no interest to a corporation, or to me and should really be irrelevant—actual environmental impact of emissions, biodiversity, etc., are regional issues that have to be handled separately as discussed in Chap. 1. What the consumer need is the information about relative difference—just as we know that \$2 is twice as much as \$1 without having and understanding of what a monetary value of \$1 really means—so that a choice can be made.

Second, there is also another dimension to consistency not mentioned in Table 5.1 concerning how economic and environmental dimensions can be treated consistently *together*. Such consistency is hugely beneficial but missing completely today. Such similarity will ease diffusion of a new system, and today's cost management practices can be utilized *directly*. Then, we can actually talk about environmental impact, or degree of sustainability, and monetary costs in the same breath without having to perform a project first to find a value-laden estimate for the environmental impact that have many critics. This is illustrated well in my earlier publications in which a comprehensive method for performing integrated Activity-Based Cost and Environmental Management is presented.[46] Today, because we try to measure actual environmental impact (which is inherently incomparable), we cannot do this, and naturally in the corporate world, environmental issues become a sidelined issue delegated to specialists and glossy annual reports. This is no way to proceed if we are to have any chance to become anything looking like sustainable.

Next, I will try to put all this together in a simple, conceptual model about the Invisible Hand, and then, we can more easily discuss how capitalism must be reengineered to foster sustainability.

[45]According to Winston, A. (2014). "Resilience in a Hotter World." *Harvard Business Review* **92**(4): pp. 56–64.

[46]See, for example, Emblemsvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.

5.4 The Invisible Hand and How to Foster Sustainability

> People who do not think far enough ahead inevitably have worries near at hand.
>
> Confucius
> Analects 15:12

The invisible hand is a complex adaptive system, and its development over time can conceptually be described like an attractor as discussed in Chap. 1. Just like all attractors, the number of parameters governing it is relatively few but fundamental. With the risk of simplifying it too much, Fig. 5.1 outlines the Invisible Hand as seen from the level of an actor in the economy, and when a large set of such actors (nodes) interact in a network, the result will be a complex adaptive system whose behavior can be modeled as an attractor. This attractor will give rise to spontaneous order in the economy which is hard to grasp in simple, direct cause-and-effect terms; hence, the figurative term "the Invisible hand" as if someone was behind it.

The degree and type of specialization depend on the comparative advantage of each actor; actors typically specialize according to what they are best at. To satisfy our material wants and needs (a core aspect of the economic problem), an actor performs her specialized skills in a context of productive powers including other actors and in a market. This process results in material or immaterial products and services that allow each individual to choose (the economic problem) according to their own selfishness and sympathy for man. Finally, we reap what we sow

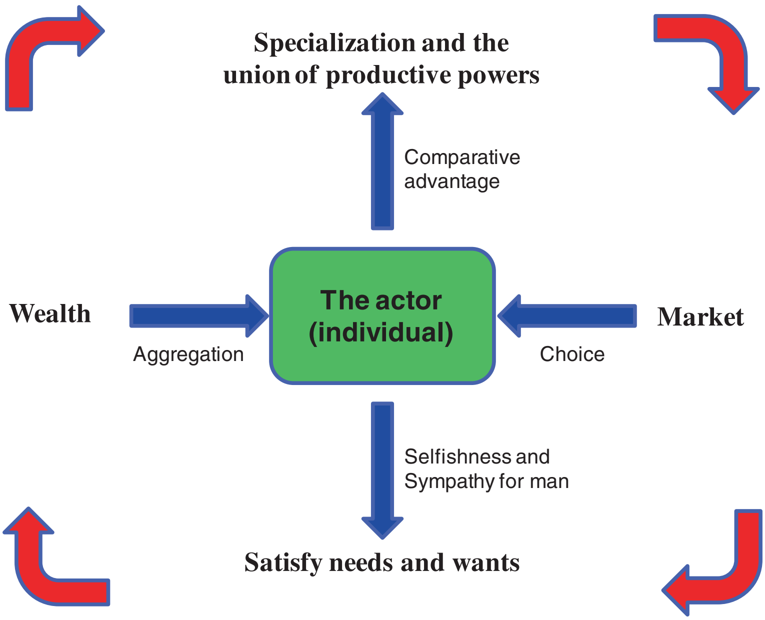

Fig. 5.1 A node in the Invisible Hand

according to our choices and aggregate wealth correspondingly. Our wealth can then be deployed in further specialization and investment in productive powers.

The model also depends to a significant extent—at least on transactional basis—on something far less manageable than what we like to acknowledge—luck. In fact, some[47] claim that the very reason free markets work is that they allow people to be lucky thanks to aggressive trial and error, not by giving rewards to incentives for skill. The argument for this is that most of the CEOs that Jim Collins and his research team interviewed for their *Good to Great* book,[48] actually attributed much of their success to "luck"—in fact, some described it as the most important success factor. For example, we read about major innovations that were accidental and sometimes even unwanted by the corporations… in the beginning. For example, 3 M may be one of the corporations that have benefited the most from its "mistakes" as they have been skillful in learning from their mistakes and taking the opportunities. Examples include the Scotch™ masking tape (developed by Dick Drew in the 1920s despite being told to stop), the Post-it® Notes adhesive (developed by Spence Silver from a mistake), and 3M's entire ceramic business owes its existence to mistakes in developing a new abrasive grit.[49]

Furthermore, on a grander scale, Robert Locke claims that the successful industrialization of the USA took place in a distinct historical context and owed much more to the external circumstances than to the quality of the management principles used.[50] Even science has been full of accidental and important discoveries.[51] Also, Ecclesiastes 9:11 emphasizes the same:

> I have seen something else under the sun:
> The race is not to the swift
> or the battle to the strong,
> nor does food come to the wise
> or wealth to the brilliant
> or favor to the learned;
> but time and chance happens to them all.

This said about what others believe about the importance of luck. Richard Wiseman[52] has studied luck for more than 20 years and he has a number of interesting findings, which briefly stated are as follows:

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[47] For example, Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. London, Allen Lane. p. 366.

[48] See Collins, J. (2001). *Good to Great: Why some companies make the leap… and others don't*. New York, Random House Business Books. p. 324.

[49] According to Brand, A. (1998). "Knowledge Management and Innovation at 3 M." *Journal of Knowledge Management* **2**(1): pp. 17–22.

[50] See Locke, R. R. (1996). *The Collapse of the American Management Mystique*. Oxford, Oxford University Press. p. 372.

[51] See Roberts, R. M. (1989). *Serendipity: Accidental Discoveries in Science*. New York, John Wiley & Sons. p. 288.

[52] See Wiseman, R. (2004). *The Little Book of Luck*. London, Arrow Books. p. 128.

1. People create much of their luck/bad luck by the way they think and behave.
2. Lucky people love new experiences.
3. Lucky people have a strong sense of gratitude and focus on what has worked well in their lives.
4. Lucky people tend to trust their intuition and lucky hunches.
5. Lucky people do not see their decision in life as being right or wrong.
6. Lucky people work hard, but also take time off to enjoy life's little pleasures.
7. Lucky people set goals for themselves, and this helps them notice opportunities that bring these goals closer.
8. Lucky people focus on long-term relationships and treat others well.
9. Lucky charms work psychologically.
10. Lucky people take responsibility for their own failings and hence learn from past mistakes.
11. Lucky people focus on the aspects of their lives that are positive and successful.
12. Lucky people sweep aside self-imposed constraints and enjoy the good fortune and energy that flow from following their passion.
13. Lucky people are prepared to persevere even in the face of great adversity.
14. Lucky people are socially "magnets" that draw other people to them.
15. Lucky people smile more (37 percent more) than unlucky people.
16. Lucky people have a good sense of humor.
17. Lucky people are constructive by taking control of the situation, evaluating many different options, deciding how to move forward, and solving the problem.
18. Lucky people put bad fortune behind them.
19. Lucky people are relaxed about life and therefore identified opportunities others miss.
20. Lucky people tend to see the positive side of their misfortunes.
21. Lucky people are good at referencing and therefore put their misfortunes in context.

So the market is both favoring the lucky, but the lucky has it somehow within himself. I think this is where the wisdom of Louis Pasteur (1822–1895) is fitting, "Chance favors the prepared mind." Thus, luck is both random, but our ability to deal with it is internal—perhaps more of a mental trait than a skill… In any case, it highlights the enormous importance of free markets. Who knows, maybe the most important innovation toward sustainability will also be discovered serendipitously?

Consequently, the Invisible Hand works the best in capitalism because it provides the freest and best managed trade environment. It also provides the most *economic* resource effective solutions despite the aforementioned shortcomings—at least, this is the conventional wisdom. This occurs because we cannot satisfy ourselves without satisfying others—at least not in the long run. In other words, those that satisfy others the most resources effectively will on average satisfy themselves the best. By changing the rules for satisfying needs and wants, sustainable development can be fostered and only then. The question is how?

Since political and legislative processes are incapable of keeping up with technological changes,[53] governments should implement a market-oriented framework to ensure a market driven toward sustainability. A market is the aggregate effect of all the individuals that freely interact according to the Invisible Hand, which can be referred to as "the power of one" since each individual is free to choose and hence has power of one, and an effective drive toward sustainability occurs if industry can do economically well by doing environmentally good. In short, and as argued at length later, governments must create a framework in which *demand* for sustainable solutions becomes the norm and not legal compliance as today. This framework must be comprehensive, mandatory, economy-wide, broad-based, and so on as discussed thus far. It must, in short, be systemic in a wide sense in line with what Deming once said, and I have mentioned before due to its profoundness:

> As we shall see, apparent differences between people arise almost entirely from the action of the system they work in, not from people themselves.

Behind "doing well by doing good" lies the urging need for being economically viable while at the same time being sustainable, see, for example, the story of Interface Flooring Systems that aims toward becoming the first truly sustainable enterprise in history.[54] This is, however, just an instance of the Invisible Hand, but the significance is that it comes from industry. The question is, of course, how can we accommodate industry so that selfishness and concern for our environment can complement each other effectively and efficiently?

"Doing well" in monetary terms is the ruling paradigm of measuring economic success and will remain so for unforeseeable future. "Doing good" in environmental terms, however, is another paradigm in measuring business success, but no measures are available. Thus, not only do we need measurement systems for the sake of environmental management per se, but also for measuring business success. In other words, to make the Invisible Hand green, we must ideally design a reliable, comparable, and generic environmental measure with similar characteristics as money, see Table 5.1, and also link it to money thereafter. It will therefore be a systemic initiative that is required on a much broader scale than current approach. This will not be easy—although in Chap. 6 a possible approach is discussed concerning the measurement part. If we look at the systemic part—excluding the measurement system to bring environmental dimensions better into the system than today—there are number of changes to make.

The first change is a change in perspectives. From the last chapter, we see all the dysfunctional parts of the financial industry and some of them concern perspectives; short-term versus long-term, fact-based versus speculative, and special interests versus broad-based. We cannot let the destructive forces in parts of the financial world set the *modus operandi* for the capitalist system. Curbing greed and

[53] See Heaton Jr., G. R. and R. D. Banks (1997). "Toward a New Generation of Environmental Technology; The Need For Legislative Reform." *Journal of Industrial Ecology* **1**(2): pp. 23–32.

[54] According to its founder and CEO Anderson, R. C. (1998). *Mid-Course Correction*. Atlanta, GA, The Peregrinzilla Press. p. 204.

having sympathy for man are important for all of us—without reducing the topic to a metaphysical discussion only. Greed, or selfishness, and sympathy for man are all possible to deal with if we start from the premise of designing a system that is broad-based, do not promote excessive speculation and put risk back into the equation, and hence make time diversification, ,long-term and proper investment handcraft worthwhile instead of perverting the system by allowing and almost promoting "too-big-too-fail" situations, huge payments without performance for executives, and so on. The discussion of Canadian banking versus US banking is instructive; we can neither afford nor accept trial and error on the way towards a sustainable society. The consequences of trial and error are basically too large particularly if it will take a long time to realize that we are on the wrong track.

Second, we, the rich world, must come to terms with how we developed ourselves and allow others to develop too. Defending infant industries for national purposes must become accepted policy as long as countries embarking on the path of development of the productive forces and do not export too much. "Too much" is of course a vague term but something that World Trade Organization (WTO) could monitor and provide recommendations concerning the levels of duties and to what extent a country makes an earnest attempt to build their productive powers and not just aims for the typical enrichment for a chosen few in the country. Building productive powers should indeed become an important criterion for lending money for developing and poor countries. Otherwise, we just increase their indebtedness as the recent story of Greece examplifies. Naive lending is just as reckless as naive borrowing when we talk about professional actors.

This is not just important for the social side of sustainability, which I have mostly avoided to discuss in this book, but it is perhaps even more important if we are to foster a vibrant system of innovation and improvement for sustainable technologies and solutions worldwide, in general. This also includes the ability to learn and absorb knowledge from the developed world without which we will face centuries of low and wasteful technologies in large parts of the world. Let us be reminded that incomes (in real terms) in Mozambique in 1990 were lower than incomes (in real terms) anywhere in Europe (including Russia) in 1870.[55] Thus, it took about 130 years for the world's most advanced countries in 1870 to get to its current level of development. How much time will it take Mozambique? This, and much more, is discussed much more in Chaps. 7 and 8, but it is important to highlight that innovation in a broad sense, and its closely related ability to absorb knowledge, is not just important for the corporations but indeed for our whole society and hence for the capitalist system.

It should also be mentioned that the infant industry argument not only applies as outlined above, but it also applies to technologies. We must devise sound policies for helping infant technologies into the market. This is also discussed much more in Chaps. 7 and 8, but the point here is to highlight the interconnectedness with the topic of capitalism, technology development, and political, social, and national development as well—and underlying it all is the financial industry.

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[55]According to The Economist (2000). A century of progress. *The Economist*. **355**: pp. 96.

We can also add a number of other changes that should ideally come into being, which I ultimately believe is impossible to implement in foreseeable future because they concern so much changes in thinking and priorities and ultimately outlook on life for people. For example, a more sustainable future would be much easier to envision if we could get rid of negative traits such as excessive greed and shortsightedness in society. Another great thing that would be more or less ideal, but practically impossible, is to legislate and enforce into extinction is the production of substandard products, services, solutions, etc. Knowing that the cost of poor quality is somewhere between 15 and 25 percent of total costs,[56] it is staggering what the cost for society—and unnecessary environmental impact—is for the global community. We probably waste annual resources through poor quality—and hence incur unnecessary environmental impact—in the range of 10–20 trillions of dollars. Putting risk where it belongs, not only with respect to the financial industry as discussed in Chap. 4, but also with respect to product liabilities. Liabilities could also be followed to their ultimate end as a part of a quality drive in the ideal world, but it would be very difficult to enforce unless the case is very clear as in the cases of accidents and the like.

Anyway, from this discussion, we find that the capitalist system is not so far off to help us in our quest as many believe. By changing the perspectives of the financial industry and changing how the rich world try helping the developing world rise we can accomplish a lot in the quest toward sustainability.

Before we discuss innovation and the government, I would like to explore an idea for improving the measurement aspect of the capitalist system (concerning the environment)—energy accounting. This would also help a lot in our quest, but it might prove politically unlikely to achieve as the current efforts. Although from an IT technical side, it is well within reach of all OECD countries as well as many other that are relatively well developed. It boils down to political will.

[56]According to extensive experience from Joseph Moses Juran (1904–2008), see Chua, R. C. H. (2001). “What You Need to Know About Six Sigma.” *Productivity Digest* (December): pp. 37–44.

Chapter 6
Introducing Energy Accounting

What is common to the greatest number has the least care bestowed upon it.

Aristotle

Energy Accounting—what is that? This must be the immediate response for people that hear about such a term. Most people are accustomed to "accounting" concerning money, but in the context of energy it is something new for most. In the simplest form, accounting is "a statement of debits and credits."[1] That is keeping track of what comes in and goes out of an account. This is what thousands of people do worldwide for corporations to have control of their cash flow and all other financial measures they depend upon. Yet, when it comes to a highly complex vision of becoming sustainable, this is not on anybody's mind.

The fact is that unless we can establish reliable information flow in *addition* to monetary terms, monetary terms will prevail and only that. As we saw in Chap. 2, in Table 2.1, current practices in environmental management do not provide intercorporative basis for information exchange. If a manufacturer today wants to choose suppliers on the basis of their impact on their environment, they will have no reliable decision support. Therefore, such comparisons are extremely rare and belong to the world of academic research and ad hoc projects. Yet, unless we make such comparisons possible in the future, our quest toward sustainability will be beached on poor information flow. In conjunction with the insight from the last chapters, we also realize the importance of such information flows being completely value free, that is without subjective interference of any kind. Consequently, the information flow must be broad-based and without special interests. The only systems we have today in the world that can somewhat claim to adhere to such stringent requirements are monetary accounting systems. Hence, we have to establish some kind of accounting system to ensure effective information flow regarding environmental issues.

But why *energy*? Why not environmental impact, which is what we want to reduce? The fact is that providing comparability in direct environmental impact

[1]This definition is found in Webster (1983). *Webster's New Universal Unabridged Dictionary*. New York, New World Dictionaries/Simon and Schuster. p.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_6

measurements across industries and products is exceedingly difficult, although not completely impossible.[2] Also, the currently much debated topic of climate change is thought to originate from CO_2 emissions, which in many cases come from various sources of fossil fuel in an attempt to extract energy. Therefore, energy is a good substitute and it is easy to measure as will be shown here[3] and hence possible to manage. In a nutshell, why create a highly political and complex system with value-laden figures when we can have a straightforward accounting system for energy usage that actually captures the root cause of emissions and not symptoms? The potential political issues surrounding energy accounting will be whether to implement it or not and what to do with the information it provides, which are both normal issues regardless of what measurement system we discuss.

We also have to remember that much good work is being carried out around the world in nature conservation including preservation of wildlife and preservation of habitats. The increasing environmental awareness worldwide has also helped significantly in getting rid of unnecessary heavy metals, outright pollution of poisonous compounds, and so on. We are by no means at the end of these journeys, but they have started and in most cases, it is no longer a matter of limited knowledge but more a matter of limited political will to enforce environmentally sound policies. However, when it comes to grand-scale, systemic issues, we are still in the dark, and since energy is of such great importance to human civilization, it will serve as a good proxy for managerial purposes even though it does not directly measure environmental impact.

Just like money is in itself worthless and meaningless—an abstract concept assigned value by convention only—yet, money is a proxy for wealth. Similarly, energy consumption will be an even better proxy for environmental impact due to the close relation between energy consumption and socioeconomic development[4] and emissions. There are other reasons for focusing on energy consumption as well:

1. A recent projection by US Energy Information Administration (USEIA) is presented in Fig. 6.1—as we see, there has been, and projections are, that there will be significant growth. This follows from the fact that energy is critical for socioeconomic development and is therefore inevitable due to the rapid growth, particularly in Asia.

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[2]Interested readers are referred to either:

- Emblemsvåg, J. (1999). Activity-Based Life-Cycle Assessments in Design and Management. *The George W. Woodruff School of Mechanical Engineering*. Atlanta, GA, The Georgia Institute of Technology: pp. 600.
- Emblemsvåg, J. and B. Bras (2000). *Activity-Based Cost and Environmental Management: A Different Approach to the ISO 14000 Compliance*. Boston, Kluwer Academic Publishers. p. 317.

[3]My first publication on energy accounting came in 1998 from which this chapter is an expansion of, see Emblemsvåg, J. and B. Bras (1998). *Energy Accounting—A Step Towards Sustainability*. Proceedings of the 42nd Annual Conference of The International Society for the Systems Sciences, Atlanta, GA, International Society for the Systems Sciences (ISSS).

[4]According to Olsson, L. E. (1994). "Energy-Meteorology: A new Discipline." *Renewable Energy* **5 Part II**: pp. 1243–1246.

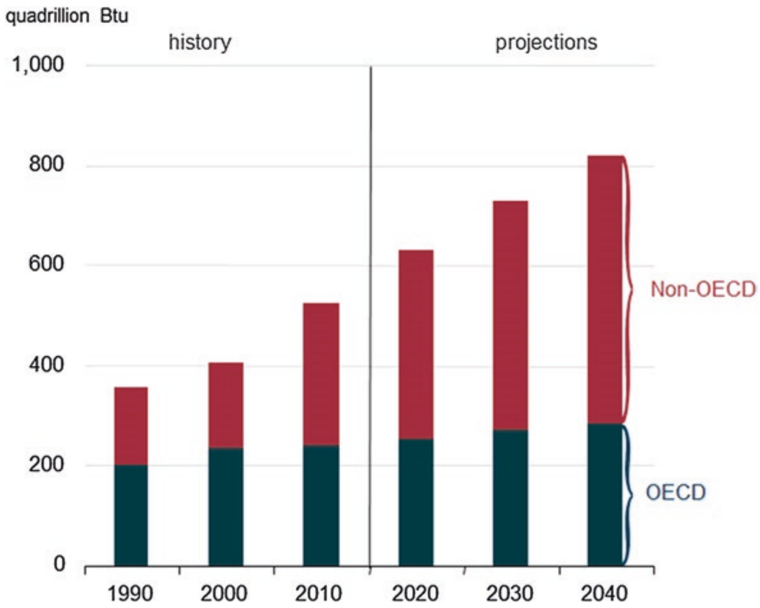

Fig. 6.1 World total energy consumption 1990–2040. *Source* US Energy Information Administration

2. On a worldwide basis, 57 percent of CO_2 emissions stemmed from energy consumption[5] in 1990, while in the USA, the number was 99 percent[6] roughly at the same time. In Fig. 6.2, we see that the number has increased to 78 percent… It therefore seems likely that as societies become more and more industrialized, the correlation will approach well above 90 percent with our current sources for energy.
3. Major studies[7] indicate that the technical potential of energy savings (in the USA) is in the range of 25–75 percent. This means that if the industrialized countries in the world start to increase the efficiency of energy consumption, the increase of energy consumption in the developing countries can be partially or fully offset. This leads to the principle of OECD, which states that OECD countries should support developing countries to enable them to grow economically without increasing dramatically the burden of atmospheric carbon,[8] because of the strong correlation between energy consumption and CO_2 emissions.

[5]According to Fowler, R. J. (1990). International Policy Responses to the Greenhouse Effect and their Implications for Energy Policy in Australia. *Greenhouse and Energy*. D. J. Swaine. Melbourne, C.S.I.R.O.

[6]According to Seki, M. and R. Christ (1995). African Regional Workshop on Greenhouse Gas Emissions Inventories and Emission Mitigation Options: Forestry, Land-use Change and Agriculture, UNEP: pp.

[7]See Levine, M. D., J. G. Koomey, L. Price, H. Geller and S. Nadel (1995). "Electricity End-Use Efficiency with Technologies, Markets, and Policies Throughout the World." *Energy* **20**(1): pp. 37–61.

[8]According to Smith, P. F. (1994). "Carbon Emissions Linked to Capital and Technology Transfer." *Renewable Energy* **5, part II**: pp. 1219–1230.

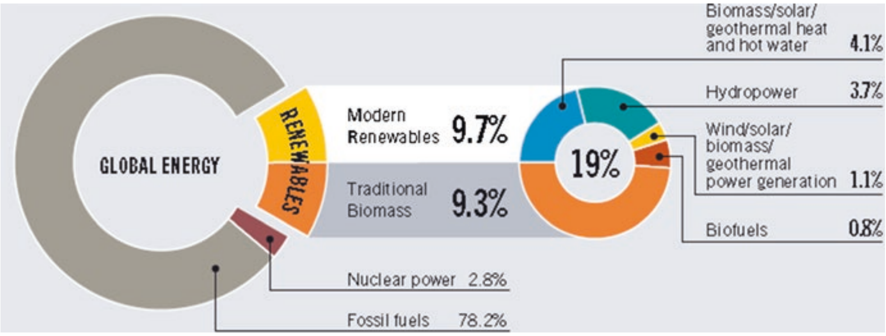

Fig. 6.2 Estimated renewable energy share of global final energy consumption, 2011. *Source* REN21 (see REN21 (2013). *Renewables 2013: Global Status Report*. Paris, UNEP, Renewable Energy Policy Network for the twenty first Century (REN21), Secretariat. p. 177.)

4. The approach of simply increasing the energy prices with, e.g., a factor of 2 or 20 or whatever, would not work well because there is no systematic gathering of energy consumption data. Corporations and individuals would therefore be left to their own devices to find out how to reduce energy consumption, and it would lead to quick fixes like to reduce the energy bill, but in general, companies would have small impact on the overall energy consumption because they cannot make choices of products due to upstream energy consumption. The reason for that is that pricing decisions in corporations are not based on energy costs simply because energy costs for the majority of the economy constitute a small piece of the pie. Therefore, only higher costs would be the end result, and for this to work, the system must be thorough and consistent over time.
5. Energy consumption does not reflect large costs on most corporate budgets; hence, there is relatively little management focus on energy. In earlier years, it is only the lack of energy that has caused any significant actions—like after the oil embargo following the Yom Kippur War in October 1973. However, as the energy crisis declined, so did the interest in energy analyses. Even today, energy consumption is not very high on the agenda. It must therefore receive extra attention—attention that only a system like energy accounting can provide.

Before reading on, there are two clarifications to be made:

1. I stated that money is worthless in itself. The reason is that money only signifies the right for a certain amount of monetary resources, whereas the money itself has negligible value of the metal or paper. The German term for money is therefore very instructive—*Banknoten*—a note issued by a bank to signify some predefined amount of monetary value.
2. With energy in energy accounting, it is meant energy consumption accounting, but this is very cumbersome, so for simplicity, the term energy accounting is used.

Despite the obvious advantages of focusing on energy, there is a significant hurdle-politics. As Adrian J. Bradbrook notes[9]:

> Traditionally, where significant societal changes occur requiring legal protection, one of two possible developments occur: either the courts intervene on their own initiative and create new remedies, as a part of common law process; or the legislature enacts new legislation or amendments to existing legislation in order to remedy the perceived deficiencies. Unfortunately, in the energy sector neither of these developments has occurred. Moreover, in the writer's opinion neither of these developments are likely to occur in foreseeable future.

This he wrote in 1994, and the situation has not changed significantly. Even after the signing of the Kyoto Protocol in 1997, the situation has remained largely unchanged. As of 2013, the 12 most common policies globally can be divided into three main groups[10]:

1. Regulatory policies;
   - Renewable energy targets.
   - Feed-in/premium payment.
   - Electric utility quota obligation/renewable portfolio standard (RPS).
   - Net metering.
   - Biofuels obligation/mandate.
   - Heat obligation/mandate.
   - Tradable renewable energy credit (REC).
2. Fiscal incentives;
   - Capital subsidy, grant, and rebate.
   - Investment and production tax credits.
   - Reductions in sales taxes, energy taxes, CO_2 taxes, value-added taxes, and other taxes.
   - Energy production payment.
3. Public financing;
   - Public investment, loans, and grants.
   - Public competition bidding/tendering.

With this array of incentives, totaling USD 88 billion in 2011[11] growing to about USD 140 billion year-end 2013,[12] renewable energy continues to be one of the

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[9]See Bradbrook, A. J. (1994). "Environmental Aspects of Energy Law—The Role of the Law." *Renewable Energy* **5, part III**(5-8): pp. 1278–1292.

[10]This list is compiled by Boekhoudt, A. and L. Behrendt (2013). *Taxes and incentives for renewable energy*. Zug, Switzerland, KPMG International Cooperative. p. 63.

[11]According to International Energy Agency (2012). *World Energy Outlook 2012*. Paris, International Energy Agency (IEA)/Organization for Economic Co-operation and Develop (OECD). p. 700.

[12]The number for 2013 is provided by The Economist (2014). Curbing climate change. *The Economist*. **412:** pp. 22–26.

world's strongest growth industries,[13] but the overall adoption rate of renewable policies has slowed considerably due to uncertainty about renewable energy policies, overcapacity, and price pressure,[14] and by 2035, only 31 percent of the energy generation mix will be from renewable sources.[15] This means that we cannot rest on the achievements so far, and the focus on energy efficiency will most likely become increasingly important something current energy initiatives seem to indicate. Indeed, the International Energy Agency (IEA) estimates that the investments needed for "decarbonizing" future electricity production are alone at an astounding $44 trillion. Hence, the best hope for avoiding much global warming is a huge increase in energy efficiency.[16]

Increases in energy efficiency have also been crucial thus far. Since the 1970s, 11 IEA countries, including many G7 countries, saved an equivalent of 1.4 million tons of oil in 2011, worth $743 billion.[17] To put this in context, this saving amounted to more than their total final consumption in that year from gas, coal, or any single fuel. Cutting energy consumption, or increasing energy efficiency, must therefore be an overarching goal. In fact, some[18] estimates that the cost of saving a kWh is 2.8 cents, whereas the retail price is about five times higher. The payback is therefore measured in months and not in years.

We should also remember REN21, "…the global renewable energy policy multi-stakeholder network that connects a wide range of key actors including governments, international organizations, industry associations, science and academia, and civil society, with the aim of facilitating knowledge exchange, policy development, and joint action towards a rapid global transition to renewable energy".[19] The results mentioned above have been eclipsed and "Renewables made up just over half of total net additions to electric generating capacity from all sources in 2012. By year's end, they comprised more than 26 percent of global generating capacity and supplied an estimated 21.7 percent of global electricity, with 16.5 percent of electricity provided by hydropower.[20]" 2012 also represented a watershed in that for the first time, the developing world invested more than the developed world.

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[13]According to Boekhoudt, A. and L. Behrendt (2013). *Taxes and incentives for renewable energy*. Zug, Switzerland, KPMG International Cooperative. p. 63.

[14]According to Boekhoudt, A. and L. Behrendt (2013). *Taxes and incentives for renewable energy*. Zug, Switzerland, KPMG International Cooperative. p. 63.

[15]According to International Energy Agency (2012). *World Energy Outlook 2012*. Paris, International Energy Agency (IEA)/Organization for Economic Co-operation and Develop (OECD). p. 700.

[16]See The Economist (2015). *Special report: Let there be light*. London, The Economist. p. 12.

[17]See The Economist (2015). *Special report: Let there be light*. London, The Economist. p. 12.

[18]The American Council for an Energy-Efficient Economy, see The Economist (2015). *Special report: Let there be light*. London, The Economist. p. 12.

[19]See REN21 (2013). *Renewables 2013: Global Status Report*. Paris, UNEP, Renewable Energy Policy Network for the 21st Century (REN21), Secretariat. p. 177.

[20]Quote from REN21 (2013). *Renewables 2013: Global Status Report*. Paris, UNEP, Renewable Energy Policy Network for the 21st Century (REN21), Secretariat. p. 177.

Unfortunately, there is no room for celebration in that renewable energy in total (as opposed to just electricity) constitutes a relatively small proportion of global energy consumption (see Fig. 6.2), which means that there is still much work to be done in developing the energy supplies toward sustainability. That said, the IEA estimates that by 2050, solar power may constitute in the best case as much as 27 percent of electricity worldwide.[21] That the growth of solar power at any rate will be enormous is beyond doubt, and it is the result of four innovations:[22] (1) regulation, (2) industrialization, (3) technology, and (4) financing. Interestingly, these were prominent factors in the Industrial Revolution as well.

Regulatory support has been paramount. A number of incentives have been used ranging from guaranteed price per kilowatt of solar power to subsidies to manufacturers of solar panels. However, the most important is that governments have realized the long-term potential of solar power and wanted to create a market for it: an infant industry as well as an infant technology argument. Germany has been most aggressive in this respect adding 35 GW of solar power in the last ten years. That this has worked seems to be clear—in 2007, all solar installations in California took subsidies, while six years later only 40 percent did (not counting the federal subsidies).

Industrialization over the last decade, chiefly in China, has led to leaner supply chains, improved economies of scale, and reduced price of polysilicon (used to make the wafers) by 90 percent. In turn, this has resulted in the cost of solar panels falling by 80 percent since 2005, and they keep falling.

The improvement of technology has also been significant. Efficiency rates have peaked at about 20 percent (two watt is produced for every ten watt of solar energy hitting the panel), but that could improve even further at some stage.

For a typical house in the USA, it costs about $15,000–$20,000 per installation. This can be a significant hurdle, but new financing models have aided the diffusion of the technology substantially by leasing so that the homeowner pays a fixed monthly fee, while the third-party owner of the installation installs it and maintains it. This approach is, of course, dependent on relatively low interest rates to work. With the poor demographic profile of many countries, this will most likely become a quite permanent condition—assuming peace and no other major type of interruptions—simply because productivity will be low in decades forward and perhaps even become negative.

The challenge with many renewable energy sources is that they depend on local conditions to a large extent and have to be backed by fossil fuels in many cases. For example, Norway with its abundant hydropower still relies on influx of power generated from fossil fuels in continental Europe to prevent significant price variations and potential power shortages. This is because hydropower depends on

[21]According to Pinner, D. and M. Rogers (2015). “Solar Power Comes of Age: How Harnessing the Sun Got Cheap and Practical.” *Foreign Affairs* **94**(2): pp. 111–118.

[22]See Pinner, D. and M. Rogers (2015). “Solar Power Comes of Age: How Harnessing the Sun Got Cheap and Practical.” *Foreign Affairs* **94**(2): pp. 111–118.

precipitation, and in a climate with more extreme variations, this may ultimately become also a less reliable source of energy.

If we talk about solar power, however, the major improvement in batteries has offered great opportunities to store the energy at night, for example. Indeed, the lack of competitive battery solutions has held back *all* renewable for years. The key to unlocking the power of renewables is therefore battery technology,[23] and great improvements have been made since 1800 when Alessandro Volta (1745–1827) invented the battery and Gaston Planté (1834–1889) invented the lead–acid battery used in cars ever since and since 1991 when the first lithium-ion batteries were produced by Sony. Costs have falling enormously as well. In 1995, a battery with a capacity of one kilowatt-hour costs $3000 compared to only $200 today. Clearly, research and development in battery technology should become a major priority in our quest toward sustainability.

Also, it is somewhat questionable the extent some of these renewable energy sources are truly sustainable and whether they actually add energy to the grid or consume more resources than what they return. An obvious example of this is wind power concerning the net benefit in terms of energy consumption, but when it comes to solar power, it requires quite exotic materials typically found in microelectronics, and it is vital that the solar industry does not repeat the same mistakes as the microelectronics industry.[24]

Another issue that needs to be solved is the cost of being connected to a grid, which is necessary. Today, these costs are largely ignored but that cannot continue indefinitely; otherwise, the utilities will have a big problem with maintaining their grids. How the economics will look is still being debated, but this is primarily a practical issue.[25]

Perhaps the most troubling aspect of renewable energy is that it may not bring any net benefits for the environment when everything is correctly accounted for. The problem is that today we compare various energy sources by comparing grand averages. Using an approach called "levelized calculations" , the total amount of power over the lifetime of an energy source is divided by the life cycle costs over the lifetime of the same energy source, but this ignores variation both in prices and supply, and the reliability of supply and demand. Therefore, the levelized cost for an energy source can be the same mathematically, while at the same time, it has very different net economic benefits. As Paul L. Joskow puts it[26]:

> In a nutshell, electricity that can be supplied by a wind generator at a levelized cost of 6¢/KWh is not "cheap" if the output is available primarily at night when the market value

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[23]According to LeVine, S. (2015). "Battery Powered: The Promise of Energy Storage." *Foreign Affairs* **94**(2): pp. 119–124.

[24]According to Mulvaney, D. (2013). "Hazardous Materials Used in Silicon PV Cell Production: A Primer." *solarindustrymag.com* **6**(8).

[25]See Warshay, B. (2015). "Upgrading the Grid: Mow to Modernize America's Electrical Infrastructure." *Foreign Affairs* **94**(2): pp. 125–131.

[26]See Joskow, P. L. (2011). "Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies." *American Economic Review* **101**(3): pp. 238–241.

of electricity is only 2.5¢/KWh. Similarly, a combustion turbine with a low expected capacity factor and a levelized cost of 25¢/KWh is not necessarily "expensive" if it can be called on reliably to supply electricity during all hours when the market price is greater than 25¢/KWh.

If we correct for these methodological mistakes induced by levelized calculations, we may get a quite different picture. For example, relative to wind plants, solar plants have much more attractive production profile because we need most of the energy during the day when the sun is shining, whereas wind can come any time during the day. So, even though the levelized life cycle cost of solar power is higher than wind energy, it provides electricity that is more economically valuable.[27] This means that we currently cannot really say which electricity generating technology is best from a life cycle perspective—at least not with accuracy and certainty. Subsidies and attempts to include externality costs such as the costs of carbon emissions make this even worse to calculate. Again, we end up with value-laden estimates disguised in economic numbers. The troubling aspect, however, is that these questionable numbers are then used as basis for policy-making.

When it comes to solar power, however, the consensus seems to be that it is net positive in both energy consumption and carbon emissions, which is good news. Hydroelectric power is very cost-effective, but very location dependent. Wind might be profitable on certain locations, but overall seems to not be a good idea thus far. Therefore, the future holds variety as the primary answer, which means that a consistent energy accounting regime will be even more important. This is particularly true if we take into account the fact that some two billion people lack electricity outright or have very poor service. The average American consumes 50 times more energy than an average Bangladeshi and 100 times more than an average Nigerian.[28] This is not because they do not want to consume more energy—it is simply not available. In fact, a group of researchers led by Vijay Modi has shown that villagers in Mali and Uganda are willing to pay about ten times higher price than the typical prevailing price in developed countries.[29] Not only that, the IEA believes that the number of so-called energy poor will remain close to what it is today 20–30 years down the road. So, we are far from solving the energy issues.

Therefore, focusing on energy consumption, or energy efficiency, can become a crucial aspect of sustainable development no matter how we look at it. Solar power will help, but it is no panacea if our world is to become sustainable for all.

Whether or not energy accounting can be politically sellable is hard to say, but since energy accounting is fairly simple, it is at least much easier to explain and implement than complex systems such as the ones discussed in Chap. 2. What is

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[27]See Joskow, P. L. (2011). "Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies." *American Economic Review* **101**(3): pp. 238–241.

[28]See Bazilian, M. D. (2015). "Power to the Poor: Provide Energy to Fight Poverty." *Foreign Affairs* **94**(2): pp. 133–138.

[29]Quoted by Bazilian, M. D. (2015). "Power to the Poor: Provide Energy to Fight Poverty." *Foreign Affairs* **94**(2): pp. 133–138.

positive is that the IEA is proposing an Energy Development Index (EDI) to track national development toward providing modern energy access.[30] Why not go all the way as suggested here and provide a consistent framework for tracking energy consumption and thus promote energy efficiency across whole economies and indeed the global economy? Modern energy access will be an important by-product. It is also worth noting that in the aftermath of the 2008 Financial Crisis, a whole array of improvements were implemented that years before would probably had been seriously resisted. This goes to show that old dictum—where there is a will, there is a way.

The remainder of this chapter is organized by first exploring some other forms of energy accounting found. Then, an important concept—"energy content"—is defined followed by a presentation of the overall framework. The last two sections concern implementation and pros and cons.

6.1 Other Forms of Energy Accounting

> Never ask for money spent
> Where the spender thinks it went
> Nobody was ever meant
> To remember or invent
> What he did with every cent.
>
> Robert Frost
> The Hardship of Accounting

In the literature, there are several types of energy accounting. The California Energy Commission (CEC) is working on[31] one type of monetary energy accounting for managing utility costs. For CEC, energy accounting is a tool for managing energy costs. Figure 6.3 shows a spreadsheet for manual reporting. There are software tools available as well. However, their experience is that energy accounting in this monetary sense will not help by itself, but "energy accounting can help your organization understand how energy is used and can help motivate people to take actions that can result in significant utility cost savings."

A more holistic approach has been taken by Intel Corporation. At the start of 2008, the CEO of Intel, Paul Otellini, set out to reduce environmental impact in key areas, including energy and water, with a 20 percent reduction in emissions on 2007 levels by 2012. By 2011, Intel had achieved 60 percent reduction compared to 2007 with 41 percent increase in sales. A part of this was the usage of videoconferencing instead of physical traveling, and in 2011, this gave a 65,000 metric tons

[30]See International Energy Agency (2012). *World Energy Outlook 2012*. Paris, International Energy Agency (IEA)/Organization for Economic Co-operation and Develop (OECD).p. 700.

[31]See California Energy Commission (2000). *Energy Accounting: A Key Tool in Managing Energy Costs—Energy Efficiency Project Management Handbook*. Sacramento, CA, California Energy Commission: Energy Efficiency Division.p. 30.

Energy Accounting Worksheet					
Facility:	Fairfield School		Year:	1995	
Account:	TPY 47 6209		Meter #:	2S5987	
Month	Usage kWh	Demand KW	Cost	Number of Days	Cost/Day
January	53,000	210	$5,013.80	30	$167
February	50,100	195	$4,739.46	29	$163
March	52,300	203	$4,947.58	31	$160
April	49,700	191	$4,701.62	29	$162
May	55,200	245	$5,221.92	31	$168
June	62,800	270	$5,940.88	32	$186
July	71,200	280	$6,735.52	30	$225
August	70,600	284	$6,678.76	30	$223
September	68,000	275	$6,432.80	31	$208
October	53,200	210	$5,032.72	30	$168
November	54,700	198	$5,174.62	29	$178
December	53,900	204	$5,098.94	34	$150
Total	694,700		$65,718.62	366	$180

Fig. 6.3 Energy accounting worksheet from the California Energy Commission (see California Energy Commission (2000). *Energy Accounting: A Key Tool in Managing Energy Costs—Energy Efficiency Project Management Handbook*. Sacramento, CA, California Energy Commission: Energy Efficiency Division. p. 30.)

reduction of CO_2 emissions with cost savings exceeding $73 million.[32] Needless to say, although greatly encouraging for Intel, is that this kind of excellent performance has resulted in many acclaimed awards such as winning Computerworld's Top Green-IT Organization in both 2010 and 2011.

Both these cases are interesting in that they show that great savings can be achieved by embarking on a "green" voyage similar to the first sustainability wave style mentioned in Chap. 1. The puzzling part is why only so few corporations adopt this kind of thinking, and an intriguing question is what could CEC and Intel achieved if they had been aided by energy accounting as envisioned in this book? While a clear-cut answer to these questions is difficult, I think it is safe to argue that when it comes to that adoption rate, there are a number of reasons:

1. Lack of management knowledge, attention, and focus—basically, there are bigger savings to be achieved by focusing on other issues. Also, the attitude toward environmental issues is varying a lot. Some care, but do not know how to proceed. Some care and can, while others neither care nor can.
2. Lack of consistent pressure from governments. Much of the achievements in the automotive industry have been achieved due to regulatory pressures.

[32]For the whole case, see Curry, E., B. Guyon, C. Sheridan and B. Donnellan (2012). "Developing a Sustainable IT Capability: Lessons From Intel's Journey." *MIS Quarterly Executive* **11**(2): pp. 61–74.

Thus, if we had information consistency through the supply chains in all industries—as secured by an accounting system—and regulatory pressure, it is likely that the Intel case could become the norm and not one of few sunshine stories amid a large corporate world that does not care or lack competence about it. Robert Frost would definitively have an easier job.

For energy accounting to work as envisioned in this book, we rely on the important concept of energy content—something akin to the cost of something. This is discussed next.

6.2 Defining Energy Content

A well directed imagination is the source of a great deed.

Chinese Proverb

As the word "content" alludes to, energy content is the energy contained in something in the sense that the given amount of energy has been expended in the supply chain to produce and distribute something. This "something" can be either a physical object (like a product) or service. The energy content is defined as the sum of all the energy consumption expended in the supply chain up to the assessment point of that particular object or service. Thus, a natural phenomenon has no energy content by this definition—unless we build a device to harness the energy. Then, we must include the energy we spent building that device.

Before continuing, note that energy content is therefore similar to the monetary cost or the price of something. Note that it is written "cost" *or* "price"—this is to signify that there will be no profit in the monetary sense. It will be purely a way to transmit energy content information throughout the supply chain. The assessment point is the point in the supply chain where an assessment is conducted, while the supply chain represents all the upstream activities. Human energy consumption in terms of food is not included since we need to eat no matter what. Companies producing food are nevertheless also subject to energy accounting to ensure that food is produced as energy efficiently as possible, and consumers can buy food according to the energy content if they want.

Consider Fig. 6.4 where a simplified illustration is provided; the total energy content of electricity created from renewable energy resources is the overhead energy consumption (energy consumed when, e.g., building the hydroelectric power plant) plus the direct production energy consumption (energy used to run the power plant). The total energy content is then divided by the electricity output of the power plant to find the energy content of 1 kWh. Thus, there are no direct energy expenditures from the input itself (water), because renewable energy harnesses the energy directly from nature which is not depending on human resource expenditures. Consequently, the direct sources of renewable energy have no energy content according to our definition. For example, a tornado has enormous amount of energy, but the energy content is zero.

Non-renewable energy, on the other hand, is associated with direct energy consumption in bringing the input to the process of generating electricity. In that case, the energy content of the electricity is roughly the same as for the renewable energy plus the direct energy consumption of the input. The direct energy consumption is, e.g., the amount of energy spent in extracting crude oil plus the amount of energy spent in refining it (see Fig. 6.4). In addition, the supply chain for non-renewable energy is longer than that for renewable energy as shown in Fig. 6.4, which induces energy expenditures not illustrated in the figure as well.

In Table 6.1, Fig. 6.4 is explained with a numerical example of how the energy content of 1 kWh oil-generated power is to be determined. The numbers are only for illustration, of course. We see that the direct energy consumption consists of three values—"raw material extraction," "raw material processing," and "production."

Assuming that we are production in this value chain (since it stops there), the energy content of the extraction and processing processes is really the energy

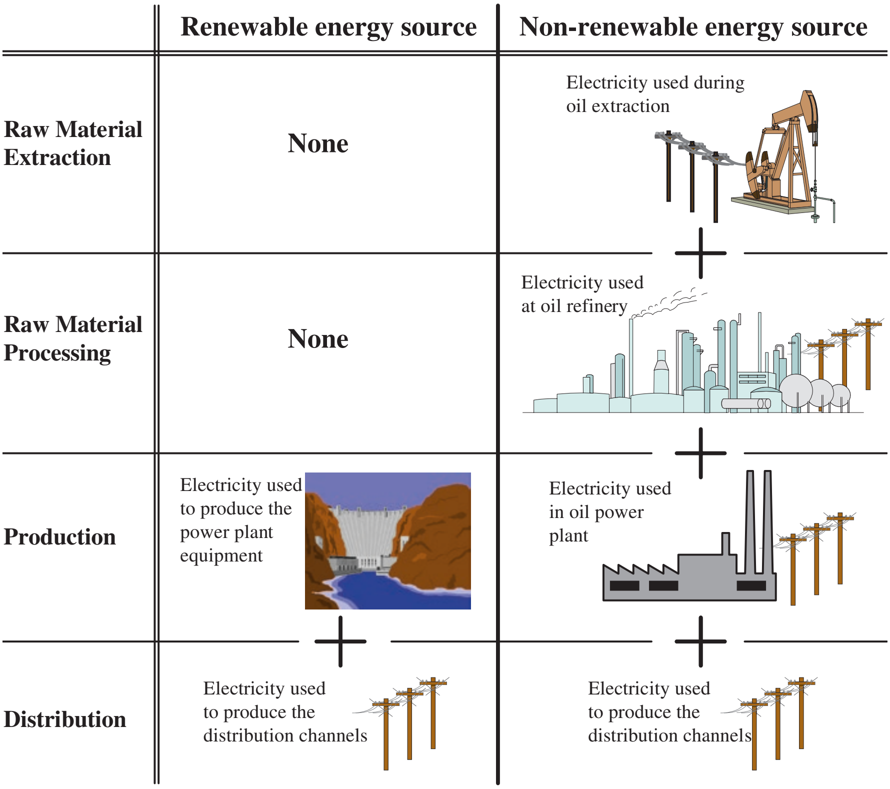

Fig. 6.4 Energy content calculation of hydroelectric versus fossil fuel power

Table 6.1 Energy content calculations of 1-kWh oil-generated power

Activity	Input	Output	Energy consumption (MJ/year)			
			Direct		Overhead	Total
			Purchase	Production		
RM extraction		1,000,000 c.o.b./year	0	300,000	50,000	350,000
RM processing	750,000 c.o.b./year	700,000 o.b./year	262,500	1,000,000	300,000	1,562,500
Production	500,000 o.b./year	2,000,000 kWh	1,116,071	350,000	250,000	1,716,071
Direct EC	1 kWh					0.86
Distribution	5,000,000 kWh	4,500,000 kWh			500,000	500,000
Overhead EC	1 kWh					0.11
Energy content	1 kWh					0.97

Note! *EC* is the short for “energy content,” *RM* is the notation for “raw material,” *c.o.b.* is the short for “crude oil barrels,” and *o.b.* is the short for “oil barrels.”
Total energy consumption = direct purchase energy content + direct production energy consumption + overhead energy consumption

content of purchased raw materials for production. We see that in this case, the energy content of 500,000 purchased oil barrels is 1,116,071 MJ (megajoule, where 1 MJ = 3.6 kWh). The overhead energy consumption is energy consumed by support activities not related to production—just like overhead costs. In this case, we talk about "distribution." Ideally, we should have included the energy content of building the facilities and discounted it over the life span of the facility. The sum of direct energy consumption and overhead energy consumption is the total energy consumption. The value chain is as follows:

- The raw material extractor produces 1,000,000 barrels of crude oil per year, and 350,000 MJ (300,000 MJ + 50,000 MJ) of energy is consumed by that company. The raw material extractor then sells 75 percent of the production to the next link in the value chain—the raw material processor that may be another business unit of the same company or a totally different company—the remaining 25 percent is sold somewhere else.
- The crude oil the raw material processor bought has a purchase energy content of 262,500 MJ [350,000 MJ * (750,000 c.o.b./1,000,000 c.o.b.)]. The processing itself requires an additional 1,000,000 MJ annually, which gives a total energy consumption of 1,562,500 MJ—including 300,000 MJ in overhead. The output from this processing is 700,000 oil barrels, and 500,000 of them are sold to the next link in the value chain. The remaining 200,000 are sold somewhere else.
- Similarly, the oil power plant produces 2,000,000 kWh annually by burning the 500,000 oil barrels it bought from the raw material processor. The purchase energy content is 1,116,071 MJ [1,562,500 * (500,000 o.b./700,000 o.b.)]. The total energy consumption is 1,716,071 MJ/year, which divided by the total output (2,000,000 kWh) gives 0.86 MJ/kWh. However, the power needs to be distributed to the customers before we have the total energy content of 1 kWh.
- The distribution transfers 5,000,000 kWh, but due to losses, only 4,500,000 kWh are actually received by their customers. The energy spent in keeping the distribution network operative is 500,000 MJ. The distribution energy consumption of 1 kWh is then simply 500,000/4,500,000 MJ/kWh, which is 0.11 MJ/kWh.
- The total energy content of 1 kWh is then the sum of direct energy content and overhead energy content, which yields 0.97 MJ/kWh. This means that to provide the consumers with 1 kWh, the value chain expends 0.97 MJ (or 970 kJ) per kWh.

Similar calculations in the case of renewable energy are shown in Table 6.2. We see that due to the much simpler supply chain—no raw material extraction resource usage—renewable energy has lower energy content (greater energy efficiency). According to the made-up numbers, the energy consumption is more than 50 percent less, and hence—using the logic in this book—we assume that the environmental impact is about 50 percent lower as well although we are not able to specify exactly how because then we enter the value-laden field of judgment. In this fashion, we see that energy accounting would enable the marketplace to make informed choices about what kind of energy to purchase. However, there may be cases where non-renewable energy can be more environmentally friendly than renewable energy if the overhead energy consumption by the renewable energy

Table 6.2 Energy content calculations of 1 kWh hydroelectric power

			Energy consumption (MJ/year)			
Activity	Input	Output	Direct		Overhead	Total
			Purchase	Production		
Production		2,000,000 kWh		350,000	250,000	600,000
Direct EC	1 kWh					0.30
Distribution	5,000,000 kWh	4,500,000 kWh			500,000	500,000
Overhead EC	1 kWh					0.11
Energy content	1 kWh					0.41

sources is very large or the electricity output is very low or the output is very unpredictable such as for windmills in many locations. Again, energy accounting enables informed choices throughout the supply chain.

To sum up this illustrative example, renewable energy sources have no direct energy content because it is generated by nature, while non-renewable energy is brought into the effect by human resource expenditures and is therefore associated with direct energy content and a longer supply chain. Renewable energy sources will therefore in many cases be more energy efficient and therefore be a more sustainable source of energy, provided that the output is significant and stable enough.

6.3 The Framework Supporting Energy Accounting

Action will remove the doubt which theory could not solve.

Chinese Proverb

Just as monetary accounting, energy accounting would also rely on certain principles. If we take a look at the Generally Accepted Accounting Principles (GAAP) which refers to thousands of tenets, practices, and principles, they represent to a large extent the product of political maneuverings and represent a series of compromises between users, practitioners, and governmental interests. The Financial Accounting Standards Board is constantly pressured to change existing standards and to develop new ones. There is no reason to believe that a similar approach cannot be established for energy, and for the USA, it will be an extension of the 1987 National Appliance Energy Conservation Act which established minimum standards for 12 products[33] and the 1992 Energy Policy Act which extended the mini-

[33]See Levine, M. D., J. G. Koomey, L. Price, H. Geller and S. Nadel (1995). "Electricity End-Use Efficiency with Technologies, Markets, and Policies Throughout the World." *Energy* **20**(1): pp. 37–61.

mum efficiency to a wider range of products.[34] The critical element will be definition of energy content because that will determine a lot of what such an accounting scheme will report.

To make energy accounting work, an international organization to standardize the principles should be formed or an existing organization can take the job. An energy taxation organization can also be formed by the nations that constitute an energy accounting area, which is to determine taxation issues, energy customs, and benchmarking for a certain geographical area. Then, in the USA, for example, the Department of Energy can be responsible for implementation of an energy tax and energy customs estimation. The energy tax will be a monetary tax corporations must pay to the authorities. The tax can, for example, be 1 USD/MJ, which means that if a company consumes 100,000 MJ/year, the energy tax will be 100,000 USD/year. The estimation of customs tax is more difficult because there are two cases:

- Case I—Imported goods from countries within the energy accounting area. In this case, the energy taxation organization set a customs tax rate, similar to the taxation, e.g., 1 USD/MJ. Like in the current monetary accounting systems, deliberately wrongful estimations are possible; however, since the energy tax is the same in all countries within an energy accounting area, there is no incentive to underestimate energy content estimates.
- Case II—Imported goods from countries outside the energy accounting area. This case involves some political issues, because some poor countries simply do not have the information infrastructure nor the capability to acquire this infrastructure to carry out energy accounting. In this case, the energy taxation organization set benchmarks based on the best performing comparable products within the energy accounting area, which in essence is a subsidy to poor countries. For countries, that do not "care" the energy taxation organization can set the worst comparable products within the energy accounting area as benchmark, which will make it harder for companies from such countries to compete. Thus, countries outside the energy accounting area is not an accounting problem, but it may, however, be a political problem.

To make energy accounting workable, some other key issues need to be incorporated, e.g.,

1. Depreciation of long-lived assets to the specified accounting period. This is important since we ideally want to handle overhead energy consumption. Depreciation is of particular interest here since depreciation directly will affect how beneficial it is to use recycled (depreciated) material. When the material is entering the process of recycling, the energy content is zero, because when material is ready for recycling, it is in essence raw material ready for extraction. Once the material is recycled and ready for use, however, the material has an energy content that will depend on the efficiency of the recycler.

[34]See Congress, U. S. (1992). *Energy Policy Act of 1992*. Washington DC, U.S. Government Printing Office.p.

2. The matching principle relating energy consumption to a specific product or service. This is important in a monetary accounting system as prices of products are important for competition. In energy accounting, the situation is somewhat different, because the energy tax is for the overall corporate consumption and not the individual products. However, for a corporation to have good energy consumption management, the matching principle is important, because it is important for the corporation to understand what causes energy consumption and not just the magnitude of it in the aggregate. Also, the energy content of a product can be used in marketing efforts as well as a selection criterion in procurement.
3. The relation of other energy consumption to a particular accounting period. This is important for taxation purposes, preventing (or maybe allowing) corporations to "fix" years with high energy consumption by transferring energy consumption numbers to another period and thereby flattening out the average annual energy consumption.
4. The principle of conservatism. In financial accounting, this implies that costs are to be put at the lower estimates, e.g., estimates of inventory. In energy accounting, however, it is opposite—the energy estimates are to be put at the high estimates.
5. Audit from third party just like with monetary accounting will be necessary.

Other principles need to be incorporated as well, but this is currently beyond the framework outlined here because it concerns only high-level concepts. Also, the purpose here is not to outline this system in every detail but to rather show that we can use today's accounting systems as basis for an energy accounting system that will produce reliable, extensive, and value-free estimates for all the participants in the economy. For governments, there will be many ways to influence corporate behavior via this system and associated systems such as taxation systems, for example. Next, some issues on the implementation are aired.

6.4 Implementing Energy Accounting

> If we do not change our direction, we are likely to end up where we are going.
>
> Chinese Proverb

Technically speaking, implementing energy accounting is straightforward. Forty years ago, it would have induced large costs to corporations, but today, with the modern IT systems, it is just a matter of political will. To ease the implementation, we can simplify it by omitting overhead energy expenditures the first few years and focus solely on the direct energy content. It will still be a huge leap forward from today's situation where nobody knows what the true energy content is of anything.

There is also doubt from academia. Some researchers apparently like the idea of energy accounting but find it impossible because organizations do not know where all their supplies come from.[35] This argument holds if and only if energy accounting is implemented in an ad hoc manner, because the materials requirement planning (MRP) systems in a company traces where all "bolts and nuts" come from. In the approach to energy accounting discussed here, the energy content will be provided along with the price of the product and corporations will have a direct financial incentive (tax and customs) to reduce the energy content of their products. This can only be achieved by (1) reducing the overall energy consumption in the corporation or by (2) producing more with the same amount of energy consumption or most likely (3) a combination. Irrespective, the energy efficiency will be improved, and thereby also the environmental impact.

To implement energy accounting, the following approach of implementation can be envisioned: The very first step is to determine the principles and details for accounting, e.g., according to the principles outlined here. Then, the following steps of implementation can be followed:

- Year 1—all corporations that extract material from earth (raw material extractors) must record and submit to authorities in the country how much energy they spend totally and per product unit in terms of, e.g., MJ electric power consumed.
- Year 2—all corporations that buy the products from the raw material extractors (manufacturers) must record and submit to authorities in the country how much they bought from the raw material extractors in terms of MJ and how much electric power they used.
- Year 3—all corporations that buy the products from the manufacturers (service industry) must record and submit to authorities in the country how much they bought from the manufacturers in terms of MJ and how much electric power they used.
- Year 4—all other corporations must record and submit to authorities in the country how much they bought from the others in terms of MJ and how much electric power they used.
- Year 5—value-added taxes (VAT) are restructured partly away from monetary costs toward energy content, for example. Alternatively, an explicit energy tax can be envisioned. This will help corporations and individuals alike go for the products and services with the lowest energy content both indeed and according to their wallet whichever comes first. Once this is achieved, the economy will start changing toward a more sustainable future.

After this first-stage implementation, the government can collect energy taxes, which finally introduces a market-based system *without* serious data deficiency where energy consumption will become an important factor in the management and success of any corporation. It is clear that in the first few years, the energy consumption estimates will be crude, but after 5–10 years the estimates should be fairly reliable and stable. The submission of records to the government in a

[35] See, for example, Finch, E. F. (1994). "The Uncertain Role of Life Cycle Costing in the Renewable Energy Debate." *Renewable Energy* **5, part II**: pp. 1436–1443.

country makes it possible to validate and cross-check the records from each and every company, preventing errors and crime. With today's IT systems, this is really not a problem. It is a matter of choice.

6.5 Pros and Cons

> There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things.
>
> Niccolo Machiavelli
> The Prince (1532)

It is clear that energy accounting will cause some upheaval in corporations as they have to implement a parallel system to their already existing monetary accounting systems, which undoubtedly will increase the costs of running a corporation in the short term. However, due to IT this will not be a big problem. The shear economic benefit on both individual level and societal level from improving the energy efficiency is addressed in many publications[36] and mentioned earlier as well. I therefore believe that implementing a mandatory energy accounting system will eventually result in a win-win situation after the initial period of possible confusion and discussion about rules, implementation, and complaining about the costs of implementation.

The greatest challenge with the whole idea is political—it will most likely be a hard sell. However, with the swiftness, we managed to ratify the ineffective measures discussed in Chap. 2, and if there is will to foster sustainable development, then energy accounting is something that should be contemplated. Thus, it will be hard to implement but not impossible—the point here is to merely air the idea.

Another issue is the possibility of deliberately underestimating the energy consumption of a corporation. Just as that can be done in existing monetary accounting systems, that can also be done in an energy accounting system; however, it will not be any easier than that in the existing systems since it is built up along the same principles. It must be so because in many countries, there is an inherent skepticism toward more intervention in the marketplace by governmental or supranational organizations. Needless to say, this can seriously jeopardize the credibility of energy accounting if it is perceived as such. However, similar sentiments have been aired when new drastic measures have been carried out in history. Furthermore, if we think that sustainability can be achieved *without the slightest change in behavior*, it will be farfetched. Changes will be miniscule if *status quo* is to prevail.

[36]See, for example, Levine, M. D., J. G. Koomey, L. Price, H. Geller and S. Nadel (1995). "Electricity End-Use Efficiency with Technologies, Markets, and Policies Throughout the World." *Energy* **20**(1): pp. 37–61.

There are consequently good reasons for believing that energy accounting is money well spent for present *and* particular future generations. In fact, due to the energy savings, it may even give a significant net economic return. However, it needs to be performed as a systematic and integrated aspect of every corporation and not on an ad hoc basis. This will also meet the specification from Schmidt Bleek of the Wuppertal Institute: "A system must be found that is sufficiently simple, safe and cost-effective so that a million products can be assessed quickly and repeatedly." This is in essence what a monetary accounting system does, and as we see this is also possible in an energy accounting system. Thus, the advantages outweigh the disadvantages. Ultimately, we have to think of the words of John F. Kennedy;

> There are risks and costs to a program of action, but they are far less than the long-range risks and costs of comfortable inaction.

Then, we have a weighty counterargument that must be dealt with. It revolves around the simple fact that why not work on making energy generation more environmentally friendly at the source instead of instituting a system for identifying how energy is consumed in order to put in place incentives to reduce environmental impact? While this question seems to be logic and simple, it is in fact not. Take some of the renewable energy resources, they are today portrayed as environmentally friendly because they allegedly result in no climate gas releases—zero emission is the mantra. A windmill, for example, is believed to be completely environmentally friendly since it harvests a free resource (wind) without any smokestacks attached. Unfortunately, this is most likely a big illusion. The energy consumed in making the windmill or making a battery pack for storing energy is not accounted for. If this is also compared to the relatively minor and unpredictable output of windmills, it is clear that they are costly and unclear as to the environmental performance. However, they may have some merit certain places on earth where the wind is stable and suitably strong. Thus, they can be good local supplement, but not the main source of energy on national or global scale. Thus, when one of the founders of Green Peace, Patrick Moore, travels the world to promote nuclear power,[37] it is due to a simple realization—it is the only alternative source to fossil fuels that as of today can significantly impact the energy supply anywhere and have low/no CO_2 emissions. Or at least, so it seems—without energy accounting we cannot really tell.

The challenge to nuclear power is obvious after a number of accidents—it has a poor public image. This is exacerbated by the fact that risk analyses of high-impact, low-probability (HILP) issues are providing incorrect decision support causing unnecessary public worries. Therefore, in the next chapter, a discussion on risk analyses for HILP cases is provided. This also goes for technological development in general—we cannot analyze alternative, technological solutions the wrong

[37]See, for example, an interview with him by Murphy, G. (2008). "A Conversation with Patrick Moore: Why Former Greenpeace Leader Supports Nuclear Energy." *EIR Science & Technology*(16 May): pp. 58–63.

way. Then, we risk deciding on the wrong solution and that is definitively not the way to proceed toward a sustainable future as discussed earlier.

In short, this chapter has tried to revive an old idea. The implementation, however, is different than before. The difference is that the discussion here calls for a *comprehensive* and *mandatory* framework whose purpose is to bring the *entire economy* and *entire supply chains* into consideration. To do that, it is proposed to extend today's monetary accounting and GAAP into energy accounting. This is feasible due to IT systems, and moreover, it will most likely not cost more than it tastes. In fact, due to the potential large energy savings, it will most likely result in a net economic gain, especially if global energy demand rises as projected. However, and most importantly, due to the strong correlation between energy consumption, socioeconomic development, and CO_2 emissions, energy accounting may be an important step toward sustainability by helping us with the vital information flow necessary to assess the true energy efficiencies for products, services, and processes throughout a global economy. Then, we can establish a market-based approach where the invisible hand can become green as discussed in Chap. 5. Unfortunately, it is only by trying we can find out, and this may not be the best way or definitively not the *only* way. However, we must try something different than today's approach because it is obviously not working sufficiently as discussed in Chaps. 1 and 2. In the wise words of Franklin D. Roosevelt:

> It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something.

So, I think our global community should try out something like energy accounting as outlined here. The details must, of course, be discussed and sharpened, and there are probably several practical hurdles to revolve concerning international trade and countries that do not want to adopt the system. I would, however, argue that energy accounting will be far less contentious than the ETS or similar trading schemes. More importantly, it will most likely produce tangible results, which is the best way to measure its merit.

Chapter 7
Technological Development—Necessary but not Sufficient

An important scientific innovation rarely makes its way rapidly winning over and converting its opponents; it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning.

Max Planck
The Philosophy of Physics, 1936

Economic studies estimate that technological change has contributed to over half of the growth in economic output since the Great Depression and 17 percent or more in the growth of productivity since 1973.[1] Yet, at the same time Nobel Laureate Robert Solow identified what later became called the "Solow paradox" as he once quipped that "you can see the computer-age everywhere but in the productivity statistics."[2] The paradox has been defined as the "discrepancy between measures of investment in information technology and measures of output at the national level,"[3] but its causes are still disputed.[4] Some argue that recent innovations in the digital world are basically less impressive than they seem and certainly not sufficient to offset the effects of demographic change, inequality, and indebtedness, whereas others claim that it is simply a matter of time because there is significant time lag between technological progress and improvements in productivity.

The long and winding road of technological development is therefore important to understand to have a realistic sense of what can be achieved within what time

[1]According to Fagerberg, J. (1994). "Technology and International Differences in Growth Rates." *Journal of Economic Literature* **32**(September): pp. 1147–1175.

[2]See Solow, R. M. (1987). "We'd Better Watch Out." *The New York Times*(July 12): pp. 36.

[3]See Wetherbe, J. C., E. Turban, D. E. Leidner and E. R. McLean (2007). Information Technology for Management: Transforming Organizations in the Digital Economy. Hoboken, NJ, John Wiley & Sons: pp. 720.

[4]According to The Economist (2014). *Special report on World Economy: The third great wave*. London, The Economist. p. 18.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_7

frame in our quest toward sustainability. Of equal importance is to understand how it is being evaluated because that has to do with *what* technology is promoted to the market and what ends up being largely forgotten. It is particularly four aspects of evaluation that are important to shed light upon:

1. Risks—this has a direct impact as to whether or not the technological solution is acceptable or not as the situation around nuclear power so amply illustrates. It also has to do with how the solution will eventually materialize itself as a product through various fail-safe mechanisms, robustness to randomness, etc. It is also a highly critical element of the nuclear power debate which is a debate it is impossible to ignore in this book.
2. Cost—this has direct impact as to whether the solution will be viable in the marketplace from an economic perspective.
3. Quality—this has a directly impact on the life cycle performance of the solution. This is a well-researched field, and there are many influential writers to consult for more information including Deming, Joseph Moses Juran (1904–2008), and Genichi Taguchi (1924–2012).
4. Energy consumption, or ideally we would like environmental impact but that is currently not practical—if we had a system for conducting energy accounting, this could have become a part of such evaluations, but as of today it is not feasible as discussed in the previous chapters.

When it comes to cost, I would like to refer to my book on Activity-Based Life Cycle Costing,[5] which covers also risk and uncertainty analyses in the context of cost management. Thus, in this chapter I will focus on technological development as such and risk analyses in general related to development of technology with high negative impact if things go wrong, such as nuclear power. Since it is important to have some understanding of the nature of technological development, the discussion on technological development proceeds the one on risk. However, risk management is equally important because technological development is fraught with risk.

Before proceeding, it should be noted that with "technology" it is understood not just material artifacts but the "application of knowledge to the practical aims of human life or to changing and manipulating the human environment. Technology includes the use of materials, tools, techniques, and sources of power to make life easier or more pleasant and work more productive. Whereas science is concerned with how and why things happen, technology focuses on making things happen."[6] It is important to realize that the "soft" aspects of technology are perhaps much more important than the "hard" aspects and certainly much harder to manage. It is perhaps instructive to look at one of the most recent, major technological waves—computer development; from 1988 to 2003, the effectiveness of computers increased 43 million times. However, better processors only accounted for a minor part of this improvement—improved algorithms accounted for the

[5]See Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[6]This definition is from http://www.merriam-webster.com/dictionary/technology.

lion's share.[7] Thus, when we talk about technological development, we must take a wide approach and possibly realize that the road to sustainability is probably not secured by a miracle machine but rather by new ways of doing things. This may also shed light upon the Solow paradox—new technology in itself may not produce much effect unless there is a genuine change in practice.

Today, technological development has become more or less synonymous with innovation, which is discussed next. In the past, happenstance was just as important as a process like innovation. Happenstance, however, is not the way to proceed for sustainable development, so it is not discussed any further. Although happenstance will probably be a big contributor in the future also.

7.1 The Ways of Innovation

> Concerns for man and his fate must form the chief interest of all technical endeavors. Never forget this in the midst of your diagrams and equations.
>
> Albert Einstein

Innovation including Research & Development (R&D) has become an entire industry—large R&D institutions and departments in corporations live well off these pastures. R&D constitutes about 1 percent of gross domestic product (GDP) in the EU, whereas in the United States R&D constitutes 1.7 percent of GDP, and globally about ¾ of all R&D activity is conducted in the private sector.[8] In fact, in the UK it is estimated that two-thirds of the productivity growth in private sector between 2000 and 2007 was due to innovation,[9] and a worldwide study confirms the importance of innovation in developed countries in general.[10] More than 80 percent of executives find innovation extremely or very important to their corporation's growth strategies.[11] Thus, innovation is important—also for sustainable development, which is why understanding the innovation process in technological development is important.

Before we continue, we must define what we mean by R&D. R&D is defined by the OECD as "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society

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[7]This interesting fact is from Brynjolfsson, E. and A. McAfee (2012). *Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity, and Irreversibly Transforming Employment and the Economy*, Digital Frontier Press. p. 98.

[8]These data are from PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[9]According to NESTA Innovation Index 2009, see www.nesta.org.uk.

[10]See OECD (2010). *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*. Paris, Organisation for Economic Co-operation and Development. p. 226.

[11]According to Capozzi, M. M., B. Gregg and A. How (2010). *McKinsey Global Survey results: Innovation and Commercialization, 2010*. Boston and Los Angeles, McKinsey & Company. p. 8.

and the use of this stock of knowledge to device new applications."[12] This includes basic, curiosity-driven science as well as application or market-oriented research.[13] As we shall see a little later, innovation is a term also encompassing activities that do not necessarily involve so much research in the sense just mentioned. Innovation and R&D is therefore not the same, but strongly related.

The idea of bringing about change intentionally stretches back to the Enlightenment which had introduced the idea "*that human beings could control their future through intended change, that people could make causal forces work for their own well-being* [italics not added][14]." Today, methods to bring about deliberate change in the shape of innovation for the benefit of technological development have been developed further and further. However, often this is impeded by poor management or execution—the success rate of R&D projects is abysmal as will be evident from reading Sect. 7.1.1—or by governments whose policies unintentionally inhibit such change. The latter will be discussed in the next chapter, but next, the innovation process is outlined. This is important because a lot of people in my experience fail to take into account the whole process. Some focus intensively on getting a good idea, some focus intensively of getting any volume out of it, whereas others are concerned about the diffusion of the innovation in society. However, to succeed the whole process must work. In short, there are four main steps:

1. Creative search for the invention,
2. Screening which invention to develop,
3. Commercializing the innovation, and
4. Diffusing the innovation into society at large.

These four main steps are outlined in subsequent sections. Note that this is not like the prototypical linear model of innovation so many have been taught in school. The linear model of innovation is depicted in Fig. 7.1, and it follows sequentially from new scientific discoveries to the development of new products, processes and services, production, and finally marketing and sales. This model gained a lot of support after World War II due to its success in explaining the process behind a number of important, new military capabilities such as the atomic bomb.[15] In fact, the science advisor to Franklin D. Roosevelt, Vannevar Bush (1890–1974), wrote a

[12]See OECD (2002). *Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*. Paris, Organisation for Economic Co-operation and Development. p. 256.

[13]According to Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

[14]According to Burns, J. M. (2003). *Transforming Leadership: A New Pursuit of Happiness*. London, Atlantic Books. p. 319.

[15]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

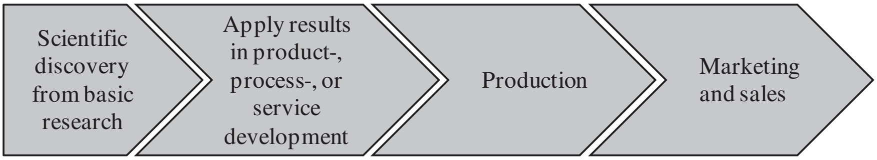

Fig. 7.1 The linear model of innovation

treatise titled *Science, The Endless Frontier*[16] in the 1920s in which this model was promoted.

The linear model, however, is at odds with most current findings on innovation, but the most disturbing aspect of it is that it makes the innovation process look sequential when it is iterative[17] and also concurrent.[18] Its sequential nature has also lured scores of business executives to believe that they can outsource parts of it without consequences. With a demanding target like sustainable development in mind, the first thing we have to do is to rid our mind of any linear delusions. When this is done, we can read on and enter the world of non-linear innovation. A model that illustrates the complex interactions is the so-called chain-link model of innovation.[19] However, Fig. 8.1 does an equally good job based on an empirical study of UK.

7.1.1 Creative Search for the Invention

The interplay between the environment and the corporation is important to understand in order to understand innovation—as Tom J. Peters and Robert H. Waterman Jr. put it in *In Search of Excellence*; "innovative companies are especially adroit at continually responding to changes of any sort in their environment."[20] In order to understand how innovations, the environment, and a corporation interact, we must distinguish between the types of innovations and their sources. If we read the literature on innovation, we find scores of definitions

[16] A reproduction was issued in Bush, V. (2011). *Science, the endless frontier; a report to the President on a program for postwar scientific research*. Charleston, SC, Nabu Press. p. 250.

[17] See, for example, the engineering design process of Pahl, G. and W. Beitz (1984). *Engineering Design*. London/Berlin, The Design Council/Springer-Verlag. p. 450.

[18] According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[19] See Kline, S. and N. Rosenberg (1986). An Overview of Innovation. *The Positive Sum Strategy*. R. Landau and N. Rosenberg. Washington, DC, National Academy Press: pp. 275–305.

[20] See Peters, T. J. and R. H. Waterman Jr. (1982). *In Search of Excellence: Lessons from America's Best-Run Companies*. New York, HarperTrade. p. 360.

and interpretations. In Webster's,[21] we find innovation definedsimply as "something new or different introduced." Most studies in the literature focus solely on the newness or novelty part.[22] "Differentness" seems to be ignored, or it may at best lie implicit in the discussions found on what is often referred to as *radical innovations* versus *incremental innovations*. In any case, the result is that important types of innovation are usually forgotten because we get entangled in nomenclature as the mind gets framed or caged in as it were. Even the influential[23] definition that innovation is "…the processes by which firms master and get into practice product designs and manufacturing systems that are new to them[24]" ignores this fact. This is too simplistic.

The process of innovation is nonlinear and complex, and it crucially starts with an invention of some sort. This invention can be anything, and we can for examplediscuss the resulting innovation from a number of perspectives: (1) nature of innovation, (2) scale of innovation, (3) scope of innovation, (4) approach of innovation, and (5) sources of innovation. There are possibly other perspectives as well. The first four perspectives are depicted in Fig. 7.2, whereas "sources of innovation" is somewhat a different perspective in that we look behind the innovation as it were. Depending on the situational factors, the exact configuration of these perspectives will vary. Hence, the grid in the middle of Fig. 7.2 is to signify that there are almost a limitless number of configurations in real life although from the figure we calculate 320 configurations. Also, the boxes in the figure are not as clear-cut in reality as they appear in the figure—models and figures must necessarily simplify. The most important, however, is to not accept this as "the truth" either—because then we have already created a mental cage which in the next turn will create incongruities and the like as discussed later. "Theories conceal as much as they reveal," Hegel said, and in the world of innovation, this is the enemy number one.

In Table 7.1, the characteristics of three types of innovations are assembled for illustrational purposes—(1) the incremental innovation more correctly denoted as continuous improvement, (2) the radical type of innovation denoted technical innovation here, and (3) the type of innovation derived from "differentness," market-based innovation. The most common type of innovation is undoubtedly those minor ones that arise from continuous improvement programs. In fact, many will argue that continuous improvement is not "innovation." If we use the definition above, it is clear that newness or differentness is innovation and that continuous

[21]See Webster (1989). *Webster's Encyclopedic Unabridged Dictionary of the English Language*. New York, Gramercy Books. p. 1854.

[22]See, for example, the literature review in Johannessen, J.-A., B. Olsen and G. T. Lumpkin (2001). "Innovation as newness: what is new, how new, and new to whom?" *European Journal of Innovation Management* **4**(1): pp. 20–31.

[23]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[24]This definition is from Nelson, R. R., Ed. (1993). *National Innovation Systems: A Comparative Analysis*. New York, Oxford University Press. p. 556.

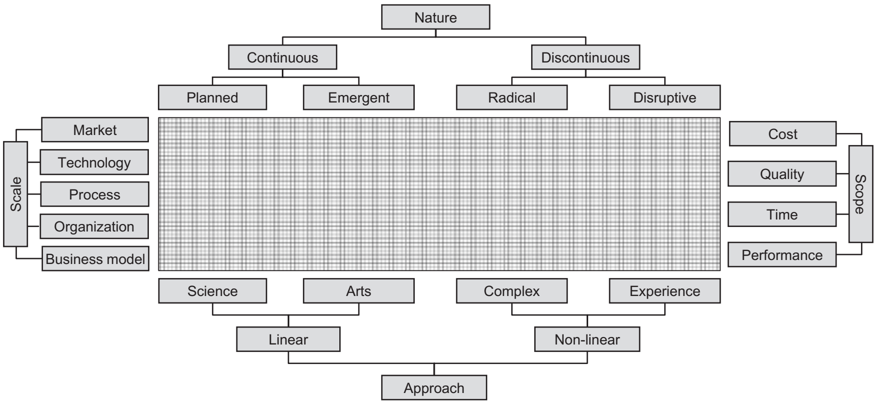

Fig. 7.2 The innovation space

improvement hence constitutes innovation—albeit an incremental one. If we use the definition Drucker proposed[25] that innovation is "change that creates a new dimension of performance," continuous improvement and innovation becomes a matter of degree: If the continuous improvement process leads to significant improvement, then it may be called innovation which requires time and consistency. Otherwise, continuous improvement is simply an improvement. Because the ambiguity and the vagueness of the definitions found in the literature, I have made my own definition based on the insights of Drucker that fit the overall theory in this book the best.

In my view, the distinction between improvement and innovation lies in the approach and result, see Table 7.1. Improvements can be made steadily and methodically, and over time they may yield large improvements—what Drucker refers to as innovation, but most of the time small steps of progress are made because the boundaries of knowledge is not pushed to any significant degree. Continuous improvement can consequently be defined as "the methodical pursuit of improvements within existing context of knowledge, experience, and culture"—thus, the invention is missing. Note that out of all knowledge available to mankind, existing knowledge in one corporation may not be existing knowledge in another corporation since nobody has full overview of all existing knowledge. We have to go back to the time of Gottfried Wilhelm Leibnitz (1646–1716) before a person could have full overview—it is often said that he was the last person to know everything. This is why learning from each other is so beneficial, for example, a team from a corporation going to visit another corporation to see what they are doing. There is nothing innovative about it—it is learning from each other to improve. What is often forgotten in such field visits is the element of corporate

[25]According to Hesselbein, F. (1997). The Circular Organization. *The Organization of the Future*. F. Hesselbein, M. Goldsmith and R. Beckhard. San Francisco, Jossey-Bass Publishers: pp. 81–85.

Table 7.1 Most common types of innovation and their characteristics

	Continuous improvement	Technical innovation	Market-oriented innovation
Focus	Marketing, design, and production	Science and technology	Unmet market needs
Targeting	Broad • Value (quality/cost) • Speed • Product development	Narrow • Feature • Technique	Focused • Business model • Incongruities
Expertise	Conventional know-how	Leading edge, breakthrough	Adapted conventional know-how
Capital needs	Very modest	Major investments	Modest
Approach	Used of methods and tools	Research	Systematic critical evaluation
Progress	Small steps	Big jumps	Relatively big jumps and/or shifts
Results	Continuous	Uncertain	Growing
Visibility	Small	Uncertain	Industry defining
Involvement	Everyone	Selected few	Everyone
Cooperation	Group activity	Individual effort	Group/Individual effort
Recognition	Effort, process	Results	Result
	Evolution	**Revolution**	**Shifts**

culture—what may work in one place may not work in another place at least not right away.

Innovation, however, is characterized by a very different approach. Technical innovations lie on the very edge of knowledge, see Table 7.1. Here, we find the prototypical invention—the magical machine nobody has seen before. Although the pursuit of technical innovations may be systematic—and methodic in that sense, the actual process is more experimental and research-oriented than anything else. This is also evident from the major failure rates. As Albert Einstein put it, “If we knew what we were doing, it wouldn’t be called ‘research’, would it?” Technical innovations can therefore be defined as “the pursuit of new knowledge and its embodiment in new and significant applications.” New knowledge in an innovation can, of course, be old knowledge somewhere else because knowledge is contextual.[26] Often, the market must be created by the diffusion of the innovation.

Market-oriented innovations, however, involve neither new knowledge nor solely methodical approaches as to the actual innovation process, which explains why it is probably one of the most ignored mechanism of innovation regardless of

[26] The importance of context is highlighted by Davenport, T. H., D. W. Delong and M. D. Beers (1998). “Successful knowledge management projects.” *Sloan Management Review* **39**(2): pp. 43–57.

the fact that it has great potential. By critically evaluating current operations in an industry or a market segment, incongruities between current practices and available knowledge can be identified. This cannot be done with the same rigor as continuous improvement because the sources of innovation are discontinuous, that is, they exist in some periods, and then, they are gone for a while or are changed. It can, however, be done systematically by constantly sensing the market and critically evaluating what is observed by competitors, by customers and by ourselves.[27] Articulating the demand can be slow and riddled with dangers resulting in marketing research catastrophes like New Coke and Ford Edsel. Therefore, market-oriented innovations can be defined as "the pursuit of incongruities between current practices and available knowledge to improve current applications or create new ones for the market." In other words, unlike the technical innovation we now start with the market and try to figure out how we can exploit incongruities and in the process we come up with the invention.

There are also many more characteristics other than "approach" that separate the various forms of "betterification," see Table 7.1. The key characteristics of continuous improvement are that it has a broad focus, it involves only conventional know-how, the improvements are small steps, the capital needs are minor, and that the risks are relatively low. The success rate of continuous improvement is therefore far higher than any other type of innovation, and "The relative decline of US industrial competitiveness during the 1980s has often been attributable to the nation's inability to master incremental innovation."[28] This has created a significantly poorer performance compared to a number of competitor nations such as Japan and Germany. Incremental innovation is another word for continuous improvement, but using the term "innovation" in this context is incorrect based on my understanding of the process because the inventive element is not present in incremental work unless we talk about so small increments that it becomes purely semantics. Continuous improvement is not inventive and should therefore be the principal mechanism for corporations in order to secure the cash flow and the operating well-being of the corporation. This can also be argued from studies[29] that imply that the demand side of innovation (inventive activities primarily responding to needs such as market-based innovations) is more important in the short term to medium term than the supply side of innovation (creating opportunities by new discoveries and the steady contribution of new scientific knowledge such as technical innovations). But as for all evolutionary processes, there is an

[27]See, for example, Jackson, T. L. (2006). *Hoshin Kanri for the Lean Enterprise: Developing Competitive Capabilities and Managing Profit*. New York, Productivity Press. p. 206.

[28]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[29]See:

- Schmookler, J. (1966). *Invention and economic growth*. Cambridge, MA, Harvard University Press. p. 332.
- Griliches, Z. (1990). "Patent statistics as economic indicators: a survey." *Journal of Economic Literature* **XXVIII**(December): pp. 1661–1707.

inherent weakness in continuous improvement—the process will stagnate after a while and hence produce poor results. Some bigger leaps are therefore needed from time to time, and some industries like pharmaceuticals, chemicals and materials are heavily dependent on such leaps via scientific breakthroughs.[30]

The greatest leaps are undoubtedly derived from technical innovations, at least so it seems; it depends on what the measure of success is. If the measure of success is revolutionary changes in new gadgetry, functionality, and cutting-edge performance, then technical innovations are the right type to pursue. However, be aware that technical innovations often require major investments, patience and are highly uncertain when it comes to producing results. Therefore, technical innovations are rarely commercial successes. In fact, Drucker claims that "nine out of ten 'brilliant ideas' turn out to be nonsense. … And nine out of ten ideas which, after thorough analysis, seem to be worthwhile and feasible turn out to be failures… The mortality rate of innovation is—and should be—high.[31]" Along the same token, several studies state that "between five, and as many as nine, out of ten new products end up as financial failures. … Apple Computer, for instance, stopped making the striking G4 Cube less than 12 months after its launch in July 2000 because the company was losing too much cash on the investment."[32]

If the measure of success is commercial success, then market-oriented innovations are needed. Market-oriented innovations are in many ways quite similar to continuous improvements, but they usually focus on the more basic part of the corporation—its business model or incongruities between industry norms and market need and as such, there is an invention—and hence lead to either shifts in the industry or major jumps of market performance. In fact, as technical innovations, market-oriented innovations can produce entirely new industries or revamp old industries. For example, the containerization for maritime transportation reduced the port downtime from twelve days to twelve hours,[33] cut the cost of loading cargo onto a ship from \$5.83 per ton in 1956 to merely \$0.16 per ton in 2005,[34] and hence revolutionized the maritime transport industry. Unlike technical innovations, however, the capital needs of market-oriented innovation are modest. Often, it is a matter of critically review current operations and thinking outside the box when identifying solutions. Most successful, major innovations are therefore market-oriented according to the historical record and academic studies as mentioned before.

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[30]See Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[31]See Drucker, P. F. (1973). *Management: Tasks, Responsibilities, Practices*. New York, HarperCollins. p. 792.

[32]See Andrew, J. P. and H. L. Sirkin (2003). "Innovating for Cash." *Harvard Business Review* **81**(9(Sept)): pp. 76–82.

[33]See Drucker, P. F. (1992). *Managing for the Future: The 1990s and Beyond*. New York, Truman Talley Books.p.

[34]See The Economist (2006). *The physical internet: A survey of logistics*. London, The Economist. p. 18.

The various types of innovation have many sources. In the aforementioned study[35] on innovation and successes and failures, they identified six "idea factors" of innovation; (1) "need spotting," (2) "solution spotting," (3) "mental inventions," (4) "random events," (5) "market research," and (6) "trend following." Then, they linked these sources to the success/failures rates and found that the worst was by far "trend following" and "mental inventions," which produced three times as many failures as successes. "Need spotting," however, produced twice as many successes as failures. "Market research" generated four times more, while "solution spotting" provided seven times more successes than failures. The best source of innovation, however, was undoubtedly "random events" with a 13:1 ratio between successes and failures. This list of six factors is useful in determining what tools can be used in development and research, but the list does not contain the actual sources of innovation—more the tools of innovation, in my opinion, and in particular relevant for market-oriented innovations.

Before we continue, it is useful to finally define the term "invention." This term is often used but rarely defined—also in the literature. However, the Office of Technology Assessment has provided a useful definition; "Invention refers to the act of devising or fabricating a novel device, process or service,"[36] a definition clearly rooted in Schumpeter's thinking.[37] Inventions therefore arise from an act—not a process and certainly not with necessarily any relevance or significance like an innovation. However, all innovations ultimately come from some invention(s). I believe that the act of inventing is where creativity lies and where great minds leapfrog the mediocre—this act is either there or not; there is nothing in between. As Robert Frost so eloquently put it:

> Two roads diverged in a wood, and I - I took the road less traveled by. And that has made all the difference.

Some innovations may simply spring from a flash of genius so to speak, but those are rare—in fact, one might argue that such flashes are not even innovations but rather inventions that happen to be accepted in the market. Even individual corporations may have problems pulling off an innovation in isolation.[38] According to Drucker,[39] there are seven sources of innovation; (1) unexpected occurrences, (2) incongruities, (3) process needs, (4) industry and market changes,

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[35]The study is quoted in Franklin, C. (2003). *Why Innovations Fail: Hard-won Lessons for Business*. London, Spiro Press. p. 232. And subsequently quoted by The Economist (2003). Expect the unexpected. *The Economist Technology Quarterly*: pp. 3.

[36]See Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[37]See Sect. 1.1 in Chap. 1.

[38]This fact is also highlighted by Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[39]See, for example, Drucker, P. F. (2002). "The Discipline of Innovation." *Harvard Business Review* **80**(August): pp. 95–102.

(5) demographic changes, (6) changes in perception, and (7) new knowledge. If we compare these seven sources of innovation with the six aforementioned tools of innovation, we see that there is a many to many relationship between sources and tools, e.g., “incongruities” can be identified in several ways.

Before I proceed, I would like to point out that all these seven sources of innovation arise from the two principal sources of innovation as mentioned earlier—incongruities and new knowledge. “Unexpected occurrences” is a source of innovation because incongruities are created or new knowledge discovered. “Process needs” arise likewise due to a mismatch, or an incongruity, between current applications and needs, or perceived needs in the case of “changes in perception.” “Industry and market changes” creates incongruities by default for those that do not pay attention to such changes and the same is true for “demographic changes” as well. The seven sources of innovation that Drucker identified is, however, a more useful categorization when it comes to actually identifying the opportunities for innovation because that categorization is more finely granulated as well as it can be organized according to external and internal opportunities for strategy purposes.

According to Drucker, demographic changes are the most reliable source of innovation, but often neglected. Due to the long and known lead times of demographic changes, those that pay attention to them can reap great benefits with relatively limited risk exposure. Over the last decades there have been many demographic changes that have opened up new opportunities for those that paid attention to them and threat for those that ignored them. Examples include as follows:

1. The increase in affluence shifted the focus of the automotive industry from providing cheap cars to providing quality cars. The Japanese capitalized on this, whereas the American automotive industry in the 1980s failed to recognize this change and consequently suffered huge losses.
2. Spending and profitability in some industries can actually increase despite the number of consumers fall. An example of this is the USD 33.7 billion industry in the USA related to hunting trips, weapons, and gadgetry.[40]
3. The rise of divorce rates and unmarried people in cities have provided a fast rising market for apartments, while villas have developed relatively more slowly.
4. The increased level of education in the Western world have eroded to a large extent the need for assistance in many service industries, which in turn gave rise to many Internet-based services that have changed many service industries in particular. This change is still underway.

[40]See The Economist (2013). “Bowhunting in America: In a dark wood.” *The Economist* **409**(8867): pp. 58–60.

5. The aging population has introduced entirely new-market opportunities and threats.[41] Two forces drive this demographic change; (1) large birth rates after World War II and (2) a massive increase in life expectancy—30 years or so. In fact, some describe this increase in life expectancy as the most profound change over the last 5000 years. The impact this will have on society is hard to fully contemplate—it will be massive.

Clearly, the trend related to the increasing affluence, or wealth, of society impacts society in many ways, and here we find one that can potentially shift the entire formula of corporate success. Traditionally, corporations have been held accountable for shareholder value, customer and employee satisfaction, but now corporations are increasingly being held accountable for social results as well. This trend has come under the terms such as corporate social responsibility (CSR),[42] and broadly speaking proponents have pointed to four justifications for it[43]; (1) moral obligation, (2) sustainability, (3) license to operate, and (4) reputations. Yet, some see CSR as just one out of many fads the 1990s brought about.

What these skeptics fail to see is that CSR is a part of a larger trend driven by increasing wealth that started more than 200 years ago—in fact, it was a quite hot topic in the 1970s, Howard Rothmann Bowen (1908–1989) spoke about the "social responsibilities of the business man" already in 1953[44] and Smith in his classic talks about "the sympathy of man" as a necessary condition of the economic/capitalistic system. It seems that the more affluent the society becomes, the more influence will social results have on corporate image, reputation, and ultimately its bottom line irrespective of the eloquent arguments of Friedman. He is right, but the problem is that customers do not see it like this—they point their finger to immediate causes (corporate actions) and not root causes (political governance) assuming that we do not talk about corporate violations of the law. In fact, studies from particularly North America seem to support this claim, but the results

[41]For an excellent discussion with respect to marketing and the aging population, see Moschis, G. P. (2003). "Marketing to older adults: an updated overview of present knowledge and practice." *Journal of Consumer Marketing* **20**(6): pp. 516–525.

[42]In the literature, CSR is often used interchangeably with other related concepts such as corporate (global) citizenship, community integration, and corporate social performance. Furthermore, there are no generally accepted definitions and even scopes of the term. For more information, see, for example,

- Göbbels, M. and J. Jonker (2003). "AA1000 and SA8000 compared: a systematic comparison of contemporary accountability standards." *Managerial Auditing Journal* **18**(1): pp. 54–58.
- Balabanis, G., H. C. Phillips and J. Lyall (1998). "Corporate social responsibility and economic performance in the top British companies: are they linked?" *European Business Review* **98**(1): pp. 25–44.

[43]According to Porter, M. E. and M. R. Kramer (2006). "Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility." *Harvard Business Review* **84**(12): pp. 78–92.

[44]See Bowen, H. R. (1953). *Social Responsibilities of the Businessman*. New York, Harper & Row.p. 276.

are not conclusive.[45] This degree of inconclusiveness is probably due to the fact that measuring social responsibility is not straightforward.

For example, if we look at working conditions, we see this trend very clearly. Working 12 h today is considered a long working day, but throughout the nineteenth century, many recent immigrant workers to the USA worked for up to 16 h a day.[46] Even after the 1847 Factory Act, which reduced the working hours for children and women to 10 h a day, which came into force in 1848, there were still many loopholes that were exploited by employers. For example, many employers did not allow mealtimes during the working day—from 09:00 a.m. to 07:00 p.m.[47] Furthermore, it was only around 1910 that most US states "modified the common-law tradition that a worker accepted the risk of accident as a condition of employment and was not entitled to compensation if injured unless it could be proved that the employer had been negligent.[48]" Imagine a 12-h working day of hard physical labor (in bad working environment) without a lunch break and if you got injured you were on your own! Clearly, as society became wealthier, these practices were banished often with the push of paramilitary-like unions. This led to many conflicts that still linger in the corporate world today many places in that there is an ingrained distrust between unions and management. Nonetheless, it was only well into the twentieth century that we began to witness "modern" regulations on working hours.[49]

As working conditions have improved immensely over the last 100 years, most people focus on how corporation behave towards the environment and its social responsibility toward external stakeholders. The rapidly changing social environment from the 1960s and onwards fueled this trend further. Today, the social results are so important that they can make or break a company. A good example here is The Body Shop[50]—the English cosmetics company. It had been seen as the embodiment of CSR as the founder Anita Roddick had built the corporate image on a form of enlightened capitalism claiming to change society for the better,

[45]According to Balabanis, G., H. C. Phillips and J. Lyall (1998). "Corporate social responsibility and economic performance in the top British companies: are they linked?" *European Business Review* **98**(1): pp. 25–44.

[46]According to Cochran, T. and W. Miller (1942). *The Age of Enterprise: A Social History of Industrial America*. New York, The Macmillan Company.p.

[47]According to Hobsbawm, E. J. (1999). *Industry and Empire: From 1750 to the Present Day*. London, Penguin Books. p. 432.

[48]According to Garraty, J. A. and M. C. Carnes (2000). *The American Nation—A History of the United States*. New York, Addison Wesley Longman.p.

[49]For a thorough overview of working hours and conditions, see Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

[50]For a more complete story, see Parston, G. (1997). Producing Social Results. *The Organization of the Future*. F. Hesselbein, M. Goldsmith and R. Beckhard. San Francisco, Jossey-Bass Publishers: pp. 341–348.

protecting the environment, opposing animal testing, and so on. The Body Shop thrived on this image, but after a series of critical reports in 1994, image, profits, and market worth plummeted.

On a more positive angle,[51] Levi Strauss & Co. is recognized as one of the leading corporations for its commitment toward CSR and has received several awards for its efforts in promoting global socially responsible practices. Another corporation is Lever Bros. Ltd, which devotes the equivalent of at least 1 percent of its pretax profit to community involvement. DuPont has saved over $2 billion on reduced energy consumption since 1990.[52] Yet, what is most often the case is that most corporations fail to make these efforts truly productive. There are two reasons for this; (1) many corporations pit business against society and (2) most CSR initiatives are generic in nature and not appropriate to each corporation's strategy. In fact, according to Michael Porter and Mark Kramer[53]; "The prevailing approaches to CSR are so disconnected from business as to obscure many of the greatest opportunities for companies to benefit society."

Yet, corporations can no longer argue solely out of their self-interest anymore. Most people do not share the idea that the sole responsibility of corporations is to maximize profits for its owners as Friedman argues[54] despite the compelling truth of it as argued in Chap. 1. In fact, studies show that corporations cannot obtain a legitimate decision-making role in society without first having demonstrated[55] (1) respect for fellow citizens, (2) commitment toward the community and (3) exposure in the discussion. With the numerous corporate scandals the last 20–30 years this trend is likely to become even tougher than before. Thus, the entire corporate landscape is changing; (1) tougher demands on financial accountability, transparency, and integrity from the large institutional investors as mentioned earlier and (2) tougher environmental and social demands on accountability from the society at large. In fact, just like we today have acknowledged quality and environmental standards such as ISO 9000 and ISO 14000, new standards on accountability are

[51]See, for example, Zairi, M. (2000). "Social responsiblity and impact on society." *The TQM Magazine* **12**(3): pp. 172–178.

[52]The DuPont example is provided by Porter, M. E. and M. R. Kramer (2006). "Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility." *Harvard Business Review* **84**(12): pp. 78–92.

[53]According to Porter, M. E. and M. R. Kramer (2006). "Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility." *Harvard Business Review* **84**(12): pp. 78–92.

[54]See Friedman, M. (1970). The social responsibility of business is to increase its profits. *New York Times Magazine*:pp.

[55]According to Saiia, D. H. and D. Cyphert (2003). "The Public Discourse of the Corporate Citizen." *Corporate Reputation Review* **6**(1): pp. 47–57.

rapidly emerging, such as the AA1000 and SA8000 standards.[56] Although such standards are today voluntary, history has shown us that what is voluntary today can easily become a requirement tomorrow either by law or market expectations. For example, many socially acceptable practices described in the 1970s were less than 20 years later regulated by statute.[57]

These forces will most likely reshape the corporate landscape at least to the same extent that the major social and political changes in the 1960s and 1970s did. What is important to recognize is that although these trends are slow and face setbacks—they are steady as long as the society grows wealthier. Corporations that fail to anticipate them will be at great risk. The greatest challenge is the fact that they are slow, because that makes them less visible for the uncritical eye. This said, it should be emphasized that corporations should probably not spend too much on social demands before reaching a minimum level of economic performance.[58] Instead of focusing on the points of conflict between corporations and society, corporations and society can both prosper by focusing on the points of common interests. Then, economic performance and sustainability can go hand in hand.

The single most challenging demographic change our planet is facing is probably the fact that the birth rates around the world are *too* low. Phillip Longman has made a compelling case[59] that should shake up most policy makers and executives. Some of his findings can be summarized as follows:

- Large parts of the world including Latin America, the Middle East, and China are experiencing a "hyper-aging." Mexico, for example, is aging five times faster than the USA. The problem with this is that, as Longman puts it "Countries such as France and Japan at least got a chance to grow rich before they grew old. Today, most developing countries are growing old before they get

[56]The AccountAbility 1000 (AA1000) standard, which was launched in 1999 by The Institute of Social and Ethical AccountAbility (ISEA), is an accountability standard designed to improve accountability and performance by learning through stakeholder engagement. It was developed to address the need for corporations to integrate their stakeholder engagement processes into daily activities. The Social Accountability 8000 (SA8000) standard, which in introduced by The Council on Economic Priorities Accreditation Agency (CEPAA), is an auditable standard for third party verification system to ensure both ethical sourcing of products and goods and workplace conditions worldwide. The SA8000 is based on international workplace norms in the International Labour Organization (ILO) conventions and the UN's Universal Declaration of Human Rights and the Convention on Rights of the Child. For more information on these standards, see the respective corporations Web sites, and for a brief overview and a comparison, see Göbbels, M. and J. Jonker (2003). "AA1000 and SA8000 compared: a systematic comparison of contemporary accountability standards." *Managerial Auditing Journal* **18**(1): pp. 54–58.

[57]See Vyakarnam, S. (1992). "Social responsibility: what leading companies do." *Long Range Plannig* **25**(5): pp. 59–67.

[58]See Ullmann, A. (1985). "Data in search of a theory: a critical examination of the relationships among social performance, social disclosure, and economic performance of US firms." *Academy of Management Review* **10**(3): pp. 540–557.

[59]See Longman, P. (2004). "The Global Baby Bust." *Foreign Affairs* **83**(3): pp. 64–79.

rich." This will have major repercussions for innovation and entrepreneurship globally. For example, in 2002 as Babson College and the London School of Business released their index of entrepreneurial activity it showed a clear correlation between countries with a high ratio of workers to retirees and those with a high degree of entrepreneurship. There is plenty of evidence suggesting that population aging itself works to depress the rate of technological and organizational innovation.
- Due to the mounting costs of pensions and health care, government spending on research and development, as well as on education, will likely drop. The Center for Strategic and International Studies has made many dire calculations that support this claim. For example, in countries such as France, Germany, Italy, Japan, and Spain, somewhere between a quarter and a third of all national output will be consumed by old-age pensions and healthcare programs before today's 30-year-olds reach retirement age.
- Japan's population peaked in 2005 or thereabout and will then fall by as much as one-third over the next 50 years—a decline equivalent to the plague in medieval Europe as demographer Hideo Ibe puts it. Trends like this will change markets substantially and make the growth of emerging economies much more difficult. The reason is that while Japan and South Korea and other recently industrialized countries relied on massive exports to the USA and to Europe to develop, but where will demand come from and let emerging economies develop further when the population in Europe and Japan drops substantially and the population in the USA ages considerably?
- In another 20 years, the USA will be no more able to afford the role in the world policeman than Europe and Japan are today. Nor will China be able to assume the job, since it will soon start to suffer from the kind of hyper-aging that Japan is already experiencing. In my opinion, this may pose a major, international security threat whose consequences nobody can foretell other than they will most like be unpleasant if militant Islamic groups are as active as today. Their demographics are on the rise…

Clearly, demographic changes should be of major concerns for anybody who intends to build corporations that last, and societies are to become sustainable.

<u>Changes in perception</u> is another important source of innovation, and Drucker points to the fact that our health has improved by any measure, yet "never before have there been so much concern with or fear about health." For example, he notes that:

1. In 1983, the fastest growing new US business was a company that made indoor exercise equipment.
2. Many countries in Africa have recognized that it is more profitable to keep their large cats and other major predators alive due to tourism than to hunt them down to save livestock.
3. Many of the environmental issues have created markets that did not exist before due to changing perceptions about man and the environment. This has created major challenges for many corporations particularly in low margin industries, but it has also created corporations.

In fact, many of the changes brought about by demographic changes also result in changes in perception as the case of The Body Shop shows.

According to Drucker, innovations based on new knowledge—whether scientific, technical, or social—are the ones that rank the highest. Such innovations are the ones that get the money, publicity and fame, but they are time-consuming, risky but "nine out of ten 'brilliant ideas' turn out to be nonsense."[60] In fact, it is estimated that during the last 100 years the American economy grew sevenfold largely due to improvements in technology.[61] However, Drucker remarked that "it is widely believed that scientific discoveries turn much faster in our day than ever before into technology, products, and processes. But this is largely illusion.[62]" I do not know what Drucker bases this opinion on concerning, because there is substantial evidence for the opposite view, namely that the conversion of scientific knowledge to practical application *is* accelerating.

In 1958, a controversial paper introducing a quantitative "law" about the acceleration of technological applications was published.[63] The "law" has been ridiculed, but according to some researchers it has merit, see Table 7.2. The purpose here is not to necessarily agree on each date in Table 7.2, but to rather exemplify the acceleration. In my opinion, the acceleration can also be explained by deducing it from the fact that the more we know, the more likely it is that we can apply new knowledge. It must be so because the number of interconnections in our science and innovation system (see Chap. 8) increases exponentially as we add "elements" of new knowledge and increase the speed of it flowing (using information technology, for example).

One of Drucker's favorite examples of new knowledge and innovation—the personal computer (PC)—illustrates the point discussed here. The PC required no fewer than six separate strands of knowledge.[64] Although all the necessary knowledge was available by 1918, the first operational digital computer did not appear until 1946. That is a time lag of 28 years, which would fit quite well with Table 7.2.

In materials, a 20-year time lag is often the case.[65] The point is, however, that much knowledge exists in small pockets that are not interconnected, but as the web of knowledge increases and the speed of search and transfer increases, these

[60] See Drucker, P. F. (1973). *Management: Tasks, Responsibilities, Practices*. New York, HarperCollins. p. 792.

[61] See The Economist (2004). Cycles and commitment. *The Economist*. **373**: pp. 78.

[62] See Drucker, P. F. (1985). *Innovation and Entrepreneurship: Practice and Principles*. New York, Harper-Collins.p.

[63] The 'law' is derived from Phase Rule Law and the time-lag between discovery and common technological application is given by $Ae^{-\frac{t}{T}} - B$ where A, B, and T are empirical constants. For more information, see Grompone, J. (1997). "The Zeno Event." *Futures* **29**(No. 6): pp. 519–531.

[64] See Drucker, P. F. (2002). "The Discipline of Innovation." *Harvard Business Review* **80**(August): pp. 95–102.

[65] See Eagar, T. W. (1995). "Bringing New Materials to Market." *Technology Review* **98**(February/March (No. 2)): pp. 42–49.

Table 7.2 Time lag between discovery and application for several relevant technological events

Event	Discovery	Application	Difference	Adam's Law
Photography	1727	1839	112	117
Steam machine	1769	1854	85	81
Telephone	1820	1876	56	51
Radio	1867	1902	35	32
Radar	1925	1940	15	16
Transistor	1948	1953	5	12
Moon expedition	1961	1969	8	10

Source Grompone (see Grompone, J. (1997). "The Zeno Event." *Futures* 29(No. 6): pp. 519–531) and used with kind permission from Elsevier

pockets can be found more and more effectively and this brings us probably to the core of the disagreements concerning speed of development and time. As Chauncey Starr (1912–2007) points out[66]—and I agree—"…the time from conception to first application (or demonstration) has been roughly unchanged by modern management, and depends chiefly on the complexity of the development. However, what has been reduced substantially in the past century is the time from first use to widespread integration into our social system." In other words, the speed of inventing has remained largely unchanged, whereas the speed of commercializing it into an innovation and diffusing it into society has been substantially reduced. This makes perfect sense since inventing is a creative exercise as discussed earlier, whereas the rest of the innovation process is more a matter of management, systems such as IT and financing. This is discussed more in the next section.

First, however, I would like to add another facet to the issue of new knowledge, innovation, and the speed of which new knowledge is converted into innovations. The literature is virtually full of statements such as "knowledge workers"[67] and "unprecedented changes." Such kind of expressions and similar ones derive from lack of historical perspectives. It is today widely assumed that today's economy is much more knowledge-based than say 200 years ago. This is only partially true. It is true in the sense that the sheer amount of available knowledge and its usage in the economy is far greater, but it is not true in its implications that knowledge was unimportant 200 years ago. In fact, so important was knowledge that poaching skilled workers was common among countries well into the nineteenth century to boost their own innovation and economic development. In fact, thanks to France's and other European countries' attempt to recruit skilled workers on a large scale, Britain finally galvanized into introducing a ban on the emigration of skilled workers in 1719. The punishments were severe—fines, imprisonment, or even losing

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[66]See Starr, C. (1969). "Social Benefit versus Technological Risk." *Science* **165**(3899): pp. 1232–1238.

[67]An expression coined by Drucker, P. F. (1968). *The Age of Discontinuity: Guidelines to Our Changing Society*. New York, Harper-Collins.p.

citizenship. In 1825, the law was lifted due to the increasing embodiment of knowledge in machinery.[68] Prior to mechanization and industrialization, the knowledge was tacit—hidden in the heads of the workers and not coded in, for example, an operating manual or a machine center. This made skilled workers a strategic asset. Interestingly, today the same trend reappears after a century with focus on the machine—it is now widely accepted that it is the tacit knowledge that embodies the true competitive advantage for companies[69] because it is not easily transferable or decipherable for other corporations than for the corporation it was initially conceived. In fact, Drucker claimed that roughly 75 percent of a firm's expensive knowledge resource was neither identified nor controllable[70] in the context of accounting.

Possibly the greatest myth, however, in today's business literature is that we believe that there are so many changes going on today than say 100 years ago. Again, this is only partially true. The changes themselves are no greater than 100 years ago. Think about what happened 100 years ago; the automobile came, the radio came, electricity came, and so on. These were momentous innovations that forever changed our world perhaps even more profoundly than the IT revolution, which was initiated in 1964 by the launch of the IBM 360. What *has* changed, however, is the rate of change, which is evident from Table 7.2, but this is of little interest to those in the middle of change whether it is today or hundred years ago.

The rate of change is mainly driven by two factors in my opinion; (1) the increasing accessibility to financial capital and (2) the increasing speed of which information can be processed, disseminated/distributed and converted into knowledge. Therefore, the understanding of how knowledge is generated is of pivotal importance in order to understand tomorrow's business environment because once the knowledge is generated, it is just a matter of funding and time before we may have innovations—particularly in clusters with an open culture and sharing of information. In fact, the greater success of Silicon Valley compared to Route 128 has been attributed in part to the more open culture of Silicon Valley.[71]

A very useful model in this context is the SECI process which is an explication of the work of Ikujiro Nonaka and Hirotaka Takeuchi.[72] The SECI process is depicted in Fig. 7.3, which is strictly speaking a juxtaposition of several figures presented in their work, and I have added some thoughts of my own. They studied

[68]For more insights, see Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

[69]See, for example, Cavusgil, S. T., R. J. Calantone and Y. Zhao (2003). "Tacit knowledge transfer and firm innovation capability." *Journal of Business & Industrial Marketing* **18**(1): pp. 6–21.

[70]See Flaherty, J. E. (1999). *Peter Drucker: Shaping the Managerial Mind*. San Francisco, Jossey-Bass. p. 445.

[71]See Saxenian, A. (1994). *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA, Harvard University Press. p. 226.

[72]See Nonaka, I. and H. Takeuchi (1995). *The Knowledge-Creating Company: How Japanese Companies Creat the Dynamics of Innovation*. New York, Oxford University Press. p. 298.

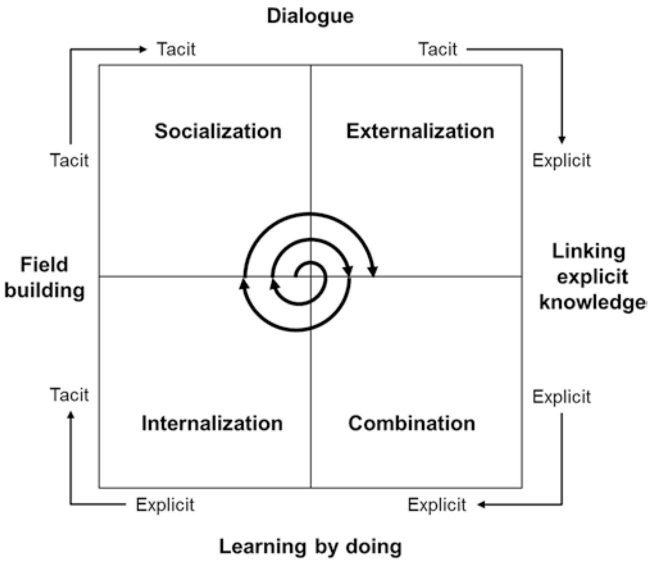

Fig. 7.3 The SECI process. Derived from the work of Nonaka and Takeuchi (see Nonaka, I. and H. Takeuchi (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York, Oxford University Press. p. 298)

so-called knowledge-creating companies in the context of innovation. Another term the "SECI model" has been used later by others. However, due to the convenience of the "SECI process" term, it is used here.

First of all, the acronym SECI consists of the first letters of the four modes of knowledge conversion—socialization, externalization, combination, and internalization. These four knowledge conversions consist of four possible configurations of tacit versus explicit knowledge. These terms were first proposed by Michael Polyani (1891–1976).[73] He actually proposed a dichotomy in three: (1) explicit knowledge, (2) implicit knowledge, and (3) tacit knowledge. While most agree on the definitions on the explicit type of knowledge, the definitions of tacit knowledge vary—also because some view implicit knowledge as a type of tacit knowledge. Explicit knowledge can be defined as "knowledge that can be fully expressed and communicated clearly," which includes all codified knowledge, rules, procedures, and methods. Implicit knowledge is another form of expressive knowledge, but it is not expressed due to various settings such as cultural customs and organizational styles. Tacit knowledge, on the other hand, is a type of elusive and illusive "awareness" of individual that cannot be expressed in words—a part of this type of knowledge is referred to as mental models[74] which includes schemata, paradigms,

[73]See Polanyi, M. (1966). *The Tacit Dimension*. New York, Anchor Day Books. p. 108.

[74]See Johnson-Laird, P. N. (1983). *Mental Models*. Cambridge, Cambridge University Press. p. 528.

perspectives, beliefs, and viewpoints. From this, Polyani has been credited with two much quoted sentences—"we can know more than we can tell" and "we know more than we realize"—important insight, which is easy to believe applies to ordinary conversations only and not to scientists. However, the fact is that Polanyi came up with the idea of tacit knowledge in 1946 as he had to explicate the process of scientific discoveries by scientists. In other words, tacit knowledge applies to us all. While the explicit and to some extent the implicit knowledge is quite straightforward to manage—and corporations have "…sunk billions of dollars…"[75] in Knowledge Management (KM) solutions to capture knowledge without much results, the irony is that tacit knowledge embodies the true competitive advantage for companies[76] because it is not easily transferable or decipherable for other corporations than where it was initially conceived. KM solutions therefore contain the least business critical knowledge, whereas people has the tacit, critical knowledge. All serious businesses are therefore people businesses.

The fact that implicit knowledge is ignored by Nonaka and Takeuchi presents us with a definitional problem as to whether or not the implicit part of expressive knowledge is included or not—at least if we subscribe to a Western tradition of epistemology. However, Nonaka and Takeuchi are Japanese and they here demonstrate an important point that they in the Japanese epistemological tradition can easily live with ambiguity,[77] and so can I. Not that implicit knowledge is unimportant, but the purpose here is to explain a phenomenon (the SECI process) and not to use it analytically based on surveys and the like and make relatively precise empirical studies.

The SECI process starts often with the socialization mode. This is because knowledge resides in people—and only in people from an organizationally point of view. Books can contain facts, assumptions, discourses, and so on, but unless it resides within a human, it is not in the corporation. Socialization is absolutely crucial for learning from past experience, attitudes, judgments, and so on (tacit knowledge). In fact, some of the most successful companies Nonaka and Takeuchi discuss apply brainstorming camps and parties to help this mode of knowledge conversion work effectively. This is what they refer to as building field where people can share mental models and experiences.

The knowledge spiral leads us from the socialization mode to the externalization mode where the tacit knowledge is converted from tacit knowledge to explicit knowledge and hence made available for the rest of the corporation. The main vehicle for this is dialogues in the proper sense meaning conversations where assumptions are made explicit and available for all and the goal is to reach an understanding. Discussions, in contrast, have the goal of winning—not necessarily

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[75]According to Sveiby, K. E. (1997). *The New Organizational Wealth—Managing & Measuring Knowledge-Based Assets*. Brisbane, Berret-Koehler Publishers, Inc. p. 275.

[76]According to Cavusgil, S. T., R. J. Calantone and Y. Zhao (2003). "Tacit knowledge transfer and firm innovation capability." *Journal of Business & Industrial Marketing* **18**(1): pp. 6–21.

[77]See Nonaka, I. and H. Takeuchi (1995). *The Knowledge-Creating Company: How Japanese Companies Creat the Dynamics of Innovation*. New York, Oxford University Press. p. 298.

gaining understanding. We can also find storytelling, models, metaphors, hypotheses, concepts, and analogues useful in externalizing the tacit. Due to the relative inaccessible nature of tacit knowledge, metaphors and analogues are the most common approaches. Once the knowledge is made explicit, it can be linked with other explicit knowledge and can yield new insights. This takes place in the combination mode. This is the typical focus for many in knowledge work, but we are barely half-way according to the SECI process. In the next step in the knowledge spiral, we go to the final knowledge mode—internalization. This means to truly grasp the explicit knowledge and make it our own understanding and add to our current tacit knowledge. Learning by doing can be very effective in this respect. Then, we have closed the circle, as it were. This means that we have come around but on a higher level of understanding, and the words of T.S. Eliot spring to mind:

> We shall not cease from exploration
> And the end of all our exploring
> Will be to arrive where we started
> And know the place for the first time.

The importance of this is that modern way of organization with close interaction between people is far better than the highly, formalistic old-fashion approach where the thinkers and doers are highly separated. In many ways, with new knowledge we could also add new knowledge concerning organizing work and human interaction to foster innovation. By the way; new ways of organizing and interacting also occured during the Industrial Revolution.

With unexpected occurrences, Drucker refers to the cases where the corporation out of the blue discovers an unexpected opportunity in the market for technology it already possesses or can easily adapt to. For example, IBMs reign in the computer industry was due to an unexpected opportunity offered by its accounting machine developed in the 1930s. It turned out that when the banks, for which it was originally designed, did not want to buy the machine under the Depression, New York Public Library wanted to purchase more than hundred such machines because under the New Deal legislation, libraries actually had money. In the 1940s, the first computers came along as well, but they were huge and filled entire rooms and were used only for heavy computational work. The UNIVAC I used 5,200 radio tubes, was as large as a garage (4.3 m × 2.4 m × 2.6 m), was 13 metric tons, and required an electric input of 125 kW. It is in those days we have the famous quote from Thomas Watson, Sr. in 1943 that "I believe there is a world market for perhaps five computers." Then, about 15 years later, Univac offered an advanced machine for payroll. IBM saw the links and became industry leader within five years in the new computer industry. Being able to capitalize on failure is equally important—perhaps even more important—and 3M is a corporation that is good at that as the stories about the Scotch™ masking tape, the Post-it® Notes adhesive, and 3M's entire ceramic business.[78]

[78]According to Brand, A. (1998). "Knowledge Management and Innovation at 3M." *Journal of Knowledge Management* **2**(1): pp. 17–22.

Incongruities are another important source of innovation. Incongruities are discrepancies between reality and perceptions. They arise from economic realities which forced the corporations to look at the world in a new way such as the steel industry and the disruptive introduction of steel mini mills.[79] They arise from expectations and results which in, for example, maritime transportation leads to the containerization—they realized that it was waiting at the harbor that cost; not the work of unloading and loading a ship or fuel costs or anything else. They arise from many other discrepancies as well.

Another major source is process needs. Ducker exemplifies[80] how process needs gave rise to what we today call 'media' due to two innovations from the 1890s. One innovation was the linotype of Ottmar Megenthaler (1854–1899), which made it possible to produce newspapers quickly and in large volume. The second innovation was modern advertising, invented by Adolph Ochs (1858–1935) of the *New York Times* and Joseph Pulitzer (1847–1911) of the *New York World*. Military history is also filled with countless innovations that arose from process needs. For example, the inferiority of the Confederate Navy in the American Civil War resulted in the first submarine called the Hunley.[81] Also on the strategic level has technology lead to innovations—for example, the various generations of warfare throughout history have been enabled by steadily improved technology, due to the process of warfare, which has now culminated with fourth generation warfare.[82]

Labor cost has also historically been an important driver for innovation. In fact, researchers argue that the relatively higher cost of labor in North America compared to Britain propelled North America in a more labor-saving, capital-intensive technological trajectory of mechanization and standardized production which enabled US manufacturing to surpass British productivity levels as early as 1850.[83]

Process needs resulting in process innovations can also be very powerful. In 1880, the total US steel output was about one million tons, but by 1913, US steel output had climbed to 31 million tons. This massive increase was due to major radical process innovations in the 1850s and 1860s notable the Bessemer process.[84] The result of process innovation reduced the cost of steel by 80–90 percent

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[79]See Christensen, C. M. and M. E. Raynor (2003). *The Innovator's Solution: Creating and Sustaining Successful Growth*. Boston, MA, Harvard Business School Press. p. 301.

[80]See Drucker, P. F. (2002). "The Discipline of Innovation." *Harvard Business Review* **80**(August): pp. 95–102.

[81]Source: Office of Naval Research Website.

[82]See Lind, W. S., K. Colonel Nightengale, J. F. Captain Schmitt, J. W. Colonel Sutton and G. I. Lieutenant Wilson (1989). "The Changing Face of War: Into the Fourth Generation." *Marine Corps Gazette*(October): pp. 22–26.

[83]According to Abramovitz, M. A. and P. A. David (1994). *Convergence and Deferred Catch-up: Productivity Leadership and the Waning of American Exceptionalism—CEPR Publication No. 401*. Stanford, Stanford University Press.p.

[84]See Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

from the early 1860s to the mid-1890s.[85] The need to control costs became paramount, and one of Andrew Carnegie's (1835–1919)—the steel magnate—favorite dictum was "Watch the costs and the profits will take care of themselves."[86] By 1880s, he had probably the most accurate cost data of any enterprise in the USA.[87]

Arguably, process needs is a very strong and profitable source for innovation. Japan's success in the global marketplace[88] has often been attributed to its ability to harness or develop complementary assets, such as the manufacturing capabilities that allowed it to introduce new products faster than US corporations. Japanese corporations boasted faster product development cycle times than US corporations and often achieved higher quality in the process. As a result, they were able to bring new and improved products to market faster and win large portions of the market. Large investments in process technology rather than product technology increased this advantage, as US corporations continued to pour greater resources into product innovation. Adequate manufacturing capacity and skill can be important complimentary assets. Other examples include suitable marketing and distribution channels and after-sales support.

From this, we understand that we can use an entirely different and simpler topology when it comes to innovation—product innovation, process innovation, service innovation, and organizational innovation. This is a very intuitive typology and easy to communicate, and one I use frequently to help people think wider than product and technology in the traditional, linear sense. However, for the purpose of understanding the innovation process, it adds little value because all three can be radical, incremental, technical, continuous improvement based and can even have the same six sources—there are only two differences; (1) that one concerns physical artifacts (products), one concern processes and one concerns services, which is essentially a special type of process, whereas (2) it can result in quite different strategic positions as the story of Japan versus the US illustrates. On top, process innovation is much easier to protect intellectually,[89] so the investments are less susceptible to the market failure discussed at the opening of this chapter. This

[85]According to Landes, D. S. (1969). *The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present*. Cambridge, Cambridge University Press. p. 576.

[86]The quote is from Chandler jr., A. D. (1977). *The Visible Hand: The Managerial Revolution in American Business*. Cambridge, MA, Belknap Press. p. 608.

[87]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

[88]For the whole story see Mansfield, E. (1988b). "Industrial R&D in Japan and the United States: A Comparative Study." *American Economic Review* **78**(2): pp. 223–228.

[89]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

typology is therefore important to not forget, and the OECD and EuroStat are actually using it with these definitions[90]:

- Product innovation: the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness, or other functional characteristics.
- Process innovation: the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment, and/or software.
- Marketing innovation: the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing.
- Organizational innovation: the implementation of a new organizational method in the firm's business practices, workplace organization, or external relations.

The last source is industry and market changes. Such changes cause major structural changes that provide tremendous sources of innovation. According to Drucker,[91] industries tend to change if the industry grows as much as roughly 40 percent in 10 years or less. Over the last 20 years, several industries have undergone rapid growth including the financial industry, the computer industry, the telecom industry, and the mobile/cellular telephone industry which has opened up for many innovations.

The main lesson from the discussion thus far is that successful corporations are those that work in a systematic manner, stay focused, and of course have the knowledge to identify the opportunities. Also, it is important to realize that any taxonomy for innovation is likely to be flawed—innovation is by its very nature impossible to completely box in. Innovation is therefore also a leap of faith and a classic study from Germany also highlights the importance of a power holder[92]—someone must have the power to carry the innovation through. Thus, innovation is hard work, but luckily, there are methods to increase the likelihood of success. The late founder of IBM—Thomas John Watson, Sr. (1874–1956)—is often quoted, saying that "The fastest way to succeed is to double your failure rate."

For the creative mind, there should be ample possibilities to come up with good ideas which might become innovations if they succeedscaling. However, first they typically have to survive the internal screening procedures of projects. This might also be a killing field of good ideas. There are countless approaches for evaluating such ideas, and it is beyond the scope of this book to discuss them all, however, based on my own experience are a couple of classic caveats discussed next.

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[90]See OECD and EuroStat (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. Paris, Organisation for Economic Co-operation and Development. p. 163.

[91]See Drucker, P. F. (2002). "The Discipline of Innovation." *Harvard Business Review* **80**(August): pp. 95–102.

[92]See Witte, E. (1977). "Power and Innovation: A Two-Center Theory." *International Studies of Management & Organization* **7**(1): pp. 47–70.

7.1.2 Screening Which Invention to Develop—Two Common Caveats

Screening ideas may sound like the simplest of things in this process, but surveys show that this is one of the more challenging part of the innovation process.[93] Regardless of which method is employed when screening inventions, and there are many, there will be an economic analysis of some sort. Typically, this involves estimating the cost of turning the invention into an innovation, estimating future performance of the innovation and comparing it to other alternatives. In this process, there are two common caveats—ignoring the moving baseline and using wrong discounting factors.

The moving baseline is a concept that is vital for investment decisions. Discounted cash flow (DCF) methods, such as net present value (NPV), implicitly assume that the cash flow remains constant if an investment is not made. In most—if not all—cases, however, this is simply not a realistic assumption. A minimum degree of advancement is simply needed just to remain competitive in the marketplace—standing still is the equivalent of falling behind, and this is essentially what the theory of the *moving baseline* acknowledges.

According to the theory, an "…incremental cash flow attributable to a capital investment decision is higher than the capital investment model dictates because a company's cash flow without the investment is unlikely to remain constant. Therefore, the incremental cash flows that should be built into the capital investment model should be based on an assumption of *declining* cash flows in the future"[94]—the corporation is being eroded so to speak. The more groundbreaking the innovation, the higher the potential improvement, and often the longer the time for positive cash flow to occur. The reason for this may be that the market may take time to mature due to the diffusion time for the innovation or because the initial investments are larger before any significant positive cash flow is obtained.

This also illustrates a very well-known problem with the commonly applied payback method, namely that since the acceptance criteria, which is normally a maximum payback period such as 5 years, good, long-term investments can be missed because the highest positive cash flows come late in the project. Another way of losing out on good investments by using the payback method is that if the annual improvement is too small to provide a positive NPV by the maximum payback period. Payback methods should therefore not be applied when investments have a long-term scope such as in the case of many sustainable development investments. Payback methods should basically only be employed for smaller investments that we know will either make or break within a short period of time.

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[93]See Capozzi, M. M., B. Gregg and A. How (2010). *McKinsey Global Survey results: Innovation and Commercialization, 2010*. Boston and Los Angeles, McKinsey & Company. p. 8.

[94]See Howell, R. A. and W. A. Schwartz (1997). Asset Deployment and Investment Justification. *Handbook of Cost Management*. B. J. Brinker. Boston, MA, Warren, Gorham & Lamont: pp. D4-1–D4-32.

For society to develop in a more sustainable direction, we must therefore stop pretending that the baseline of any investment choice is zero or any other constancy of some sort. Failure to take actions results in a *declining* baseline, and this declination is perhaps the opposite of sustainable development as it will result in slow decay.

Such moving baseline evaluations are clearly very important for corporations, but they are equally important for researchers of sustainability since research at the end of the days should result in something useful for mankind—at least if we subscribe to the relativistic/holistic/social school of epistemology. In this school of thought, the validation process of science, and consequently of research, is "…a gradual process of building confidence in the usefulness of the new knowledge with respect to a purpose."[95] The point here is that if something is to be judged as useful it has to be correctly evaluated.

Once the moving baseline is understood and defined, the next caveat is the discounting. All DCF (discounted cash flow) methods rely on a seemingly simple concept; the cash flow over the period is discounted using a factor that is supposed to account for the facts that a dollar today is better than a dollar tomorrow (the time value of money) and that a dollar today is secure, whereas one tomorrow is not (risk). However, choosing a correct discounting factor is not easy, and there are several ways of going wrong, including the following:

1. Choosing a too high discounting factor.
2. Using a discounting factor in cases when it should not be applied.
3. Mistreating tax and inflation issues. This is mostly a technical issue, which is not of conceptual importance. The important thing to remember is that if taxes and inflation are to be included, they must be included consistently.[96] It is best, however, to ask whether the whole issue can be omitted and what would the consequences be of such an omission, and if such technical issues are to be included, it is best to include them stepwise in the "foot and tic" fashion learned by every accountant.[97] Large, complex formulas,[98] and in spreadsheets, can easily lead to wrong estimates because their implications and hidden assumptions may be hard to keep full track of.

[95]According to Seepersad, C. C., K. Pedersen, J. Emblemsvåg, R. Bailey, J. K. Allen and F. Mistree (2006). The Validation Square: How Does One Verify and Validate a Design Method? *Decision Making in Engineering Design*. K. E. Lewis, W. Chen and L. C. Schmidt. New York, American Society of Mechanical Engineers (ASME): pp. 303–314.

[96]As shown in Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[97]As advocated by Barringer, H. P. (2001). *How To Justify Equipment Improvements Using Life Cycle Cost and Reliability Principles*. Power Machinery and Compression Conference 2001, Galveston, TX.

[98]As presented, for example, by Park, C. S. and G. P. Sharp-Bette (1990). *Advanced Engineering Economics*. New York, NY, John Wiley & Sons, Inc. p. 740.

Choosing a correct discounting factor is one of the most difficult financial questions in economic analyses.[99] Often, the problem is that the discounting factor is set too high—typically supported by arguments along the line that "if we can obtain 15 percent return in the stock market, then we should also demand 15 percent return on this investment." On the surface, this sounds like a valid argument, but in reality, it is wrong for several reasons. First, a statement like this fails to account for the fact that a company cannot invest in the stock market, and *should* not invest in the stock market, if it is to develop *itself*. Thus, such comparisons essentially compare incomparable or unreal alternatives. Put differently, discounting factors based on external alternatives are only financially viable in the short term and may ruin the company in the long run by rejecting investments that should have been made. For example, suppose your corporation need a CNC machine, but by using a discounting factor of 15 percent, it is rejected even though a discounting factor of 10 percent would have given a positive NPV. Clearly, a mistake was made and the wise words of Henry Ford come to the mind of every production manager:

> If you need a machine and don't buy it, you pay for it without getting it.

Second, the capital in most corporations constitutes of both equity *and* debt unless they are completely debt-free. Because the cost of debt is normally different (and lower) than the cost of equity, we can neither use the cost of equity as a discounting factor nor a purely external factor like debt—we must use the weighted average of both debt and equity because all capital is capital. This is the basis for the weighted average cost of capital (WACC), and it is calculated as shown in Table 7.3. There are several advantages of using WACC as discounting factor:

1. It produces a weighted average based on the fact that all capital is derived from either equity or debt in some fashion. No single source of capital is therefore overemphasized, which would result in either too low or too high discounting factor.
2. It takes into account past performance of the company (capital structure, retained earnings, and the like), past performance of the company compared to the stock market (the *beta*) as well as macroeconomic situation (the so-called risk-free rate and the premium). Beware of the limitations of betas and calculating the cost of equity.
3. It can also take into account future expectations by including the borrowing rate of both short-term and long-term debt. If desirable, the same expectations can be included in the cost of equity by simply overriding the mathematical calculation by an informed guesstimate. Note that establishing this informed guesstimate can be very difficult to obtain in cases with many small investors, such as most publicly traded companies.

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[99]According to Barringer, H. P. and D. P. Weber (1996). *Life Cycle Cost Tutorial*. Fifth International Conference on Process Plant Reliability, Houston, Texas, Gulf Publishing Company and HYDROCARBON PROCESSING.

Table 7.3 An example of calculating WACC

Description	Value	Definition
Cost of equity		
Risk-free rate	4 %	Current long-term government bond rate
Beta (β)	1.1	Individual stock volatility versus market
Market risk premium (Mp)	6 %	Fifty-year average
Cost of equity	**10.6 %**	$=\text{Rf} + (\beta \times \text{Mp})$
Cost of debt	3 %	Company's current weighted average borrowing rate (short and long term)
Tax cost	2.8 %	Assumes 40 percent marginal tax rate
After tax cost of debt	**2.2 %**	
Capital structure		
Equity	70 %	Equity/(equity + debt)
Debt	30 %	Debt/(equity + debt)
WACC	**8.1 %**	=Equity × cost of equity + debt × after tax cost of debt

4. It reflects an opportunity cost in the sense that it reflects the returns the company can obtain for other investments of similar risk.[100]
5. The usage of the WACC in economic analyses provides a relatively clear interpretation if the analyses are conducted along the lines of economic profit (EP) calculations.[101] A positive NPV, for example, indicates that the investment will result in an increase in the book value of the company, because "…EVA is NPV by period and helps one understand the pattern of [economic] value creation throughout the project life."[102] Note that EVA, or economic value added, is a trademark of Stern Stewart & Co in New York for their version of the EP method.

We should be aware of a couple of facts concerning determining the cost of equity of publicly traded companies:

- Using long-term government bond rate is only one of two common approaches. It is used in Table 7.3. Another approach is to use treasury bills, which are more "risk free" than government bonds, but bonds have a distinct advantage in that

[100]See Young, S. D. and S. F. O'Byrne (2001). *EVA and Value-Based Management: A Practical Guide to Implementation*. New York, McGraw-Hill. p. 493.

[101]See Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[102]See Gandhok, T., A. Dwivedi and J. Lal (2001). *EVAluating Mergers and Acquisitions—How to avoid overpaying*. Mumbai, Stern Stewart & Co. p. 8.

they better reflect expected future interest rates than treasury bills.[103] In the USA, many companies use the 10-year US Treasury bond.[104]
- To infer investors' expectations for the market risk premium, we must look at periods longer than a year, and "…conventional wisdom suggests one should select the longest period possible."[105]

Based on the discussion Chap. 4, it is clear that the calculation of cost of equity in Table 7.3 is not without problems, and also the WACC has its problems. The CFROI approach has solved these weaknesses in one way, but personally I must say that given all these methodological issues and their inherent uncertainties, I find a simple rule such as 10 percent rate of return just as satisfying. Particularly when we realize from Chap. 4 that 10 percent is actually far above what most money managers can pull off consistently over time.

In privately held companies, it is even easier; it is sufficient to ask the owners what they demand as return on equity, which often is somewhere around 10 percent. It should be noted that one of the world's foremost financial investors Warren Buffet typically use "…either the interest rate for long-term (meaning ten-year) U.S. bonds, or when interest rates are very low, he uses the average cumulative rate of return of the overall stock market."[106] Therefore, it is not like many seem to believe that the higher discounting factor they use, the more safe they are that the investments they make will yield large returns. In fact, since there is a strong and positive correlation between risk and return, they are actually *accepting larger* risks and forgoing safer investments, which bring us to the third point.

Third, by using too high discounting factor, companies run the incalculable risk of underinvesting because many investments appear to be unprofitable due to too aggressive discounting[107] as the little example of the CNC machine illustrates. In fact, as researchers that have studied the markets for years state, "In our attempt to

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[103]According to Dimson, E., P. Marsh and M. Staunton (2000). "Risk and Return in the 20th and 21st Centuries." *Business Strategy Review* **11**(2): pp. 1–18, Dimson, E., P. Marsh and M. Staunton (2000). "Risk and Return in the 20th and 21st Centuries." *Business Strategy Review* **11**(2): pp. 1–18.

[104]According to Godfrey, S. and R. Espinosa (1996). "A Practical Approach to Calculating Costs of Equity for Investments in Emerging Markets." *Journal of Applied Corporate Finance* **9**(Fall, 3): pp. 80–89, Godfrey, S. and R. Espinosa (1996). "A Practical Approach to Calculating Costs of Equity for Investments in Emerging Markets." *Journal of Applied Corporate Finance* **9**(Fall, 3): pp. 80–89.

[105]According to Dimson, E., P. Marsh and M. Staunton (2000). "Risk and Return in the 20th and 21st Centuries." *Business Strategy Review* **11**(2): pp. 1–18, Dimson, E., P. Marsh and M. Staunton (2000). "Risk and Return in the 20th and 21st Centuries." *Business Strategy Review* **11**(2): pp. 1–18.

[106]According to Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[107]See Dimson, E., P. Marsh and M. Staunton (2000). "Risk and Return in the 20th and 21st Centuries." *Business Strategy Review* **11**(2): pp. 1–18.

maximize returns to capital, we reduce returns to capital."[108] This is the result of how most investors resolve what they refer to as "The Capitalist's Dilemma", which is "Doing the right thing for long-term prosperity is the wrong thing for most investors, according to the tools used to guide investments." Ironically, the actual return on capital for many venture capital investors over the last decade is close to zero percents which is a far cry from the 25 percent return they were promised. This is a paradox William Sahlman fittingly calls "capital market myopia."[109]

Furthermore, the cost of capital in the market is very low with central bank borrowing rates less than 1 percent in many major economies except China, which clearly illustrates the madness of using discounting rates of 15 percent and upward. In fact, in many cases single-digit discounting factor would be more appropriate.

Fourth, financial performance calculated by a model may be quite different than reality because many aspects of investments cannot be quantified well, yet these investments may produce large economic values over time. Buffet's strategy of putting great emphasis on understanding the investment case is therefore very wise and outperforms the rest of the financial investors even though he uses smaller discounting factors. In fact, he emphasizes the importance of understanding the investment case so much that his choice of discounting factor amounts to the risk-free rate of return.[110] He handles risk by choosing investments with an in-built margin of safety—not by modeling.

Clearly, choosing discounting factors is not easy. In cases where we discuss matters of great societal importance, discounting factors should not be used at all.[111] One of the basic premises of using discounting factors is the time value of money. Whereas this is certainly true in the economic domain, it may be a disaster in other domains where values do not depreciate. For example, the value of a forest is just as large 100 years from now as it is today—perhaps even larger, which would imply a negative discounting factor. The value of a human life is also not depreciating. Thus, it is important to be careful when selecting discounting factors to not fall prey to the notion of time value in cases where value does not depend on time. Therefore, the primary driver of choosing discounting factors should be the *purpose* of the analysis. When the purpose is clearly understood, choosing a discounting factor is much easier, but we must recall the wisdom of Albert Einstein:

> Not everything that counts can be counted, and not everything that can be counted counts.

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[108]See Christensen, C. M. and D. van Bever (2014). "The Capitalist's Dilemma." *Harvard Business Review* **92**(6): pp. 60–68.

[109]According to Christensen, C. M. and D. van Bever (2014). "The Capitalist's Dilemma." *Harvard Business Review* **92**(6): pp. 60–68.

[110]See Hagstrom, R. G. (2005). *The Warren Buffett Way*. Hoboken, NJ, John Wiley & Sons. p. 245.

[111]See Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

Discounting may incorrectly incur such losses in our quest for sustainable development because sound environmental investments may never be realized due to erroneously calculated return on investment. This also illustrates the concern expressed here and one of the reasons for writing this book; in our quest for sustainable development, it is so easy to look for new technologies, laws, and regulations—and for good reasons as well. However, all these innovations may stumble under the scrutiny of executive suites, board rooms, and research institutions around the world if we fail to correctly appreciate and evaluate the performance both environmentally and economically of these innovations.

7.1.3 Commercializing the Innovation

Commercializing inventions into innovations is the most perilous part of the innovation process. The reason is that "commercialization refers to the attempt to profit from innovation through the sale and or use of new products, processes and services."[112] In fact, less than 40 percent of respondents in a global survey find their corporation good at it,[113] and in Canada the CATAAlliance talks about a "commercialization gap"—as opposed to the more common term of "innovation gap." They estimate that[114];

> On the average, it takes a Canadian company about 1.5 times longer to commercialize its innovation to the point of recouping its costs than it took to develop the innovation from an idea to a product or service ready for the market, leading to a total time from idea to breakeven commercialization in excess of 4 to 7 years, depending on the industry sector and the particular company.

Canada is a G7 country, with one of the most generous financial support of R&D for emerging technology corporations,[115] so I think it is fair to say that the image they here portray probably represents most countries in the world to some significant degree—many are potentially worse off. They have studied the causes of this gap too and they are (1) lack of commercialization expertise, (2) weak culture of collaboration, (3) insufficient capitalization and funding for commercialization, and (4) lack of competitive drive and strength. Importantly, they admit that

[112]The definition is from Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[113]See Capozzi, M. M., B. Gregg and A. How (2010). *McKinsey Global Survey results: Innovation and Commercialization, 2010*. Boston and Los Angeles, McKinsey & Company. p. 8.

[114]See CATAAlliance (2011). *Executive Summary: Beyond R&D—Getting Economic Value through Effective Commcercialization of Innovations: Findings and Consultions from 2011 CATA Pan-Canadian Industry Study of Commercialization of Innovations*. Ottawa, ON, Canadian Advanced Technology Alliance (CATA). p. 13.e.

[115]According to Hurwitz, S. (2011). *Beyond R&D: Canada's Commercialization Challenge and How to Meet It*. Boston, MA, Choate, Hall & Stewart LLP. p. 18.

Canada suffers from "…an unwarranted emphasis on product innovation to the detriment of other aspects of innovation outside of the science and technology aspects."[116] This is, as argued earlier, a common problem certainly not confined to Canada.

The causes which are relevant for the discussion here, however, is the lack of capitalization and funding because that influences both the scaling capability and capability to handle disruptive innovations, and one of the key ingredients according to researchers is venture capital (VC).[117] Venture capital—defined as equity or equity-linked investments in young, privately held companies, where the investor is a financial intermediary who is typically active as a director, an advisor, or even a manager of the firm—dates back to the formation of American Research and Development in 1946.[118] However, their importance was not studied until the 1970s. In fact, studies of 20 manufacturing industries in the USA between 1965 and 1992 show that VC-backed technology corporations are approximately three times more effective in creating patents than traditional corporate research.[119] One can, of course, always argue that patents is not the same as innovation,[120] but other studies show that there is a strong relationship between the number of patent citations received and the economic importance of a patent[121] and therefore innovation. It should be noted, however, that most patents have very little economic impact. In fact, according to the US Patent and Trademark Office and the World Intellectual Property Organization there were about 280,000 and nearly a million patents issued, respectively, in 2013 alone, but only roughly 10 percent of them will yield any commercial benefits.[122] What is more, on average a patents earn less money than it costs to obtain and there are a number of risks in the patenting process.[123] Furthermore, only 10 percent of all patents are renewed for their entire

[116]See CATAAlliance (2011). *Executive Summary: Beyond R&D—Getting Economic Value through Effective Commcercialization of Innovations: Findings and Consultions from 2011 CATA Pan-Canadian Industry Study of Commercialization of Innovations*. Ottawa, ON, Canadian Advanced Technology Alliance (CATA). p. 13.

[117]According to the research of Furman, J. L., M. E. Porter and S. Stern (2002). "The determinants of national innovative capacity." *Research Policy* **31**(6): pp. 899–933.

[118]According to Kortum, S. and J. Lerner (2000). "Assessing the Contribution of Venture Capital to Innovation." *RAND Journal of Economics* **31**(4): pp. 674–692.

[119]According to Kortum, S. and J. Lerner (2000). "Assessing the Contribution of Venture Capital to Innovation." *RAND Journal of Economics* **31**(4): pp. 674–692.

[120]An excellent study on the difficulties of using patent statistics is Griliches, Z. (1990). "Patent statistics as economic indicators: a survey." *Journal of Economic Literature* **XXVIII**(December): pp. 1661–1707.

[121]According to Trajtenberg, M. (1990). "A Penny for Your Quotes: Patent Citations and the Value of Innovations." *RAND Journal of Economics* **21**(1): pp. 172–187.

[122]According to Kotha, R., P. H. Kim and O. Alexy (2014). "Turn Your Science into a Business." *Harvard Business Review* **92**(11): pp. 106–114.

[123]As shown by Kotha, R., P. H. Kim and O. Alexy (2014). "Turn Your Science into a Business." *Harvard Business Review* **92**(11): pp. 106–114.

statutory period—yet, there are some few patents that have very large impact.[124] This said, according to the historical account,[125] corporations take the trouble of patenting because patents serve as bargaining counters and ensures rights of entry into a field. Patents, however, do not—as many believe—necessarily prevent any competitive developments, and in sufficiently dysfunctional legal environmental—like the US patent laws—patenting can be used to prevent innovation. So-called patent trolls have in the USA made patenting a source of revenues with litigation. In 2011 alone, roughly 5,000 corporations were named as defendants in patent lawsuits paying more than $29 billion out of pocket.[126] This has been particularly a battlefield for software corporations where ambiguous patents have been filed and used in return to sue a corporation that comes close to a possible interpretation of the patent. Therefore, the software industry in the USA tried unsuccessfully to push the US Congress to reform the patent laws. Wall Street, however, has successfully negotiated special provisions allowing financial corporations to challenge patents covering their services and products. Another victory for special interests…

A major study from the UK[127] highlights public funding as well. In the USA, where the VC industry is mature, corporations backed by VC constitutes up to 20 percent of GDP in some years, and in our Canadian case, we find that Canadian VC- financed technology corporations receive on average only 36 percent of the funding of their VC-backed direct US competitors.[128] It is important to realize, however, that top-tier VC does not only bring money—they bring "smart money" in the sense that they offer a range of benefits for their corporations, including[129]:

1. Entrepreneurial operating corporate experience.
2. Sector and domain industry knowledge.
3. Insight as to the competitive landscape.
4. Financial expertise.
5. Networks, contracts, and access in and to global customer markets, strategic clusters, substantial pools of international capital and serial entrepreneurs.

Lately, so-called crowdfunding platforms are appearing online. Here, start-ups and small corporations can raise equity online without first hiring an investment bank to underwrite their stock. Today, this approach is partially hindered at least in the

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[124]See Griliches, Z. (1990). "Patent statistics as economic indicators: a survey." *Journal of Economic Literature* **XXVIII**(December): pp. 1661–1707.

[125]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

[126]See Jessen, J. (2015). "The Anti-Innovators." *Foreign Affairs* **94**(1): pp. 55–60.

[127]See Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

[128]According to Hurwitz, S. (2011). *Beyond R&D: Canada's Commercialization Challenge and How to Meet It*. Boston, MA, Choate, Hall & Stewart LLP. p. 18.

[129]According to Hurwitz, S. (2011). *Beyond R&D: Canada's Commercialization Challenge and How to Meet It*. Boston, MA, Choate, Hall & Stewart LLP. p. 18.

USA by regulation. This is something that should be improved, and in 2012, the US Congress passed the so-called Our Business Startup Act where crowdfunding up to 1 million US dollar is allowed.[130] This is essentially a further development of the ESOP discussed earlier and represents an even more broad-based approach without employment requirements.

Financing is a very crucial element of commercialization because this is the process of the overall innovation process that is by far the most capital intensive. Below we see the typical distribution of costs for new products introduced in 1985 by 100 US and Japanese corporations in the chemical, machinery, electrical and electronic, rubber, and metal industries[131]:

- Applied research—USA 18 percent whereas only 4 percent in Japan.
- Preparation of product specifications—both at about 7.5 percent.
- Prototype or pilot plant—both at about 16.5 percent.
- Tooling and equipment—Japan 44 percent whereas in the USA it constitutes only 23 percent.
- Manufacturing start-up—USA with 17 percent and Japan only 10 percent.
- Marketing start-up—USA with 17 percent and Japan only 10 percent.

When it comes to the process itself, however, scaling is perhaps the most ignored part of commercialization. It is as if we believe that if we have a good idea, an invention, the rest is done if we manage to also think through the case commercially. Well, this might be true in some cases but for innovations that require significant amount of financing scaling is the hardest part. Former CEO of Intel Corporation, Andy Grove, puts it straightforward; "Scaling is hard work but necessary to make innovation matter" [132] because the investments required are much higher than in the previous phases. As a telling example he mentions "By the early '90s the cost of the factories that would be able to produce the new Pentium chips in volume rose to several billion dollars. The decision to build these plants needed to be made years before we knew whether the Pentium chip would work or whether the market would be interested in it."

It is evident that in a fast-moving industry like the electronics and computing industry, the scaling is extra hard to be on the top—a few years of poor profits can prevent you from having the financial strengths to lift such investments. However, also in slow-moving industries it can be hard enough because the cash flows are also smaller, returns are smaller, and the market share of the market leader is less dominant than in the chip industry where almost everything goes to the top two. An interesting example is the biotechnology industry where scaling up does not simply means scaling up the laboratory, but a whole new process must be invented

[130]See Litan, R. E. (2015). "Start-up Slowdown." *Foreign Affairs* **94**(1): pp. 47–53.

[131]See Mansfield, E. (1988a). "Industrial Innovation in Japan and the United States." *Science* **241**(4874): pp. 1769–1774.

[132]See Grove, A. (2010). How America Can Create Jobs. *BusinessWeek*: pp. July 1st.

along the product.[133] So, various industries have their peculiarities in scaling, hence they are important to understand and manage.

Then, we have "disruption", which is a very different animal altogether. The concept was developed by Clayton M. Christensen[134] to introduce an antithesis of the common innovation models that result in "…better products that can be sold for more money to attractive customers." These common innovation models he calls "sustaining." Disruption, however, is the antithesis resulting in "simpler, more convenient product that sells for less money and appeals to a new or unattractive customer set." If the market favor the sustaining kind, incumbents are likely to beat newcomers, whereas in settings of disruption it is opposite. The disrupting process has three critical elements:

1. In every market, there is a rate of improvement that customers can utilize or absorb.
2. In every market, there is a distinctly different trajectory of improvement that innovating companies provide as they introduce new and improved solutions—this is the sustaining innovation trajectory. Over time, this will eventually overshoot what the customers are able to utilize in the future.
3. In every market, there will consequently emerge incongruities between what customers need and what corporations offer. This opens up for disruptive innovations where the trajectory becomes redefined. This is achieved by introducing innovations that are not as good as the competition offered through sustaining innovations, but it is good enough and more importantly; typically they are simpler, more convenient, and less expensive.

This process results in what Christensen calls "innovator's dilemma." The innovators that have become industry leaders face disruptive innovations that undercut revenues and margins, but with a resource level and a resource allocation process designed and perfected to support sustaining innovations the innovators have two options—fight or flight. Fleeing to market segments with better margins in the belief that there is safe ground from the low-cost entrants is dangerous as Christensen shows on a large number of cases in history—e.g., the story of the steel mini mills. Once the entrants have got a foothold, they typically start with sustaining innovations and before you know it they have caught up and the former market leader is ousted from the market. The solution is therefore to fight and do what it takes to respond. This can be a highly unpleasant process and change entire industries completely, but the alternative is worse in the long run.

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[133] According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[134] See Christensen, C. M. and M. E. Raynor (2003). *The Innovator's Solution: Creating and Sustaining Successful Growth*. Boston, MA, Harvard Business School Press. p. 301.

The type of disruptions we have alluded to so far is so-called low-cost disruptions, and they are old. In fact, the rise of British factory-made cotton textiles in the first wave of the Industrial Revolution ruined the Irish linen industry.[135] Thus, disruptions do not only apply to products and corporations but to entire industries and countries if the technological change is significantly enough. However, there is a second kind as well—"new-market disruptions." These disruptions compete against non-consumption and the challenge is to establish a new network of suppliers and customers where none have tried before. If they manage, the rewards can be great.

In real life, many disruptions are hybrid because the customer bases can be very different due to different customer preferences. For example, people buying luxury cars will never be enticed to buy a cheap car regardless of price differences. However, people owning luxury cars might be tempted to buy a new high-end electric car.

While scaling concerns being on the offensive, disruption brings most corporations on the defensive because many choose to flee consciously either by going into market segments where the margins are still good or by even ignoring the threat altogether. A very famous example of ignoring a disruptive threat is IBM; "Despite inventing reduced instruction set computing (RISC), IBM was slow to introduce computers based on the new technology, in part because it feared the new machines would detract from sales of its existing product lines. Commercialization of RISC awaited new entrants, such as SUN Microsystems and Apollo Computer Systems, who had no stake in the existing complex instruction set computing (CISC) technology."[136] While the actions of IBM in this case seem strange, the fact is that the fear of cannibalization—new products removing/altering the demand for older ones—is real, common, and understandable since many other corporations would have reacted exactly the same way.

There are a number of steps that can be taken to counter the attacker whether you are an entrant or an incumbent, as Christensen outline, but the point here is not to give a complete overview of disruption as a process in all its facets. The point is to realize that if governments are to prevent painful industry changes by legislation, they also inadvertently prevent change and perhaps also sustainable development. The rationale behind that is simple—sustainability is to do more with less and those that succeed in doing that will disrupt the others hence causing large changes. Furthermore, the effects of innovations cannot usually be managed as to separate desirable consequences from undesirable ones.[137] Indeed, typically undesirable, indirect, and unanticipated consequences of an innovation go together just as desirable, direct, and anticipated ones do. Again, this emphasizes the importance to not overmanage our quest toward sustainability. There will be

[135]According to Abramowitz, M. (1986). "Catching Up, Forging Ahead, and Falling Behind." *The Journal of Economic History* **46**(2): pp. 385–406.

[136]According to Ferguson, C. H. and C. R. Morris (1993). *Computer Wars: How the West Can Win in a Post-IBM World*. New York, Times Books. p. 288.

[137]According to Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.

painful changes. There will be great opportunities. There will be many unanticipated consequences—some desirable and other ones not.

In many countries, innovation is often supported by the government, but very often this funding does not include commercialization and (to my knowledge) rarely scaling. It is, in fact, predominantly focused on trade tariffs, taxation obstacles, and legal/administrative obstacles.[138] For this reason, Stephen Hurwitz points[139] out something of great importance to many governments—not just the federal Canadian Government which he was addressing:

> The Canadian government's support for R&D of its emerging technology companies has become, in effect, a subsidy to US businesses which acquire the most promising of these capital-starved but R&D-rich Canadian companies cheaply, then reap the financial rewards by commercializing that R&D and bringing those companies to industry leadership. Worse still, these companies are often moved to the US, resulting in the loss of Canadian jobs, revenues and exports. The bottom line: Canada is losing much of the benefits of its billions of dollars in R&D funding for its emerging technology companies.

This does not seem, however, to be due to lack of capital per se, but more that the government chose to act like this or are basically unaware of the consequences. Even in oil-rich Norway—where the Government Pension Fund Global (GPFG) as of year-end 2013 was worth about NOK 5038 billion (or USD 829 billion) and the largest sovereign wealth fund in the world[140]—we have missed out several innovations that are now owned by foreign companies or sold out corporations that are definitively better investments than South-European junk-bonds.

However, having the industrial system or a substantial system of handcraft does not guarantee success. The innovation must be diffused widely into society to have real substantial, game-changing effects. This is particularly true in the case of sustainable development which required the participation of all for the benefit of all. Therefore, the final step is discussed next—diffusing the innovation.

7.1.4 Diffusing the Innovation into Society at Large

After a product is commercialized and sales starts to increase, it has become important for the corporation, but it may still fail to be important for society at large. This is where diffusion comes into play. Diffusion of innovations takes over the final leg in the process of producing lasting, change on

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[138]According to CATAAlliance (2011). *Executive Summary: Beyond R&D—Getting Economic Value through Effective Commcercialization of Innovations: Findings and Consultions from 2011 CATA Pan-Canadian Industry Study of Commercialization of Innovations*. Ottawa, ON, Canadian Advanced Technology Alliance (CATA). p. 13.

[139]See Hurwitz, S. (2011). *Beyond R&D: Canada's Commercialization Challenge and How to Meet It*. Boston, MA, Choate, Hall & Stewart LLP. p. 18.

[140]See http://www.swfinstitute.org/fund-rankings/.

significant scale—preferably on the societal level when we talk about sustainable development.

Once society accepts an innovation, it will be adopted, improved, and even copied by other corporations. Then, the innovation as a concept no longer belongs to the innovator but becomes a force for real change in society. Some of the more famous cases include the T-ford, the IBM compatible computer (PC), and Dell Computer's business model. This is not merely a question of protecting Intellectual Property Rights (IPR) or the lack of it, but the fact is that once the market sees an innovation that becomes dominating, the market tend to follow it by coming up with variants and solutions that do not infringe IPR. Therefore,

$$\text{Innovation} + \text{diffusion of innovation} = \text{societal change}$$

Typically, the diffusion process as mapped out over time and the percentage of adopters can be described as in Fig. 7.4. The early adopters are naturally always early, but we see that for the two different innovations (I and II), the late adopters adopt very differently. For Innovation I, the time lag between early and late adopters is relatively small as the number of adopters rises quickly, whereas for Innovation II, there is a significant difference. Typically, we would expect that the number of adopters per time unit is greatest when the diffusion is half-way. In the figure, I have used the bell curve to denote the number of adopters and the resulting percentage of adoption to be the corresponding s-curve. In real life, the curves will of course be somewhat different.

The process is due to the underlying factors discussed in Chap. 1 and how they are managed. Also, some innovations basically take more time than others as mentioned before.

History has provided us with insight that is perhaps not directly transferable to sustainable development issues but they should give each and every one of us something to reflect about. As J.D. Eveland writes; "It is impossible for anyone to speak 10 words about diffusion without two of them being 'agricultural extension'… In many ways, it constitutes the defining metaphor for all technology transfer."[141] What he is referring to is The Agricultural Extension Service in the USA which was set up in 1911 and onwards to diffuse agricultural research to farmers by the US Department of Agriculture. There are a number of reasons this model turned out to be so successful according to Rogers[142]:

1. It was flexible toward environmental changes.
2. Clients participated in identifying local needs, planning programs, and performing evaluation and feedback.
3. Agricultural research activities are oriented toward the utilization of research results which facilitates the effectiveness of the extension service.

[141] See Eveland, J. D. (1986). "Diffusion, Technology Transfer and Implications: Thinking and Talking About Change." *Knowledge* **8**(2): pp. 303–322.

[142] See Rogers, E. M. (2003). *Diffusion of Innovations*. London, The Free Press. p. 551.

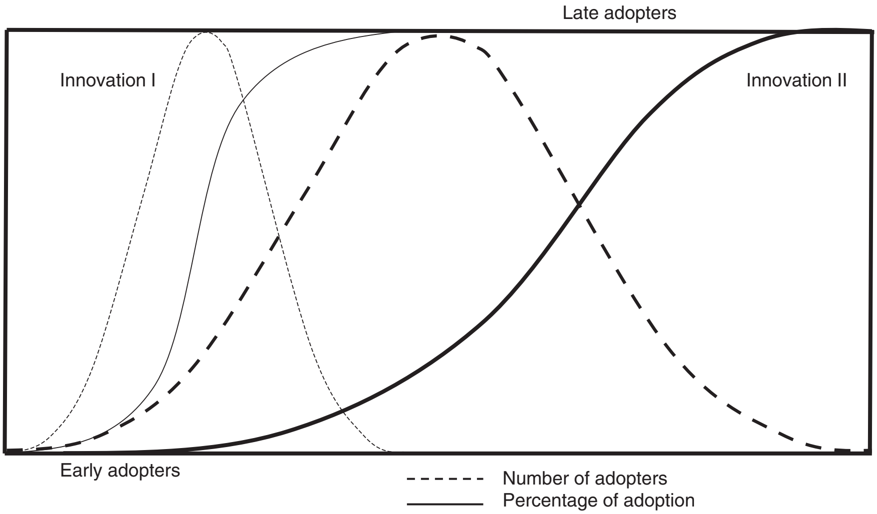

Fig. 7.4 The diffusion process

4. Close social- and spatial contact between agricultural researchers, academia, and change agents facilitate close linking between research-based knowledge and farmer problems.
5. It includes not only a systematic procedure for the diffusion of innovations from researchers to farmers, but also institutionalized means of orienting research activities toward user's needs resulting in a total innovation system.

The agricultural extension model has for various reasons, however, been more effective in diffusing agricultural production technology to farmers than in diffusing other subject-matter content to farm and non-farm audiences. It should be mentioned that while the agricultural extension service is a relatively centralized system, there are also relatively decentralized systems and most are combinations of the two.

The degree of centralization is an important issue to be discussed from a policy perspective, which is done in Chap. 8, but first let us look at what it means, see Fig. 7.5. A centralized diffusion system fits into the linear model of innovation where steps go nicely in sequential order from abstract and formal knowledge developed via R&D to implementation. The centralized diffusion system model delineates better what take place in the market after production than the linear model of innovation depicted in Fig. 7.1.

In a centralized system, change agents are needed to help opinion leaders lead change via influencing people to adopt. the agricultural extension service was quite close to this system. In a decentralized diffusion system, local innovators interact with adopters (which can be innovators for other cases) and between themselves without any central influence whatsoever. Implicit assumptions of the

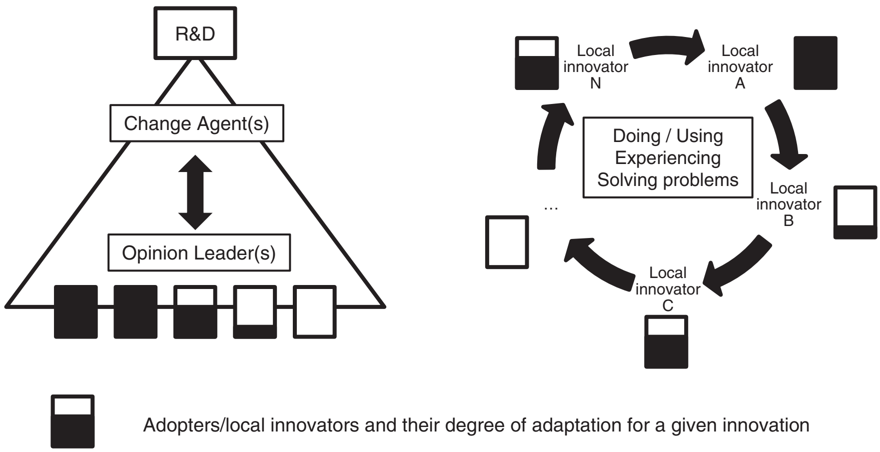

Fig. 7.5 Centralized versus decentralized diffusion systems

decentralized diffusion system are therefore that (1) the users are highly educated and technically competent practitioners and (2) the innovations being diffused do not involve a level of technological sophistication that these users cannot handle or master. This model is a quite accurate description of the market-leading maritime cluster in Norway, for example. Most real-life situations are probably a mix, however.

Rogers did a lot of research on this across multiple industries and he came to the following characteristics that I have tried to embody into Fig. 7.5:

1. In a centralized system overall decision-making of the diffusion process is conducted centrally by, for example, national government in cooperation with subject-matter experts, whereas in a decentralized system, there is wide sharing of power and control among the members in the diffusion system so much diffusion is spontaneous and unplanned.
2. A centralized diffusion system is therefore based on a top-down, hierarchical approach, whereas in a decentralized system, a network of interactions (formal and informal) leads to peer diffusion of an innovation without any particular direction.
3. The background for the top-down approach is the expertise of the subject-matter experts via formal R&D and the traditional linear approach discussed earlier. In a decentralized diffusion system, however, there may not be any experts as such—it is users that via doing, using, experiencing, and solving their problems experiment their way to an improved solution typically via trial-and-error approach.

4. The subject-matter experts together with top administrators typically determine what innovations to diffuse or not in a centralized system. In a decentralized system, however, it is the ability to solve problems as they understand it that determines what is diffused or not. Typically, the assessment of performance is informal and based to a very small extent on statistical evidence of some sort.
5. The centralized approach is obviously based on technology push and the innovation creates its own needs simply because it is so new that local adaptors have little, if any, understanding of the potential before they try it. The decentralized approach, however, is very oriented toward solving problems locally and as such this approach creates a technology pull.
6. Due to the technical know-how required for centrally pushed innovations, there is typically little local adaptation of the innovation. Improvements and reinventions take place to a low degree, whereas for a decentralized approach, this is the norm. The innovation that starts the diffusion process may therefore be very different than then one that prevails in the end if any dominant solution emerges at all.

Clearly, compared to centralized diffusion systems, user needs are more closely satisfied in a decentralized diffusion system. Indeed, user motivation drives the whole process and can therefore be very cost-efficient. However, there are disadvantages, of course, as well:

1. Technical expertise is hard to bring to bear on decisions about which innovations to diffuse and adopt. Ineffective innovations may therefore win the day due to lack of quality control and lack of understanding. Technologically advanced innovations may suffer problems.
2. Since non-experts lack understanding of diffusion systems choosing the right diffusion strategies will be based on trial and error and hence potentially both time-consuming, leading to a loss of quality and in the worst case a complete stop of the diffusion process.
3. National governments may also find it hard to diffuse innovations for which the people do not perceive as important.

Due to the lack of an international supranational body with real decision-making power, a centralized diffusion approach will probably be more difficult in relation to sustainable development than a decentralized diffusion approach. The latter, however, requires a market-based approach which is currently also not established, which explains our current predicament. The ETS and similar are too value-laden and hence political. A market-based approach must be apolitical for the participants, whereas the framework around it must of course be established by governments.

This is by no means all there is to say about innovation as such. However, I hope it is sufficient to highlight the complexity of innovation in many of its facets as it relates to the topic of this book, and that whatever we do in relations to sustainable development it must be market-based and not top-driven. Next, we explore another important aspect of technological development—taking the *right* risks.

7.2 Taking the Right Risks to Manage Technological Change

A brave man runs no more risk than a coward.

Lord Horatio Nelson

When many discuss risk management, they focus on risk being bad things happening. However, it is important to emphasize that "risk is not just bad things happening, but also good things not happening."[143] For technological development to help sustainable development in the right direction as effectively and efficiently as possible, it is vital that risks are managed properly so that good solutions are not discarded by poor implementation or the like. Luckily, as risk analyses have come to age, these techniques have led risk management away from the superstitious to the more scientific, but risk analyses are not without problems. It turns out that the choice of risk analysis approaches may impact the identification of risk sources in terms of magnitude and location.[144] In fact, three independent consulting companies performed a risk analysis of the same hydroelectric power plant and reached widely different conclusions.[145] Risk analyses have also lead to decision-makers taking risks they otherwise would not have taken.[146] For example, the Vajont disaster in Italy in 1963, where at least 2000 lives were lost, was due to overly reliance on the models of engineers and geologists that failed to read the signs of the mountain. This disaster has become a classic example of the consequences of the failure of engineers and geologists to understand the nature of the problem that they were trying to deal with. Clearly, there is room for improvement in how risks of new technology are managed, but how?

From more than a decade of research on risk management—both quantitative and qualitative—I have concluded that risk management has to be augmented by both uncertainty analysis and knowledge management. This has resulted in the augmented risk management process as briefly mentioned in Chap. 3. However, in the context of technological change we can run into a special challenge that I will discuss here in greater detail. It starts by realizing that probability can be defined in many ways using other terms like subjective probability and possibility that incorporate many similar ideas. Consequently, probability can be assigned in many ways. The most common approach regardless of domain is based on the

[143]According to Jones, M. E. and G. Sutherland (1999). *Implementing Turnbull: A Boardroom Briefing*. City of London, The Center for Business Performance, The Institute of Chartered Accountants in England and Wales (ICAEW). p. 34.

[144]See Emblemsvåg, J. and L. E. Kjølstad (2006). "Qualitative risk analysis—some problems and remedies." *Management Decision* **44**(3): pp. 395–408.

[145]As reported by Backlund, F. and J. Hannu (2002). "Can we make maintenance decisions on risk analysis results?" *Journal of Quality in Maintenance Engineering* **8**(1): pp. 77–91.

[146]According to Bernstein, P. L. (1996). *Against the Gods: the Remarkable Story of Risk*. New York, John Wiley & Sons. p. 383.

so-called frequency interpretation of probability.[147] This holds that for n repetitions of an experiment[148]:

> The probability that the frequency ν/n differs from its mean value *p* by a quantity of modulus at least equal to ε tends to zero as n → ∞ however small e > 0.

For example, if something has occurred 10 times over a 200-year period, the probability estimate would be 1 occurrence per 20 years or 5 percent probability of occurrence per year. Using data like this is very common in disaster risk management (DRM) to estimate probability, but this definition can be highly deceptive and lead to erroneous conclusions as illustrated later. The reason is that there are certain assumptions that are difficult to fulfill in real-life settings. The most important ones for this book are that both the conditions of the repetitions must remain constant and the number of repetitions must be relatively high.[149] If that is not the case, the probability estimates are not reliable. With this in mind, the problems are clearly visible for high-impact, low-probability (HILP) events.

Firstly, derived from the very definition, the frequency of occurrence is low (*n* is small sometimes even zero). In other words, we have virtually no data available for estimating the frequency. Second, a violation of the aforementioned assumption is often prevalent. Areas of instable rock slopes erode and change constantly so that the conditions change. The same applies to the seabed resulting possibly in tsunamis. Areas of earthquakes are also instable, which can result in tsunamis which in turn can flood technological installations as in the Fukushima case. In other words, none of the important assumptions associated with the frequency interpretation of probability are fulfilled. The theoretical basis for using frequency for estimating the probability is therefore risky.

If we are to use the frequency interpretation of probability, we must (a) be able to model the fact that deteriorating conditions leads to an accelerating frequency, i.e., the probability of triggering the event increases from year to year as we approach the event, and (b) we need a long record of data as a basis for data sampling. While the latter is possible to solve realistically, the former is impossible to solve for new technology. For the rockslide example in Sect. 7.2.1, it is impossible for two reasons; (1) we do not know when the fractures in the rock formations started and (2) we do not know what the critical fracture size right before failure is. Moreover, these two parameters would ideally have to be known for a large variety of rock slides in order to take into account the problem of random variations. To date, none of these problems have been solved to my knowledge. The American Society of Civil Engineers (ASCE) Council on Disaster Risk

[147]According to Honderich, T., Ed. (1995). *The Oxford Companion to Philosophy*. New York, Oxford University Press. p. 1009.

[148]See Cramér, H. (1966). *Mathematical Methods of Statistics*. Princeton, Princeton University Press. p. 575.

[149]See Hodges jr., J. L. and E. L. Lehmann (1964). *Basic Concepts of Probability and Statistics*. San Francisco, Holden-Day, Inc. p. 375.

Management published a monograph[150] that illustrates very well how various natural hazards much be tackled in different ways for assessment of risk. However, all the approaches known to me suffer from this fundamental issue of the frequency interpretation of probability, and in extreme cases, these so-called HILP events, these methods can lead decision-makers seriously astray, which is why they are so important to discuss and hence the focus in this book. The favorite topic in that respect has been nuclear power, but it can easily come up for other technologies once they emerge if they have potential for destruction.

In the next section, the danger of using the frequency interpretation of probability is illustrated in a specific case, and also how to solve the problem. Then, I will illustrate that a similar problem existed in the Fukushima case with tragic results and that it could have been avoided with simple readjustments of the approach. This is very critical if we are to get nuclear energy back on track.

7.2.1 Using Risk Analyses to Make Decisions About a Rockslide (Åknes) Case

Åknes (or Åkernes) is a bend in an about 500 m deep fjord in the northwestern part of Norway called Synnylvsfjorden. The surrounding mountains are roughly 1500 m high, see Fig. 7.6. With such steep mountains, this beautiful area is potentially treacherous. So far, the geologists[151] have identified about 70 rockslides larger than 0.5 million m^3 in this area since the last ice age. The largest rockslide in this area—it is in fact visible in Fig. 7.6 right below the text "Synnylvsfjorden"—is estimated to be around 400 million m^3. In the last century three major rockslides in this region claimed 175 lives alone in this area.

Before I continue I would like to emphasize that this case is obviously by itself uninteresting for this book. However, since the Geological Survey of Norway—NGU—has published good data sets and it has the HILP characteristics it serves well as an illustration of how risks can be erroneously analyzed for HILP events.

The problem with Åknes today is that it is a site of a steep unstable rock slope that will almost with complete certainty turn into a rockslide—it is only a matter of time.[152] Since 1985 measurements of the cracks visible at the top indicates that the crack is widening. In fact, "…continuous extensometer measurements showed

[150]See Uddim, N. and A. H. S. Ang, Eds. (2011). *Quantitative Risk Assessment (QRA) for Natural Hazards*. ASCE Council on Disaster Risk Management, Monograph No. 5. Reston, VA, Amercian Society of Civil Engineers (ASCE). p. 87.

[151]According to Blikra, L. H., E. Anda, J. Høst and O. Longva (2006b). *Åknes/Tafjord-prosjektet: Sannsynlighet og risiko knyttet til fjellskred og flodbølger fra Åknes og Hegguraksla*. Trondheim, Norges Geologiske Undersøkelse. p. 20.

[152]According to Professor Bjørn Nilsen of The Norwegian University of Science and Technology (NTNU) in Trondheim, Norway, there is only a theoretical possibility that the movement of the rock slope will stop, see Røsjø, B. (2005). Norges vakreste trussel. *GEO*: pp. 18–23.

Fig. 7.6 The location of the Åknes. *Source* NGU

an opening of fractures at a mean rate of about 4 cm/year in the upper part of the slope, with values up to 15 cm/year in the most active part."[153] The instable rock slope can be divided into two broad sections.[154] The smallest moves the fastest and constitute of roughly 8–16 million m^3 of rock. The largest section (including the smallest) moves more slowly, but has an estimated volume of between 30–40 million m^3 or there is an alternative interpretation of 80–100 million m^3 rock. The scenarios NGU has been working on are 10 and 35 million m^3 rock. For simplicity, I use the same definition of scenarios here, denoting the largest (35 million m^3 rock) Scenario 1 and denoting the smallest (10 million m^3 rock) Scenario 2. The inhabitants[155] at risk in the area is about 3000, but it is estimated that in any

[153]See Roth, M., M. Dietrich, L. H. Blikra and I. Lecomte (2006). *Seismic Monitoring of the Unstable Rock Slope Site at Åknes, Norway*. The 19th Annual Symposium on the Application of Geophysics to Engineering and Environmental Problems (SAGEEP), Seattle, WA, Environmental & Engineering Geophysical Society.

[154]See Blikra, L. H., E. Anda, J. Høst and O. Longva (2006b). *Åknes/Tafjord-prosjektet: Sannsynlighet og risiko knyttet til fjellskred og flodbølger fra Åknes og Hegguraksla*. Trondheim, Norges Geologiske Undersøkelse. p. 20.

[155]These numbers are based on the demographic data for the counties involved, which are Stranda, Norddal, Stordal, and Ørskog.

given day during the summer part of the year there is about 25,000 tourists[156] in Geiranger at the end of the fjord. Thus, thousands of people are potentially at risk so this is a case of utmost importance to handle correctly. Norway has also a moral responsibility—not just to its own inhabitants—but more so to the thousands of tourists we invite to Geiranger every year since this is a world heritage site.

The interesting in our context, however, is not the measurements and geological estimations NGU has provided so far, but rather how they use this information to estimate risk and provide recommendations. NGU has chosen a conventional approach—prescribed by most.

In the NGU report[157] they base their estimates of probability on the frequency interpretation of probability. They note that the last time there was a rockslide lager than 15 million m^3, was in 1756. Geologically, however, they find that such large rockslides tend to appear once every 2500 years in this area. This estimate is based on the fact that they have identified four rock slides in this region since the last ice age (about 10,000 years ago), but by using additional information they use the probability estimates shown in Table 7.4. That is, they estimate that the probability of a Scenario 1 type rock slide is between 1/3000 and 1/1000, while the probability estimate of a Scenario 2 type rock slide is set in the range of between 1/100 and 1/300. To calculate the possible loss of lives they assume that inhabitants and tourists are 50 and 25 percent respectively of the time within the danger zone. They also assume that there is a 30 percent probability of surviving a tidal wave and that the tourist season is 3 months long. This gives that for Scenario 1 there is a potential loss of lives in the range of 630–1470 and between 280 and 490 for Scenario 2.

After choosing what they conceive as the most likely numbers, they calculate the risk as shown in Table 7.4. It should be noted that other reports from the same project with much the same people involved offer slightly different numbers.[158] These discrepancies are insignificant so it does not alter the argumentation here—the same basic risk management approach is used in all reports issued by NGU.

By comparing the risk of Åknes to snow avalanches and similar they conclude that the risk associated with a rock slide at Åknes is 200–1000 times lager. According to the Norwegian law the general acceptance criteria for loss of lives is

[156]The number of tourists is the maximum number of tourists in the peak season; however, these numbers are expected to increase as Geiranger has recently obtained status as World Heritage site by UNESCO.

[157]See Blikra, L. H., E. Anda, J. Høst and O. Longva (2006b). *Åknes/Tafjord-prosjektet: Sannsynlighet og risiko knyttet til fjellskred og flodbølger fra Åknes og Hegguraksla*. Trondheim, Norges Geologiske Undersøkelse. p. 20.

[158]See, for example, Blikra, L. H., E. Anda, S. Belsby, K. Jogerud and Ø. Klempe (2006a). *Åknes/Tafjord prosjektet: Statusrapport for Arbeidsgruppe 1 (Undersøking og overvaking)*. Stranda, Åknes/Tafjord-prosjektet. p. 57.

Table 7.4 Annual probabilities, consequences, and risks

Scenario	Probability (per year)	Consequence (loss of lives)	Risk (loss of lives per year)
10 million m^3 (Scenario 2)	1/200	400	2.000
>35 million m^3 (Scenario 1)	1/2000	1050	0.525

Source NGU (See Blikra, L. H., E. Anda, J. Høst and O. Longva (2006b). *Åknes/Tafjord-prosjektet: Sannsynlighet og risiko knyttet til fjellskred og flodbølger fra Åknes og Hegguraksla*. Trondheim, Norges Geologiske Undersøkelse. p. 20)

0.1 percent,[159] which means that the Åknes risk is too high. For this reason they are now installing surveillance- and evacuation system, which they claim will reduce risk by at least 90 percent—hence, reduce the risks below acceptable levels. While all this sounds good, there are some fundamental flaws in their analysis.

Firstly, calculating the annual loss over a 2000 year period of lives is nonsensical in a situation where we know with almost 100 percent certainty that a rock-slide will come—and probably much sooner than later in a 2000-year perspective. Secondly, not only are the probability estimates highly uncertain, but they are also fundamentally flawed because the rock slope is "instable" and the geological record is very limited—thus, violating fundamental requirements for use in the frequency interpretation of probability as discussed earlier.

Clearly, the work done so far in this case has its shortcomings, but much good geological groundwork has been done and an advanced surveillance system is established. Therefore, let us investigate how we can use the same data to achieve a totally different analysis that gives decision-makers a more correct basis for action.

First of all, we start by noting the obvious—the rockslide is inevitable. Thus, it is considered too improbable to consider "no rock slide" as a scenario. Therefore, there are only two interesting questions from a geological perspective:

1. When will the rockslide(s) take place?
2. How large tidal waves will be created at the various settlements and towns?

However, from a decision-makers perspective, which is the most important since a decision is warranted about course of actions, only the second question matters. The reasons is that *when* is not very relevant for a decision-maker because the decision-maker cannot discount future generations. Put differently; a decision-maker—particularly an elected representative of the people—cannot think that saving 1000 lives now is more important than saving 1000 lives 30 years from now. This is an additional reason for claiming that using the frequency

[159]According to Aven, T., M. Boyesen, O. Njå, K. H. Olsen and K. Sandve (2004). *Samfunnssikkerhet*. Oslo, Universitetsforlaget. p. 296.

interpretation of probability is fundamentally misleading. A frequency interpretation lends itself to time-series thinking.

What is much more interesting is *when*, for *any* given year. This is because a rockslide in the peak of the tourist season—with maybe three to five cruise ships anchored up in Geiranger in addition to the thousands of tourists that come by car and other means of transportation—will have far greater consequences than in the middle of the winter on a weekday. Another improvement made in this approach is to avoid excessive usage of averages in the modeling.[160] The third major improvement is that uncertainty is explicitly modeled as uncertainty distributions and then calculated numerically using Monte Carlo methods.[161]

With this thinking, we get a model which gives the results for the deterministic case, which is the case where we ignore the uncertainty in the numbers in the model, as presented in Table 7.5. For most decision-makers it will be far more compelling to know that you may face an average loss of lives in the range of about 1500 to 3000 depending on the size of the rockslide, the time of year and when it strikes in the time of the day, than knowing that about 2 lives will be lost on average per year over two millennia. Note that what time it is during the day is incredibly important, but so far the model does not encompass such considerations.[162]

However, to get a better idea of the potential loss of lives uncertainty must be included in the analysis since some numbers have quite a high level of uncertainty associated with them. Notably, when the event takes place during the year is extremely important. A hot summer day will mean crisis compared to a day in the winter. In Fig. 7.7 the probability distributions for the risk of both scenarios are shown. Clearly, there is a small probability for losses up to 4500 lives but they will always exceed about 1000 lives.

There are three chief reasons for these numbers being so much higher than those presented by NGU. First, the numbers are not multiplied by the frequency of large rockslides. Second, this model avoids excessive usage of average numbers. Third, uncertainty is included—average numbers can be very deceiving. Using the Monte Carlo methods also allow proper sensitivity analyses to the risk analysis.[163] Then, we can identify the most important factors in the case, see Fig. 7.8. Many of the factors are hard to deal with such as the length of the tourist seasons and the

[160]As prescribed by Emblemsvåg, J. (2005). "Business analytics: getting behind the numbers." *International Journal of Productivity and Performance Management* **54**(1): pp. 47–58.

[161]For a detailed introduction to this, see Emblemsvåg, J. (2003). *Life-Cycle Costing: Using Activity-Based Costing and Monte Carlo Methods to Manage Future Costs and Risks*. Hoboken, NJ, John Wiley & Sons. p. 320.

[162]Note that the complete modeling and results are presented in a book written for the Norwegian audience in Norwegian only, see Emblemsvåg, J. (2008). *Flodbølger fra Åkneset. Før eller Senere—Tiltak eller Katastrofe?* Oslo, Kolofon Forlag. p. 193.

[163]This is described well in Emblemsvåg, J. (2011). Augmenting the risk management process. *Risk Management Trends*. G. Nota. Rijeka, Croatia, InTech: pp. 1–26.A.

Table 7.5 Summary of the deterministic model

Scenario 1	Probability	Consequence	Risk
Tourists	25 %	8345	2086
Inhabitants	75 %	1402	1051
Sum			**3138**
Individual risk			**10.6 %**

Scenario 2	Probability	Consequence	Risk
Tourists	25 %	3679	920
Inhabitants	75 %	701	526
Sum			**1445**
Individual risk			**4.9 %**

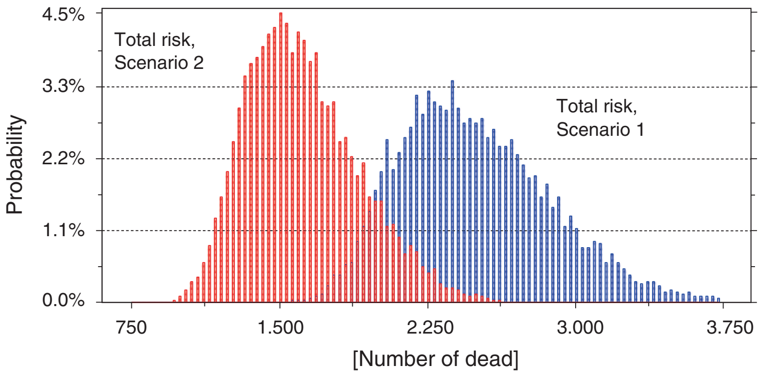

Fig. 7.7 Overlay chart showing the risk of the two scenarios

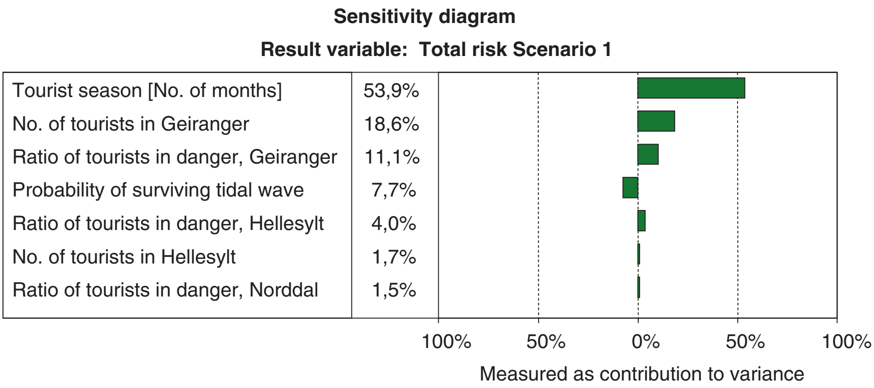

Fig. 7.8 Sensitivity analysis of Scenario 1

exposure of the tourists since the fjord itself is the main attraction. However, what might be of interest is to increase the probability of survival when the tidal wave comes. Maybe building concrete emergency shelters that people can run into once the alarm is set off? In any case, this analysis clearly offers much more insight and a far more compelling message to the decision-makers.

This case was about a rockslide and you may argue that it does not apply to sustainable development, and it does not. However, the approach does. The crux of the alternative approach employed in the Åknes case is not to try to figure out *if* an event will take place which is a big issue in the conventional approach, but to rather say; *when* the event will take place, *how* can it play out and *what* can we do about it? Therefore, the alternative approach is more focused on impact mitigation—or risk-based impact mitigation—than the conventional approach. This is fully in line with behavioral psychology research also, which shows that "one needs to present comparison scenarios that are located on the probability scale to evoke people's own feeling of risk,"[164] and this is particularly true for HILP events due to the low-probability of occurrence. To tell a decision-maker that a probability of a certain event is 0.0001 percent is meaningless—even understanding 10 percent probability can be hard enough.

Next, the Fukushima case is reviewed and with the information available I will try to argue how the risk management should have been conducted. Then, it will become clear that the quest for sustainability does require correct risk management not just to handle the case correctly in a technical sense but also to make sure the accidents do not happen and hence prevent the loss of public trust in technologies that may prove vital.

7.2.2 The Fukushima Daiichi Case

Presenting the Fukushima case at the same level of detail as the Åknes case is impossible due to data availability. However, more than enough is known to highlight how a different approach to risk management could have produced an entirely different outcome. There were many things that went wrong in the case as such, which could have improved the outcome, but here we are only going to review the risk analysis part because that is perhaps the root cause to the tragic outcome of the accident. Threats and risks were basically underestimated.[165]

[164] According to Kunreuther, H., N. Novemsky and D. Kahneman (2001). "Making Low Probabilities Useful." *The Journal of Risk and Uncertainty* **23**(2): pp. 103–120.

[165] According to Acton, J. M. and M. Hibbs (2012). *Why Fukushima was Preventable*. Washington, DC, Carnegie Endowment for International Peace. p. 44.

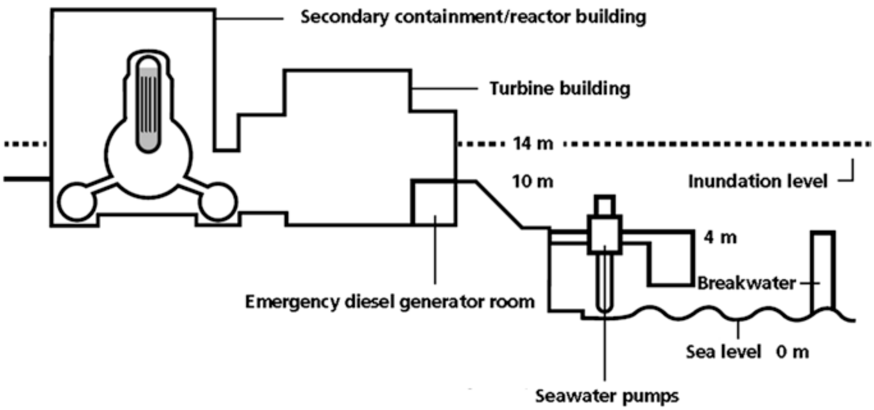

Fig. 7.9 Simplified cross section through one of the reactors at Fukushima Daiichi showing the approximate location of critical components damaged by the tsunami. Not drawn to scale. *Source* Acton and Hibbs (see Acton, J. M. and M. Hibbs (2012). *Why Fukushima was Preventable*. Washington, DC, Carnegie Endowment for International Peace. p. 44) and used with kind permissions from Carnegie Endowment

The obvious question by a layman is why were the seawater pumps that cool the reactors located just 4 m above sea level when it became inundated by 14 m as is clear from Fig. 7.9? According to the official licensing documents, Fukushima Daiichi was designed for tsunamis up to 3.1 m above sea level.[166] Given this, the seawater intake buildings were located 4 m above sea level—providing some margin of safety—and the main buildings at 10 m above sea level.[167] Later, the new design criterion was set to 5.7 m. The fact that the facility was not upgraded accordingly is one thing, but regardless of design criterion something is wrong with the approach. Some researchers correctly question that approach stating that "The underestimation of the seismic hazard provides evidence of systemic problems in disaster prediction and management," and this is not a local incident—in fact, "The approach to hazard prediction for Fukushima Daiichi appears to have been at variance with both international best practices and, in some cases, with Japanese best practices"[168] but not fundamentally different.

[166]According to IAEA (2011). *IAEA International Fact Finding Expert Mission of the Fukushima Daiichi NPP Accident Following the Great East Japan Earthquake and Tsunami*. Wien, International Atomic Energy Agency (IAEA). p. 160.

[167]Contrary to some media reporting there is not a proper sea wall at Fukushima Daiichi. There is a shallow breakwater around the plant, but it was apparently not designed to play any role in tsunami protection and is not regulated by NISA. Its role was simply to create a calm harbor for shipping, see Acton, J. M. and M. Hibbs (2012). *Why Fukushima was Preventable*. Washington, DC, Carnegie Endowment for International Peace. p. 44.

[168]See Acton, J. M. and M. Hibbs (2012). *Why Fukushima was Preventable*. Washington, DC, Carnegie Endowment for International Peace. p. 44.

This approach rests, like in the Åknes case and all traditional DRM approaches, of an estimate of hazard which in turn is used to estimate risk. These estimates are typically based on historical records and in the Fukushima case they based it on a 1960 earthquake off the coast of Chile which created a tsunami of that height on the Fukushima coast.[169] However, if they had used a longer time horizon they would have, for instance, found from historical records of tsunamis in and around Japan that show something very different. In fact, since 1498 12 events had maximum amplitude of more than 10 m, six of which had maximum amplitude of over 20 m.[170] So, what if we had data 2000 years back or more… what would the danger estimate become then?

With HILP events the traditional approach is basically dysfunctional because of the behavioral aspects of people trying to understand low probabilities—we simply cannot understand their meaning, as noted before, and from a risk management perspective the only viable strategy is impact mitigation.[171] Therefore, the only viable approach is to rather ask—*when* the facility is inundated with water; *what* will happen and what can we do to prevent system failure? Or, *when* the facility is hit by an earthquake of 9.0, *what* will happen and what can we do to prevent system failure? This kind of questioning, and their associated answers, should in turn be open for two-way discussions so that the public can be assured that it will work as intended—thereby improving risk perceptions. We see, for example, from Table 3.1 the similarity in risk perception across all groups when it comes to smoking, and this is undoubtedly due to all the publicity around smoking and health issues for decades. As confirmed by psychometric research[172]; a two-way process is crucial to risk perceptions and hence the acceptance of solutions—experts and laymen cannot respect each other unless they have some basic understanding of each other and this can only be achieved through a two-way process. Education in a wide sense is the key.

In the Åknes case we saw how this changes the quality of the decision support, and I believe that in the public debate about nuclear power such risk management practices would have contributed toward rebuilding some trust in nuclear power or some other powerful technology in the future, say, fusion. In fact, a risk management approach that takes for granted that destructive, natural events *will* take place and will inflict damages, will provide much more realistic design criteria for the engineers to find fail-safe technologies.

[169] See IAEA (2011). *IAEA International Fact Finding Expert Mission of the Fukushima Daiichi NPP Accident Following the Great East Japan Earthquake and Tsunami*. Wien, International Atomic Energy Agency (IAEA). p. 160.

[170] According to Mohrbach, L., T. Linnemann, G. Schäfer and G. Vallana (2011). Earthquake and Tsunami in Japan on March 11, 2011 and Consequences for Fukushima and other Nuclear Power Plants. www.vgb.org/vgbmultimedia/News/Fukushimav15VGB.pdf:pp.

[171] For a thorough discussion, see Kunreuther, H., N. Novemsky and D. Kahneman (2001). "Making Low Probabilities Useful." *The Journal of Risk and Uncertainty* **23**(2): pp. 103–120.

[172] See Slovic, P. (1987). "Perception of Risk." *Science* **236**(4799): pp. 280–285.

To finally illustrate the folly of today's conventional approach, let us consider the mass extinctions of life on Earth. There are apparently five major peaks in extinction rates in Earth history according to the literature on Phanerozoic marine diversity.[173] The so-called Big Five theory is so widespread that it has given rise to the popular term "sixth extinction" in relation to the current environmental crisis.[174] With the conventional risk management approach we would say that since the risk of such major extinction events is one event every 100 million years the probability is 10^{-8}. In these events, we can say, for the sake of argument, that about 80 percent of all life was extinct, which would translate into a complete extinction of the human race today. With a population on Earth of about 7.2 billion, this means that the risk would be 7.2 billion times 10^{-8} or a death toll of 72 people per year. Since there are numerous activities on Earth causing more than 72 deaths per year, it follows that such a mass extinction event is nothing to worry about. Preventing small accidents become far more important than saving humanity.

Clearly, this example is ludicrous in the sense that obviously is a mass extinction event hugely worrisome, but the point is that conventional risk management gives no useful decision support. This leads us to the more relevant question, where is the cut-off between when the conventional approach is useful and when it is not? The answer is, as shown earlier, that conventional risk management does not work for HILP events. Period.

Finally, in our discussion about technological development, I will briefly highlight a moral aspect which we cannot escape if we are going to have an effective and efficient process toward sustainable development—delivering quality workmanship.

7.3 The Moral Duty to Delivery Quality Workmanship

> The bitterness of poor quality remains long after the sweetness of low price is forgotten.
>
> Unknown

When I grew up, my father was constantly reminded me of the importance of doing a good job. Being brought up in the protestant work ethic that Weber wrote so famously about[175] his argument was primarily out of moral duty; we had a moral duty to perform our best. Later, after adopting the same attitude, I realized that this is not only a moral duty but also a business duty and that it makes very good economic sense.

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[173] See:

- Raup, D. M. and J. J. Sepkoski Jr. (1982). "Mass extinctions in the marine fossil record." *Science* **215**(4539): pp. 1501–1503.
- Raup, D. M. (1986). "Biological extinction in earth history." *Science* **231**(4745): pp. 1528–1533.

[174] See Glavin, T. (2007). *The Sixth Extinction: Journeys Among the Lost and Left Behind*. New York, Thomas Dunne Books. p. 318.

[175] See Weber, M. (2001). *The Protestant Ethic and the Spirit of Capitalism*. London, Routledge. p. 320.

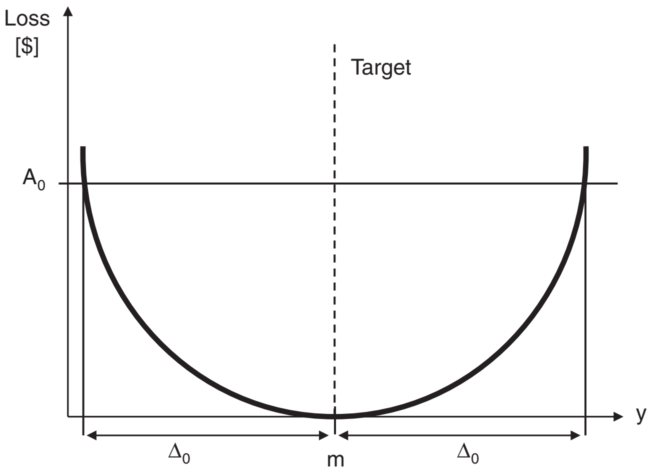

Fig. 7.10 Quality Loss Function. *Source* Taguchi's Quality Engineering Handbook (see Taguchi, G., S. Chowdhury and Y. Wu (2005). *Taguchi's Quality Engineering Handbook*. Hoboken, NJ, John Wiley & Sons. p. 1662) and used with kind permission from John Wiley & Sons

Sustainability and quality are, in fact, closely related—because nothing is more wasteful that producing substandard products and services, causing customer dissatisfaction and hence waste and possibly repurchase somewhere else. Furthermore, quality and economic performance is closely related both with respect to the bottomline, the topline, and even the triple bottom line if we want to use that term because poor quality gives higher consumption with all that higher consumption implies for the environment. The cause of this problem is complex but shortsightedness and ignorance is probably root causes, about which we can do little other than educate and to some extent legislate as we shall see later.

From an educational point of view, it starts by realizing that quality is about loss—or rather avoiding loss. Taguchi has proven this in the most explicit way by introducing his quality loss function (QLF), see Fig. 7.10. Indeed, Taguchi defines quality as "the loss imparted by the product to the society from the time the product is shipped."[176] His point is that there are two aspects to this. There is a justice aspect in that whenever we delivery work that misses the target we end up in an unjust situation where either the customer gets less than paid for or the corporation gets less than what the customer pays. In turn this implies erroneous assignment of costs which affects the customer next; either cases represent waste for society. Then, we have the more obvious quality aspect which in cases of medicine can prove fatal or in terms of generating antibiotic resistant bacteria which can prove fatal in the long-term. Clearly, this is not sympathy for man—at best it is sympathy for oneself—essentially, however, it is outright "cheating" as Taguchi says.

[176]See Taguchi, G., S. Chowdhury and Y. Wu (2005). *Taguchi's Quality Engineering Handbook*. Hoboken, NJ, John Wiley & Sons. p. 1662.

Eliminating such waste has huge, positive economic consequences and eliminating waste is one of the core ideas behind the Toyota Production System (TPS) and lean whose economic impact is well known.[177] Another system that focuses on eliminating deviations is Six Sigma, and the results from Six Sigma implementations are also well known.[178] This "cheating" is systemic and indirectly and not directly removing something from someone as a thief. However, the interesting question is why are there no criminal charges and persecution as to deliver substandard products? This is a much more common type of theft… with far greater consequences.

Paul Midler has written a highly entertaining book titled *Poorly Made in China: An Insider's Account of the China Production Game* about the extensive amount of creativity locals exercise at the expense of foreign customers. Yet, consensus is that Chinese authorities do little about this that seem to work. As long as China was a poor country, we could reason that this was a kind of unspoken help along the arguments of List and a country's right to defend infant industries, but this is less and less the case since China is rising rapidly and strongly.

I used China as an example here because it is well documented, but the same situation applies to other countries as well as to various corporations. It is well known that the Western world at some point did much the same. For example, List writes about how Prussia engaged quite creatively in obtaining the insight in machine tool technology from British engineers such as Mawdslay. Without passing a judgment on technology transfer and how various countries in various historical contexts have been creative in various ways, I think it is interesting to note what has happened in the automotive industry. A car today is among the most reliable products in the world by most standards, but this is largely due to strict governmental safety rules and regulations. The same applies to aircrafts. The point is that the industry adapted to clear demands and unconditional rules and regulations, and today, the quality level is high by any standards by most car manufacturers in the world.

If we believe in the importance of sustainable development—for which failure means huge problems for future generations—why should we accept less? Why not envision that the same can be obtained with respect to environmental impact of products if industry was given much clearer objectives as to performance? This is where clear legislation and maybe also energy accounting would come into play as well. The old maxim that "The mother of invention is necessity" applies. One way this can be brought about is by the government acting as a demanding lead-user and innovator of major research and development programs. This, and much more, is discussed next.

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[177] See, for example,

- Liker, J. K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer* New York, McGraw-Hill Professional. p. 350.
- Womack, J. P., D. T. Jones and D. Roos (1990). *The machine that changed the world*. New York, Rawson Associates. p. 323.

[178] See, for example, Hutschins, D. (2000). "The power of Six Sigma in practice." *Measuring Business Excellence* **4**(2): pp. 26–33.

Chapter 8
The Role of the Government

> *Govern a great country as you would fry a small fish: Don't poke at it too much.*
>
> Lao-Tzu

The role of the government is crucial in building an effective science and innovation system—Apple, for example, would most likely never had achieved its success without the active role of the state.[1] Furthermore, the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine in the USA claim that "Since the Industrial Revolution, the growth of economies around the world has been driven largely by the pursuit of scientific understanding, the application of engineering solutions, and continual technological innovation."[2] Based on the review in Chap. 5, it is clear that this is a too narrow or one-sided, technology-oriented statement. If we look at the immediate causes of the growth, the statement rings true; however, from the insight of List, as discussed in Chap. 5, it is clear that technology was not the root cause for the first Kondratieff cycle. Back then, the world was largely agricultural yet the early days of manufacturing made huge impact due to correct political choices. Later on, we must also add the laws of limited liability. However, given that these fundamental institutions are in place, the statement is largely true if we remove 'technological' and interpret 'innovation' widely covering processes, organizational structures and -practices and business models. The challenge today with respect to sustainable development is that important institutions need reformation or even replacement.

Anyway, one of the fundamental problems with innovation left in a market without any governmental assistance is that the benefits of innovation spill over to other corporations who have not had any costs or risks associated with the innovation. This stifles innovation and results in a "market failure" or lack of appropriability.

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[1]This bold claim is made by several including The Economist (2013). "The entrepreneurial state." *The Economist* **408**(8851): pp. 52.

[2]See National Academy of Sciences, National Academy of Engineering and Institute of Medicine (2005). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC, National Academies Press. p. 592.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_8

For those that believe that this can easily be protected by patents or copyrights, the news is that these old-fashioned ways of protecting immaterial assets are relatively easy to circumvent,[3] particularly in some industries. Furthermore, in some countries they are blatantly violated without any immediate consequences worth mentioning.

This said, it is clear that the role of appropriability via patenting was also important for the Industrial Revolution although less pronounced than the role of finance. This is particularly true for those industries in which process and product are closely related such as chemical industries which came around the 1900s and onward.

There are two reasons for this "market failure"[4]: (1) Successful innovation requires the creation and maintenance of complex knowledge bases and infrastructures that cannot be provided by corporations on their own, and (2) innovation is characterized by investment commitments under conditions of elevated risk and uncertainty. This is where the laws of limited liability came into effect and made the Industrial Revolution truly a revolution in the 1800s. The question we are grappling with now is what will it take to fuel sustainable development in a similar fashion? In this chapter, the role of the government is therefore explored, and it is pivotal as the discussion thus far shows. It should be noted that "The proper role for government can often be determined only on a sector-by-sector basis."[5] This is important to keep in mind, but for this book, an industry-specific debate is not fitting for the scope of the book—it would be too detailed.

Naturally, the government has a number of roles to play in our quest toward sustainable development. Broadly speaking, we can group them in six areas with respect to the topic of this book:

1. Provide political leadership.
2. Reengineer finance and capitalism.
3. End dysfunctional practices.
4. Start supportive practices.
5. Provide financial incentives to the economy.
6. Build and maintain a vibrant science and innovation system.

In the next six subsequent sections, these broad areas are discussed. Then, in Sect. 8.7, some final comments concerning the government are discussed.

Before we continue, it should be noted that no distinction is made between the legislative branch of government and the executive branch of government. The distinction between government, parliament (or similar bodies such as senate), agencies, and the bureaucracy of various departments is also missing. This is because

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[3]See van Reenen, J. (2011). "Big ideas: Innovation Policy." *CentrePiece, the magazine of economic performance* **16**(2 (Autumn)): pp. 2–5.

[4]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[5]See for example Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

various countries have different ways of organizing these branches of government and to choose one model over the other is not my intention here. So, when I refer to "the government," I basically mean all organizations that belong to the state in one way or the other. It should also be kept in mind when reading on that in Europe and Japan, industry and government are more closely linked than in the USA and universities play a smaller role in industrial research. In Japan, corporations also have a stronger history of collaboration than in the USA.[6] National differences can therefore be substantial, but ignored here.

8.1 Provide Political Leadership

After conducting a thorough and critical review of the construction of global warming and the politics of science, David Demeritt notes that[7]

> I am concerned that the dominant science-led politics of climate change rests on a weak foundation. Given the immensely contentious politics, it is tempting for politicians to argue that climate policy must be based upon scientific certainty. This absolves them of any responsibility to exercise discretion and leadership.

I cannot agree more. Politicians must stop pushing the scientists and industry ahead of themselves. The fact is, as outlined earlier, that there are a number of great uncertainties, and many aspects of climate modeling are value-laden. In other words, it is no problem to cause debate and inaction on the issue of climate change as we witness today.

What is crucial is to realize that the climate and sustainability challenge is not primarily a science challenge but rather a systemic challenge involving finance, the capitalist bedrock and naturally the science and innovation system, as argued in preceding chapters, and a number of other political changes. Government policies in many countries have largely been predicated on the linear model of innovation.[8] Governments must realize, however, that most innovation is non-linear and systemic efforts are warranted. This is exemplified by the fact that studies show that roughly one-third of all innovations are delayed primarily by lack of complementary technologies.[9] Governments must also realize that there can be a quite

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[6] According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[7] See Demeritt, D. (2001). "The Construction of Global Warming and the Politics of Science." *Annals of the Association of American Geographers* **91**(2): pp. 307–337.

[8] See for example Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[9] See Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

long and winding road from science to innovation for two reasons (in addition to all those relates to the innovation process itself discussed in Chap. 7):

1. Most industrial R&D is actual defensive or imitative in nature—in other words, catching up, making minor improvements, technical service, and other short-term activities.[10] This means that most industrial R&D today will not produce anything significantly new.
2. There can be a significant time lag between scientific knowledge and actual application, yet often the innovations could not have taken place without.[11] This means the science is not a quick road toward sustainable development through breakthrough/radical innovations, although it might often be necessary.

Therefore, there is only one way forward—we must start with those technologies, processes, and organizations we have today and then make steady improvements while fostering close relations between industry, government, and academia to nurture innovations. Once this is realized, many new avenues for political leadership open up, but first politicians have to free themselves from the tyranny and short-sightedness of mass media.

The problem is that "Because media focuses on the shallow factors, so too often have political leaders[12]." With four-year election periods, and that being the maximum length of planning and even less when it comes to execution since they have to prepare for the next election, it goes without saying that sustainable development will have no real, political leadership. This is not acceptable, because "… successful innovating economies invariably possess successful public-policy systems."[13] This is easy to understand from the facts[14] that during the 1970s and early 1980s, the USA and Switzerland maintained a *per capita* patenting rate well in excess of all other OECD members. So what did they do differently? Well, much of what I have been discussing in previous chapters and in this. However, some other countries have since then adapted and come up on a comparable level—Germany, Japan, and the Scandinavian countries—whereas the UK and France have not improved much over the last 25 years.

[10]See for example Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

[11]In one survey of 76 major US corporations, most respondents believe that a significant portion of their new products and processes introduced between 1975 and 1985 could not have been developed without fundamental research in the fifteen years prior to the innovations, see Mansfield, E. (1991). "Academic research and industrial innovation." *Research Policy* **20**(1): pp. 1–13.

[12]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[13]See West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[14]Facts are provided by Furman, J. L., M. E. Porter and S. Stern (2002). "The determinants of national innovative capacity." *Research Policy* **31**(6): pp. 899–933.

Therefore, the overriding aim of political leadership in our quest toward sustainability must be to design and implement an effective public policy system to support innovation in a wide sense and put finance back to its original purpose. For many countries, the political system must probably start by redesigning itself so that we avoid impotent political leadership characterized by professional politicians more concerned about their positions and not achieving something, minority governments that spend most of the time negotiating their own existence instead of doing something that has any impact and this also includes a redesign of the bureaucracy as well which in many instances are more concerned by protecting *status quo* than to serve—they have fallen into the iron cage Max Weber so famously spoke about.[15] This is something that society *can* and *must* do something about. This is not straightforward, however, because several difficult choices will have to be made including what dysfunctional practices to end, what practices to support, how to provide the right financial incentives, and redistribute returns so that the socialization of risk can be still viewed as legitimate also in the future.

The iron cage of Weber does not only refer to bureaucracies but also society at large via our rationalization, which is particularly a problem in the Western world. This comes fully in line with the financialization of society and all its problems as discussed in Sect. 4.1. Indeed, the financialization of society can be viewed as a result of the rationalization of society. Therefore, another overriding aim of political leadership for our quest toward a sustainable society is to realize the limits of rationality. Governments must stop using the cost guesstimates of externalities to argue for/against certain policies. We must realize that externalities are truly external to the economic system and hence such cost guesstimation techniques must be used carefully. Some things have an intrinsic value in itself of far greater worth than their apparent economic worth, and this must be taken into account. In such cases, a much broader perspective than merely the economics must be used. Some wise words of Oscar Wilde come to mind:

> A cynical is one who knows the price of everything and the value of nothing.

Once the political system has managed to meet the overriding aim of implementing an effective public policy system, many things become possible. Most important, political leadership must create a bold vision for our society so that the relatively abstract terms “sustainability” and “sustainable development” can become something concrete in the eyes of the people. This will most likely entail some bold projects—a moon landing or two, if you like—that can also be used to change the political system as well. It is also likely that this will have a different meaning to different places on the globe depending on their given circumstances, and it is likely that this will also change over time as we progress.

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[15] See for example Weber, M. (2001). *The Protestant Ethic and the Spirit of Capitalism*. London, Routledge. p. 320.

Initially, energy efficiency could be the issue. Once we have a highly energy-efficient economy—the first green Kondratieff cycle—the next green Kondratieff cycle could be about something that some decades from now will be the next big topic. Using the natural tendencies in the economies to form such cycles must be used by governments, but in order to do that more effectively than today, they must do a few things to reengineer the global system.

Next, one of the most important jobs for the government in terms of reengineering the global system is discussed. If we cannot make finance serve the real economy in better ways than today, I believe that sustainable development will be much, much slower or even never be realized—just recall the lessons from history in Chap. 5.

8.2 Reengineer Finance and Capitalism

Capitalism as such is a very wide concept, and there is not a single type of implementation of it across the world. Yet, there are some basic principles as discussed in Chap. 5. Concerning the role of government, finance, and what has to be done with respect to sustainable development, there are four important aspects to address.

First, the rich world must come to terms to its own road to wealth, recognize that different countries have somewhat different paths, and we cannot use World Trade Organization (WTO) and International Monetary Fund (IMF) to spread our blueprint for growth around the world independent of cultural context and stage of development. A number of countries and researchers have voiced their opinion against this,[16] but apparently with little effect. This is a huge topic discussed only cursorily in this book, but the narrative of List briefly discussed in Chap. 5 should be a clear reminder of its importance, and governments must find a better way than today for helping the not-developed world climb up the ladder. His account, however, is also relevant to the argument of not only protecting infant industries, but also the need to protect infant technologies, which is a relevant issue in our quest toward sustainable development. The issue of infant technologies is discussed in more depth later.

Second, there are a number of obvious problems related to subsidies and similar political interventions in the market that cannot continue simply because they tilt the market in the way of special interests and outright perverted resource usage diametrically against sustainable development. The magnitude of this is simply staggering, and one thing is providing protection of infant industries so that they can build a country, but why the oil and gas industries receive such subsidies is puzzling. As *The Economist* states[17], "The extraordinary complexity of the various

[16]See for example Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

[17]According to The Economist (2001). Big Oil and its subsidies. *The Economist*. **358**: pp. 82.

"taxes" and "subsidies" affecting the oil industry is revealing in itself—eloquent testimony to politicians' desire to meddle, and to obscure the true cost of their meddling." The motivation for this meddling is probably growth and employment—or ultimately reelection—but if they understood how detrimental this is, and increasingly will be, maybe there would be a change. If such basic things are not understood and acted upon, I must say that we can all subscribe to the rather gloomy sentiments of Mark J. Dourojeanni, Chief of the Environmental Division, Inter-American Development Bank, when he stated that[18]:

> The fundamental constraint to achieving sustainable development is social inequity and its associated evils: poverty and ignorance. While most humans must live without choices and almost without hopes, a minority of humans are fiercely resisting the concessions which may provide to the entire world a solid basis for a harmonious relationship among humans and nature.
>
> Currently, the rich nations and rich people are avoiding the real problem mostly by pressuring the poor nations and the poor people to follow the rules they know are necessary for survival. Even more, in some ways, because it is good business, the rich are taking advantage of environmental matters to become richer. This situation translates into very little progress in the key subjects: equity and environment.
>
> The only hope for a change is that, sooner or later, even the richest in the world will be affected by social and environmental degradation. Therefore, as always in the past, reason will be imposed by despair and not as a timely, progressive and voluntary decision.

A third issue related to capitalism is that the measures we use should be complemented to better capture the environmental dimension. I have outlined energy accounting here since that is relatively straightforward technically speaking and will give very good track on energy consumption, which is one of the major factors in socioeconomic development.[19] Realistically speaking, energy accounting will probably be a hard political issue to sell since it will impose extra costs to society in the short term, but it will probably work much better than today's costly cap-and-trade solutions such as the Emissions Trading System (ETS). If ETS is to work, two major changes must absolutely be imposed so that it better mimics the SO_2 allowance trading system[20] which was established in 1990 in the USA:

1. Sinks must be removed so that planting trees and the like cannot be used to balance carbon emissions.
2. Prices must be regulated so that producers cannot send the increased costs to consumers who have little chance, or interest or even knowledge, to act differently. Hence, today it becomes simply another tax to pay for consumers. To regulate, the prices do not necessarily mean that we need a single, global price level—it can be regional or even national—but whatever geographical unit is

[18]The statement came during Earth Day in April 1995, in San Diego, USA.

[19]See Olsson, L. E. (1994). "Energy-Meteorology: A new Discipline." *Renewable Energy* **5 Part II**: pp. 1243–1246.

[20]This system is also known as the Acid Rain Program and the SO_2 cap-and-trade system.

chosen, it must be regulated and consistent within. How feasible this would be is hard to say—it would probably be as difficult as implementing energy accounting but far less effective since it is much more narrow in its scope.

However, even if these changes were introduced, the ETS would still have many shortcomings as shown in Chap. 2.

Fourth, and by far, the most important aspect of capitalism to review and reengineer is the financial industry and the politics around it—and not just in the West but probably worldwide. Finance permeates everything people, corporations and governments do in a modern society; hence, to discuss sustainability without discussing finance is like discussing work without its tools. From Chap. 4, we can recognize a number of issues where the government has potentially a pivotal role.

First of all and perhaps most important, the financial industry in a number of countries has essentially been protected against a number of risks that other industries face. This is particularly true for the largest financial corporations, which are deemed "too big to fail." Today, there are essentially two approaches to financial regulation. We have the simple and rugged approach where the financial industries are not overly regulated, but where they are kept small enough to be expendable. This naturally limits their appetite for risky gambles and greed and hence creates a much more stable system such as the Canadian banking system as explained in Chap. 4. On the other hand, we have the US system, and similar systems, where they refuse to put simple and foolproof mechanisms in place, such as a clear cap on size. The result is a highly complex system where regulations have been added and added as one crisis after the other has swept the land over the last 200 years.

However, there is another side to this discussion I have avoided since not everything can be said at once. The US science and innovation system is also known for its innovative capacity. In fact, reports from the governments in the UK,[21] Australia[22], and a number other countries are clear that their own systems are inferior to the US system as measured by shear amount of innovation. As noted earlier, a key ingredient of the US science and innovation system is venture capital, there is a relatively high degree of venture-backed projects that fail to deliver returns, and finally venture capital tend to shy away from capital-intensive cases. Thus, we have an interesting mixture of high degree of innovation, high degree of failure, and avoidance of certain types of innovation cases. An interesting question from this is whether a Canadian governance model for the financial industry superimposed on US industry will reduce innovation in the USA? No one can give a conclusive answer to that, but we can get some ideas by noting the following facts, as presented earlier:

1. The market for trading risk is more than 8–10 times the gross world product (GWP). Much of this volume is also due to rapid trading including high-frequency trading (HFT) which seems to be more destructive than constructive. If

[21]See for example Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

[22]See West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

this ration was reduced to, say 5, will it really matter? I doubt so since getting in and out of positions on a daily, hourly, or even shorter basis can hardly be associated with engaging in the real economy at least when we discuss equities.

2. Value investing practices produce superior results to trading equities in the traditional sense, which I, along the arguments of Graham, refuse to call investors,[23] and value investing is characterized by relatively long holding periods to equities. Hence, reducing the ratio of trading volume to GWP should have no real impact on investing, which what actually contributes to corporations and society.
3. Changing the system does not have to be done in one big bang—stepwise changes will reduce the risks of changes and allow governments to survey the impact and make adjustments underway.

I would in fact argue that despite the fact that VC is relatively more important in the USA and VC-owned corporations produce relatively more patents than others, the main causes of the success of the US science and innovation include its size and diversity. Ironically, despite political rhetoric, the USA has an active government as illustrated both by the importance of the defense industry and by highly successful public innovation programs such as the Agricultural Extension Service and the Apollo program which generated a huge number of innovations. Arguably, the USA was one of the first countries in the world that cracked the code of England's rise to greatness—and copied it. In fact, one of List's best cases of protecting infant industries was the United States of North America as he called it.[24] Indeed, some[25] argue that he actually got the idea of protecting infant industries from his travel to the USA and that he is not the father of the infant industry argument but rather Alexander Hamilton, one of the founding fathers of the USA, which in his *Reports of the Secretary of the Treasury on the Subject of Manufactures* published in 1791 argued for protecting infant industries. He was also the architect behind the first bailout of a US bank and as such is most likely one of the persons with most influence on the trajectory of the US financial system.[26] Thus, the USA has a very long and strong tradition of supporting its industries, and this must be an important ingredient in their science and innovation system.

With the environmental degradation of our globe and indeed humanity at risk, I cannot see how a major restructuring of the financial industries to mimic more the Canadian system can do any harm. Indeed, it is hard to argue that people in Canada are any worse off than people in the USA, and Canada is also one of

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[23]See Graham, B. (2005). *The Intelligent Investor*. New York, HarperCollins Publishers. p. 269.

[24]See List, F. (2005). *The National System of Political Economy—Volume 1: The History*. New York, Cosimo Classics. p. 142.

[25]See Chang, H.-J. (2002). *Kicking Away the Ladder: Development Strategy in Historical Perspective*. London, Anthem Press. p. 187.

[26]See The Economist (2014c). The slumps that shaped modern finance. *The Economist*. **411**: pp. 47–52.

the major economic powers in the world and a member of the G7 club of major economies. So, what seems to be an obvious conclusion from this discussion is that the financial system must be overhauled—and this time according to intention and design, and not happenstance due to crisis and lobbying thereafter. The most important criteria of such an overhaul must be derived from history, and it seems to be that we must avoid "too big to fail" so that risk can be put back where it belongs, with directors and shareholders. Special privileges for some executives and directors—such as the practice of stock repurchases with corporate cash to manage the share prices and in the process giving these people handsome returns—must be removed as well.

We all remember how the so-called Robber Baron's of early American capitalism rose to predominance in their industries. They used many dirty tricks, to call it that, to outmaneuver opponents, unions, and anybody in their way. However, the fact is that they actually built industries although their means were highly questionable in a number of cases. Today, however, we have some executives and directors that take no risk themselves, are highly paid from outset with salary, and use the corporation itself and the system to manipulate stock prices and thereby enriching themselves even further and in many cases when they fail they have huge severance packages. These are the true Robber Barons of today's capitalism, and they must be stopped because they undermine the whole system and its legitimacy also for those executives and directors that do a really good job and deserve high returns for their work. Furthermore, they divert huge sums of capital as noted earlier away from innovation and investment toward personal enrichment.

Second, during such an overhaul, some other criteria must be added as well. The objectives of the industry must become more broad-based supporting initiatives such as ESOPs and crowdfunding and making the system much more difficult to use for political ends. Here, the Canadian system is instructive as well, and the financial crisis of 2008 should be a stark reminder of how badly things can go when the system becomes an object of political meddling to solve social issues such as secure housing for all and other notable objectives. However, as pointed out in Chap. 4, it is much better to explicitly handle social issues politically, which was done in Canada, instead of covertly handling such issues by altering the rules of such a complex system as the financial system, which was done in a number of countries worldwide.

The risks of interfering in such a complex system as the financial system should be intuitively easy to understand—it is akin to human interference in many natural habitats which in many cases have been disastrous. Furthermore, this will greatly reduce the need for lobbying as well provided that the politicians can keep their hands off the rules and regulations of the system. A way of doing this is to lift certain issues concerning financial regulation to the level similar to constitutional issues, which in a number of countries require 2/3 or 3/4 or similar type of majority to result in legislative changes. Today, in most countries, simple majority of 50.1 percent is enough and this opens up for all the meddling discussed earlier.

Third, some practices today should be abolished simply because it fails to meet the purpose of the system in the first place. HFT and many stock repurchases today are exploiting the system. Abolishing it altogether is probably unwise; however, there can be placed clear cap on the volume on a 12-month running basis or perhaps even more effective to limit the usage of earnings for stock repurchases. This will lead executives to either invest more, which is be desirable from an innovation point of view, or pay more in dividends, which can also be positive for the environment since investors can then reinvest in “green” technologies and the like. There are also many other possibilities as mentioned throughout this book. These should be evaluated from other criteria than providing liquidity because if liquidity is the only criteria, we know where it will go: The logic behind the short-term arbitrageur is evident, as discussed in Chap. 4, and with ever faster computers and networks, HFT is a logical evolution on the path toward an automated financial industry where words do not count and numbers get all the focus. This will be dangerous because it will undermine innovation, which can also be understood from the words of the investment banker Robert Mahoney:

> What kind of numbers do we like to see? The more mature a business is, the more we rely on numbers. For newer business, the numbers matter less and the words matter more.’

Everything else in the financial world has diminishing returns—it seems extremely unlikely to me that liquidity is the first exception. Thus, it is time to weigh liquidity up against other criteria such as providing industry and society in general with capital for investment and innovation.

When all this is said about the financial industry and capitalism as such, it is important to realize that there is another aspect of our quest toward sustainability and that is to actually provide financial incentives as well. Providing financial incentives, which is discussed next, however must be provided given that the issues discussed previously are rectified as well. Otherwise financial incentives will only end up in the pockets of a few and not serve as intended.

8.3 Provide Financial Incentives

The chapter started with claiming that there is a “market failure” when it comes to innovation. This statement is not made out of thin air. Already as early as 1962, Nobel laureate Kenneth Arrow showed that a freely functioning market will fail to achieve the best possible resource allocation due to the fact that the innovators cannot capture the sufficient returns to justify bearing the risks.[27] This has later been confirmed by large, empirical studies.[28] There is therefore a broad, international consensus that public spending on science and innovation has a positive impact on private sector spending on science and particularly innovation,[29] but the reverse is also true—private sector spending has broad benefits for society such as

[27]See Arrow, K. J. (1962). Economic welfare and the allocation of resources for invention. *The Rate and Direction of Inventive Activity: Economic and Social Factors*. U.-N. B. C. f. E. Research. Cambridge, MA, National Bureau of Economic Research: pp. 609–626.

[28]See for example Furman, J. L., M. E. Porter and S. Stern (2002). “The determinants of national innovative capacity.” *Research Policy* **31**(6): pp. 899–933.

[29]See, for example:

Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

higher productivity, faster communications, safer vehicles, and improvements in health.[30] How this spending is financed is one of the factors that various countries solve very differently. For example, when it comes to financing, "Anglo-American capitalism" typically relies on VC, whereas in European "welfare capitalism" the government plays a significant role and in Japan large corporations and their "*keiretsu* capitalism" take the lead.[31] A challenge with VC, however, is that they tend to shy away from capital-intensive industries.[32]

Since innovation is a risky affair as argued in Chap. 7, the purpose of financial incentives is to help corporations limit risks/secure returns, and as we see, there are various models for doing that. Some incentives can directly prevent risks by helping corporations afford more rigorous innovation processes with more highly qualified (and thus more expensive people). Others can help corporations mitigate the risks of failures, and other parts of the financial incentives packages can be with as a direct transfer of risks to the government. In real life, the financial incentives of successful science and innovation systems are numerous, comprehensive, and systemic in the sense that they represent a totality. This is evident from the sheer list of characteristics listed in Table 8.1. Therefore, one important role of the government in our quest toward sustainable development is to limit innovation risks for the global system and reward entrepreneurial activities. The entrepreneur is critical in matching technology and market by understanding user requirements better than competitors and also ensures that adequate resources are committed.[33] In many ways, we can say that the government helped fuel the Industrial Revolution by removing the risks of death, imprisonment, and poverty for entrepreneurs and corporations and reducing the risks of bankruptcy by protecting infant industries. This time, the government must help fueling the sustainability revolution by limiting the risks of innovation; otherwise, corporations will always take the easiest and quickest road and entrepreneurs will fail. One of the most important aspects of this is to build a vibrant science and innovation system, as discussed in Sect. 8.6, but there must also be financial incentives to tilt the playing field in the desired direction even more, which is the topic of this section. This,

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[30]According to PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[31]See for example:
Dore, R. (1994). Japanese capitalism, Anglo-Saxon capitalism; How will the Darwinian contest turn out? *Japanese Multinationals: Strategies and management in the Global Kaisha*. N. Campbell and N. Burton. London, Routledge: pp. 9–30.
Berger, S. and R. Dore, Eds. (1996). *National Diversity and Global Capitalism*. Cornell Studies in Political Economy. Ithaca, NY, Cornell University Press. p. 376.
Dore, R. (2000). *Stock Market Capitalism: Welfare Capitalism; Japan and Germany versus the Anglo-Saxons*. New York, Ocford University Press. p. 280.

[32]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[33]According to Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

Table 8.1 Key characteristics of an effective science and innovation system

Performance categories	Knowledge creation	Knowledge diffusion	Knowledge application and value capture
Money	• Sufficient public sector funded research • Strong private sector funded and performed research • Funding from other sources	• Effective funding for applied research and innovation investment • Foreign direct investment into R&D facilities and translational activity	• Timely access to risk capital alongside advice, skills, networks, and market disciplines • Exit routes that provide access to markets and finance for growth companies
Talent	• Ability to attract, train, and retain world-class researchers • Population instilled with intellectual curiosity and inspired by science	Sufficient quantity of individuals in companies and public sector with right absorptive capacity: • Specific science and technology understanding across a broad spectrum • More generic basic STEM[a] knowledge management and business translation skills	• Entrepreneurial aspirations and business building skills • General business skills, e.g., strategy, management, marketing, and production • Basic skills (literacy, numeracy, problem-solving, ICT) relevant for business productivity
Knowledge assets	• High-quality research infrastructure • World-class, internationally collaborative, highly cited published research	• High-performing clusters with world-class research institutions and critical mass • Strong business/academia coauthorship	• Patents, trademarks, and other intellectual property that can be commercialized
Structures and incentives	• Competitive excellence driven funding, with sufficient stable investment in new areas • Balance between curiosity-driven ("pure") and needs-driven ("applied") research • Balance between deep expertise and interdisciplinary research • Meaningful career paths for world-class researchers	• Attractiveness of research roles and mobility of global talent • Incentives for and access to international collaboration • Incentives for business/researcher collaboration, cocreation, and mobility • Sufficient coordination and strategic alignment among key actors	• Sufficient intellectual property (IP) protection to incentivize innovation and capture value

(continued)

Table 8.1 (continued)

Performance categories	Knowledge creation	Knowledge diffusion	Knowledge application and value capture
Broader environment	• Sufficient number of companies willing and able to invest in knowledge creation	• Open markets and competition encouraging innovation as a source of competitive advantage • Mutually reinforcing activities within and links between science base and business population	• Productive dynamic between large firms and vibrant growth companies • Sophisticated demand, including from citizens and public sector • Generally positive business environment (tax, regulation, planning, etc.)
Innovation outputs			• Revenues, exports, profits, productivity, and growth derived from science and innovation • Improved societal outcomes due to better level and application of knowledge

Source Department for Business Innovation & Skills (See Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.)
[a]STEM is an abbreviation for science, technology, engineering, and mathematics

however, means that society is socializing the risk of business even more than before, and this is an important observation for Sect. 8.5. When this is said, it is of utmost importance that these incentives are explicit and overt and not covert and made by meddling with the financial system—then, we solve some problems and make a huge systemic problem.

Corporations tend to prefer general tax relief or lower corporate tax rates,[34] and one of the reliable ways is indeed to stimulate innovation is tax credits for corporate spending on innovation. Researchers[35] have found that tax credits over time stimulated significantly American R&D spending. In fact, R&D tax credits easily outweigh the costs, which means that tax credits for corporate innovation spending are a successful policy.[36] This may sound like a narrow strip of initiatives, but the list of various tax initiatives that various countries deploy is long, for example[37]:

1. Super deduction of R&D expenses.
2. R&D tax credit.
3. Accelerated depreciation on R&D investments.
4. Immediate deduction of capital expenditures used in R&D.
5. Social tax reduction for R&D personnel.
6. Training tax credits.
7. Tax holidays for income resulting from R&D-related income such as patent boxes.
8. Special tax incentives for R&D services and companies.
9. Property tax reductions for property used in R&D activity.
10. Targeted tax incentives related to geography, industries, size, etc.
11. Subfederal/substate tax incentives.
12. Investment tax credits (ITC) on investments in "high technology" equipment and/or software.
13. Customs duty relief.

And if we add generic legal and fiscal initiatives, the list becomes even longer:

14. Government grants and loans for R&D.
15. Foreign investment guarantees.
16. Rapid and easy business licensing.
17. Minimal tariffs.

[34]According to PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[35]See Hall, B. and J. van Reenen (2000). "Fiscal Incentives for R&D: A New Review of the Evidence." *Research Policy* **29**: pp. 449–469.

[36]According to Griffith, R., S. Redding and J. van Reenen (1999). "Bridging the Productivity Gap." *CentrePiece, the magazine of economic performance* **4**(3): pp. 14–19.

[37]This list is compiled by PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

18. Free movement of capital.
19. Minimal IP infringements.
20. Special economic zones.
21. No foreign ownership restrictions.
22. Venture and private equity ready.
23. Minimal hire/fire costs.

The government can easily reduce the speculative behavior of the market either by introducing holding periods for securities or by using tax incentives. US tax laws, however, provide no incentive to hold stocks for sustained periods, and the average period a stock is held has declined from over seven years in 1960 to just over two years in 1990.[38] Today, it is under one year,[39] so the trend is clear. It takes time to understand the workings of a corporation, but with holding periods less than a year, one might argue that there are no real overseers of management of corporations except when it comes to financial numbers. Who are to think long-term then? In many ways, some major corporations have become headless beasts and they certainly act accordingly.

When it comes to entrepreneurs, specifically, the government can reduce their risks by providing a social net that they can rely on if they fail, they can provide financial support such as interest-free loans, and they can provide competence. This is important because entrepreneurs take huge, often personal, risks which are evident from the facts that[40]:

1. Over half of American start-ups are gone within five years.
2. Three quarters of venture capital-backed start-ups never return their invested capital let alone ever provide positive returns.
3. Compared to ordinary employees, the average entrepreneur earned 35 percent less over a ten-year period.

The US government has also a Small Business Innovation Research program that funded Compaq and Intel as start-ups, and similarly, the Small Business Investment Company provided crucial loans and grants in early stages such as for Apple in 1978.[41]

However, all policies are most effective when they are linked to performance provided that they are transparent and hold people accountable.[42] The implication

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[38]According to Porter, M. E. (1992). *Capital Choices: Changing the Way America Invests in Industry—a report presented to the Council on Competitiveness and co-sponsored by the Harvard Business School*. Washington, DC, Council on Competitiveness. p. 135.

[39]According to data from NYSE and quoted by Mortimer, I. and M. Page (2013). *Why Dividends Matter*. Investment Research Series. London, Guinness Atkinson Funds. p. 11.

[40]See studies referred to by The Economist (2014a). Entrepreneurs anonymous. The Economist. **412**: pp. 66.

[41]According to Mazzucato, M. (2015). “The Innovative State: Governments Should Make Markets, Not Just Fix Them.” *Foreign Affairs* **94**(1): pp. 61–68.

[42]According to PricewaterhouseCoopers (2010). *Government’s Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers’ Center for Technology and Innovation. p. 65.

for sustainable development is clear; whatever financial incentives governments chose to use, they must be linked to performance and not across the board approach. The challenge is that with the failure of current approaches, benchmarking and measuring environmental performance in a systematic, value-free, and undebatable approach is hard and very costly today. This is another place where energy accounting can come into play with potentially great benefits.

As discussed in Chap. 6, energy accounting can be made as rigorous and accurate as the current monetary accounting frameworks because they are built on the same idea and concept. Due to its rigor and value-free structure, it will serve excellently as basis for financial incentives. In fact, *The Economist* argues that taxation on corporations should be abolished altogether since they constitute only a transactional element in the economy.[43] This argument would be even more interesting if it was coupled with the idea of taxation on energy consumption, on the level of today's corporate taxation, to force corporations to innovate toward more environmentally friendly solutions. Again, energy accounting would solve the information flow issues and hence make something like this possible.

Note that it is widely believed that corporate income tax is the only tax corporations pay. In fact, a study by PricewaterhouseCoopers (PwC)[44] shows that the average global corporation pays 43.1 percent in taxes of its commercial profits out of which 16.3 percent is labor-related, 16.1 percent is profit-related, and 10.7 percent is other. Reengineering the tax system will therefore have huge repercussions, and this must also be contemplated, and I believe an idea would be to shift the basis for taxation entirely as noted to foster sustainable development.

This sections contained many examples of financial incentives—many more exists and it is really only creativity that limits policy makers and their ability to innovate the tax system. Next, we must end some practices as well.

8.4 End Dysfunctional Practices

When discussing dysfunctional, or outright destructive, practices, it is important to realize that this varies from country to country and it probably makes sense to distinguish between poor countries and rich countries as well. Locally, in various countries, there are probably many such practices I am unaware of, but there are at any rate a couple of dysfunctional practices that seem universal and should be ended:

1. End the inherent tendency in laws and regulations to protect old and outdated technologies.
2. End subsidies of raw material extraction.

[43]See The Economist (2014d). *Special report: companies and the state*. London, The Economist. p. 16.

[44]Quoted by The Economist (2014d). *Special report: companies and the state*. London, The Economist. p. 16.

First, the inherent protection in laws and regulations of old and polluting technologies in established industries prevents disrupting technologies to gain foothold (the sailship effect), and on top of it, established corporations can cash in windfall profits due to cap-and-trade systems. However, even if the laws and regulations are sensible, there are still problems in most countries in that nepotism and corruption help entrenched market leaders in stifling innovation by having policies enacted to protect their old and outdated business models.[45] There are also other, less morally questionable, reasons for new products having problems becoming accepted. For example, new technologies can have difficulties in dislodging older technologies due to resistance from potential users—maybe, the new improved technology requires changes in the ways people perform certain tasks[46]… Another part of this puzzle might be that some designs are becoming so dominant that users prefer it to improved technologies. For example,[47] the IBM personal computer (PC) set the standard but incorporated no leading-edge technologies, and similarly, the DC-3 aircraft became the standard for civil aviation yet lagged behind several competing design in terms of range and payload.

Ironically, poorer countries actually have a potential edge in this respect—in the same way that bombed-out Germany and Japan after World War II had to invest in modern industrial systems, whereas many of the allied victors were stuck with old and outdated industries. Countries with few, if any, established industries usually lack investments in old technologies that inhibit change, but their challenge is that they often lack the political stability and often basic societal institutions such as rule of law and political stability to benefit from new technologies. Nonetheless, it is clear the rich countries have a special responsibility in cleaning up their own, old, and outdated industries, and this requires political courage.

Probably, the politicians leading this change where innovation will replace conservatism will face problems being reelected unless it is mandated by law comming into effect after some time, hence removing the decision from daily politics and individual politicians. Most importantly, the exact wording of such laws must not be so convoluted that it becomes too difficult to apply—it is better to err at the side of being clear and demanding than convoluted and apparently just. It is likely that a clear enforcement of such laws will raise the cost of goods in the short term, since corporations must depreciate technologies more quickly than before unless governments can aid such transitions and give financial support. However, such support must be explicit and not indirect via some market mechanism that distorts both the markets as such but also removes risk from shareholders as been the case in the financial industry in the USA. Given that more than 90 percent of earnings are diverted to share repurchases and dividends in 449

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[45] According to PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[46] As argued by Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[47] These two examples are from Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

companies on the S&P index.[48] corporations should have no problem spending more money on innovation to stay in business for the sake of our common future.

Second, there are massive subsidies worldwide of raw material extracting industries that come in addition to the more generic subsidies of industry and other organizations. The logic behind this is hard to understand from a sustainability point of view since it artificially lowers the cost of extracting raw materials, artificially increases consumption, and hence increases environmental impact. The large subsidies of the oil and gas industry, mentioned earlier, are particularly puzzling when governments are at the same time trying to curb climate gas emissions from fossil fuel consumption. However, I assume that the logic behind it is to preserve employment in raw material extracting industries and also to make sure countries have access to basic raw material due to national security or other fundamental interests for nations. Another such industry is agriculture, but we also find it in forestry, fisheries, mining, and many other raw material extracting industries. It is probably naïve to argue that this should be altogether banned due to the employment and social issues, but it should be realistic to expect that politicians could improve the record particularly concerning industries that can be relatively rapidly be established such as forestry and fisheries with relatively low amount of capital.

In a similar vein as the dysfunctional practices to end, there are a number of practices to start doing and these are discussed next. Note that for some countries, this is just a continuation of current practices. This is also the case when it comes to practices to end—some countries have already begun.

8.5 Starting Supportive Practices

It is well known that the government can be important in pushing new technology into the market and in many cases actually *create* the market, but the role of the government is widely underestimated.[49] In fact, given that "industry generally invests only in developing cost-competitive products in the three-to-five-year time frame"[50] and that the "free" market can greatly hamper the diffusion of new technologies by improving existing technologies (the sailship effect),[51] it is clear that the government has an important role to play in long-term technology development. It is therefore highly likely that governments must play an important role in technology development for sustainability. It is not uncommon that it takes thirty years

[48]See Lazonick, W. (2014). "Profits without prosperity." *Harvard Business Review* **92**(9): pp. 46–55.

[49]According to Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* London, Anthem Press. p. 266.

[50]Statement from a report by the President's Council of Advisers on Science and Technology according to The Economist (2014d). *Special report: companies and the state*. London, The Economist. p. 16.

[51]It is well known that the diffusion of the steam engine was significantly delayed by a series of minor improvement in existing water power technologies, see Rosenberg, N. (1976). *Perspectives on Technology*. Cambridge, Cambridge University Press. p. 364.

for diffusion to take place after the initial invention, and for radical innovations patient government sponsorship has proven vital over and over again.[52] This is something that has already been a practice in many countries; however, the point here is that it is probably not enough. Also, some countries have lost their way.

One way of doing this is by being a demanding lead user. Indeed, in many countries, the government is a lead user and can as such enforce a number of improvements on the economy by using a specific set of criteria for rewarding contracts. For this to work, the government must specify the intent or the functionality but not the solution, which has been the practice many places. By specifying the solution, the creative potential is severely constrained and the chance for innovation becomes smaller. For the very same reason, I am fundamentally skeptical about politicians finding the practical solutions to the environmental challenges—they must concentrate of defining the correct governance structures of the market, building an effective science and innovation system and then the market must via its invisible hand find the best, or at least a good enough, solution.

The lead user approach is a recommended approach by both private institutions and government bodies such as the Technology Strategy Board[53] in the UK. The history of innovation is also filled with examples of how government programs directly fueled innovation as innovator, for example:

1. Development of the Minuteman missile system and procurement for the Apollo program of the National Aeronautics and Space Administration (NASA) generated most of the demand for integrated circuits (IC) and jump-started the semiconductor industry.[54]
2. The Global Positioning System (GPS) began as a 1970s US military program called Navstar.[55]
3. Defense R&D laid the groundwork for today's telecommunications and computing industries.[56]
4. Today's Internet traces its history to the ARPANET, a computer network established by the Department Of Defense's Advanced Research Projects Agency (ARPA) around 1970.[57]

[52]See Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

[53]See Technology Strategy Board (2011). *Concept to Commercialisation: A Strategy for Business Innovation, 2011–2015*. Swindon, Techology Strategy Board. p. 27.

[54]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[55]According to Mazzucato, M. (2015). "The Innovative State: Governments Should Make Markets, Not Just Fix Them." *Foreign Affairs* **94**(1): pp. 61–68.

[56]According to Alic, J. A., L. M. Branscomb, H. Brooks, A. B. Carter and G. L. Epstein (1992). *Beyond Spinoff: Military and Commercial Technologies in a Changing World*. Boston, MA, Harvard Business School Press. p. 400.

[57]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

5. The US government invested heavily in the technologies that unleashed the shale gas boom.[58]
6. The major improvement in battery technology has been greatly aided by the US government.[59]
7. Government can also aid via funding to academics, and this has resulted in many innovations including[60]:
   (a) Touchscreen technology was developed by academics with funding from the government.
   (b) The algorithm that made Google so successful was created with the aid of a grant from National Science Foundation in the USA.

Unfortunately, for the USA, the successful approach—lead user and/or innovator—of the past has been largely abandoned.[61] This approach was based on the Pentagon giving its business to a diverse group of private firms, including start-ups and university spin-offs. Furthermore, contractors were required to share their technologies with the universities and other private corporations—indeed, the Pentagon encouraged contractors to adopt open technical standards. This encouraged further innovation outside the government contracts. This was in stark contrast to France and the UK where government contracts were used to promote national companies. Today, the US government has across the board increasingly favored strong special interests—just like in finance as discussed in Chap. 4—and in the process made it harder for start-ups to succeed the last 30 years,[62] and technological innovation has been stifled.[63] As in Finance, the corrosive influence of money in politics is a major culprit. The shear amount of money in lobbying is a clear indicator of that as discussed in Chap. 4.

This brings us to a second area where the government can play a supportive role by not just being a lead user and innovator but to actively help out in the process for private corporations. This is particularly important for small- and medium-sized corporations for two reasons[64]: (1) They often lack the resources themselves due to their size, and most importantly, (2) they contribute disproportionally to the overall innovation in most developed nations. The US Environmental Protection

[58]See Mazzucato, M. (2015). "The Innovative State: Governments Should Make Markets, Not Just Fix Them." *Foreign Affairs* **94**(1): pp. 61–68.

[59]According to LeVine, S. (2015). "Battery Powered: The Promise of Energy Storage." *Foreign Affairs* **94**(2): pp. 119–124.

[60]See Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* London, Anthem Press. p. 266.

[61]For more information see Jessen, J. (2015). "The Anti-Innovators." *Foreign Affairs* **94**(1): pp. 55–60.

[62]See Litan, R. E. (2015). "Start-up Slowdown." *Foreign Affairs* **94**(1): pp. 47–53.

[63]According to Jessen, J. (2015). "The Anti-Innovators." *Foreign Affairs* **94**(1): pp. 55–60.

[64]See Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

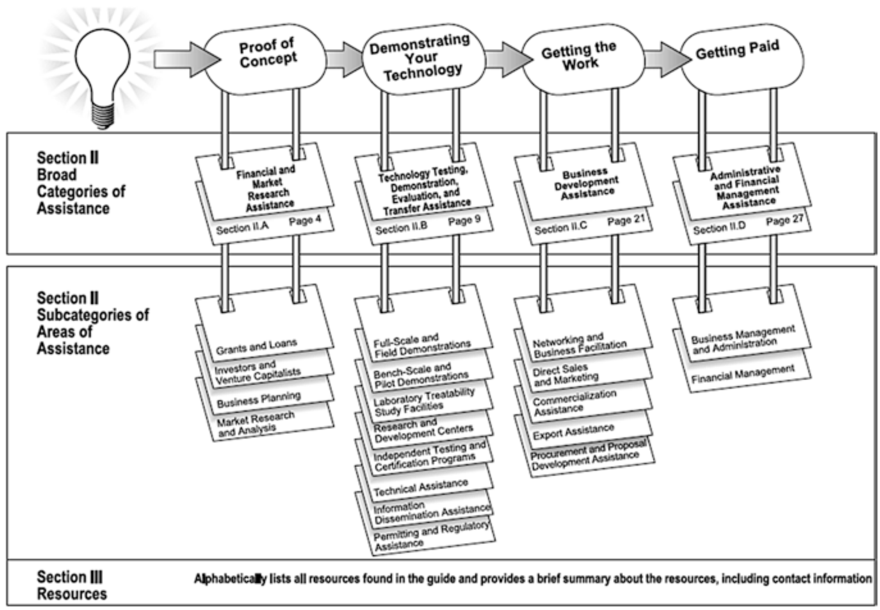

Fig. 8.1 Types of assistance available to support the technology development process. The section references to the bottom refer to the section in the EPA report (See EPA (2000). *Innovative Treatment Technology Developer's Guide to Support Services (Fourth Edition)*. Washington, DC, US Environmental Protection Agency, Office of Solid Waste and Emergency Response. p. 96.)

Agency (EPA) has done this for years, and in Fig. 8.1, we see a model of their support system, and as we see, it is comprehensive and starts from the idea conception phase and goes all the way until money flows the right direction. The actual detailed elements are similar to what has been discussed in parts of this book since the typology of successful programs is becoming increasingly diffused among researchers internationally and to informed policy makers.

An example is the so-called Superfund Innovative Technology Evaluation (SITE)) program in which the EPA helps the development and diffusion of new environmental remediation technologies by allowing vendors to test new technologies at contaminated sites.[65]

Third, in many walks of life, operations require licensing. This might be something to consider in the financial markets as well. Indeed, there are such licenses today. The license needed is determined by several factors, such as the

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[65]See EPA (2000). *Innovative Treatment Technology Developer's Guide to Support Services (Fourth Edition)*. Washington, DC, US Environmental Protection Agency, Office of Solid Waste and Emergency Response. p. 96.

type of investments to be sold, method of compensation, and the scope of services that will be provided. Maybe it is time to also consider the *approach* of their services and *performance over time*, because with all the boom and bust in the market—not to mention questionable behavior—the current approach to licensing cannot work. Why should the mere existence of financial capital—either your own or as an agent for others—virtually automatically qualify you as an investor? After all, they all rely on the socialization of risk in society to operate so society should have a say or two in their *modus operandi*. With the dismal records of mainstream Finance and their lack of solid methodological foundation, can they be viewed as reliable custodians of the financial institutions? Also, with more algorithmic trading and/or electronic trading, there can be significant productivity savings in making the requirements for financial licensing much tougher and much easier to lose upon demonstrated poor judgment. In this way, we can keep the best and put the majority of these people into productive work.

Fourth, some governments have large investment funds—typically for future pension obligations. Today, these are very passive investors, which I think is good since we do not want governments to use the funds for political means in the market. However, what could have been a good idea was that these funds started to think more like value investors. The challenge is obvious regarding the largest of these funds as to where to put all their money… They would either have to relax the strict policies many the funds have as to size of ownership in any one stock, or they would have to scale down and rather deploy the remaining funds in infrastructure and similar and charge for its usage—for example, roads and the like. Probably, both approaches would be needed. As for increasing the size of their ownership, they could no longer be as passive as today. Personally, I do not see that as a problem as long as their representatives in the corporate boards were business-like and not political. The good thing about this approach from these investment funds is that their corporations would have long-term investors which could enable proper long-term value creation.

Among the most important roles of government, however, is building and maintaining a vibrant science and innovation system. This is perhaps one of the most important areas where England truly superseded the other nations during the Industrial Revolution. When this is said, we must not be naïve and delude ourselves to the blind belief in “magic” technology that will make it possible for us to not change anything in our lives while at the same time become richer and richer and work less and less, which is fashionable talk in some quarters of welfare states.

8.6 Build and Maintain a Vibrant Science and Innovation System

There is broad international consensus that sustainable economic growth requires increases in productivity, which in turn is fueled by innovation in the broadest sense,[66] and to promote innovation, policy makers must tilt the playing field in favor of higher risk-adjusted returns to innovators.[67] To reengineer the capitalist system to foster, sustainable development is therefore just as much a matter of innovation and risk management as climate science—perhaps even more so. Ironically, the leader in science and innovation since World War II, the USA, is probably one of the more skeptical countries as to the current practices outlined in Chap. 2. Yet, this is perhaps the country that holds vital insights as to innovating ourselves toward sustainability—not just by its size and impact on the environment, but perhaps even more due to its vibrant science and innovation system and huge successes in the past including the Agricultural Extension Service and the Apollo Program.

Some authors[68] focus more narrowly on the innovation system defining it as the "set of institutions whose interactions determine the innovative performance… … of national firms." In essence, national innovation systems perform three vital social functions[69]: (1) It mobilizes and allocates resources, (2) it determines the appropriation and allocation of returns, and (3) it manages the risk needed to undertake technological advances. Here, we lose out science and also market innovations as defined in Chap. 7. Thus, this is a bit too narrow definition, but many critical aspects are covered.

A full expansion and description of a science and innovation system is perhaps impossible due to its sheer complexity. However, one way to define it is to say that a science and innovation system is to build national innovation capacity where we can define national innovative capacity as a country's potential—as both economic and political entity—to produce a stream of innovations. The concept of *national innovative capacity* is from the work of Jeffrey L. Furman, Michael E. Porter, and

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[66]See for example:
Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.
National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2005). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC, National Academies Press. p. 592.

[67]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[68]See Nelson, R. R., Ed. (1993). *National Innovation Systems: A Comparative Analysis*. New York, Oxford University Press. p. 556.

[69]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

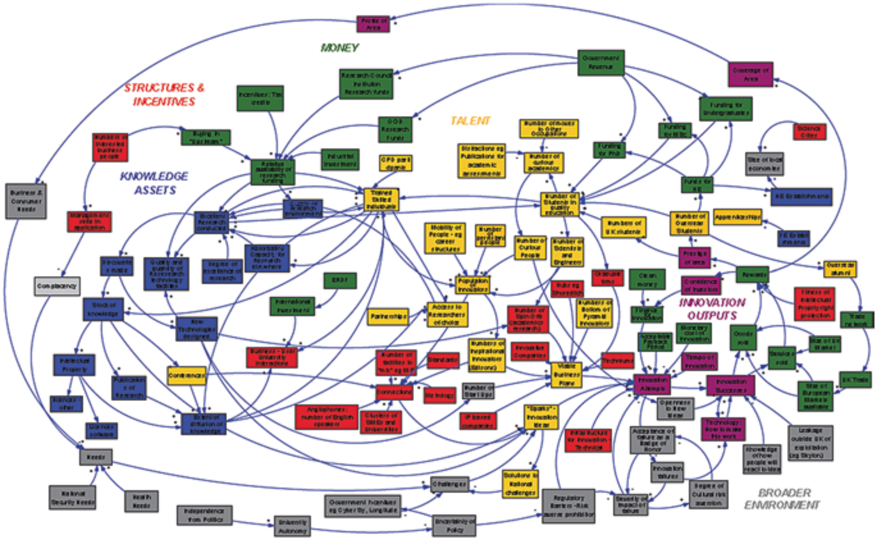

Fig. 8.2 Map of the UK's science and innovation system. *Source* Department for Business Innovation & Skills (See Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.)

Scott Stern.[70] In their definition, they highlight "commercially relevant innovation" and not just "innovation" as above. However, the way innovation is defined in this book, directly using their definition, would be pleonasm since innovations per definition are commercially relevant. Their concept is a synthesis of (1) ideas-driven, endogenous growth theory by Paul M. Romer,[71] (2) Michael E. Porter's cluster-based theory of national industrial competitive advantage[72], and (3) research on national innovation systems.[73] Nonetheless, their empirical findings of a dataset from 17 OECD countries from 1973 to 1996 are quite in tune with the findings discussed below, which is reassuring since cross-checking results are always important.

To illustrate the complexity of such a science- and innovation system for a country, in this case the UK, Fig. 8.2 serves as a good illustration. Seeing the details of the figure is, of course, not the point here but to rather realize the immense number of interactions and six key areas for a science- and innovation system; (1) money (green boxes), (2) talent (yellow boxes), (3) knowledge assets

[70]See Furman, J. L., M. E. Porter and S. Stern (2002). "The determinants of national innovative capacity." *Research Policy* **31**(6): pp. 899–933.

[71]See Romer, P. (1990). "Endogenous technological change." *Journal of Political Economy* **98**(5): pp. s71–s102.

[72]See Porter, M. E. (1990). *The Competitive Advantage of Nations*. New York, Free Press. p. 896.

[73]See Nelson, R. R., Ed. (1993). *National Innovation Systems: A Comparative Analysis*. New York, Oxford University Press. p. 556.

(blue boxes), (4) structures and incentives (red boxes), (5) broader environment (gray boxes) and (6) innovation outputs (purple boxes). The key characteristics of an effective science and knowledge system as defined by these six key areas are presented in Table 8.1.

First note that in Chap. 7, we saw four steps of innovation in developing technology. However, the same process can be viewed from the perspective of the government in three steps, as done in Table 8.1, according to various policy options: (1) knowledge creation, (2) knowledge diffusion, and (3) knowledge application and value capture. In fact, the Department for Business Innovation & Skills in the UK "…have found that science and innovation systems are complex and made up of a large number of complimentary elements; that their effectiveness is crucially determined by how the elements interact within and respond to the demand of the broader economic and societal system; and that different countries succeed with different mixtures of inputs and structures."[74] PricewaterhouseCoopers (PwC) have provided a good overview on a number of countries concerning financial incentives that also illustrate the differences.[75]

A study of 120 countries by the World Bank also illustrates the importance of modern infrastructure such as Internet and similar. For every 10 percent rise in broadband penetration, there is a 1.3 percent rise in GDP.[76] Another example of using government muscles to build the innovation system is South Korea's governments plea to "invest 84.5 billion USD, or about 2 percent of GDP, in green technologies over the next five years (as of 2010). In addition, they plan to create a nationwide smart electricity grid by 2030 which can create up to 500,000 jobs and reduce energy consumption with about 3 percent[77]." On the intellectual property (IP) side, most countries have some measure of protection, but there is a challenge for smaller companies and for society because smaller technology companies are precisely those with high levels of innovation but often cannot afford such protection.[78]

The importance of infrastructure is also a historical fact—it constitutes an important part of what List refers to as the productive powers in the rise of nations. For example, Kenneth Lee Sokoloff (1952–2007) identified how the waterways in the US in the early nineteenth century led to higher rates of patenting in counties adjacent to the waterway than other counties. In fact, he also showed how the

[74]Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

[75]See PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[76]Referred to by PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[77]According to the Economist Intelligence Unit, see PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

[78]See PricewaterhouseCoopers (2010). *Government's Many Roles in Fostering Innovation*. Innovation. San Jose, CA, PricewaterhouseCoopers' Center for Technology and Innovation. p. 65.

introduction of water transportation due to either the construction of new canals or dredging of rivers was followed by a sharp increase in the rate of patenting in counties affected by these infrastructure improvements.[79]

Researchers[80] have made key observations about national science and innovation systems. It is important that government policies support these observations. The first key observation is that the prototypical linear model of innovation discussed in Chap. 7 is fundamentally flawed in that this is actually the anomaly; R&D, and even science, is more often not the source of innovation but an effect of innovating decisions. Corporations very often seek to innovate by exploiting their existing knowledge assets due to their "bounded vision"[81] or strategic choice. However, as unforeseen problems arise, the solution to these problems often requires R&D and often solutions can be found by serendipity. This said, many of the truly radical innovations stem from scientific breakthroughs,[82] but they are rare in comparison.

A second observation is that the science and innovation system is not just important for its ability to support innovation in corporations and in the public sector, but it is equally important for its absorptive capacity which refers to an organizations capability "to recognize the value of new, external information, assimilate it and apply it to commercial ends."[83] In short, spending on innovation and R&D is just as important for being able to imitate as to innovate.[84] The drivers of this are largely people related such as[85]:

1. Highly skilled workers.
2. Science, technology, engineering, and mathematics (STEM) skills.
3. Diversity of skills.
4. A significant proportion of skilled individuals in-house.
5. Quality of management.

In short, other studies[86] show that economic growth is not due to the population size of the economy, but rather the amount of human capital. It must be similar for sustainable

[79]See Sokoloff, K. L. (1988). "Inventive Activity in Early Industrial America: Evidence from Patent Records, 1790-1846." *The Journal of Economic History* **48**(4): pp. 813–850.

[80]See West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[81]See Fransman, M. (1993). *The Market and Beyond: Cooperation and Competition in Information Technology*. New York, Cambridge University Press. p. 352.

[82]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[83]According to Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

[84]See van Reenen, J. (2011). "Big ideas: Innovation Policy." *CentrePiece, the magazine of economic performance* **16**(2 (Autumn)): pp. 2–5.

[85]According to Allas, T. (2014). *Insights from international benchmarking of the UK science and innovation system*. London, Department for Business Innovation & Skills. p. 223.

[86]See for example Romer, P. (1990). "Endogenous technological change." *Journal of Political Economy* **98**(5): pp. s71–s102.

development indicating that general education of the population will be important both for building absorptive capacity and for creating demand as discussed earlier. This is evident from the fact that human capital is crucial in all areas of development.

A third observation is that the capabilities of innovating, whether we talk about corporations or countries, are cumulative and they consequently build over time.[87] Creating an effective science and innovation system is therefore no quick fix, but it can be ruined quite quickly which is an important reason for a stable state being important. An important part of the cumulative capabilities is technical standards. They are particularly important because "…they help channel resources toward a limited number of designs. Standards also provide a basis for products to interact compatibly."[88] To foster innovation in the best possible way, it is important that those standards are suitable and performance-based and not overly prescriptive. An example of this is military procurement standards in the USA that at least up to 1995 was prescriptive, and they were cited as factors inhibiting innovation in developing system for the military and that segregated the military and commercial domestic production bases.[89] One of the most famous environmental impact cases these standards resulted in was that in 1989, it was estimated that 50 percent of global CFC-113 gas (which is ozone depleting) used in electronic circuit board manufacturing was determined by US military specifications.[90] Furthermore, if we look at the composition of R&D expenditures of two of the leading industrial powers over the last 40 years, we see the mix of the types of R&D necessary to succeed:

1. Eight percent of R&D expenditures in the USA went to basic research, whereas the same number for Japan was 10 percent. This is negligible difference.
2. A similar small difference exists on applied research where the USA spent 23 percent of R&D expenditures and Japan 27 percent.
3. When it comes to product-related R&D versus process-related R&D, there is substantial difference. 68 percent of R&D expenditures in the USA were product related, whereas only 36 percent were product related in Japan.
4. A similar difference also exists when it comes to researching entirely new products and processes where the USA is expending 47 percent, whereas Japan spends only 32 percent of R&D budgets.

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[87]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[88]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

[89]See Office of Technology Assessment (1994). *Assessing the Potential for Civil-Military Integration: Technologies, Processes, and Practices, OTA-ISS-611*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 191.

[90]See an unpublished report by Alan Miller, Pamela Wexler, and Susan Conbere titled "Commercializing Alternatives for CFC_113 Solvent Applications", cited in Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

5. When it comes to projects with relatively low chance of success, the numbers are again very similar with 28 percent for the USA and 26 percent for Japan, respectively.
6. For projects with stipulated duration of more than five years, the numbers are the same—38 percent for both the USA and Japan.

As discussed in Chap. 7, we see that Japan has less product focus and more process focus than the USA and this is a vital observation that is supported well by the discussion here. A science and innovation system is not stronger than its weakest link, and if processes do not improve in conjunction with the rest, it will inevitably become a liability. The uncritical outsourcing of production processes is an excellent example as Andy Grove, former CEO of Intel, explains in the context of Silicon Valley outsourcing of production processes to China.[91]

A fourth observation is that innovation is just as common in "low- and medium-"technology industries as in "high" technology industries. In fact, in "low- and medium-"technology, industries include significant proportions of innovating corporations that develop new products and generate significant sales from new and technologically changed products. Therefore, the whole distinction between "low- and medium-"technology industries and "high" technology industries is misleading[92] in technology development context and should be abolished from government policies.

A fifth observation is the role of universities and colleges, and since many of them are public or nonprofit organizations including foundations, it should be an integral part of government policy in building and maintaining a vibrant science and innovations system. This is because universities and colleges have shown a steady acceleration in their R&D performance, particularly with basic research—today, more than half of basic research is conducted in universities in the USA[93]—in other countries, the number is probably even higher due to the relatively large proportion of private sector funding in the USA. In fact, from 1979 and onward, private sector R&D passed government spending, growing more than threefold after controlling for inflation between 1975 and 2000[94]. However, a number of studies show a more troubling fact; private sector is increasingly emphasizing short-term R&D for immediate problem-solving, or near-term development over basic research, and basic research is being directed toward the needs of product development and manufacturing teams. This is due to tougher competitive pressure.[95] This is not good news for long-term issues such as sustainable development. It also highlights the naiveté of the current ETS with all its holes as

[91]See Grove, A. (2010). How America Can Create Jobs. *BusinessWeek*: pp. July 1st.

[92]According to West, J. (2013). *Increasing Innovation Through Government Policy*. Sydney, Australian Innovation Research Centre. p. 26.

[93]According to National Science Foundation, Science and engineering indicators 2006.

[94]According to National Science Foundation, Science and engineering indicators 2006.

[95]According to Office of Technology Assessment (1995). *Innovation and Commercialization of Emerging Technology, OTA-BP-ITC-165*. Washington, DC, U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office. p. 96.

discussed in Chap. 2, because private sector is unlikely to put any more efforts into R&D for climate purposes than what is necessary. Private sector needs proper financial incentives, strict regimes, and a leveled playing field as discussed later.

This means nonetheless that universities and colleges are important players in the science and innovation system in most countries particularly concerning the long-term national innovation capacity. This is obvious concerning building absorptive capacity via education and problem-solving expertise. As leading institutions for basic research, the capability to transfer inventions to the private sector is also important, but this process is more problematic and risky. Also, several studies confirm that corporations rely on outside sources of knowledge and technical inventions for their vast majority of their commercially significant new products.[96] This is particularly true for immature industries where university research is often the source of new inventions.[97]

In the USA, for example, they use Technology transfer offices (TTO) to help out here, and this system was conceived as early as 1924.[98] However, it does not work as well as it should because it relies too much on maximizing licensing and patent revenues[99] despite the fact that The Carnegie Mellon Study of Industrial R&D found that the most commonly reported diffusion mechanisms of public research to industry were publications, conferences, and informal meetings. Patents ranked low in most industries except pharmaceuticals.[100] This is evident from the ascertainment that "not all inventions are patentable, not all inventions are patented, and the inventions that are patented differ greatly in "quality," in the magnitude of inventive output associated with them."[101] Studies[102] even document that the costs of imitation raise very differently according to industry, 30–40 percent for pharmaceuticals, 20–25 percent for chemicals, but only 7–15 percent in electronics (including semiconductors, computers, and communication equipment).

[96]See for example Freeman, C. and L. Soete (1997). *The Economics of Industrial Innovation*. Oxford, Routledge. p. 470.

[97]This is evident from National Science Foundation (1995). *National Patterns of R&D Resources*. Arlington, VA, National Center for Science and Engineering Statistics. p. 57–69.

[98]According to Sampat, B. N. (2006). "Patenting and US academic research in the 20th century: The world before and after Bayh-Dole." *Research Policy* **35**(6): pp. 772–789.

[99]According to Litan, R. E., L. Mitchell and E. J. Reedy (2008). Commercializing University Innovations: Alternative Approaches. *Innovation Policy and the Economy, Volume 8*. A. B. Jaffe, J. Lerner and S. Stern. Chicago, IL, University of Chicago Press: pp. 31–57.

[100]See Cohen, W. M., R. R. Nelson and J. P. Walsh (2002). "Links and impacts: The influence of public research on industrial R&D." *Management Science* **48**(1): pp. 1–23.

[101]According to Griliches, Z. (1990). "Patent statistics as economic indicators: a survey." *Journal of Economic Literature* **XXVIII**(December): pp. 1661–1707.

[102]See for example:

Levin, R. C., A. K. Klevorick, R. R. Nelson and S. G. Winter (1987). "Appropriating the Returns from Industrial Research and Development." *Brookings Papers on Economic Activity* **18**(3): pp. 783–831.

Mansfield, E., M. Schwartz and S. Wagner (1981). "Imitation Costs and Patents: An Empirical Study." *The Economic Journal* **91**(December): pp. 907–918.

Regardless of these perceived problems, out of the 3376 academic spin-off corporations that were created in the USA from 1980 to 2000, fully 68 percent remained operational in 2001,[103] and another study finds that 8 percent of all university spin-offs go public, which is 144 times higher than the general US rate of corporations that become publicly traded.[104] So, it is not that it is bad—it could just be better, and several models have been proposed[105], and they share some commonalities: (1) they provide rewards for moving innovations into the marketplace, (2) they focus on faculty as key agents of innovation and commercialization; and (3) they emphasize further standardization in the interactions of campuses with their faculty and with industry.

A sixth, and crucial observation, is the existence of disruptive innovations. This does not just apply to corporations but also the government, which is why dysfunctional practices must be ended as discussed earlier. However, as a part of building and maintaining a vibrant science and innovation system, the government must understand that it will inevitably produce disruptive innovations. The important aspect of that here is that we must solve *innovator's dilemma*, or else old, wasteful technologies will prevail over new, environmentally friendly technologies in many industries for a long time. This will particularly be true in industries with large capital expenditures and large factories with many employees where disruptive innovations will lead to an initial loss of employment and capital on a significant scale with all the potential problems that entails. This is therefore, in many cases, not just innovator's dilemma but just as much a societal dilemma. This must be dealt with on a case-by-case basis, of course, but the point here is that we have to realize that to protect industries for the sake of employment and sunk costs in the long run is wasteful and thus environmentally unfriendly and hence not supportive of sustainable development.

I would like to add a seventh observation; the impact of popular press and public opinion on innovation and development. There are a number of technologies that are labeled as "green" today, and they typically receive laurels and endorsements all over the place. Yet, there exist few thorough analyses as to their life cycle performance that could justify such praise. energy accounting would definitively help settle some of the discussions although some of the green labels are quite self-evident, such as hydroelectric power compared to burning fossil fuels.

[103]According to Association of University Technology Managers (AUTM) (2002). *AUTM Licensing Survey: FY 2001*. Northbrook, IL, Association of University Technology Managers (AUTM). p.

[104]According to Goldfarb, B. and M. Henrekson (2003). "Bottom-up versus top-down policies towards the commercialization of university intellectual property." *Research Policy* **32**(4): pp. 639–658.

[105]See Litan, R. E., L. Mitchell and E. J. Reedy (2008). Commercializing University Innovations: Alternative Approaches. *Innovation Policy and the Economy, Volume 8*. A. B. Jaffe, J. Lerner and S. Stern. Chicago, IL, University of Chicago Press: pp. 31–57.

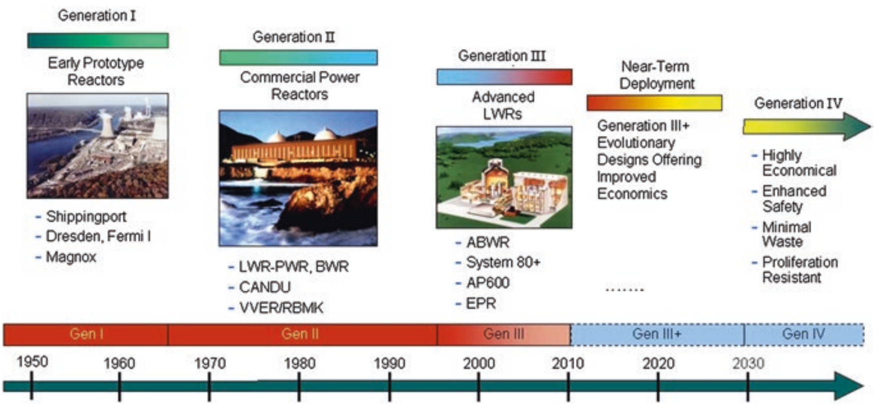

Fig. 8.3 The development of nuclear energy reactors. *Source* Licensed under public domain via Wikimedia commons

However, a number of sources for energy are quite contentious due to incorrect cost calculations, such as levelized cost calculations where variations are ignored as if consumers would accept power interruptions and delivery problems. Other contentions arise due to unwise risk communications causing illogical risk perceptions and ultimately public fear overpowering political decisions. Nowhere has this problem been clearer, in my opinion, than in the debate over nuclear energy in the wake of the Fukushima accident; would it not be wiser to close the oldest nuclear plants that cannot be modernized (if any), then modernize the rest so that they can handle flooding, earthquakes, and so on instead of entering unproductive discussions about quitting nuclear energy altogether? For example, for France, the nuclear energy accounts for 75 percent as of April 2011[106] with 58 plants in operation and two under construction—does anybody really believe that these plants will be closed and that it would do any good? Ironically, after Germany decided to close seven of the oldest nuclear plants in the wake of the Fukushima nuclear accident, they had to import electricity from the nuclear plants of France and the Czech Republic to keep the energy grid in Germany working.[107] Therefore, a more useful debate is how to develop nuclear energy further to become completely safe with improved performance (see Fig. 8.3). We have to remember that most of nuclear reactors in operation in the world today are Generation II; there are some Generation III, but the new and improved Generation IV with significant advances in sustainability, safety, and reliability and economics is still under research and is not expected to be under commercial construction before 2030.[108] Maybe governments should try to speed up this development process? I believe in line with many others that nuclear energy is here to stay and might be one of our most

[106]Source: World Nuclear Association, IAEA.

[107]See Spiegel Online International, April 04, 2011.

[108]According to The European Nuclear Society.

important cards in reducing the usage of fossil fuels for foreseeable future particularly where solar energy can be difficult to rely on.

The discussion in this chapter cannot be exhaustive since national situations vary. The most important is therefore to illustrate that government is pivotal and that there are many avenues to explore beyond the simplistic belief in cap-and-trade.

8.7 Some Final Comments on the Government

Whatever governments do, they must be consistent. This is the message from industry leaders time and again.[109] This is obvious when it comes to investments where unnecessary fiddling with rules and regulations creates uncertainties that make investors nervous about the returns ten years or so down the road. However, a perhaps equally important aspect of consistency is the importance of removing the impact special interests has on policy-making. Special interests not only inhibit the passing of new laws and the removal of old laws and technologies, but they also destabilize the financial system which must grease the wheels of sustainable development and as such they can hugely delay the entire progress toward sustainable development. Special interests are putting everybody's interests at risk, and this cannot continue irrespective whether we talk about the financial industry, stock repurchases, political meddling, and so on.

As stated before, I have intentionally avoided discussing social policy issues, such as redistribution of returns, in this book simply because that is a major subject matter on its own, which must also be attended to in our quest toward sustainable development. This is obviously an area for governments to engage themselves either directly via social policies or indirectly via financial incentives. The most important to remember is to avoid political meddling with the market mechanisms to support various political agendas, which was done in the USA causing the huge collapses of Freddie Mac and Fannie Mae. At the same time, governments must be aware of the fact that as sustainable development offers an increasing number of investment opportunities, there will become increasing income gaps and hence rising social inequality. This is evident from the data before and after the Industrial Revolution, and it would be naïve to believe that another revolution would refrain from such unwanted side effects simply because it concerns a more noble cause as it were. As long as the financial markets will be heavily involved, there will be winners and losers.

The improvement of "social capability," to use the concept of Moses Abramovitz (1912–2000) which is highly in line with List, will be one of the most important roles of governments in years to come. With "social capability," we

[109]According to The Economist (2014d). *Special report: companies and the state*. London, The Economist. p. 16.

understand countries' ability to absorb new technology, attract capital, and participate in global markets.[110] The combination of technological gap and social capabilities defines a country's potentiality for productivity advance by way of catch-up. Critical in this context is the facilities for (1) diffusion of knowledge, (2) the conditions facilitating or hindering structural change, (3) macroeconomic and monetary conditions encouraging and sustaining capital investments and (4) the level and growth of effective demand.

Before we continue, I would like to tie this to the Industrial Revolution and innovation as well. If I had continued the historical delineation in Chap. 5, I would have faced the part where Britain starts to decline—being caught up. This occurred at the end of the nineteenth century where the USA surpassed Britain quite rapidly.[111] This is evident from the historical datasets covering the labor productivity growth of 16 industrialized countries from 1870 to 1979.[112] In 1870, the agricultural share of the USA employment was 50 percent; in 1979, it was only 3.5 percent. For the 15 other countries, the corresponding figures are 48 and 8 percent on average. What holds for the USA in the future is not easy to say, but the fact is that over the last 30 years, the rate of start-up formation has slowed markedly—even the IT industry is dominated by older companies.[113] In fact, the proportion of corporations older than 16 years (mature) has risen from 23 percent in 1992 to 34 percent in 2011. This may indicate that the famous innovation of the USA is slowing down, just like Britain did roughly 150 years earlier relatively to the upcoming leaders such as the USA.

It turns out that there is a flip side of the infant industry argument and that is the latecomer advantage argument initiated by the theory of Alexander Gerschenkron (1904–1978) derived from his studies of German and Russian corporations in the steel industry.[114] Essentially, a latecomer has the advantage of not having to invest in less productive facilities and obsolete technology, which pioneers must do in order to build the industry from scratch. The latecomer can therefore leapfrog directly to the state of the art in economically sized facilities. This process has been confirmed by others later in other industries and countries,[115] but a significant part is missing—they could have borrowed from List, the importance of the

[110] See Abramowitz, M. (1986). "Catching Up, Forging Ahead, and Falling Behind." *The Journal of Economic History* **46**(2): pp. 385–406.

[111] According to Abramowitz, M. (1986). "Catching Up, Forging Ahead, and Falling Behind." *The Journal of Economic History* **46**(2): pp. 385–406.

[112] See Maddison, A. (1982). *Phases of Capitalist Development*. New York, Oxford University Press. p. 288.

[113] According to Litan, R. E. (2015). "Start-up Slowdown." *Foreign Affairs* **94**(1): pp. 47–53.

[114] See Gerschenkron, A. (1962). *Economic Backwardness in Historical Perspective*. Cambridge, MA, Harvard University Press. p. 468.

[115] See for example Shin, J.-S. (1995). Catching up, technology transfer and institutions: A Gerschenkronian study of late industrialization from the experience of Germany, Japan and South Korea with special reference to the iron and steel industry and the semi-conductor industry. *Darwin College*. Cambridge, Cambridge University: pp.

productive powers. Assets and technology are not enough—social capability in the wide sense is crucial.

With reference to the SECI process discussed earlier, social capability can be thought of the national capability not only to absorb knowledge ("absorptive capacity") but also to also put social institutions in place that will facilitate such absorption on a national level and not just on individual- or corporate level. These prerequisites must be present in a country before economic catch-up growth can occur, and it probably explains to a large extent why there are still major international inequalities in the world today. It is my belief that similar issues are highly relevant for our quest toward sustainable development—not to catch up with a leading nation but to catch up with the necessary progress toward sustainable development to avoid potential disaster. After reviewing and a huge amount of literature for this book, one thing is clear—our hindrance is not lack of formal knowledge but lack of willingness and/or missing social capability for change. Let us hope that we can prove Mancur Olson wrong this time in that we can change without a catastrophe, because, as he writes,[116] in the past defeat in war and accompanying political convulsions have served as radical ground-clearing experiences opening the way for new men, new organizations, and new modes of operation and trade better fitted to technological potential. Education will therefore be a critical element so that formal knowledge can be internalized to become understanding by a sufficiently large number of people so that political change and change toward sustainable development can take place. As the discussions in this book show quite clearly—three of the critical areas will be political leadership, reengineering finance and build an effective science and innovation system.

From the aspect of political leadership, it means that we must accept the fact of life that disruptive forces will be necessary to replace the old with the new—if political leadership is to be guided by popular vote in every decision, then we have a huge, fundamental problem. Therefore, in our quest toward sustainability, we will probably need politicians that are willing to do what is right even though it will cost them the ballot. An even better solution is an educated population that will see the necessities of change and be willing to take the consequences. Therefore, I would like to emphasize the importance of being unreasonable in the sense of George Bernard Shaw as quoted earlier. If governments are to tackle every grunt and discontent in our quest toward sustainable development, there will be no movement forward—just endless meddling. We must learn from Lao-Tzu; turn up the heat, place the fish in the pan, and do not poke at it too much!

The good news is that a recent study by OECD concludes after studying data used to compute the so-called environmental policy stringency (EPS) for 24 OECD countries from 1990 to 2012 covering 44 million corporations that "…an increase in stringency in environmental policies does not harm productivity

[116] See Olson, M. (1984). *The Rise and Decline of Nations: Economic Growth, Stagflation and Social Rigidities*. New Haven, CT, Yale University Press. p. 288.

growth."[117] In other words, there is no excuse to not make legislation tougher—the playground can be tough as long as it is even.

Leadership is to take people where they ought to be and not necessarily where they want to go, and this time, humanity will be ultimately put on this test both as leaders and followers. If not, the rather gloomy sentiments of Mark J. Dourojeanni will become a quite accurate prediction of what is to come.

[117]Quoted by The Economist (2014b). Free exchange: Green tape. *The Economist*. **414**: pp. 59.

Chapter 9
The End of the Beginning

Now this is not the end. It is not even the beginning of the end but it is perhaps the end of the beginning.

Sir Winston Churchill
In a speech at the Mansion House in London City in late 1942

Reengineering the capitalist system to foster sustainable development is a hefty goal. Yet, this is precisely what we, the inhabitants of the Earth, must do if we want our children to inherent an Earth that can nurture future generations. On July 3–4, 2012, the IMD's Center for Sustainability Leadership held a colloquium on strategic innovation for sustainability, and one of the viewpoint papers closes like this "Ultimately, solving the interlinked macro social and environmental challenges require game-changing innovation."[1] This is very true, and it requires so much more than what we have done so far, but how *do* we change the game?

In general, games can be changed in only three ways: (1) changing the participants, (2) changing the rules, and (3) changing the enforcement of the rules. With rules, we must in the context of sustainable development use generous interpretations due to the wide- and deep scope of the matter. Also, note that the participants of a game will set clear ramifications as to the rules of a game—a game designed for five-year-olds will inevitably have different rules than a game designed for grown-ups. Therefore, participants and rules will be interlinked. Enforcement will in turn be related to the rules—some rules are possible to enforce, whereas others are difficult and some might be even outright impossible to enforce. In sum, we realize that participants, rules, and enforcement are interlinked.

I will start by discussing the participants and then go on to the rules and end up with a discussion on enforcement. The innovation in this cannot be to make matters even more complex than today. Indeed, I believe innovations understood by five-year-olds are probably more suitable for international politics than the complex systems we are entangling ourselves in today. Not because we have an intelligence level of a five-year-olds, but the fact is that the rules must be simple, rugged,

[1]See Szekely, F. and H. Strebel (2013). "Incremental, radical and game-changing: strategic innovation for sustainability." *Corporate Governance* **13**(5): pp. 467–481.

J. Emblemsvåg, *Reengineering Capitalism*, DOI 10.1007/978-3-319-19689-3_9

and unquestionable—otherwise, we end up like today with endless discussions and very little action. This should be kept in mind when discussing changes—it is better to be approximately right than exactly wrong, or it is better with a 70 percent solution that works sufficiently well than a 100 percent solution that does not work. In the words of a Chinese proverb:

> Action will remove the doubt which theory could not solve.

9.1 Changing the Participants

> My choice early in life was either to be a piano player in a whorehouse or a politician. And to tell the truth, there's hardly any difference.
>
> Harry S. Truman

The majority of the world's population has today little real impact on how we can proceed in our quest for sustainable development. Even if we narrow the list of participants to OECD countries, the majority of the citizens of those countries have little real impact despite the fact that these are democratic countries. At best, these citizens can influence who is elected for various public institutions. However, in these election campaigns, sustainable development is only one out of many important topics. So, I think it is fair to say that currently there is no broad, real participation in our quest toward sustainability.

In fact, it is much easier to go the other way and ask who has influence in any notable fashion? The answer to that is limited to an elite consisting of the leaders within government, finance, corporate majors, and scientists. Yet, the government is the only participant that legitimately can fundamentally alter the game. The other ones are essentially participants *in* the game, and as such finance has most of the money, major corporations have the innovative capabilities so that changes in the game actually results in changes in real life and science has an advisory role and to some extent a knowledge-creating role in concert with corporations and government. In any case, this means that government must start changing the rules before we can expect any serious improvements. This is discussed in Chap. 8, so what is more?

I would like to emphasize the importance of you, me, and everybody else in this world engaging. Today, sustainability and the environment is a cursory issue for most of us. Those of us who can afford a washing machine buy a new washing machine according to the price and brand (in the hope that quality brands have quality products) and if the machine has a good rating for energy efficiency that would be an added benefit. Most people in the world, however, wash their clothes by hand. This might be seen as a sustainable solution, and it is if we look at the direct carbon emissions of washing clothes in isolation to the rest. However, the fact is that it is wasted human effort and therefore lost opportunities for improving society. There is consequently a genuine need for engagement across society, and an important element of this is the social aspects of sustainability as mentioned before.

The participants can no longer only be the elites in the world—we need a genuine broad-based approach. The rich will always have their ways of succeeding irrespective of the circumstances. The focus must therefore be on bringing the individual actions of everyone to bear—the quest toward sustainability must be broad-based both in the financial markets as well as in the economy in general. This means we need the markets both to be open for more people, not steeped in special interests, and it must pull in the desirable direction toward sustainability. The rich will necessarily have a greater say per person—because they are wealthy and can spend more money—but in absolute numbers, the middle classes and those less fortunate are far greater in numbers and will as such also have considerable influence in a market.

Then, what is left is to make this market work so that we can do economically well by doing environmentally good. Today, everything rests upon the cap-and-trade systems such as ETS discussed in Chap. 2. But this does not work, so the rules of the game must be changed as discussed next both to ensure that the markets work as intended but also to ensure the participation from broader parts of society. In fact, changing the participants without changing the rules is probably completely pointless—it is no reason to believe that a different set of people in key positions will produce a significantly different results. People behave according to the actions of the system they live in—rich and poor alike. Changing the rules and their enforcement is therefore the most important.

9.2 Changing the Rules

> One may compare these rules [related to the scientific method] with the rules of a game in which, while the rules are arbitrary, it is their rigidity alone which makes the game possible. However, the fixation will never be final. It will have validity only for a special field of application.
>
> Albert Einstein
> The Theory of Relativity & Other Essays (1950)

Today, the playing field is tilted quite heavily in the direction of special interests. Some people see this as their right because they pay so much in tax or have large fortunes employing many people in the process. However, we must not mix economic worth with human worth. Sustainability is not an economic issue. It surely has a large economic component, but it is much wider than mere money and financial assets. Ultimately, it encompasses all aspects of the society. The rules must therefore be changed so that participation can become much more broad-based, and then, the rules cannot be tilted in favor of special interests.

There are a number of rules of the game, naturally, that are interlinked and necessary for achieving our grand goal, but from complexity theory we remember that although there is a vast number of variables in a complex system, there are always a handful variables that have disproportionate impact. This means that most likely there are only a few things we really need to change for the process of sustainable development to take hold. In the preceding chapters, I have discussed many of them—probably not all since my knowledge is limited. Naturally, some of them are more important than others.

First, government must resist special interest pressures, and government, rules, and regulations must be reengineered to be broad-based—of the people, for the people. This means, for example, that limited liability must be limited and not conditionally limited in that some corporations are deemed "too big to fail". If they are, they should at least be treated as what they really are—a governmental agency—and delist them from stock exchanges, remove stock options, and the like to their directors. Today, they have it both ways… they pretend to be competing in the market but they have the safety net of a governmental agency. We cannot continue this charade—the rules must be the same whether you belong to a large investment bank or a small, local bank—of course, subject to the rules that applies for certain securities and subject matters. The huge lobby industry must find their own existence fruitless—then, we have government that is broad-based. The best way is to severely reduce the room for meddling—then, there is nothing to lobby about and these thousands of people in Washington DC and other capitals around the world can be put to useful work instead. If politicians want to learn about something from reality it is probably much more effective to visit those they need to talk to instead of having highly paid intermediaries present glossy reports and powerpoint packs.

Ideally, we should come to the level of enlightenment that even special interests realize that their legitimacy is based on the broader society's perception of them and not their own ability to negotiate special solutions for themselves with other people also eyeing special treatment like election campaign support and the like. From List's account of European economic history, we realize that those countries that succeeded were those where a broad-based, strategic view was taken—I think it will be a grave mistake if we today believe that countries can be built by special interests. The major challenge of sustainability is that even national interests might be considered special interests in that respect which calls for measures on global scale. This implies simplicity and ruggedness or robustness in whatever we do.

Second, the financial industry must be reined in toward its original purpose. Today, I think it is fairly safe to say that significant parts of the financial industry have become almost completely self-serving both in objectives, approaches and attitude. How to realign finance is a big topic in many ways; however, as my discussion shows—and experience tell us—there are solutions and they can be quite straightforward. The Canadian banking system seems to be an interesting one to study further simply because it has proven that during over 200 years of existence it has not failed spectacularly a single time and only two medium crises have taken place—and both in the 1830s. Most Western countries have had a dozen or more crises, so apparently the Canadians are doing something very correct particularly when we take into account that Canada is a prominent economic power belonging to the G7 club of economically leading countries. Then, finance must stop acting as "just because it can be done, it should be done." In the wise words of Chan Master Baiyun, True Record of Baiyun:

What can be said but not practiced is better not said. What can be practiced but not spoken of is better not done.

HFT is an example of using modern technology, but for what purpose? We must not let the unquestionable and almost dogmatic belief in liquidity hinder us from asking whether liquidity has no diminishing returns and costs to society and that maybe we do not need a financial industry with notional values exceeding eight to ten times the combined gross world product. Maybe five times would be enough? Judging from historical records of booms and busts, it is no reason to believe that maximizing notional value has any real value. Again, I am afraid that special interests are serving their own ends and must be reined in as suggested earlier in this book.

Then, we have the huge amount of cash used for gaming the whole system in the shape of stock repurchases. Not only does this tap the corporations of funds that could have been used for innovation and the like, but even shareholders that are investors (as opposed to speculators) are losing from this. The whole problem is really a testimony to the fact that ownership has become so fragmented that there is no real overseeing of many corporations and in the process value extraction for a few has become the norm and not creating significant value for the future. Society did not grant corporations limited liability for such doubtful usage of the corporate entity. Stock repurchases should be greatly reduced so that stock repurchases were only allowed for a limited volume to make sure that corporations have enough stocks for reasonable remuneration packages.

Again, this and many more issues discussed earlier are really the result of special interests. Many of the practices we read about serve not the corporation, not the true investor, certainly not society, not customers, not employees, or anybody else for that matter—except some special interests. This cannot continue or we risk derailing the whole system away from its important job of providing capital at reasonable cost for society, either due to lack of trust or due to massively misallocated capital forcing serious market participants to find new capital markets elsewhere. The former is a well-known problem with popular trust in the financial industry on very low level, see Fig. 9.1, and the latter is already starting to happen as discussed earlier as shadow banking is greatly on the rise.

The importance of trust is unquestionable as CEO of CFA Institute, John Rogers, stated[2] "Trust is the building block that enables capital markets to serve society's needs." The worst is that the trust level is not better among investors either according to another Edelman study. So, clearly the financial industry has a serious job to do, and I believe they must start by questioning many of their dogmas and realize that they must reengineer themselves to become much more broad-based and supportive of society. This is not a call for socialism or worse. It is simply a statement of worry based on the fact that legitimacy must be earned and with a trust level as low as the financial industry this may become a serious problem if it persists over time.

[2]Quoted in CFA Institute & Edelman 2013 Investor Trust Study.

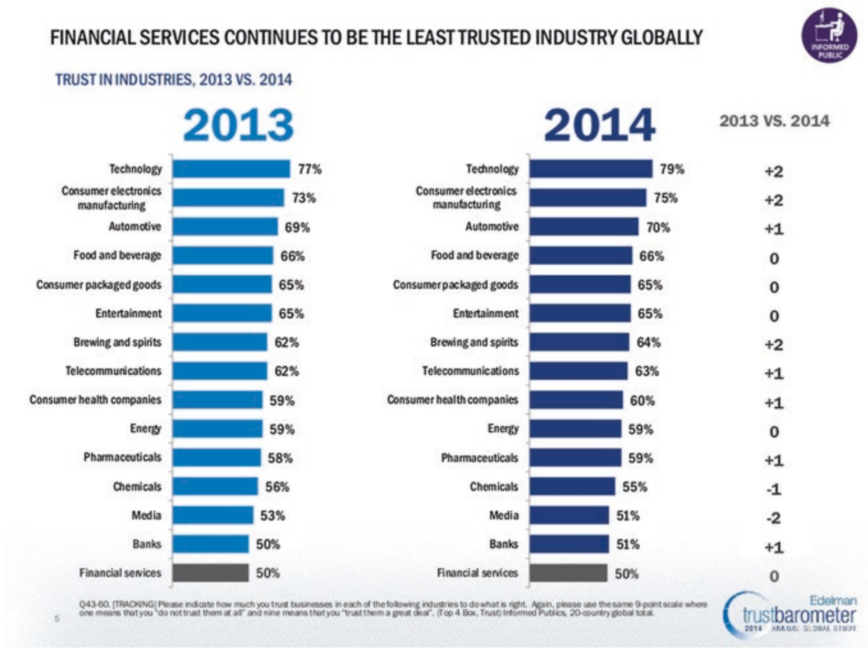

Fig. 9.1 Trust in various industries. *Source* Edelman Trust Barometer 2014

Needless to say, they must abolish the obvious self-serving aspects of the industry that everybody can see—rightfully or wrongfully according to their opinions. The financial industry must rebuild trust, and trust derives from credibility, and credibility is only achieved when results and plan correspond over time. In other words, the financial industry must actually start performing as intended.

Unfortunately, as important as trust is in all aspect of society and life and in the contracts of society in general, not only the financial industry has problems. Only 43 percent of their respondents find chief executive officers (CEO) credible as spokesperson for a corporation according to the Edelman Trust Barometer 2015. In the same survey, they also discover something else that is of great importance in our quest toward sustainable development—only 24 percent of the respondents believe that business innovation aims at actually "make the world a better place" and only 30 percent believe that innovations aim at "improve people's lives." The list could go on and on—the fact is that corporations, government, and their leaders are not trusted and their intentions are not associated with anything noble like improving the lives of people. On the contrary, 54 percent believe that greed/money is the primary driver for corporate innovation, 66 percent believe corporate growth is the primary driver, and 70 percentbelieve that technology itself is the primary driver.

If we believe that innovation will play a significant role in our quest toward sustainable development, we must understand that society must believe in this process otherwise its results, or promised results, will be distrusted and met with disbelief.

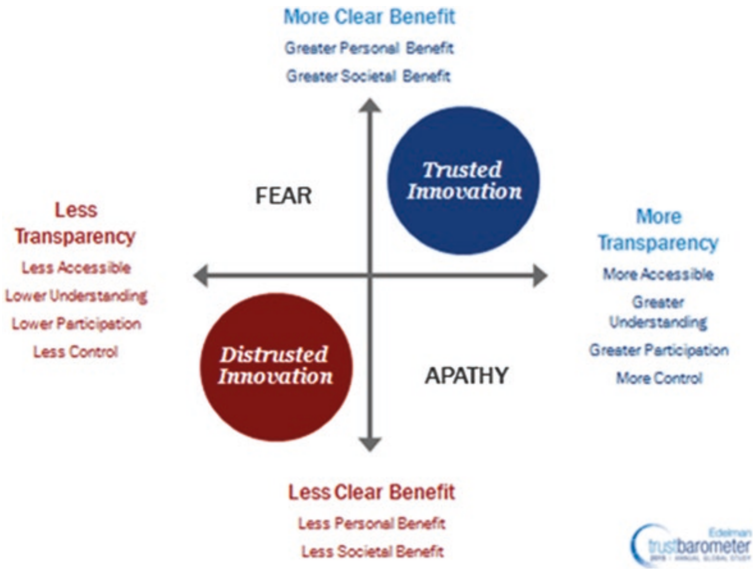

Fig. 9.2 The innovation trust matrix. *Source* Edelman Trust Barometer 2015

This will, of course, do anything but speeding up the transition toward a sustainable society. From this book, we see that broad-based and understandable solutions either from historical evidence or logic, on the one hand, and clear benefits on the other hand are crucial in a number of the topics discussed. This is also supported by the findings of the Edelman Trust Barometer 2015 which is evident from their Innovation Trust Matrix model shown in Fig. 9.2.

If we take the ETS system, it clearly fails in terms of understanding, control, and benefits to society and personally, which most people struggle to see. The result is a distrusted system, and this largely encapsulates the problem of today's approach—it is too complex, too abstract, too political, too elitist, and people struggle to see the relevance to their daily lives. People understand the importance of reducing carbon emissions, but why do governments allow expansion of coal mining to build even more fossil fuel power plants while at the same time preaching about the importance of curbing global warming? This is probably very hard to understand for many, and it is. However, the grander problem is that over time as more and more people understands "the game" as it works today, the end result might be apathy. Then, we have all lost. Fundamental in the process of bringing about change is engaging the many, but with apathy on the rise this may be seriously jeopardized.

This leads us to a third item; the capitalist system must be expanded to better include environmental issues as discussed both in this book and elsewhere. Today, the approach is complex and convoluted, and such approaches produce little more than discussions, very little actions, and subsequent apathy. The ETS, which aims to use the financial markets, is not working as discussed in Chap. 2, and directly estimating the monetary costs of environmental issues external to the economic system may give some interesting number for policy-making, but it has virtually no value in everyday decision-making. We must think anew.

I have introduced the idea of energy accounting to show that it is possible to provide relevant—energy is crucial in socioeconomic development—timely, repetitive, economy-wide, and consistent decision support *if* we want. However, it must be mandatory and implemented with the same rigor as monetary accounting. While I realize that this will be a hard political job to sell, the fact is that it is simple, it will actually work from a technical perspective, people understand energy efficiency as a goal, and they can see the effect on their wallet and will therefore be important in making our whole economy much more energy efficient. From the Innovation Trust Matrix, we therefore get an innovation that has the potential at least to be trusted unless this too is politicized by special interests and convoluted rules. The results from this should be more than ample to pay for the cost of the system; however, the whole system rests upon a leap of faith—do we believe that managing energy throughout the economy is so important that it outweighs the costs of such as system? Personally, I am in no doubt. We waste energy today, and increasing the energy efficiency is a much easier and much more cost effective way to improve the energy situation of the world than to research new technologies and build out new technologies on a grand scale. Probably, we will have to do both, but energy efficiency is crucial because it works much quicker. In fact, the International Energy Agency (IEA) estimates that the investments needed for "decarbonising" future electricity production alone at an astounding $44 trillion. Hence, the best hope for avoiding much global warming is a huge increase in energy efficiency.[3]

Assuming that we managed to muster the political will for implementing energy accounting, this will also give governments another dimension to rethink taxation. Energy usage could become an important element of taxation, which will increase the pressure toward energy efficiency. Another way of doing this is to simply raise the cost of energy by magnitudes. Then, energy costs might constitute such a large part of total costs that it will become an important element of decision-making. However, this will probably be a very costly approach since we cannot expect any changes by just increasing the prices by 50 percent—we must probably talk about 10–50 *times* simply because energy costs constitute such a small portion of total costs in most applications today—and this will greatly hamper economic development and it will not solve the information flow issue. However, unless we do something serious like increasing energy costs substantially or introducing energy accounting, I cannot see any reason to believe that we will change our course… From the corporate world we know the maxim that "what we measure is what we get." Why should it be any other way toward sustainability?

Fourth, once the infrastructure of information and finance is realigned, an effective science and innovation system can really speed up the process—just like it did during the Industrial Revolution, and then, we have a self-reinforcing loop in place that will speed up the process significantly, and hence, we might face a

[3]See The Economist (2015). *Special report: Let there be light*. London, The Economist. p. 12.

sustainability revolution. What could be better? Well, there is a backside to it… old and outdated technologies must yield and this will cause changes in employment and societal structure, but this is the inevitable result whether we do something or not. The only question is who will be in charge… humanity or destiny? So much for the rationale, but add the severe distrust in the intentions or purpose behind innovation in society. Why should the workers or the local community believe that by closing down their work, we will do any good when they do not trust the rationale behind from an innovation point of view (displacing old technology for the benefit of new and improved) and certainly not from a corporate point of view (purpose versus profits)? The challenge the science and innovation system has is less than the trust challenge of the financial industry and leaders, but it is still significant and it is unfortunately getting worse. Therefore, whatever we do we must start to take seriously the element of building trust—remember that the socialization of risk rests upon society's willingness to accept certain risks on behalf of a corporation, but will this last if trust is eroded away? Probably not, which bring us to the fifth and final element.

Fifth, moving risk management from the superstitious toward the enlightened is also an important aspect of the quest toward sustainability. This goes for finance as well as for innovation of major technologies with potential for large-scale destruction, such as nuclear energy. This is partly a matter of methods and training/education, but also a matter of perception and obtaining a license to operate. We see that the financial industry has lost so much trust that their very existence may at some point be questioned or hugely constrained unless they start to realize their own limitations for their own good. We also see that nuclear accidents have given the same results with a massive loss of public trust. All this is very sad because it robs us from tools and approaches in our quest toward sustainable development. Therefore, risk management is very important and should become a much more integral part in what we do provided that we do not blindly follow approaches designed for other situations. Georg Wilhelm Friedrich Hegel once stated that:

> Theories conceal as much as they reveal.

This is very true, and it is an important reason for making systems simple and robust so that they become easy to enforce and therefore produces the desirable and good enough results. Next, we must therefore discuss the enforcement of the rules.

9.3 Changing the Enforcement of the Rules

> Much of what we call management consists of making it difficult for people to work.
>
> Peter F. Drucker

Rules must be enforced to have the intended effect. This is very basic, but is seems to be forgotten these days as governments have created situations where some corporations are deemed "too big to fail". Governments have also created systems so convoluted that enforcement becomes impossible such as the ETS. What signal does this send to leaders and others that must be at the hub of our quest toward sustainability? They do certainly not receive a signal of limited liability but rather a signal of conditional liability or even no liability if they have been really skillful in lobbying. The result is what we witness all over the place—there are some people who have gotten an epiphany concerning our future and work out of either idealistic reasons or because they think the time will come what it will also make a lot of business sense, but for most the sustainability issue is one that belongs to the glossy annual statements to shareholders proving that the corporation is not worse than the rest. It goes without saying that such an approach toward sustainable development will never succeed.

Governments must start to clean up the rules and regulations and the framework surrounding the economy as argued in this book, and then, they must actually enforce it too. This will have a whole range of repercussions as discussed throughout the chapters, but if I were to pick some of the most important that would be the following.

First, "too big to fail" must be abolished—not only in the financial industry as mentioned many times, but in any industry. In the USA and many other countries, there are very clear antitrust laws preventing corporations becoming so big that they inhibit competition. Similar laws should be passed on the account that a corporation has become too big for the market to exercise limited liability.

For example, a big energy provider that does not comply with emission rules cannot be left alone on the account of the importance of the employment and tax revenues. This is common today, but the result is that infant technologies suffer and we uphold old and outdated technologies for decades longer than what should have been the case. The whole innovation mechanism via creative destruction and disruption is staged off by politicians tilting the playing field in favor of outdated technologies. We cannot continue like this if we are to make real progress on the road to sustainable development.

One way of intervening in such situations is that the government could actually remove the license to operate, so that the owners would have to sell it off to new investors or they would actually have to change to regain a license to operate. Investors routinely take over other corporations that have problems, why should not society have the right to say that under current ownership, the corporation is not performing well enough so we remove their license to operate? Such enforcement of rules would send a powerful signal to all corporations that "innovate or die" is a real option and that investors will take the heat for failing to provide the right oversight of the corporation and its management. Why should limited liability favor the incompetent and the speculative attitude, as today, and punish those that want to change the world for the better because of the shortsightedness in the markets? It is a testimony to the quality of the financial markets that some corporations and their investors feel they must go private to be able to operate well… We cannot continue like this.

This may sound like a wild idea—and I did not find anybody in the literature mentioning such an idea, which is why I present it here in this chapter as a closing note. Today, corporations face bankruptcies either through illiquidity or insufficiency—all in relation to cash flow and assets, or financials in short. If we are to take sustainability seriously and provide the environment and other intangibles with a real vote in the economy, using the license to operate actively might be an idea to explore. Basically, as an investor there would be not only a limited financial liability in case of economic problems but also a limited right to operate in case of being unable to comply with rules and regulations including no longer being sheltered by old and outdates laws that protect encumbent technologies. In return, society should built a vibrant and effective science and innovation system to help corporations.

Second, government must curb the power of special interests so that a broad-based view can be taken in political processes and not one of limited view of the specific special interest involved. This is to some extent related to the "too big to fail" syndrome, but it is also a significant problem in itself as shown in this book because it impacts a lot of legislation and systems and it essentially tilts the playing field in undue ways. We cannot expect to develop sustainably if relatively small groups are to have their say at the expense at the others—we must recall that most people will take care of their own environment if they have the means and chance to do so. Of course, this does not mean that they are right at all times in their understanding of cause and effect in the complex web of society and environment, but it is highly unlikely that a small group will be right at all times as well… Thus, a broad-based approach is the only way forward—even if it comes at the expense of speed. This is evident if we use the Innovation Trust Matrix as guidance, there is a real threat of apathy on the one hand and fear on the other hand—depending on how each individual views this concerning benefits and to whom. Both can be witnessed today—we have almost half the adult population in many countries not voting anymore, and at the same time, we have groups like the Occupy Wall Street group.[4]

Third, and almost as a corollary to the broad-based view argument, governments must to the extent possible act in a just, transparent and logical way at all times. However, when in doubt they must err at the side of *building* trust and not eroding trust. This will of, course, vary greatly from country to country depending on the average level of education and national culture, which illustrates the complex nature of our quest toward sustainability. What makes sense in some countries will probably appear as almost lunacy in others and *vice versa*. Yet, bridging this gap in understanding is crucial, which brings us to the fourth and final point concerning enforcement.

Fourth, whatever governments chose to do, or not—it must be for the long haul. Our quest toward sustainability will take time—the Industrial Revolution started more than 200 years ago, and still large parts of the world is not industrialized as others have entered an almost post-industrial society. Quick fixes will be likely to backfire and give basis for more apathy or fear. Therefore, whatever we do we must commit to it and hold the line over time. That is another reason why a 70 percent solution that works is more likely to succeed than a 100 percent solution that does not work properly.

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[4]See http://occupywallst.org/about/.

Trading environmental issues in the financial markets sounds great, but it is probably much more reliable to focus on something much more tangible like energy consumption—simply because it is easy to track and can be measured without any value-laden inputs. It is apolitical and that is what we need—there is enough meddling in society as it is and adding more will certainly not improve our situation.

Energy consumption is *not* environmental impact, but measuring and following it up over time gives *good enough* decision support—similar to gross domestic product (GDP) figures which are also not measuring value creation directly but are close enough. Furthermore, measuring energy consumption has the great benefit of helping us focus on the real culprit today—our limitless craving for energy which comes at a high cost in most places in the world today. Then, we should be on the right path if the financial markets can start focusing on their real job, and science and innovation systems can help us find better and better solutions. Over time, we will achieve our goal: sustainable development.

9.4 Some Final Thoughts

> He who wishes to serve his country must have not only the power to think, but the will to act.
>
> Plato

It has often been said that we should think globally and act locally. This is not only naïve, but inherently wrong. No one has the capacity for taking a truly global view. Only the global system of economic and legal relations can capture a global view, and its goal must be that by thinking locally, acting locally we will do globally good. This can only be achieved if the global system is broad-based taking into account a whole range of issues in a fair and relatively unbiased way—meaning not by lobbying but by understanding, and with an information system that provides reliable, value-free, consistent, and timely information in a repetitive fashion throughout the economy. There will of course be costs with such a system, but what are the alternatives? If we believe that the quest toward a sustainable society is valuable in itself, what is there to lose? The wise words of Chan Master Yuanwu in a letter to Fozhi come to mind:

> Leaders should only seek what is good, diligently striving to seek and take advice. They should question right and wrong in principle regardless of whether the matter is great or small. If the principle is right, even though it involves great expense to carry it out, what is the harm? If the thing is wrong, even though it is a small measure to get rid of it, what is the loss?

This Zen Buddhist master lived around year 1100, and we might conclude that he needs a lesson in cost management since he does not fear great expenses in carrying out a principle; however, I believe that he is ultimately right even if we take costs into account. If the principle is right, the cost of violating the principle is great; otherwise, it could not be a principle worth keeping—maybe not right away but definitely over time. Taking a great expense of carrying it through is therefore not costly, but it is proactive and ultimately cheaper than to pretend the problem is not there and then being caught up later with a greater problem whose solution might be enormously costly.

For example, for years, many industrial corporations believed that high quality was costly, but the fact is that this is not only wrong but highly misleading and based on ignorance. If we approach quality by sorting out defects, then high quality becomes costly. However, if we realize that quality must be built into the product and the processes, we realize that high quality is actually very economic because problems are removed before they materialize. In the same vein, we must realize that sustainability cannot be achieved by pollution control or damage control in general; it must be built into products and processes. For that to happen, we must have the required information in the economy and governments must set the rules so that this becomes the new *modus operandi* and not a choice. Those that fail must have their license to operate removed. Why should limited liability only be related to financial viability? It must be coupled with its capability to adapt to societal challenges as well since the risk has been socialized by limited liability. Why should it be logical to close down a corporation due to illiquidity, for example, whereas operating with lack of innovative skills resulting in outdated and polluting technologies is OK? Is it because one is very tangible (money) whereas the other is not? Lack of innovative skills also materializes itself in that the corporation no longer copes with the technological development and needs exemptions from new regulations—is that not clear indication enough? If society wants to put a premium on innovation toward sustainable solutions, it must also put a prize on the head of the incompetent management and investors. It is not human right to be manager or an investor—their credentials must be earned by competence and not incompetence and to keep them sharp there must be real consequences. Maybe not as I have outlined above, but there must be real consequences.

Strict government rules and regulations have helped many industries become what they are today—including the airline and automotive industries—sustainable development will be no different. As long as the rules are sound, broad-based and enforced well, strict rules can do only good. I have just discussed a few options in this book—there is much more to pick from; it is only a matter of our ability to innovate. If I were to pick one insight from the Industrial Revolution to help us realize that strict rules is not a new fad driven by socialism or financial naivety, but rather a necessity, I would recall an important statement from Montesquieu (*De l'esprit des lois* (1748)):

> If the State imposes restrictions on the individual merchant, it does so in the interest of commerce, and his trade is nowhere more restricted than in free and rich nations, and nowhere less so than in nations governed by despots.

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