

Tallinn University of Technology Doctoral Theses
Series I: Social Sciences, No. 16

**Technology Foresight and the Catching-up
Strategy in Small Countries:
The Case of Estonia**

MAREK TIITS

TUT
PRESS

TALLINN UNIVERSITY OF TECHNOLOGY
Faculty of Social Sciences
Department of Public Administration
Chair of Innovation Policy and Technology Governance

The thesis was accepted for the defense of the degree of Doctor of Philosophy in Public Administration on 6 May 2011.

Supervisor: Prof. Dr. Rainer Kattel, Tallinn University of Technology,
Estonia

Opponents: Dr. Matthias Weber, Austrian Institute of Technology, Austria
Dr. Jaan Masso, University of Tartu, Estonia

Defense of the thesis: 7 June 2011

Declaration: Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for any other degree or examination.

/Marek Tiits/

Copyright: Marek Tiits, 2011
ISSN: 1406-4790
ISBN 978-9949-23-110-2 (publication)
ISBN 978-9949-23-111-9 (PDF)

CONTENTS

LIST OF ORIGINAL PUBLICATIONS.....	4
INTRODUCTION	5
Scope and aim.....	5
1. Socio-economic and policy context.....	9
2. Literature Overview: State of the Art and its Evolution.....	11
3. Learning, innovation and growth in the small catching-up countries	18
4. Foresight and priority-setting in the innovation policy in the small catching-up countries	22
5. The recent foresight experience in Estonia	25
6. Summary and conclusions.....	27
References.....	29
SUMMARY IN ESTONIAN.....	35
ACKNOWLEDGEMENTS.....	38
PUBLICATIONS (Articles I – IV).....	39
APPENDIX (Article V).....	123
CURRICULUM VITAE.....	223
ELULOOKIRJELDUS	226

LIST OF ORIGINAL PUBLICATIONS

The dissertation is based on the following original publications:

- I **Marek Tiits**, Rainer Kattel and Tarmo Kalvet. 2006. "Globalization of R&D and Economic Development: Policy Lessons from Estonia." In *Globalization of R&D and Developing Countries: Proceedings of an Expert Meeting* (Geneva, 24-26 January 2005). Geneva: United Nations, 155-171.
- II **Marek Tiits**. 2007. "Technology-Intensive FDI and Economic Development in a Small Country: The Case of Estonia." *Trames: Journal of the Humanities and Social Sciences* 11 (61/56)(3), 324-342.
- III **Marek Tiits**. 2008. "Estonia's Economic Integration into Cross-Border Production Networks of the Baltic Sea Region." In Ruslan Grinberg, Peter Havlik and Oleh Havrylyshyn (eds). *Economic Restructuring and Integration in Eastern Europe: Experiences and Policy Implications*. Baden-Baden: Nomos, 281-296.
- IV **Marek Tiits**, Rainer Kattel, Tarmo Kalvet and Dorel Tamm. 2008. "Catching up, Forging ahead or Falling behind? Central and Eastern European Development in 1990-2005." *Innovation: The European Journal of Social Science Research* 21 (1), 65-85.

APPENDIX

- V **Marek Tiits**, Rainer Kattel and Tarmo Kalvet. 2005. *Made in Estonia*. Tartu: Institute of Baltic Studies. (English version was published in 2006.)

INTRODUCTION

*“National frontiers as such are basically irrelevant to economic analysis:
it is only government politics that make them relevant”*

(Nurkse 1947, 265)

Scope and aim

In the late 1990s and early 2000s, a major new theme emerged both in the literature and in the international policy discourse – the advancement of the knowledge-based economy.¹ It was widely believed that it was a time for rethinking the business strategies and economic development policies, as the future wealth of all nations depended more than ever on knowledge and technologies. See, e.g., EC 2000, KBE 2001, World Bank 2002, UNCTAD 2005, etc.

One can, however, argue that the capitalist economy has virtually always been a *knowledge-based economy*, where the advancement of knowledge and technology fuels the growth and development. At least since the Italian quasi-capitalist city-states, the various public-policy incentives can be identified that have aimed at the advancement and creative application of knowledge both for the benefit of those directly involved and the society at large. The Venetian Republic was the richest and most successful Western European economy from the 11th to the 16th century (Reinert 1999). The patent system introduced formally in Venice in 1474 is perhaps one of the earliest examples of deliberate and selective innovation-policy measures in Europe. The Venetian policy aimed at offering incentives for the development and successful commercialisation of new technologies and products, and attempted to limit the flow of the related know-how to competing economies. While doing so, Venice deliberately refused to issue a patent for the “reading glasses” so that the free flow of basic education and knowledge would be secured (May 2002).

The whole modern idea of knowledge-based growth is that of specialisation and the development of certain unique advantages which the competitors do not find easy to replicate. One can argue that this idea has existed in the modern economic theory at least since Adam Smith’s famous discussion of specialisation and learning in a pin factory (Smith 1991). Strikingly, these ideas have played a fairly limited role in mainstream economic thinking. It was only throughout the 20th century that various authors and schools of economic thought started to pay increasing attention to the role of knowledge, technology and innovation in economic development. In the last few decades, the related literature has grown faster than ever. Yet, the exact role of knowledge and

¹ The amount of English-language books published in the United States that contain the phrase “knowledge economy” grew eight-fold between 1995 and 2005 (Google Ngram Viewer).

technology in growth and development and, perhaps even more importantly, the related policies remain highly debated among the researchers, entrepreneurs and policy-makers even today.

One of the obvious reasons for the emergence of the widely diverging views in the various policy discussions in and between the different countries is that the existing knowledge assets, capabilities and resources that the various economic actors and the whole national economies possess are different. The size of the domestic markets, the conditions for the access to international markets and their structures also vary. The broader international context, e.g. the conditions to the access to financing, technologies or markets, is also different for the various countries. Finally, there will always also be a necessity for the synchronisation and co-ordination of the existing very different private-business strategies and public policies.

Therefore, as long as the starting points and specialisation patterns of the individual economies continue to vary, it is highly unlikely that a useful universal policy prescription for the successful catching-up could be proposed that all countries can easily follow (Fagerberg et al. 2006, 537). Even though the success stories and the catching-up paths of the current rapidly growing and developed nations can serve as a source of inspiration, the uncritical copying of such “ideal models” is bound to fail. What the literature on modern public policy, development economics, innovation systems and clusters offers as an alternative is a diagnostics-based approach, which focuses on the identification and alleviation of certain systemic bottlenecks rather than a prescription-based approach where one size would be expected to fit all (Rodrik 2010, Rose 1993, Porter 1990, Freeman 1987).

The majority of the available empirical research and theorising has focused on the innovation and knowledge-based growth in today’s developed nations. This is perhaps understandable, as both the scholars and the policy makers have been seeking to understand the major success stories in catching-up and the current situation in the developed nations. The literature on innovation and the technological advancement in the low and medium-income economies, and especially on the catching-up strategies for such economies, still remains rather sparse despite the recent growth of interest in this topic. The knowledge gap that continues to exist in this area is even more visible, as it has become apparent in recent years that some of the widely used theoretical constructs, e.g. the popular idea of the “triple helix” scientific and technological co-operation between academia, industry and government (Leydesdorff and Meyer 2003), do not fit the realities of the developing and catching-up countries very well (See below, also Fagerberg et al. 2006, Lundvall et al. 2009).

The international dimension of the innovation systems and clusters is, as we argue below, another topic that so far has attracted less attention in empirical

studies and theorising than it actually deserves. The small catching-up economies are particularly interesting in this context. Small countries are traditionally defined by the small size of their population, the small absolute size of their GDP and their limited domestic market. Smallness often also entails a fairly constrained territory and limited natural resources. What distinguishes the small catching-up countries for the purposes of the current discussion from the larger countries is primarily their limited domestic knowledge production and R&D capacity, and their strong dependence on the externally developed technologies and the greater reliance on the external markets (Freeman and Lundvall 1988, Edquist and Hommen 2008, Steinmetz and Wivel 2010).

Moreover, it is rather obvious that the limited resources of the small economies do not allow them to build up a complete range of cutting-edge scientific and technological capabilities and related industries (Freeman and Lundvall 1988, 63). Yet, most of the modern literature on the knowledge-based economy offers fairly little guidance on the principles of priority-setting upon which small countries could build their own policies and strategies.

The aim of the current thesis is to contribute to filling in the above gaps by studying how Estonia, or any comparable small catching-up economy, could utilise the modern technological development in devising its development strategy. I build in this work on a broad body of existing knowledge, including the neo-Schumpeterian evolutionary economics, economic history, innovation systems, clusters, foresight and other scholarly literature.

The research programme which was carried out as part of the current PhD studies started in 2004 with an extensive literature review, the selection and synthesis of a broad set of applicable earlier theoretical contributions. As part of this work, the key technology trends in the three rapidly developing technology areas – the information and communication technologies, biotechnologies and nanotechnologies –, and the sources of Estonia's recent economic growth and the main challenges were also mapped by means of secondary research. Finally, on the basis of the successful catching-up experiences in Finland, Ireland, Japan, smaller East Asian economies and elsewhere in the 20th century, three distinctly different development scenarios were outlined for Estonia (V).

Subsequently, as part of the different European research projects, a number of field studies were carried out in different regions and countries, including Galilee (Israel) and Banská Bystrica (Slovakia), and in the comparative perspective for different metropolitan, non-metropolitan and cross-border regions (EURO-COOP). Building on the above desk research and field studies, a number of research articles and edited book chapters were prepared, which discuss the different elements of the priority-setting and policy foresight

processes in the smaller catching-up economies in general and in Estonia in particular:

- **I** discusses R&D policy lessons from Estonia in the context of globalisation, in particular in relation to the role of technology transfer and FDI in the catching-up process in a small country and the priority-setting in education, R&D and innovation policies.
- **II** further extends the discussion on the role of the technology-intensive inward FDI in the economic development of a small economy. As discussed in this article, the large multinational corporations dominate both in the global private R&D investment and in the trade of knowledge- and technology-intensive goods and services. Understanding and following the global technological and industrial dynamics is therefore instrumental for small economies to be able to upgrade themselves in the global R&D, production and trade.
- In order for any catching-up strategy to prove successful, it has to rely not only on the external factors, such as the main technological trends and foreign-investment flows, but also on a comprehensive understanding of the main strengths and weaknesses of the existing industries in the economy under discussion. Therefore, **III** summarises the results of a research effort which aimed at improving the understanding of Estonia's economic specialisation in the Baltic Sea Region and assessing the status and development outlooks of these industries in Estonia, which are responsible for a major share of exports, employment and growth.²
- Finally, **IV** discusses the transition and catching-up process that has taken place in Central and Eastern Europe (CEE) over the last two decades. In this research article, a concern was voiced – prior to the onset of the 2008-2010 global financial crisis – about the non-sustainability of CEE's current development path, as the insufficient upgrading of innovation and production capabilities and the foreign-funded speculative growth had made the CEE economies highly vulnerable to external shocks.

In the following chapters of the current introduction, I first briefly describe the broader socio-economic and policy context which called for the selection of this particular research topic. Thereafter, I summarise in a brief theoretical discussion the main strengths and limitations of applying the existing literature in the contest of small catching-up economies and the possibilities of overcoming these.

² Tiits 2007 and Tiits and Jürjado 2006 provide additional details of the above study on the industrial and trade dynamics and the economic clustering in Estonia and the Baltic Sea Region.

1. Socio-economic and policy context

The last two decades, since the collapse of the Soviet Union, have been a period of remarkable political and socio-economic transformation for Estonia and CEE in general. In the global political arena, it has been the period of the triumph of market liberalism and of the relative decline of the activist state (Stiglitz 2003). The free-market ideology has perhaps had an even stronger stance in Estonia than in many other parts of the world, given its recent experience with planned economy.

The whole developed world was, however, experiencing a major economic boom that followed the rapid diffusion of the personal computers and the Internet in the 1990s. This was technologically, but also economically and socially, a transition of no less importance. The Internet boom led the United States back to a fast growth track. Everyone was attempting to set up the science parks that were inspired by the experience of Silicon Valley, and the Western European policy-makers, including those in the European Commission, were discussing the “European Paradox”. There was a widely shared view that Europe carried out a significant amount of scientific research, as characterised by the number of scientific publications, but for some reason, few of these scientific results reached markets on a major scale. The above failure in the commercialisation of R&D results was, in turn, seen to explain the gap between the GDP per capita in (Western) Europe and the United States of America.

The issues of science, technology and innovation were, nonetheless, not very high on the European policy agenda in the 1990s. It was only with the adoption of the *Lisbon Strategy*, where the European Council set the ambitious goal for the European Union “*to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion*”, that the innovation policy became a truly central element of the main strategy document(s) of the European Union (EC 2000).

Two weeks before the adoption of the *Lisbon Strategy*, however, the situation had started to change drastically at the financial markets. The technology-heavy NASDAQ composite index peaked on 10 March 2000, and then headed for a decline. Most analysts attributed this initially to a correction that had taken place at the market, and the market collapse that was to follow was not foreseen. In early April 2000, it became clear, however, that a major technology bubble had burst at the global stock markets. The global technology optimism of the 1990s faltered remarkably within the half year that followed the adoption of the EU’s *Lisbon Strategy*.

It was not only the technology investments or business strategies but also the whole global economic setting that headed for an entirely different era. The 2000s were about to become a period of relatively slow growth and record low interest rates for many advanced economies. A number of catching-up economies around the world were, however, about to continue much faster growth. Eventually, this was to lead to the global real estate and consumption boom and the increasing global trade imbalances that affected many developed and emerging markets from the US or Europe to China.

In the public-policy sphere, however, the aspirations for the development of knowledge economy continued to strengthen in Europe. As part of this, a series of more concrete strategies and objectives were also defined around European countries. The Parliament of Estonia (Riigikogu) adopted the Knowledge-based Estonia strategy on 6 December 2001, which sought to achieve an increase in Estonia's R&D investment from 0.8% of GDP in 2001 to 1.5% of GDP by 2006.

Subsequently, in 2002, the Barcelona European Council found that “*in order to close the gap between the EU and its major competitors there must be a significant boost of the overall R&D and innovation effort in the Union, with a particular emphasis on frontier technologies.*” The Council therefore agreed that “*overall spending on R&D and innovation in the Union should be increased with the aim of approaching 3% of GDP by 2010.*” Two thirds of this investment were expected to come from the private sector (EC 2002).

In the 2000s, more or less simultaneously with the European Commission, the World Bank and various UN agencies (e.g. UNIDO, UNCTAD) also became increasingly interested in the advancement of knowledge economy as part of their broader development agenda. It is the common feature of all above strategies to set the increase of the public and private R&D investments and the commercialisation of R&D results as one of their headline objectives. It is basically assumed – even though the starting points of the different member states and different international organisations are very different – that eventually, all countries should aim at roughly the same targets. Politically, perhaps only the timing of the achievement of these common objectives was subject to discussion depending on the starting points of the different economies.

On 22-23 March 2005, the European Council found, as part of the mid-term review of the implementation of the *Lisbon Strategy*, that the results so far were mixed at best. The Council re-launched the Strategy and re-focused its priorities on growth and employment (EC 2005). Two years later, Estonia reiterated its intentions to develop a knowledge-based economy and to increase its R&D investments to 3% of GDP by 2014 (KBE 2007).

On the European level, the Lisbon strategy and its aspirations for the development of the “knowledge economy” (and the never fulfilled 3% target) has perhaps been the most prominent manifestation of the importance of R&D and innovation for economic growth in the last decade. As part of the open method of co-ordination, which was established for the implementation of the strategy, R&D and innovation policies significantly gained in importance across the EU. The same theme also holds a prominent role in the recent Europe 2020 strategy (EC 2010).

Although these policies have been dominating the political rhetoric for a number of years, the actual Lisbon targets set for 2010 have remained largely unachieved (Eurostat). Estonia has experienced a rapid growth of both public and private R&D investments in recent years. Are Estonia’s aspirations for increasing the gross R&D investment by 2014 to 3% of GDP likely to be achieved? If not, what corrective actions are needed? What could be the alternative policy objectives and approaches for fostering the socio-economic development in Estonia or elsewhere in the European catching-up economies or beyond?

The above are some of the key policy questions that both Estonian and European innovation-policy-makers are facing, as the programming of the different policy measures for using European cohesion and structural funds – a key funding source for the various innovation policy measures in Central and Eastern Europe (Suurna and Kattel 2010) – for the years 2014-2020 is just about to start.

2. Literature Overview: State of the Art and its Evolution

Joseph A. Schumpeter (1934) introduced his *Theory of Economic Development* with a hypothetical model of capitalist economy, where there is no earlier capital accumulation, creation of new value is perfectly stationary, and the system reproduces itself invariably. In this imaginary system, all economic agents have established the most favourable conditions for themselves by trial and error and continue to run a beaten track. Schumpeter demonstrated that in a stationary equilibrium system, which is characterised by universal perfect competition, there is actually no room for profits for capitalists to earn. Neither is there anything that would propel an increase of living standards. Consequently, as Schumpeter argued, it is the innovation – “*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations*” (OECD & Eurostat 2005, 46) – that propels the capitalist economic development (Schumpeter 1939).³

³ Modern innovation policy is a broad horizontal policy that aims at fostering the innovative activities in the enterprises, and in the economy and society in general. As

In the first half of the 20th century, when the United States of America became the global technological and economic powerhouse, mainstream economic thinking still failed to recognise the role of technological development in the economic growth. It was only after World War II, when a group of economists was carrying out growth-accounting exercises, that it was found – as a surprise to many – that 87.5% of the growth of the gross output per man hour in the United States in 1909-1949 had come from sources other than the increased use of capital. This residual, which Solow famously dubbed *the measure of our ignorance*, was ascribed to technological change (Solow 1957).

Even though Solow's exogenous growth theory (Solow 1956, Solow 1957) brought technological progress to neo-classical growth models, the sources of technological change remained unexplained. Thence, the public investment into science, technology and innovation also continued to have fairly little relevance from the mainstream economics' point of view. While the economists of different schools continued to work on the relationships between technology and growth,⁴ the mainstream of economic policy largely continued to build on Ricardian comparative-advantage thinking (Ricardo 1821).⁵

As often happens, times of socio-economic upheaval challenge the established theory and open a window of opportunity for alternative theories to gain ground. Japan had exhibited remarkable development in the post-WWII period. The notable increase of the Japanese competitive strength became also more and more visible in the 1980s, as the Japanese automotive and electronics firms became increasingly strong at the Western markets, as well. This made the Western industrialists and policy-makers increasingly anxious to rethink their positions and policy strategies. As the world was moving towards an increasing liberalisation of the markets and globalisation, policy think-tanks such as within OECD also became more and more interested in devising policy recommendations that would allow the OECD countries to sustain and increase their living standards. The key policy question was, how to become more like Japan?

It was in this context that Chris Freeman introduced a concept of innovation systems in his 1982 unpublished discussion paper for the OECD working group on science, technology and competitiveness (NIS; Sharif 2006). Subsequently the concept appeared in Freeman's (1987, 1) book on Japan as follows:

such, innovation policy has to do with a vast variety of different thematic policies, including, foremost, the education, R&D and technology and entrepreneurship policies.

⁴ Beyond the innovation-systems literature, there were also a number of other authors in the 1980s and 1990s, who were working on evolutionary interpretations of economic development (see Dosi and Nelson 1994).

⁵ According to David Ricardo, various natural resources, including labour, land, etc. were the main productive sources.

The network of institutions in public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies may be described as 'national innovation system'.⁶

Freeman explained the success of the Japanese economy with the rate of technological change in Japan. He also argued that the success of a national economy does not depend simply on the scale of their R&D and technology-development activities. It depends upon the way the available resources are managed and organised both at the level of the individual enterprises and at the level of the whole national economy (Freeman 1987, 3).

The NIS concept, which introduced a new way of explaining the competitive strength of various economies, became rapidly popular both in academic research and more applied policy-analysis communities.⁷ Lundvall (1992) and Nelson (1993) were among the first to apply the NIS concept to a comparative analysis of the development of a number of major economies. The Scandinavian policy-makers, e.g., the Finnish Science and Technology Council, also started to use the NIS concept. Even more importantly, the interest of international organisations, such as OECD, contributed to the increasing popularity of the concept among policy-makers as well as researchers. The NIS concept was taken rapidly into use this way and continued to evolve both in academic and policy spheres.

Although Freeman's (1987) and Lundvall's (1985) early works had emphasised the role of the broad set of institutions that are all part of the NIS, Nelson's (1993) and his followers' subsequent works tended to apply a significantly narrower approach to the NIS that focuses predominantly on the domestic R&D and technology-development activities as the core input of the innovative products, services and processes, and thereby of the economic development. Unfortunately, in the course of the following decades little interaction has taken place between the two schools advancing the NIS concept. Eventually, this has led to a notable confusion among the researchers themselves as well as among policy-makers, as it is not obvious at all from the literature what elements or functions an innovation system actually consists of or performs (Edquist and Hommen 2008, 4-7).

The broad NIS concept is loose and widely open, while the narrow one is somewhat better formalised and can be adopted more easily in research and in

⁶ In fact, Lundvall (1985) was the first to officially publish a work where a reference to the concept of innovation systems (without "national") was made.

⁷ It deserves to be mentioned that Friedrich List was an important source of inspiration for Freeman, when it came to the identification of national technology strategy (List 1841, Freeman 1987, 98-100).

the collection of statistical data.⁸ The broader availability of data is, perhaps, also one of the main reasons why the narrow interpretation of the NIS has tended to prevail in the actual policy analysis, including in and by the international organisations, such as the European Commission. Yet, as I argue in the following, the narrow approach is not necessarily very well suited for analysing the role of learning, capacity-building and innovation in the actual economic development, especially so in the catching-up and small economies.

The national level, albeit in many ways the most influential one, is only one of the policy-making levels in the modern multi-level governance structure. Therefore, the various adaptations appeared fairly rapidly after the inception of the NIS concept. Cooke's (1992) concept of regional innovation systems and Malerba's (2002) sectoral innovation systems are among the best-known derivatives of the NIS approach. The basic ideas of the concept of innovation systems have also been utilised in the analysis of the technological and corporate levels (Fagerberg et al. 2006, 181-208).

While the whole discussion of the appropriate unit (or geographical scale) of the analysis keeps evolving in the innovation-systems literature even today, Porter has proposed a rather elegant solution to this issue with the concept of industrial clusters. A cluster is "*a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities. ... The geographic scope of a cluster can range from a single city or state to a country or even a network of neighbouring countries*" (Porter 1990 [1998, 199]). While innovation systems are by definition constrained by specific administrative borders or industry sectors, the clusters approach allows, if properly applied, for the analysis of industry value chains as they exist in real life in the inter-sectoral and cross-border settings.⁹

For Porter, the nature of market competition and the appropriate choice of a business strategy are the key variables that a) lead to the continued upgrading of the enterprises' and clusters' existing competitive advantages and b) explain their ability to command supreme prices at the world markets. The existence or lack of such "world class" clusters in a particular economy, in turn, determines its living standard (ibid.).

Essentially, Porter links the increase of living standards in a particular economy to its ability to produce wealth by generating export revenues at the world markets. Accordingly, in order to properly analyse the development of any

⁸ See, e.g., Eurostat's science and technology statistics, including the Community Innovation Surveys from the various years.

⁹ Historically, there has been a notable academic rivalry between innovation-systems scholars and Porter's followers. The key authors in the competing innovation-systems and clusters literature also tend to be rather critical of each other's work (see, e.g., Cooke 2006).

particular regional, national or supranational economy, the major industrial value chains in this economy need to be identified, and thereafter, the private and public economic-development initiatives can be devised as necessary. In fact, this matches very well Vogel's (1980, cited in Freeman 1987, 49) account on the foundations of the Japanese economic success:

MITI's aim is not to reduce the competition among Japanese firms but to create the strongest possible companies with the greatest competitive potential. ... MITI is divided into branches corresponding to the major industrial sectors. ... In each branch MITI tries to create the most effective league of competing companies. It helps ensure that the promising companies get the necessary capital, land, foreign exchange, technical know-how and access to resources and markets to make the best use of this potential.

Eventually, both the NIS and the clusters approach seek to explain certain evolutionary processes that lead an economy through the development and adoption of new more and more complex technologies, processes, products and services to a higher living standard. Although Freeman's groundbreaking book on the Japanese economic success paid substantial attention to the actual economic performance of the country, most of the later NIS research starts from mapping and analysing the domestic knowledge creation and the diffusion that takes place within the particular NIS, while the actual everyday economic performance of the particular economy attracts much less attention. Contrastingly, in the clusters approach, the analysis starts from the identification of the major product groups or industries, where the economy of interest has already gained a notable market share at the international markets. In other words, in the NIS approach, the analysis starts from the knowledge inputs (upstream), while the clusters approach starts from the market (downstream) end of the value chain.¹⁰ This is why the clusters approach often allows for a much closer linkage to the actual economic development than is possible in analysing the functioning of the whole national innovation systems.

Originally, the various innovation-systems and clusters studies focused on the knowledge creation and economic activities that take place within the borders of a particular regional or national economy, while the broader international

¹⁰ The greater focus on upstream (capacity-building and technological-development) activities in the value chain is perhaps also one of the main reasons why scholars applying the innovation-systems approach are typically inclined to see a greater role for the state. Contrastingly, Porter keeps emphasising the crucial role of the market competition in boosting the technological development and the upgrading of the existing competitive advantages. Having said that, Porter is still far from neglecting the role of the state in fostering and supporting the evolution of clusters.

dimension attracted fairly little attention in most cases.¹¹ The world economy has, however, witnessed a major wave of financial and trade liberalisation during the last few decades. Globalisation has substantially altered the geography of the firms and of the economic development. In the globalised economy, the industry value chains reach across the borders of the individual countries or even across continents more often than ever. This is one of the most important changes to have occurred to the world economy since the inception of the NIS and cluster approaches in the late 1980s and early 1990s. The very rapid catching-up that has occurred in the last few decades in South East Asia and the increasing relocation of both the manufacturing and the R&D jobs are perhaps the most prominent manifestations of these new developments.

As the globalisation evolved, the developing countries' innovation systems and the whole global dimension of innovation systems and clusters increasingly attracted the attention of researchers and policy-makers since the mid-2000s. This has led to the emergence of numerous new research initiatives and concepts that deal with the globalisation of innovative activities, e.g., open innovation (Chesbrough 2003), global learning, innovation and competence building systems (GLOBELICS), global innovation networks (INGINEUS). This recent literature has been, for the most part, proposing and testing the new concepts while the linkages with the other strands of related literature that deal with the global value chains¹² (global production networks), have generally remained rather shallow. Thus there is a clear need for a synthesis of the earlier theoretical and empirical contributions.¹³

With the greater interest in the innovative activities in the developing economies, it has become increasingly apparent that the Nelsonian (1993) narrow interpretations of the innovation systems that focus on the R&D do not fit very well the realities of most developing or catching-up economies (I; Lundvall et al. 2009, 85). The first differences that are typically pointed out when comparing the developed and less developed economies are the much lower gross R&D investments and the weaker linkages between the industry and the public-research institutions in the latter. This has even led to a certain

¹¹ Dieter Ernst (2002) is one of the few who has been advancing this research agenda for more than a decade.

¹² The global value chains encompass the full range of activities that are required to bring a good or service from conception through the different phases of production to the delivery to the final consumers, as well as its disposal after use (Cattaneo et al. 2010).

¹³ With Romer's (1986) endogenous growth theory, some basic indicators of the technological capability, e.g. the number of years of education, the number of patents, etc., were brought to the neo-classical literature. Yet the constructive interaction between the scholars developing an evolutionary innovation-systems approach and the neoclassical economists has remained limited. For an interesting exception, see Rodrik 2007.

debate around the question if the developing countries have innovation systems at all.

The recent controversy, which the European policy-makers called the “Swedish paradox”, is perhaps one of the most prominent manifestations of the weakness of the linkages between innovation-systems literature and the actual economic performance. The high gross R&D investment in a country is, according to the broadly shared understanding, an indication of the high knowledge intensity of the economy. This is, in turn, to secure both the high and growing living standards. Sweden’s R&D investments have been, measured as a share of GDP, among the highest in Europe for a number of years. Sweden’s GDP growth remained, nonetheless, relatively modest in the 2000s. At the same time, a number of other European economies, including the Baltic States, where the R&D investments remain fairly modest, grew much faster than Sweden during the same period (Eurostat).

An important lesson can be drawn here, namely that most theory discourse as well as public-policy literature that builds on the narrow interpretation of the NIS or the neoclassical school tend to underrate the importance of the fact that the main sources of the technological inputs are very different in the catching-up economies in comparison to the advanced economies. One can certainly see the developed nations’ innovation systems as an “ideal type” and argue that developing countries only have “emerging innovation systems” which have only some of the characteristics of the developed countries’ NIS (Lundvall et al. 2009, 366). Yet, this approach leaves the major share of the actual on-going learning, capacity-building and innovative activities out of the research scope, thus significantly reducing the explanatory power of the whole NIS concept (Lundvall 2007).

While it is certainly true that innovation and economic development policies tend to be less complex in the less developed economies, general conclusions of policies, strategies and institutions that are conducive to catching-up still remain rather limited in the innovation-systems literature. The principles of context specificity in the detection of “systemic problems”, policy learning and experimentation in public policy that the recent NIS literature stresses are certainly valid starting points, but this is not sufficient for the purposes of the actual policy advice or policy-making (Fagerberg et al. 2006, 514-542, Edquist and Hommen 2008, 442-482).

Normally, the policy-making takes place under conditions of limited resources. Therefore, the advanced economies need to consider carefully where the next scientific and technological breakthroughs may be more necessary. It is, similarly, not possible for the catching-up economies to upgrade their whole

S&T systems at once to the level of the global cutting edge.¹⁴ The resources of the smaller countries are, by definition, even more limited, both in terms of workforce and in terms of investment capital. The general guidelines for a greater investment into capacity-building (education, science and technology) that most contemporary scholarly and policy literature on the knowledge economy offers are, therefore, insufficient for devising an effective catching-up strategy, and well-informed priority setting and policy-learning processes are very strongly needed.

Porter (1990) focuses the attention of researchers and policy-makers on the existing specialisation of the particular economy and discusses the systemic linkages between the different actors who are involved in the related major value chains. This is a significantly better starting point for the discussion of potential future developments. It does not, however, sufficiently explain one of the key phenomena of today's globalised economy – the relocation of different economic activities across countries and continents.

This is why revisiting some of the historic successful catching-up experiences and earlier scholarly literature and updating it with the modern context is very beneficial for the discussion of innovation policy in small catching-up economies, such as Estonia.

3. Learning, innovation and growth in the small catching-up countries

For Abramovitz (1986), catching-up was a fairly straightforward affair. The acquisition and adoption of the already existing technologies is a simpler business than the actual development of new technologies, products or services at the cutting edge of science and technology.¹⁵ He argued, therefore, that the backwards economies can catch up fairly rapidly if their societies have the capabilities for adopting the latest technologies. The recent decades of globalisation have brought about increasing flows of products, services and capital. Along with this, the international technology transfer has become one of the most prominent forms of globalisation (Lundvall and Borrás 1997). One might hypothesise that the catching-up has become even easier with the opening-up and liberalisation of the economies that has occurred in the last few decades, as the access to finances, new technologies and markets has become easier than ever before.

¹⁴ In Japan, therefore, MITI's foresight activities and regular interaction with the major industries were instrumental to the priority-setting and the subsequent successful catching-up experience (Freeman 1987, 55-60).

¹⁵ On a similar token, Porter (1990) discusses the different stages of economic development, where resource-based growth is followed by investment-based and innovation (knowledge)-based growth.

For Gerschenkron (1962), contrastingly, catching-up was anything but an easy affair. The actual growth experience of most economies in recent decades seems to confirm this view. Some countries or regions of larger economies, such as China, have indeed experienced very rapid catching-up in recent decades. Some medium-income economies have experienced massive economic booms, some of which brought about very rapid economic growth at first, but then led to major financial or economic crises and a drastic contraction of the GDP. However, a number of economies have simply continued to lag behind (See, e.g., MDG, Rodrik 2007).

It appears from the economic history that it is not only the different economies, but also the different industries and the different fields of science and technology that evolve at a very different pace (Freeman 1987, Freeman and Perez 1988, Perez 2002). Accordingly, it is not only the globalisation and the larger market that allows for greater specialisation, but also the structure of the industry and the whole economy that matters in the growth and development. Ultimately the greater the share of the rapidly growing innovative (exporting) industries in an economy, the faster its growth is likely to be.

As Perez (2002) has shown, both the industrialisation of Europe in the 18th-19th centuries and the emergence of the United States as the global superpower in the 19th-20th centuries were fuelled by certain emerging qualitatively new industries. The British industrial revolution laid the grounds to a wave of gradual industrialisation of the Western Europe, whereby the industrialisation of the individual neighbouring countries lifted their living standards one after another. In the 20th century, Japan and East Asia experienced a similar “Flying Geese”-type development, where industrialisation and its impact on living standards “spills” from one country to the next. As a common pattern, the successful catching-up economies found their own way in adopting the skills, technologies and often also capital of the more developed countries. Each of the industrialising countries developed novel infrastructures and became a consumer of the industrial goods. Eventually, they also started to export their products to less developed (neighbouring) countries (Pollard 1973, Pollard 1981, Akamatsu 1935, V).

The industry-life-cycles and paradigms literature, which was an integral element of the early works on the national innovation systems (Freeman 1987) but is seldom referred to in the modern knowledge-based economy literature, offers a useful way of explaining both the historic developments and the increasing relocation of the economic activities that globalisation has brought about. It also offers a useful way for discussing the possibilities and risks in the economic development. According to the life-cycles literature, the evolution of the individual technologies and products, but also the whole industries that build on these, starts from the emergence of the (radically) new technologies and

products. As time goes by, the volume of the market increases, the competition intensifies, and the competing similar products start to drive the profit margins lower. The industry starts to consolidate. Eventually, as the products mature and the initial markets get increasingly saturated, the cost advantage (economies of scale) will become the main advantage in the competition, and the production is relocated to low-cost locations that are logistically close to the major mass-consumption markets (Vernon 1966, Wells 1972, Perez 2002).

The important observation that emerges from the above is that neither the technological nor the industrial development occurs in a completely random manner. The major technological breakthroughs allow for the emergence of whole constellations of mutually reinforcing technological innovations and related novel industries and infrastructures. This is how the mechanisation of the textile industries in the 18th century eventually led to the transformation of the British society, and the invention of the steam engine in the 19th century allowed for the development of a whole new generation of industrial machinery and led to the emergence of the railway networks. By this, not only the productivity growth was achieved, but with the much faster travel possibilities, the whole conception of time and space changed for the contemporaries. Similarly, the invention of microprocessors, computers and the Internet led to the emergence of a modern information society in the 20th century (Freeman and Perez 1988, Perez 2002).¹⁶

Ultimately, it is the above-mentioned structural change in the industry, whereby the traditional resource or labour-intensive industries are replaced with modern science and technology-intensive industries, which brings about an overall increase of knowledge and technology intensity of the economy. Along with this, the nature of learning, capacity-building and innovation also change. The taking-up and imitation of the available “best practice” solutions, the related learning and organisational change (DUI mode of innovation) tend to dominate in the earlier phases of catching-up. The industrial R&D activities (STI mode of innovation) gain substantially in importance only with the emergence of the modern science-based industries.¹⁷

¹⁶ The economic effects of the paradigm-leading technologies are not limited to the new industries it brings about or to the country where a new paradigm is established. The adoption of the paradigm-leading technologies also allows for a massive productivity growth in all other parts of the economy and the society. In line with the continuing ICT paradigm, the adoption of the ICTs and the related organisational change has been responsible for half of the productivity growth experienced in the Western European and OECD countries in the early 2000s (EC 2007, 35, van Ark and Inklaar 2005, EC 2004).

¹⁷ Jensen et al. (2007) discuss the different modes of learning at the micro level in great detail. Unfortunately, they do not link them explicitly with Pavitt’s (1984) well-known industry taxonomy, nor with the diametrically opposed R&D intensity and the industrial-specialisation patterns of the advanced and catching-up economies.

Moncada-Paternò-Castello et al. (2010) show that the gross domestic expenditure on R&D (GERD) in Europe lags behind compared to the United States primarily because of the weaker presence of the modern science-based industries in Europe. The same also applies, though, for Central and Eastern European or other catching-up economies as compared to (Western) Europe. Accordingly, the key catching-up question is not the one of increasing the gross expenditure for R&D *per se*, but rather the one of successfully entering the rapidly growing modern industries in terms of actual production (or service) capabilities.

Historically, major new industries have emerged in, or even in competition between, the larger major economies that were able to secure the necessary resources and also served as sizeable lead markets for the emerging new industries. Even as recently as a few decades ago, all the main elements of any particular industry value chain tended to be co-located fairly closely geographically. The globalisation and advancement of the ICTs have made the international communications and logistics, the management of the remote business units and the relocation (off-shoring) of the individual elements of the value chains massively easier. With the greater specialisation and the massive increase of the trade of manufactured intermediate goods (Cattaneo et al. 2010), successful catching-up has also become increasingly dependent on both imported technologies and subsequently emerging production capabilities and the broader global industry and market dynamics. It is, therefore, not sufficient anymore to discuss specific industries or clusters only within the regional/national borders. Instead, the industry value chains (clusters) should be analysed in broader cross-border settings or, depending on the characteristics of the particular industry, even as global value chains (V, III).

This is crucial, as the knowledge intensity and the other characteristics of the same industry tend to vary substantially across different geographic locations. Often, even the most successful catching-up economies enter the new modern industries by starting to fulfil relatively simpler manufacturing or support functions and then move gradually within the specific industries to more knowledge and technology-intensive tasks. This is, for example, how East Asia established its strongholds in the electronics industry in recent decades (See, e.g., Cattaneo et al. 2010). Both the structural change in the economy that brings about the increase of the share of the medium and high-tech industries and the upgrading that occurs internally within the individual industries are thus important elements of successful catching-up (V, McMillan and Rodrik 2011).

Along with the increasing fragmentation and delocalisation of the industry value chains, the *small country squeeze* that has been identified in the earlier literature has become even more intensive with the globalisation in recent decades. It continues to be impossible for the small economies, and often also for medium-size ones, to cover the whole spectrum of the cutting-edge science

and technology that is needed for the nurturing of new basic technologies. The concentration of resources for nurturing the new high-tech industries is an increasingly risky proposal for small economies in this context. The smaller medium-income catching-up economies are, however, also unable to compete in the scale-intensive mass production with the larger emerging economies that have abundant “cheap” labour (Walsh 1988, V).

Smallness also entails the fairly limited diversification of the innovative and productive capabilities of the economy. This may, as exemplified by the dominance of Nokia in the Finnish economy, lead both for a very strong contribution of the individual industries to the countries’ economic development as well as for the notable concentration of risks in case the dominant industry will fall into a decline (Ali-Yrkkö 2010, V).

Well-informed priority setting, both at the level of the individual businesses and the public policy, therefore has become even more important for successful catching-up. The dominance of imported technologies and the importance of the export markets, however, make the whole foresight (priority-setting) and strategic policy-planning process very different in the (smaller) catching-up economies in comparison to the larger advanced economies.

4. Foresight and priority-setting in the innovation policy in the small catching-up countries

The first foresight exercises in the modern sense, which had a Delphi study as their central element, were carried out in Japan in the 1970s and 1980s. The Japanese economic success has inspired many countries, including the United States as well as various European and Asian countries, to also launch similar exercises in the early 1990s. Georghiou and Harper find that “broadly speaking, the earlier exercises have been the most influential” (Georghiou et al. 2008, 4-5, 325), while the more recent exercises in the different parts of the world have had a lesser impact on the actual policy-making. Embedding the foresight activities more closely into the actual policy-making thus remains a notable challenge for many countries. This seems to be especially true for the various catching-up economies, including Estonia, where the first attempts at using the foresight methodologies and tools have been made only fairly recently¹⁸ (Georghiou et al. 2008, 216-316, EFMN).

¹⁸ No comprehensive evaluations of the foresight exercises have been carried out in the Central and Eastern European countries. It is not the aim of the current chapter to fill in this gap by providing a comprehensive assessment of the recent foresight experience in the catching-up economies. The objective is rather to discuss a possible foresight approach a small catching-up country, such as Estonia, could apply in devising its catching-up strategy.

It is well established in the public policy literature that the policies “borrowed” from the different times or states need always be adopted before they can be taken properly into use. Similar critical assessment is also necessary when adopting the policy-making practices or policy-intelligence tools from elsewhere (Rose 1993, Georghiou et al. 2008, 319-341).

The forward-looking activities that have had the greatest and lasting impact, have typically defined a truly visionary and attractive new Grand Narrative in the respective field. More often than not, the successful forward-looking work has been linked very closely with the actual industrial strategy or policy development in the advanced economies. Typically, its contribution has come perfectly in time for the broader strategy or policy development process. For example, the European Commission’s work on the Ambient Intelligence (Ducatel et al. 2001) had a very strong impact on gearing the European ICT R&D investment strategy in the 2000s. The United States’ National Science Foundation’s work on the possibilities of improving human capabilities and on the future convergence of a number of rapidly developing fields of science and technology (Roco and Bainbridge 2003) also provided a highly visible new narrative, which many other organisations and countries subsequently started to reinterpret for their own purposes.

The development of such Grand Narratives is highly rewarding intellectually. This thesis argues, nonetheless, on the basis of the above discussion, that the Grand Narrative approach, which is typically employed in larger advanced economies to define the future priorities for the investment into science and technology, is not very practicable for the discussion of the economic development in the (small) catching-up economies. One of the key lessons that derives from the above discussion is that the initial phases of catching-up do not necessarily entail major indigenous R&D efforts and strong R&D co-operation between academia and industry, although both of the above are the usual assumptions in much of the NIS and foresight literature.¹⁹ The domestic R&D efforts are not unimportant in the catching-up economies. Still, the international transfer of the technologies, skills and practices in combination with the inflow of the foreign direct investments often proves much more powerful in restructuring the economy and in engendering the domestic production capabilities (Porter 1990, Dunning and Narula 1996, **V, I, II**, Tiits 2007).

The main trends in the basic research and key technologies are, for the most part, established in the major advanced economies rather than in the small catching-up countries. Therefore, as I argue, the general approach and the focus of the (technology) foresight exercises should also be different in the catching-

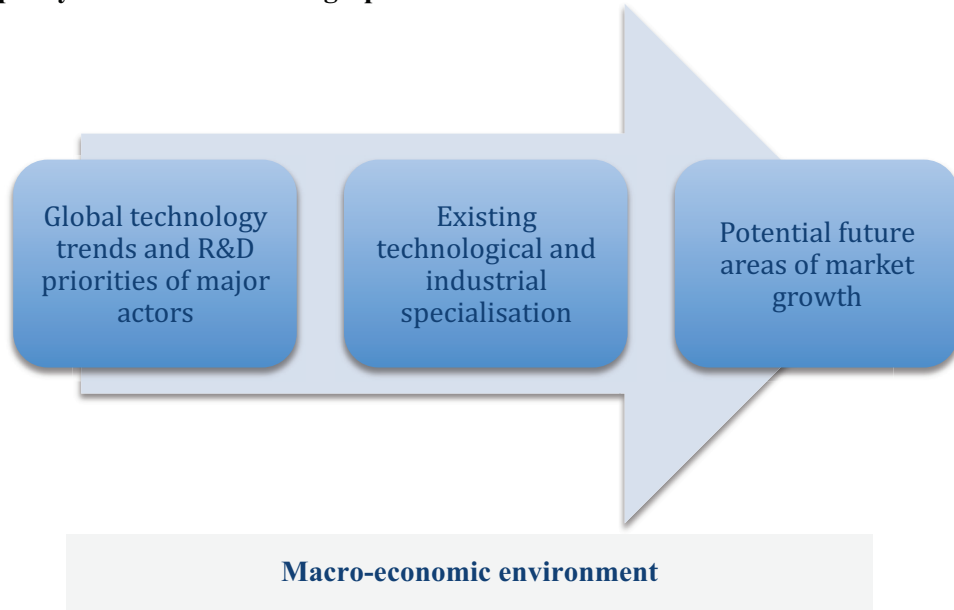
¹⁹ Industry is typically also a very strong actor in the R&D in advanced economies. Therefore, to a large extent, the discussion of the R&D agenda in the latter is therefore rather closely related to the discussion of the broader industrial development agenda. The above is, however, as a rule much less true in the catching-up economies.

up economies in order to meet their techno-economic realities. The main focus of the Intelligent Piggybacking approach, which I propose as an alternative approach for the foresight in the small catching-up economies, is not on the indigenous research and technological development *per se*, but rather on the possible future evolution of the existing technological and industrial specialisation. The key questions in this context are: what new industries are the emerging new technologies likely to bring about and how would it be possible to enter these in a relatively early phase; and how could the emerging new technologies be used for upgrading the already existing (traditional) industries. In discussing the above, both the supply of new technologies as well as the prospective future market demand need to be analysed.

Accordingly, in the Intelligent Piggybacking approach, the priority setting for the catching-up strategy should consider carefully:

- **global technology trends**, that are for the most part set in the larger advanced economies and characterise major future technological possibilities; in this respect, the techno-economic paradigms literature (Freeman and Perez 1988, Perez 2002) offers an excellent framework for analysing the evolution of longer-term priorities in science and technology, and in the global industrial dynamics that the development and dissemination of new knowledge and technologies brings about;
- **existing technological capabilities and industrial specialisation**, which define the starting point(s) of any future development scenarios or roadmaps; here a combination of Porter's (1990) clusters approach and the global-value-chains literature, FDI and trade theory provide a good starting point for analysing the existing industrial specialisation of a particular economy;
- **major domestic and international socio-economic challenges** which serve as an indication of the likely changes in the future market demand as well as the decision points for the willingness of the domestic actors for re-thinking their future production and innovation activities; here, trend analysis as well as the various participatory foresight techniques such as scenario-writing, road-mapping, etc. can prove useful (Figure 1).

Figure 1. An analytical framework for priority-setting in the innovation policy in the small catching-up economies



Source: author.

Furthermore, when devising the possible future development scenarios, policies and strategies, it is of crucial importance also to consider, besides the microeconomic foundations of growth and development, the broader macroeconomic context. The major changes in the macroeconomic environment, e.g., changes in the conditions of access to capital or in the exchange rate, can be hugely powerful in either supporting or inhibiting the impact of the activities that are or are not taken at the level of the individual firms or public institutions. Equally, the major mistakes in the macroeconomic policy can have, despite the efforts of the individual actors, a devastating effect on the whole economy (V, IV).

The current PhD research programme has taken, given the above, a rather broad approach to the discussion of the knowledge economy and economic development in the small catching-up economies and in Estonia in particular.

5. The recent foresight experience in Estonia

The recent history of (technology) foresight in Estonia started with the pilot ICT and biotechnology exercises which were carried out as part of the EU-funded *eForesee* project in 2002-2003. Simultaneously, in the same project, similar pilot exercises also took place in Cyprus and Malta (Georghiou et al. 2008, 216-236). This was a learning exercise where substantial capacity-building took place in relation to the main foresight methods and practices in Europe. In

Estonia, it was also a learning exercise in terms of the limited public-policy impact it had, and in terms of the need for rethinking the whole approach to foresight in the (small) catching-up economies.

One of the key difficulties detected was that the number of potential experts to be involved in a foresight exercise is very small in the small catching-up economies. This makes the adoption of the quantitative methods such as, e.g, Delphi survey virtually impossible. It was also detected that there tends to be a major knowledge gap in the small catching-up economies in relation to the latest strategies and priorities of the major research and industrial actors that dominate the global high-tech scene. This reinforced the need for a comprehensive background study on the major science and technology trends emerged. It also appeared that the key industrialists and policy-makers considered it to be more important to understand the sources of Estonia's recent economic growth rather than to discuss the possible future priorities in science and technology. Often, there was fairly little connection seen between these two. There was the view that perhaps the future economic growth would follow the pattern of the 1990s' rapid growth, and there is, therefore, actually no need for any more comprehensive long-term strategy. The above necessitated the initiation of new directions of research that would cover the relevant economic development theory as well as Estonia's actual growth experience and the future challenges involved (V). This work set to contribute to the development of the renewed *Knowledge-Based Estonia Strategy for 2007-2013* (KBE2) and the *National Strategic Reference Framework 2007-2013* for the adoption of Structural Funds.

Subsequently, as part of the current research programme, a more in-depth analysis of the major industrial clusters in the Estonian economy and the industrial and trade dynamics in the Baltic Sea Region was carried out (Tiits 2007, III). The idea of this was to take a step further based on the conclusions of the previous work, to analyse the status of the major clusters in the Estonian economy and to discuss the challenges and opportunities in their further development. The results of this work seek to inform both the industry itself and the preparation of the specific clusters-development programme by the Ministry of Economic Affairs and Communications and the future development of the individual cluster-development roadmaps as part of the relevant cluster initiatives.

Finally, the Estonian ICT 2018 foresight exercise, which perhaps followed the above analytical framework (see Figure 1 above) the most closely, focused on the potential major contribution of the ICTs as the paradigm-leading technologies to the socio-economic development of Estonia. In this exercise, the ICT trends and the priorities of the major international actors were mapped in an even greater detail, and the major socio-economic challenges in the development of Estonia were revisited. As a result of this exercise, two different

sets of recommendations were prepared: one relates to the priorities for capacity-building in ICT higher education and R&D so that Estonia could command the latest basic technologies that have emerged elsewhere; the other relates to the priorities for the development and adoption of the innovative ICT-based products and services (Tiits and Rebane 2009). Similarly to the previous steps, close linkage with the actual policy making was sought here, as well. The planning and the implementation of this exercise was closely linked with the programming of the national ICT R&D programme and other related policy measures.

The above research programme can be, overall, characterised as a combination of focused participatory actions that took place within a limited timeframe and continuously on-going background research. This has, foremost, to do with the vast amount of continued background research that is needed for inspiring high-quality discussions and informing the various strategy and policy discussions. It has also to do with the extended period of the current work, which made it impossible to sustain the continued stakeholder interest. Therefore, focused participatory actions were organised only when there was both a need and a window of opportunity for the actual achievement of policy change.

The key lessons from the recent foresight practice in Estonia are that the foresight practitioners should never underestimate the amount of background research that is needed for animating well-informed policy discussions. Also, the definition of the topics and the timing of the more participatory foresight activities are also absolutely crucial when they are to have a notable policy impact. The various broad-scale participatory actions should only be opted for when there is a commonly shared need for it as well as a very strong possibility for actually instituting a new strategy or public policy. This seems to be the most effective way for securing the actual take-up of the collective intellectual efforts that are put into the process.

6. Summary and conclusions

The conclusions of the current research programme come at two different levels. First, at the theoretical level in relation to the catching-up strategies in the smaller catching-up economies, and, thereafter, at the more practical level in relation to strategic choices in the public policy in Estonia.

The early ground-setting work (Freeman 1987, Freeman and Lundvall 1988, also Porter 1990) paid considerable attention to a broad set of “capacity-building” activities, incl. education and training, and on-job learning that accompanies the acquisition and full utilisation of the (imported) new technologies and equipment. Yet, unfortunately, this wisdom has largely gone missing in the course of the following decades, as a more narrow interpretation of the national innovation systems (Nelson 1993, Edquist and Hommen 2008),

which focuses foremost on R&D, has prevailed in many academic studies and high-level policy documents. The headline target of the EU Lisbon strategy itself, which seeks to increase the European R&D investments to 3% R&D, is perhaps the most prominent manifestation of such oversimplifications that have come to dominate the scene (EC 2000, EC 2002).

Even more importantly, most of the recent knowledge-based economy literature considers all technologies and economic activities to be the same in terms of their potential contribution to the economic development. It is, consequently, not very well equipped for assisting the development and implementation of the economic development strategies and policies, which always occurs in conditions of limited resources. The global relocation of economic activities, including knowledge-intensive jobs, from advanced to less developed economies is another challenge the innovation-systems and clusters theory still seeks to fully explain.

It appears from the analysis of the earlier literature and of the different catching-up episodes in the economic history that the scholars and policy-makers who are active today in advancing the knowledge-based economy have actually neglected and unlearned some very valuable elements of the earlier knowledge in the course of time. Therefore, revisiting some of the earlier literature proves very valuable for the discussion of the possibilities for catching-up in small countries.

Therefore **V** starts the discussion of the knowledge economy and of the possible catching-up paths for the small countries from the new synthesis of the literature on techno-economic paradigms, clusters, global value chains, foreign direct investments, etc. In doing so, I pay special attention to constraints that the smaller catching-up economies face in the modern world. A shorter summary of this discussion also appears in **I**.

As a result of this new synthesis, an analytical framework has been proposed that assumes that all technologies and economic activities are necessarily not the same in terms of their potential contribution to the socio-economic development. It also acknowledges the fact that the starting points of the different countries are very different and that actual policy-making always takes place in the context of limited resources. It proposes a comprehensive analytical framework for the priority-setting in innovation policy.

At the more practical policy-making level, both Estonia's starting point and the possible future development scenarios are analysed extensively in the thesis. Both the sources of Estonia's recent economic growth and the main future challenges are mapped in a broad socio-economic perspective. As a result of the above, three distinctly different scenarios present themselves for the future

economic development in Estonia, each of which also presupposes distinctly different business strategies and public policies (V).

In sum, applying the foresight approach described above in figure 1, the thesis proposes a dual strategy, which would aim at:

- upgrading Estonia's competitive position in the 5-6 major existing cross-border industrial clusters in the Baltic Sea Region, which Estonia is currently part of (V, III, Tiits 2007);
- attracting inward FDI in certain emerging high-tech industries, thus allowing for a rapid structural change in the whole Estonian industry (V, II).

Thereafter, Estonia's recent development experience is compared with the other countries in Central and Eastern Europe. As part of this work, the highly vulnerable macroeconomic position of particularly the Baltic States is also highlighted. As the global financial crisis that broke out in 2008 demonstrated, these concerns were well founded (IV, Tiits et al. 2010).

For today, some of the empirical data that is contained in the various publications that are part of the current thesis is getting slightly outdated. There is, therefore, a need for updating some of it. For example, it could be beneficial to analyse once more the post-crisis situation in the major cross-border industrial clusters which Estonia is part of. The identification of the specific industry (sub)segments and of the potential firms that could potentially be interesting for Estonia for attracting their investments should also be an ongoing process. Also, more specific roadmaps should be designed for the adoption of the ICTs as the paradigm-leading technologies in the areas of Estonia's major socio-economic challenges (Tiits and Rebane 2009), etc.

Even though the situation and the policy needs keep evolving, it is still my firm belief that the core of the analysis presented in the current thesis remains accurate and valid.

References

- Abramovitz, Moses. 1986. "Catching Up, Forging Ahead, and Falling Behind." *Journal of Economic History* 46 (2), 385-406.
- Akamatsu, K. 1935. "Waga kuni yomo kogyohin no susei" [Trend of Japanese Trade in Woolen Goods]. *Shogyo keizai ronso* 13, 129-212.
- Ali-Yrkkö, Jyrki (ed.). 2010. *Nokia and Finland in a Sea of Change*. Helsinki: ETLA.
- Ark, Bart van and Robert Inklaar. 2005. *Catching up or Getting Stuck? Europe's Trouble to Exploit ICT's Productivity Potential*, Research Memorandum GD-79, Groningen Growth and Development Centre, September.

- Cattaneo, Olivier, Gary Gereffi and Cornelia Staritz (eds). 2010. *Global Value Chains in a Postcrisis World: A Development Perspective*. Washington, DC: The World Bank.
- Chesbrough, H.W. 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press
- Cooke, Philip. 2006. *Problems and Prospects for Clusters in Theory and Practice* (manuscript). Available at <http://www.dime-eu.org/files/active/0/Cooke%2006%20Clusters%20Critique%5B1%5D.doc> (last accessed 27 October 2010).
- Cooke, Philip. 1992. "Regional Innovation Systems: Competitive Regulation in the New Europe." *Geoforum* 23, 365-382.
- Dosi, Giovanni and Richard Nelson. 1994. "An Introduction to Evolutionary Theories of Economics." *Journal of Evolutionary Economics* 4, 153-172.
- Ducatel, Ken, M. Bogdanowicz, F. Scapolo, J. Leijten and J.-C. Burgelman. 2001. *Scenarios for Ambient Intelligence*. Seville: European Commission DG JRC-IPTS.
- Dunning, John and Rajneesh Narula. 1996. *Foreign Direct Investment and Governments: Catalysts for Economic Restructuring*. London: Routledge.
- EC. 2000. Presidency conclusions, European Council, Lisbon, 23-24 March.
- EC. 2002. Presidency conclusions, European Council, Barcelona, 15-16 March.
- EC. 2004. Facing the Challenge: The Lisbon Strategy for Growth and Employment, Report of the High Level Group chaired by Wim Kok, November.
- EC. 2005. Presidency conclusions, European Council, Brussels, 22-23 March.
- EC. 2007. Annual Information Society Report 2007, European Commission, Luxembourg, March.
- EC. 2010. Conclusions, European Council, Brussels, 26 March.
- Edquist, C. and L. Hommen. 2008. *Small Country Innovation Systems. Globalization, Change and Policy in Asia and Europe*. Cheltenham: Edward Elgar.
- Ernst, Dieter. 2002. "Global Production Networks and the Changing Geography of Innovation Systems: Implications for the Developing Countries." *Economics of Innovation and New Technology* 11 (6), 497-523.
- Fagerberg, Jan, David C. Mowery and Richard R. Nelson (eds). 2006 [2005]. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.
- Freeman, Christopher. 1987. *Technology, Policy, and Economic Performance: Lessons from Japan*. London: Pinter.
- Freeman, Christopher. 1982. "Technological Infrastructure and International Competitiveness." Paper presented to the ad hoc group on Science, Technology and Competitiveness. Organisation for Economic Co-operation and Development, Paris.
- Freeman, Christopher and B.-Å. Lundvall (eds). 1988. *Small Countries Facing Technological Revolution*. London and New York: Pinter.

- Freeman, Christopher and Carlota Perez. 1988. "Structural Crises of Adjustment, Business Cycles and Investment Behaviour." In Giovanni Dosi et al. (eds). *Technical Change and Economic Theory*. London and New York: Pinter, 38-66.
- Gerschenkron, A. 1962. *Economic Backwardness in Historical Perspective*. Cambridge, Mass.: Belknap Press.
- Georghiou, Luke, Jennifer Cassingena Harper, Michael Keenan, Ian Miles, Rafael Popper (eds.) 2008. *The Handbook of Technology Foresight*, Cheltenham & Northampton: Edward Elgar.
- Jensen, Morten Berg et al. 2007. "Forms of Knowledge and Modes of Innovation." *Research Policy* 36, 680-693.
- KBE. 2007. *Teadmistepõhine Eesti. Eesti teadus- ja arendustegevuse ning innovatsiooni strateegia 2007-2013* [Knowledge-based Estonia. Estonian R&D and innovation strategy 2007-2013]. RTI 2007, 16, 78.
- KBE. 2001. *Teadmistepõhine Eesti: Eesti teadus- ja arendustegevuse strateegia 2002-2006* [Knowledge-based Estonia: Estonian R&D strategy 2002-2006]. RTI 2001, 97, 606.
- Leydesdorff, Loet and Martin Meyer. 2003. "The Triple Helix University-Industry-Government Relations." *Scientometrics* 58 (2), 191-203.
- List, Friedrich. 1841. *Das Nationale System der Politischen Ökonomie*. Basel: Kyklos (translated and published under the title *The National System of Political Economy*. London: Longmans, Green and Co., 1841).
- Lundvall, Bengt-Åke. (ed.). 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter.
- Lundvall, Bengt-Åke. 1985. *Product Innovation and User-Producer Interaction*. Aalborg: Aalborg University Press.
- Lundvall, Bengt-Åke and Susana Borrás. 1997. *The Globalising Learning Economy*. European Commission, December.
- Lundvall, Bengt-Åke. 2007. *Innovation System Research and Policy Where it came from and where it might go*. Paper to be presented at CAS Seminar, Oslo, 4 December.
- Lundvall, B.-Å., K.J. Joseph, Cristina Chaminade and Jan Vang (eds). 2009. *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar.
- McMillan, Margaret and Dani Rodrik. 2011. *Globalisation, Structural Change, and Productivity Growth*, manuscript.
- Malerba, Franco. 2002. "Sectoral Systems of Innovation and Production." *Research Policy* 31 (2), 247-264.
- May, Christopher. 2002. "The Venetian Moment: New Technologies, Legal Innovation and the Institutional Origins of Intellectual Property." *Prometheus* 20 (2), 159-179.
- Moncada-Paternò-Castello, Pietro, Constantin Ciupagea, Keith Smith, Alexander Tübke and Mike Tubbs. 2010. "Does Europe Perform too Little Corporate R&D? A Comparison of EU and non-EU Corporate R&D Performance." *Research Policy* 39, 523-536.

- Nelson, Richard R. (ed.). 1993. *National Innovation Systems: A Comparative Analysis*. Oxford: Oxford University Press.
- Nurkse, Ragnar. 1947. "Domestic and International Equilibrium." In Seymour E. Harris (ed.). *The New Economics: Keynes' Influence on Theory and Public Policy*. New York: A.A. Knopf, 264-292.
- OECD and Eurostat. 2005. *Guidelines for Collecting and Interpreting Innovation Data, Oslo Manual*. 3rd edn. Paris: OECD.
- Pavitt, Keith. 1984. "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory." *Research Policy* 13, 343-373.
- Perez, Carlota. 2002. *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Cheltenham: Edward Elgar.
- Pollard, Sidney. 1981. *Peaceful Conquest: The Industrialization of Europe, 1760-1970*. Oxford: Oxford University Press.
- Pollard, Sidney. 1973. "Industrialisation and the European Economy." *Economic History Review*, New Series, 26 (4), 636-648.
- Porter, Michael E. 1990. *The Competitive Advantage of Nations*, London: Macmillan.
- Reinert, Erik S. 1999. "The Role of the State in Economic Growth." *Journal of Economic Studies* 26 (4/5), 268-326.
- Ricardo, David. 1821 [1817]. *The Principles of Political Economy and Taxation*. London: John Murray.
- Roco, Michael C. and William Sims Bainbridge (eds). 2003. *Converging Technologies for Improving Human Performance*. Dordrecht: Kluwer Academic Publishers.
- Rodrik, Dani. 2010. "Diagnostics before Prescription." *Journal of Economic Perspectives* 24 (3), 33-44.
- Rodrik, Dani. 2007. *One Economics, Many Recipes: Globalisation, Institutions, and Economic Growth*. Princeton: Princeton University Press.
- Romer, Paul M. 1986. "Increasing returns and long-run growth." *Journal of Political Economy* 98, 71-102.
- Rose, Richard. 1993. *Lesson-Drawing in Public Policy: A Guide to Learning Across Time and Space*. Chatham, NJ: Chatham House Publishers.
- Schumpeter, Joseph A. 1939. *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. New York: McGraw-Hill.
- Schumpeter, Joseph A. 1934. *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.
- Sharif, Naubahar. 2006. "Emergence and development of the National Innovation Systems concept." *Research Policy* 35, 745-766.
- Smith, Adam. 1991 [1776]. *The Wealth of Nations*. London: Campbell.
- Solow, Robert M. 1957. "Technical Change and the Aggregate Production Function." *Review of Economics and Statistics* 39 (3), 312-320.
- Solow, Robert M. 1956. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70 (1), 65-94.
- Steinmetz, Robert and Anders Wivel (eds). 2010. *Small States in Europe: Challenges and Opportunities*. Farnham & Burlington: Ashgate.

- Stiglitz, Joseph. 2003. *The Roaring Nineties: A New History of the World's Most Prosperous Decade*, New York: W W Norton & Co.
- Suurna, Margit and Rainer Kattel. 2010. "Europeanization of Innovation Policy in Central and Eastern Europe." *Science and Public Policy* 37 (9), 646-664.
- Tiits, Marek. 2006. "Industrial and Trade Dynamics in the Baltic Sea Region since 1990s." In Rainer Kattel and Tarmo Kalvet (eds). *Creative Destruction Management: Meeting the Challenges of the Techno-Economic Paradigm Shift*. Tallinn: PRAXIS Center for Policy Studies, 101-118.
- Tiits, Marek. (ed.). 2007. *Kaupmeeste riik* [The Nation of Merchants]. Tallinn: Eesti Teaduste Akadeemia.
- Tiits, Marek and Juhan Jüriado. 2006. "Intra-Industry Trade in the Baltic Sea Region." Working Papers 02-2006, Institute of Baltic Studies.
- Tiits, Marek and Kristjan Rebane. 2009. *The Estonian ICT Outlooks* [Eesti infotehnoloogia tulevikuvaated]. Tallinn: Eesti Arengufond.
- Tiits, Marek, Dorel Tamm and Rene Tönnisson. 2010. "Estonia." Chapter in Christian Ketels. *State of the Region Report 2010 – The Top of Europe Recovering: Regional Lessons from a Global Crisis*. Copenhagen: Baltic Development Forum, 69-76.
- UNCTAD. 2005. *Globalisation of R&D and Developing Countries*. Proceedings of the Expert Meeting Geneva 24-26 January 2005, New York and Geneva.
- Vernon, Raymond. 1966. "International Investment and International Trade in the Product Cycle." *Quarterly Journal of Economics* 80 (2), 190-207.
- Vogel, Ezra F. 1980. *Japan as No. 1: Lessons for America*. Tokyo: Tuttle.
- Walsh, Vivien. 1988. "Competitiveness of Small Countries." In Christopher Freeman and Bengt-Åke Lundvall (eds). *Small Countries Facing the Technological Revolution*. London and New York: Pinter, 37-66.
- Wells, Loius T., Jr (ed.). 1972. *The Product Life Cycle and International Trade*. Boston: Harvard University.
- World Bank. 2002. *Building Knowledge Economies: Opportunities and Challenges for EU Accession Countries*. Final Report of the Knowledge Economy Forum "Using Knowledge for Development in EU Accession Countries" organised by the World Bank in cooperation with the European Commission, the Organization for Economic Cooperation and Development, the European Bank for Reconstruction and Development, and the European Investment Bank, Paris, 19-22 February.

Web sites:

- EURO-COOP. Regional Innovation Policy Impact Assessment and Benchmarking Process. Available at <http://www.iccr-international.org/eurocoop/> (last accessed 9 February 2011).

- EFMN. European Foresight Monitoring Network. Available at <http://www.efmn.info/> (last accessed 28 April 2011).
- Eurostat. Eurostat, European Commission. Available at <http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/> (last accessed 5 February 2011).
- GLOBELICS. Available at <http://www.globelics.org/> (last accessed 5 May 2011).
- Google Ngram Viewer. Available at <http://ngrams.googlelabs.com/> (last accessed 2 February 2011).
- INGINEUS. Impact of Networks, Globalisation, and their Interaction with EU Strategies. Available at <http://www.ingineus.eu/> (last accessed 5 May 2011).
- MDG. Millenium Development Goals. United Nations Development Programme. Available at <http://www.undp.org/mdg/> (last accessed 5 May 2011).

SUMMARY IN ESTONIAN

Tehnoloogiaseire ja konvergeerumisstrateegia väikeriikides: Eesti näide

2000ndate aastate alguses ilmus rahvusvahelistesse ja Eesti majanduspoliitika alasesse aruteludesse uus läbiv teema – teadmistepõhise majanduse arendamine. Eestis, Euroopa Liidus jm levis poliitikakujundajate seas üha laialdasemalt uskumus, et tulevase sotsiaal-majandusliku arengu aluseks on ennekõike uute teadmiste ja tehnoloogiate loomine ning senisest veelgi nutikam kasutamine.

Majandusarengu ja majanduspoliitika ajaloole tagasi vaadates võib samas väita, et kapitalistlik majandus on olnud sisuliselt alati teadmistepõhine majandus. Tänapäevane teadmistepõhise majanduse alase käsitluse laialdasele levikule pani suuresti aluse OECD riikides 1980ndate lõpus süvenenud majanduslik ebakindlus. Jaapani kiire majandusareng ohustas üha enam Euroopa ja Ameerika Ühendriikide majanduslikke positsioone ning varasem domineeriv majanduskäsitlus ei olnud võimeline toimumat täielikult seletama. Euroopa Liidu Lissaboni strateegia vastuvõtmine 2000. aastal oli paljus nõndasamuti kantud äratundmisest, et Euroopa peab oma positsioone konkurentsisis teiste maailma piirkondadega oluliselt tugevdama.

Tänapäevast diskursust domineeriv innovatsioonisüsteemide ja majandusklastrite alane teoreetiline (ja majanduspoliitiline) kirjandus on vaatamata selle kiirele arengule ja laialdasele kasutuselevõtule viimastel paarikümnel aastal siiski üsna varajases arengufaasis. See on keskendunud peamiselt tänaste edukate riikide eduloo kirjeldamisele ning suudab senistele mahajääjatele neile sobiliku konvergeerumisstrateegia osas pakkuda märksa vähem.

Praktiline avaliku poliitika kujundamine on alati seotud ressursipiirangutega, mis sunnivad prioriteete seadma. Kaasaegne innovatsioonisüsteemide alane kirjandus peab aga üldjuhul sisuliselt kõiki tehnoloogia- ja majandusvaldkondi ühesugusteks ning soovib ennekõike tõsta majanduse üldist teadmistemahukust ja tõhustada koostööd innovatsioonisüsteemi erinevate lülide vahel. Porteri klastripõhine majandusanalüüs toetab prioriteetide seadmist mõnevõrra paremini, kuna see keskendub olemasolevate olulisemate majandusklastrite edasiarendamisele. Kumbki neist laialt kasutatavatest tänapäevastest lähenemistest ei suuda aga ammendavalt seletada info- ja kommunikatsioonitehnoloogiate üliolulist rolli viimaste kümnendite majandusarengus või üha hoogustunud erinevate majandustegevuste ümberpaiknemist erinevate riikide ja maailmajagude vahel.

Käesoleva doktoritöö raames läbiviidud uurimistöo algas seetõttu 2004. aastal laialdasest varasemate teoreetiliste käsitluste ning tegeliku majandusarengu

kogemuste sünteesist, tuues seejuures varasemad käsitlused tänapäevasesse väikeriikide majandusarengu konteksti.

Selle töö tulemusena sündinud varasema kirjanduse ja erinevate riikide majandusarengu kogemuste sünteesi kohaselt tuleb väikeriikides konvergeerumisstrateegia kujundamisel arvestada:

- **globaalseid tehnoloogia arengutrende**, mida kujundatakse ennekõike suuremates arenenud riikides;
- **olemasolevat tehnoloogilist võimekust ja majanduslikku spetsialiseerumist**, mis on mistahes tulevaste arengustsenaariumite või teekaartide kujundamise lähtekohaks;
- **peamisi sotsiaal-majanduslikke väljakutseid**, mis osutavad tõenäolistele tulevastele muutustele nii siseriiklikus kui ka rahvusvahelises turunõudluses.

V kaardistab eeltoodust tulenevalt peamisi trende kolmes maailmas kiiremini arenevas tehnoloogiavaldkonnas: info- ja kommunikatsioonitehnoloogiates, bio- ja nanotehnoloogiates. Selles töös analüüsitakse samuti Eesti senise majandusarengu peamisi allikaid ning eelolevaid sotsiaal-majanduslikke väljakutseid. Töö viimases osas kirjeldatakse nii teooria kui ka Soome, Iirimaa, Jaapani jt riikide hiljutiste majandusarengu kogemuste baasil kolme võimalikku stsenaariumit Eesti tulevases majandusarengus.

Nii eeltoodud teooriaraamistikule kui ka erinevates Euroopa piirkondades läbiviidud empiiriliste uurimustele tuginedes on käesolevas doktoritöö raames koostatud ja avaldatud rida teadusartikleid ja raamatu peatükke, mis käsitlevad erinevaid konvergeerumisstrateegia prioriteetide kujundamise elemente nii väikeriikides üldiselt kui ka konkreetselt Eestis:

- **I** käsitleb globaliseerumise ning teadus- ja arendustegevuse üha kasvava rahvusvahelistumise kontekstis õppetunde Eesti avaliku poliitika kujundamises, pöörates seejuures erilist tähelepanu välismaistele otseinvesteeringutele, rahvusvahelisele tehnoloogiasiidlele ning prioriteetide seadmisele haridus-, teadus- ja arendustegevuse- ning innovatsiooni- poliitikas;
- **II** arendab teemat tehnoloogiamahukate välismaiste otseinvesteeringute strateegia osas edasi; võtmeküsimuseks on seejuures seosed tehnoloogiate, tööstuse ja investeeringute voogude arengudünaamika vahel ning väikeriikide võimalused rahvusvahelises tööjaotuses soodsamatele positsioonidele edasi liikumiseks;
- edukas konvergeerumisstrateegia peab lisaks laiemale rahvusvahelisele tehnoloogiate ja investeeringute voogudele jmt kontekstile arvestama ka riigi olemasoleva majandusliku spetsialiseerumisega; **III** võtab sellest

tulenevalt kokku eraldiseisva suurema uurimissuuna tulemused, mis puudutavad Eesti majanduslikku spetsialiseerumist Läänemere regiooni piiriülestes majandusklastrites;

- **IV** vaatleb lõpetuseks Kesk- ja Ida-Euroopa viimase paarikümne aasta majandusarengut; selles enne 2008-2010 aasta finants- ja majanduskriisi avaldatud artiklis hinnatakse viimaseid arengusuundumusi Kesk- ja Ida-Euroopa riikides ohtlikeks ja jätkusuutmatuteks, kuna väliskapitali sissevoolulust ja sisetarbimisest kantud spekulatiivne majanduskasv ning ebapiisav innovatsiooni- ja tootmisvõimekuste suurendamine on muutnud need majandused väliste majandusšokkide poolt kergesti haavatavateks.

ACKNOWLEDGEMENTS

First of all, I would like to thank my supervisor Prof. Dr. Rainer Kattel for his continued support during the various phases of the current PhD research, and for his always insightful and valuable contributions to the various joint undertakings. Equally, I would like to thank Dr. Tarmo Kalvet for being such a great friend and colleague for a number of years, with whom it has been always a pure pleasure to work.

A number of publications that have led to the current thesis are actually the results of my joint work with Rainer and Tarmo. These and the other publications we have worked on together would never have materialised without the contributions from both. It has been a great honour to work with both of them on the various academic and policy projects.

I would also like to thank my dear friends and colleagues in the Institute of Baltic Studies, especially Rene Tönnisson, for his unlimited energy in initiating the various new international research or other policy projects, which have been an invaluable source of inspiration and experience for the current thesis.

I would like to thank Prof. Dr. Wolfgang Drechsler, Prof. Carlota Perez and Prof. Dr. Erik Reinert for inspiring me to take up the PhD studies. I would also like to thank everyone else at the Department of Public Administration of Tallinn University of Technology and the former colleagues in the various organisations for supporting me in the various phases of the current research.

The research that led to the current thesis has been part of a number of different European policy-research projects. I would like to thank all the colleagues with whom we worked on these projects.

Last, and by no means least, I would like to thank my family for their understanding and continued support, even when I tended to spend too much time on the on-going work. Thank you so much! I am deeply indebted to you!

PUBLICATIONS (Articles I – IV)

Article I

Marek Tiits, Rainer Kattel and Tarmo Kalvet. 2006. “Globalization of R&D and Economic Development: Policy Lessons from Estonia.” In *Globalization of R&D and Developing Countries: Proceedings of an Expert Meeting* (Geneva, 24-26 January 2005). Geneva: United Nations, 155-171.

Globalization of R&D and economic development: policy lessons from Estonia¹

Marek Tiits, Rainer Kattel and Tarmo Kalvet²

Ever since the evolution of Italian city-states during the Renaissance and the Dutch and German cities in the 16th and 17th centuries, the concept and success of a modern economy have been based on geographical borders that make specialization possible, i.e. allow for the creation of economic clusters enhancing welfare. Economic theory has been based upon the principle stated by Adam Smith, according to which there is a positive link between welfare and the size of a market, because a larger market allows for greater specialization and thus also contributes to the increase of productivity and improvement of living standards (Smith [1776] 1991, Young 1928).³

Recent advances of ICT and the liberalization of markets and trade have significantly changed the meaning and role of geography and the proximity of markets. The value chains of the global economy are no longer formed in line with geographical or national borders, but more and more within particular industries. At the same time, an increasing number of economic units are being established and positioned in the states and regions where the socio-economic environment is the most suitable for the production system in question. This means that simpler production tasks are transferred to regions with lower labour costs, but still of relatively high productivity, whereas more complex, higher value-added activities remain in

¹ This paper is based on Tiits et al. 2005.

² The views expressed in this study are those of the authors and do not necessarily reflect the views of the United Nations, its Member States, or the Institutions to which the authors are affiliated.

³ Most of the early development economics is based on the same assumption; see Nurkse 1953.

countries with higher living standards. The situation has become increasingly complicated for the regions that can offer neither knowledge-based activities nor low relative labour costs.

In this context, both the enhancement of the competitive advantages of indigenous companies and the selection of locations for FDI are based increasingly on particular economic and technological factors. This makes part of the traditional policies and strategies supporting economic development obsolete or, leaves them without the intended impact. Yet it is obvious that a target of public policies should still be to support the modernization of the economy based on a vigorous private sector.⁴ No wonder that the European Commission considers the implementation of the Lisbon Strategy⁵ as the highest priority of the EU. However, the Lisbon Strategy does not provide the specific list of the individual steps member States should take in order to accomplish quickly the established objectives. Such detailed regulation does not and cannot exist, because the situations of different European countries are different.⁶

⁴ Ever since David Ricardo ([1817] 1821), the prevailing idea that a company operating in a particular location should first of all commit itself to activities where the existing environment offers some advantages has remained. However, modern economic theories do not consider such advantages spontaneous; instead, the business environment created by the State has the decisive role in the formation of specialization (Romer 1986).

⁵ A ten-year strategy of the EU to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.

⁶ For theoretical foundations, see Rodrigues 2002. See also the website of the European Commission: http://europa.eu.int/comm/lisbon_strategy/index_en.html.

1. EU membership and economic development

Estonia joined the EU in May 2004 and found itself in a new economic policy environment. Going beyond the transposition of the *acquis communautaire*, Estonia's economic convergence will require a development strategy supporting a more dynamic specialization of the country in the common market. In many respects, the macroeconomic situation environment of Estonia is already similar to that of the older 15 countries of the EU. After the forthcoming introduction of the euro, supervision of monetary policy will be transferred to the European Central Bank, while the Stability and Growth Pact of the EU will establish limitations on fiscal policy. The competence of the EU also includes agriculture and foreign trade, including the application of a customs union towards third countries. For the EU as a whole, such a situation leads to an enormous challenge to develop the economic environment in a manner that is simultaneously appropriate for member States at very different stages of development and, for industries with highly different development trajectories and international networks.

What might Estonia's specialization within the EU be in ten years time? The developments of the past decade will by and large determine the technological and industrial structure of the Estonian economy in the next five to ten years. In Estonia, as in the other Baltic States, most growth has been generated through efficiency gains produced by one-off structural adjustments, privatization and the closing down of unprofitable ventures. An analysis of the development of Estonia since mid 1990s demonstrates that the technological structure of manufacturing has not become more knowledge-intensive or complex, rather the other way round (Tiits et al. 2003).⁷ Together with some other new EU members, Estonia is

⁷ Similar developments have been observed across Central and Eastern Europe; see Watkins and Agapitova 2004, Havlik et al. 2002.

competing for FDI projects with China, India, Latin American countries and the Russian Federation (Reinert and Kattel 2004).

Until recently, relocation of certain parts of the relatively labour- and/or resource-intensive production has been one of the main motivations behind decisions to invest in Central and Eastern Europe.⁸ In most cases, foreign affiliates have outperformed domestic enterprises both in terms of knowledge intensity and sales (Damijan et al. 2003). Positive spillovers from FDI however have been relatively limited. Looking at the structure of exports and the competitiveness of manufacturing, it appears that while the other Central and Eastern European countries specialize in various medium-technology activities, Estonia has until now exclusively specialized in timber processing (including furniture, print and paper industries),⁹ and certain low-value added activities of Northern European IT and electronics firms.

The sustainability of Estonia's specialization on timber – a resource-intensive and relatively low-technology industry – is far from granted. Nor would it be reasonable to return to Soviet-era light industries or mechanical engineering. Instead, Estonia would need to gradually expand its presence in the medium- and high-technology industries of the next generation, i.e. in the value chains of IT, biotechnology and nanotechnology. The development of such new industries would need to be linked to the existing economic structure and specialization of Estonia. Otherwise the contribution of new high-technology industries to the improvement in living

⁸ Several authors have concluded, that the interest of foreign investors has been more to exploit, and less to develop local resources (Johansen 2000, Männik 2001: 216).

⁹ The Estonian timber processing industry is part of the Scandinavian forestry cluster. Over the past 10 years, it has become the most important source of productivity increase in Estonia (Havlik et al. 2002, Stephan 2003).

standards in Estonia would remain only modest, irrespective of the success of individual companies.¹⁰

In Estonia, the creation of new jobs is directly dependent on the existing knowledge and skills of the labour force and the compatibility of the education and research system with technological developments in the world and in the Estonian economy. This implies that policies aimed at the continuous modernization of industry and the education and research system which, owing to the logic described above, would need to be industry-specific and, at the same time well coordinated. Whilst the establishment of an efficient system of vocational education, advanced training and retraining and the increase of resources for R&D are equally crucial for the creation of new jobs, none of the aforementioned elements is capable alone of inducing the structural changes in society that are needed for a transition to a knowledge-based economy.

2. Main issues

a. Structure of education and science

Whereas the nominal educational level continues to be relatively high, Estonia has relatively limited lifelong learning, i.e. the renewal of people's skills and knowledge in line with the changing needs of society. While the economy has undergone drastic structural changes, the structure of education and science has evolved de-linked from economic changes. The public R&D funding system as it stands today tends to reproduce past activities rather than contributing to the creation of new ones (Nedeva and Georghiou 2003).

¹⁰ Such developments can now be observed in the IT and electronics industries of Estonia and Hungary, where foreign affiliates dominate exports, yet their contribution to the value added remaining in the country and, accordingly to the improvement of living standards is more modest (Kalvet 2004).

At the level of general principles, Estonia has in recent years fully embraced the goals of European innovation policy. However, in practice changes have been slower. R&D and innovation policies usually follow a linear approach to the role of knowledge (including scientific research) in socio-economic development, based upon the belief that massive investment in basic research and the resulting technological development would almost automatically lead to the efficient development of the economy. However, that model that once enabled several technological breakthroughs for world powers (Bush 1945) is not necessarily applicable to small or medium-sized market economies facing resource constraints (Freeman 2002, Nature 2004).

In Estonia, notwithstanding the high rate of unemployment that amounts to as much as over 20% among people under 24 years of age, companies have unremittingly pointed out problems of finding suitably qualified labour (Jürgenson et al. 2005). At the same time, as a result of demographic changes, the number of young people graduating in Estonia from secondary and vocational schools will drop from the year 2008. Since demographic challenges are similar practically everywhere in Europe, severe competition can be expected from better qualified immigrants (OECD 2004: 37, Kauhanen and Lyytinen 2003).

When considering an increase in public investment in education and science, Estonia would first of all need to make the strategic choice regarding in which industries it desires to take the lead, in which industries it would be important to participate actively in EU-wide R&D projects and, in which industries Estonia would want to sustain a minimum level of competence. In addition, modernization of the system of (higher) education in a small country with an aging population requires both the immigration of qualified persons and, a willingness to become an exporter of high-level training.

b. Preferential treatment of IT, bio- and material technologies

Although priority to IT,¹¹ *biomedicine*¹² and *material sciences* has been clearly established in the Estonian research and development strategy *Knowledge-based Estonia 2002-2006* (RTI 2001), no R&D programme has been initiated yet in these areas, nor are there in place any R&D or innovation policy measures targeting these industries. Prompt action would be required in the development of human resources and the economic environment of these areas if Estonia would like to maintain or increase its living standards in the long run. For public policy to be effective, the establishment of priorities must be followed by corresponding substantial changes in institutions and financing.

c. Low private-sector investment into R&D

Having drawn on the lessons of successful Finnish policy in the 1990s, *Knowledge-based Estonia 2002-2006* stresses the importance of the practical application of science. However, as the current structure and competitive advantages of the Estonian economy are more similar to those of Finland in the 1970s and not in the 1990s, the policy of contemporary Finland cannot be directly applied in Estonia.¹³

¹¹ In the OECD countries, more than half of the increase in productivity is derived from innovation in IT and its application. The IT revolution has not ended with the extensive spread of personal computers and the Internet. When it comes to the economic effect of ICT, the actual revolution is likely to be only beginning (Perez 2002).

¹² Massive investment in recent years into bio- and nanotechnologies and new energy technologies in the United States, Western Europe, the Republic of Korea, China and many other countries increases the probability that these industries will in the coming decades experience breakthroughs that will radically change the world.

¹³ In the 1970s, massive investments were made in forest-related Finnish industries (including pulp and paper), making the country one of the world's technological leaders in that industry.

Due to the structural problems of the labour market, Estonian companies are short of workers with much lower qualifications than required for proper R&D. At the same time, because of the current investment based phase of development of the economy and the small size of the country, R&D *per se* is not the primary source of competitive advantages or motive for Estonian economic development. It is rather the rapid application of various innovative technologies created elsewhere that prompts Estonian development (Kurik et al. 2002).

In the business enterprise, innovation is *almost always* about novel applications of existing technologies, knowledge and skills. As far as economic development is concerned, the issue is not so much the limited investment of the public sector in R&D, but literally the cost of new technologies and knowledge that Estonian companies need to purchase. Here, it is clear that while the market and competition set the limits of risks, it is the role of public policies to lower those risks for a majority of enterprises and, to create an additional stimulus for the renewal of their competitive edges.

Unfortunately the Estonian education, science, technology and innovation policies are relatively weak on assisting structural change in the economy or supporting technology transfer for upgrading traditional industries. In a market economy, it would be still the task of the state to design an institutional environment suitable for balanced socio-economic development. Consequently, for a substantial part of the Estonian private sector, R&D and innovation are just too expensive and risky.

d. Role of FDI in R&D and innovation

In a small country with an open economy the role of FDI is inevitably large. FDI can substantially strengthen the economy through spillovers and transfer of knowledge to

existing industries and, more importantly, initiate the creation and development of new high-technology industries. These roles of FDI have been acknowledged only to a certain degree in Estonian public policy. Little attention has been paid to what motivates investors to invest in Estonia, including in R&D. An overall reduction of the tax burden alone would not be enough. Such a policy could even inhibit the increase of knowledge-intensity of the economy (Bhattacharya et al. 2004, Buffet 2003).

Being a small country, Estonia lacks resources for R&D to the extent necessary to ensure the creation of new international corporations and high-technology industries through spin-off business. However, Estonia can learn from the success achieved by Finland, Ireland, Switzerland and Singapore as a result of a purposeful engagement of FDI in the modernization of the economy. Furthermore, investment by the State in the development of human resources and local competitive assets plays a crucial role in attracting the “right type” of FDI.¹⁴

Countries such as Estonia would need to exercise caution when developing new high-technology industries, since the development of some science-based industries (e.g. bio- or nanotechnology) alone may not have any immediate effect on living standards. Such high-technology industries are not necessarily connected to the rest of the economy, thereby limiting the value-added created in Estonia. In order to preclude such developments, it is very important to ensure the transfer of knowledge and skills into more traditional spheres that dominate the economy.

¹⁴ In that broader context, the success of the Finnish firm Nokia could be due more to “luck” than “regularity” (van Beers 2003, van Grunsvan and van Egeraat 1999).

e. Design and coordination of public policy

Even though *Knowledge-based Estonia 2002-2006* is an important strategic document, Estonia today mostly lacks a political and administrative mechanism that would ensure the actual transition of the Estonian economy toward greater knowledge intensity. A regular evaluation and coordination of policies in education, employment, research and development and innovation is almost non-existent. Therefore, practically no one has an overview of the impacts, weaknesses or strengths of the existing policies. As a result, public policy is not sufficiently balanced and lacks a specific goal as regards the improvement of competitiveness (Estonian State Audit Office 2003 and 2004). The connexion between public policies and the problems of the real economy is rather weak. Estonia lacks policy measures that would enable the State to deal with the factors inhibiting the growth of productivity of companies in the timber, electronics, chemical or engineering industries, i.e. industries that currently dominate the economy and exports or, to specifically contribute to the creation of new high-technology industries.

Although policy coordination is a task of the Government and the Prime Minister, policy-making suffers to a large extent from the lack of an interim level of administration that would coordinate the implementation of general horizontal strategies (like *education, research and development, and employment*). This has resulted in conflicting approaches between different sectoral activities. Very few long-term priorities have been set for education, research and innovation policies. However, it is obvious that the more general the public policy measures, the less they are effective.

There would be a need to redesign the system of public policy-making so as to ensure the coordination of policies aimed at a longer-term perspective and the regular analysis of the impacts of such policies. The elaboration of National

Development Plans for the application of the EU Structural Funds could give an impetus to general policy coordination. Yet more needs to be done to achieve better synergies between education, R&D and innovation policies.

In summary, in order to facilitate Estonia's development, a cluster-based strategy for the enhancement of competitiveness would be needed. That strategy could be based upon strategic road maps for particular technologies and economic clusters, while taking into account possible developments both in new high-technology industries and, in the traditionally significant industries (e.g. energy, agriculture etc.). The definition and implementation of such a strategy could only happen through cooperation between scientists, companies and policy-makers aiming at the enhancement of the competitiveness of a particular cluster through the application of essential technological developments (Porter 1990, OECD 2001).

3. Policy recommendations

a. Technology programmes for the enhancement of the competitiveness of economic clusters

In principle, the public sector of Estonia would need to resolve the question of how to ensure that the private sector's problems are properly taken into account in the design and evaluation of policies. A system needs to be established whereby the State can receive feedback on the actual development of the private sector and technology on a continuous basis. To that end, a system of consistent monitoring of industries needs to be created. The establishment of such a system could be one of the key components of a future development strategy. Such a system of design and coordination of policies could highlight as priorities for the five or six economic clusters that are most essential for the technological and socio-economic development of Estonia (e.g. the timber

and forestry cluster or, the IT and electronics cluster etc. which in terms of value chains, in the aggregate cover the bulk of the economy).¹⁵

In practice this means the establishment of permanent working groups of the private and public sectors, the tasks of which would include the production of regular overviews of the possible future developments, current problems and alternative solutions thereof in specific industries. These working groups would need to participate in the coordination, design and evaluation of industrial, educational, science and innovation policies. In the current institutional structure of Estonia, such working groups could logically operate within the field of administration of the Prime Minister and the Research and Development Council.¹⁶

The primary practical output of the working groups could consist of the development and subsequent evaluation and continuous modernization of the technology programmes that are essential for the development of the clusters in question. The programmes to be created could range from new curricula to schemes aiming at involving foreign affiliates and their parent companies, thus creating:

- new industries where Estonia possesses strong R&D potential in the EU context;
- R&D activities that are connected with real economic activities;
- R&D activities that are interdisciplinary; and

¹⁵ As a final outcome, it would be logical to launch national R&D programmes in the fields of administration and by way of cooperation between relevant ministries so as to support the implementation of the relevant industry-level development strategies.

¹⁶ Since the Estonian economy has been rather closely integrated with the Baltic Sea region, that system should also engage the foreign affiliates of TNCs from other Baltic and Northern European countries operating in Estonia.

- R&D activities that are based on cooperation between local and, if necessary, foreign centres of excellence.

b. Horizontal measures

In addition to the commissioning of cluster programmes, Estonia could concentrate on the following four lines of action:

- attracting talented people to work in Estonia and creating an attractive environment for them;
- supporting the transfer of knowledge and technology from foreign affiliates to domestic manufacturing and service industries;
- supporting TNCs and their local affiliates in the fields of R&D and innovation, including reciprocal opening of R&D programmes in the Baltic Sea region and beyond;
- enhancing the capability of companies to apply knowledge created abroad and the capability of scientific research establishments to create new (exportable) knowledge, including training and advanced training; basic research necessary for being current with global scientific and technological developments and, ensuring the required level of the education system.

4. Conclusion

Globalization provides ample opportunities for a more efficient international division of labour, thus contributing to a rise in living standards. The benefits of opening up markets depends on the policy measures implemented in individual countries in response to the strong pressures created by globalization to change existing specializations. There is a role for the State to play in creating positive externalities that would allow domestic enterprises move gradually to more knowledge-intensive, higher value-added activities. Labour, education and innovation policies, focused on some key technologies and

supported by industrial policies, can potentially allow for structural changes in the economy, increase innovative capacities of the industry and, finally raise living standards.

References

- van Beers C (2003). "The role of foreign direct investment on small countries' competitive and technological position". Government Institute of Economic Research, Helsinki. Mimeo.
- Bhattacharya A, Bradtke T, Hemerling J, Lebreton J, Mosquet X, Rupf I, Sirkin HL and Young D (2004). "Capturing global advantage". Boston Consulting Group, Boston, MA. Mimeo.
- Buffet W (2003). "Dividend voodoo", *The Washington Post* 20 May: A 19. <http://www.washingtonpost.com/ac2/wp-dyn/A13113-2003May19?language=printer>.
- Bush V (1945). *Science The Endless Frontier. A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945*. Washington, D.C.: United States Government Printing Office.
- Damijan JP, Knell M, Majcen B and Rojec M (2003). "Technology transfer through FDI in top-10 transition countries: How important are direct effects, horizontal and vertical spillovers?" *Working Paper* 17, Institute of Economic Research, Ljubljana.
- Estonian State Audit Office (2003). "The activity of the state in channelling funds for supporting entrepreneurship". *Audit Report No. 2-5/03/95*, Estonian State Audit Office, Tallinn. Mimeo.
- Estonian State Audit Office (2004). "Results of product development projects supported by Enterprise Estonia". *Audit Report No. 2-5/04/109*, Estonian State Audit Office, Tallinn. Mimeo.
- Freeman C (2002). "Continental, national and sub-national innovation systems – complementarity and economic growth", *Research Policy* 31: 191-211.
- van Grunsven L and van Egeraat C (1999). "Achievements of the industrial 'high-road' and clustering strategies in Singapore and their relevance to European peripheral economies", *European Planning Studies* 7(2): 145-173.

- Havlik P, Landesmann M, Römisch R, Stehrer R and Gillsäter B (2002). "Competitiveness of industry in CEE candidate countries". Composite Paper, European Commission DG Enterprise, Brussels.
- Johansen H (2000). "Nordic investments in the former Soviet Baltic frontier: a survey of firms and selected case studies", *Geografiska Annaler, Human Geography* 82(4): 207-219.
- Jürgenson A, Kalvet T, Kattel R, (2005). *Business Support Measures in the Budget Strategy for 2007-2013*, Policy Analysis No 9, Tallinn: PRAXIS Center for Policy Studies, available at www.praxis.ee/innopubl/.
- Kalvet T (2004). "The Estonian ICT manufacturing and software industry: current state and future outlook". Seville: Institute for Prospective Technological Studies–Directorate General Joint Research Centre, European Commission. *Technical Report* EUR 21193 EN, available at: <http://www.jrc.es/home/publications/publication.cfm?pub=1200>.
- Kauhanen AL and Lyytinen J (2003). "Best before 01 01 2015. Future Makers - Finland 2015: Finnish Success Factors and Challenges for the Future". Final report on the Finland 2015 programme 7. Helsinki: Finnish National Fund for Research and Development.
- Kurik S, Lumiste R, Terk E and Heinlo A (2002). "Innovation in Estonian enterprises 1998-2000". *Innovation Studies* 2/2002, Foundation Enterprise Estonia, Tallinn.
- Männik K (2001). "The role of foreign direct investments in technology transfer to Estonia". In Varblane U, ed., *Foreign Direct Investments in Estonian Economy*. Tartu: Tartu University Press.
- Nature (2004). "Enlightened enlargement", *Nature* 428 (6986) (29 April): 877.
- Nedeva M and Georghiou L (2003). "Assessment of the Estonian research development technology and innovation funding system". PREST, The Victoria University of Manchester, available at <http://www.riigikantselei.ee/failid/PRESTreport.doc>.
- Nurkse R (1953). *Problems of Capital Formation in Underdeveloped Countries*. Oxford and New York: Oxford University Press.

- OECD (2001). *Innovative Clusters: Drivers of National Innovation Systems*. Paris: Organisation for Economic Co-operation and Development.
- _____ (2004). *OECD Science and Innovation Policy: Key Challenges and Opportunities*. Paris: Organisation for Economic Co-operation and Development.
- Perez C (2002). *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Cheltenham and Northampton, MA: Edward Elgar.
- Porter ME (1990). *The Competitive Advantage of Nations*. London: Macmillan.
- Ricardo D ([1817] 1821). *The Principles of Political Economy and Taxation*. London: John Murray.
- Reinert ES and Kattel R (2004). “The qualitative shift in European integration: towards permanent wage pressures and a ‘Latin Americanisation’ of Europe?” *PRAXIS Working Paper 17*, available at: http://www.praxis.ee/data/WP_17_20043.pdf.
- Rodrigues MJ, ed. (2002). *The New Knowledge Economy in Europe: A Strategy for International Competitiveness and Social Cohesion*. Cheltenham and Northampton, MA: Edward Elgar.
- Romer PM (1986). “Increasing returns and long-run growth”, *Journal of Political Economy* 94: 1002-1037.
- RTI (2001). *Knowledge-based Estonia: Estonian Research and Development Strategy 2002–2006*. Tallinn: Ministry of Education and Research.
- Smith A ([1776] 1991). *The Wealth of Nations, vols. I, VIII*. London: Campbell.
- Stephan J (2003). “Evolving structural patterns in the enlarging European division of labour: sectoral and branch specialisation and the potentials for closing the productivity gap”. *Sonderheft 5/2003*, Institut für Wirtschaftsforschung, Halle.
- Tiits M, Kattel R and Kalvet T (2005). *Made in Estonia: The Wealth of the Nation*. Tartu: Institute of Baltic Studies, available at: <http://www.ibs.ee/MiE/>.

- _____ and Kaarli R (2003).
Competitiveness and Future Outlooks of the Estonian Economy.
Tallinn: State Chancellery.
- Watkins A and Agapitova N (2004). “Creating a 21st century national innovation system for a 21st century Latvian economy”. *World Bank Policy Research Working Paper* 3457.
- Young AA (1928). “Increasing returns and economic progress”, *The Economic Journal* 38: 527-542.

Article II

Marek Tiits. 2007. "Technology-Intensive FDI and Economic Development in a Small Country: The Case of Estonia." *Trames: Journal of the Humanities and Social Sciences* 11 (61/56)(3), 324-342.

TECHNOLOGY-INTENSIVE FDI AND ECONOMIC DEVELOPMENT IN A SMALL COUNTRY – THE CASE OF ESTONIA

Marek Tiits

University of Tartu and the Institute of Baltic Studies

Abstract. This article reviews the role of foreign direct investment in industrialisation of various catching-up economies and draws based on this lessons for policy-making in small countries. The author states that the introduction of proactive foreign investment strategy is one of the most effective means in a small country to rapidly increase the knowledge intensity of the economy. However, the Estonian innovation policy, similarly to most of the EU new member states, has underestimated the power and role of such proactive strategies. The author calls for much better focusing of the activities of foreign investment agencies and closer co-ordination of FDI strategies with education, research, employment and other policies.

Keywords: foreign direct investment, R&D and innovation policy, economic development strategy, small countries, Estonia

1. Introduction

After WW II, most developing countries were if not directly hostile then at least very cautious of foreign direct investments.¹ With the emergence of dependency theory in the 1950s, a large share of investments of multinational corporations (MNC) in the economy was seen as a threat to the host economy. The concerns were foremost related to the excessive influence of multinational corporations in the politics and economy of the country of location. Foreign investments were therefore often considered a modern form of economic colonialism and exploitation (Singer 1950, Prebisch 1959).

¹ Foreign direct investments are usually defined as acquisition of a shareholding of a company by foreign investors that unlike portfolio investments, is accompanied by the right to participate in the management of the company or control over the management of the company. See also: IMF 1977:136 and Graham and Krugman 1993:13–33.

With the strengthening of globalisation trends from the mid-1980s, the attitude towards foreign investments became almost all over the world considerably milder. Most analysts are now quite optimistic about foreign direct investments and believe that in addition to the financial resources necessary for economic development, foreign investments bring about a number of additional benefits, for example, transfer of modern management skills, knowledge and technologies, knowledge of international markets, modern accounting and auditing standards, etc., thus supporting the economic development of the host economy (Porter 1990).

The success stories of Ireland and Singapore in attracting foreign investments and the economic growth arising from it are often quoted as examples, which prove the positive effects of the inflow of export-oriented foreign investments on the development of the target country (Barry 2002, Lall 2000, Finegold et al 2004). Malaysia, where the multinational corporations' share in export amounts to approx. 75%, is at the same time a modern example of a country where the question of a possibility of an independent economic policy in the globalised world has recently proved extremely relevant (ADO 2004:224–227, Malairaja and Zawdie 2004).

Historically, the fear of foreign investments is not only typical of the developing countries. For example, the United States were really afraid of the fate of their national industry during the invasion of Japanese companies in car manufacturing and microelectronics at the end of the 1980s. Modern expressions of similar developments include Chinese investments in Germany and elsewhere in the Western Europe and takeover of their low-tech and mid-tech companies (Ewing and Roberts 2005).

Thus historic experience demonstrates that foreign investments may play either a negative or a very positive role in economic development, and the ability of the host country to benefit from the presence of multinational corporations through an increase in productivity is often a great challenge. The impact of direct investments on the host country depends largely on the public policy implemented by the country under discussion. After all, it is public policy that makes political borders important in global economy (Nurkse 1953).

The aim of this article is to review the role of foreign direct investment in industrialisation of various catching-up economies and to draw based on this lessons for policy-making in small countries.

2. Technological development and global relocation of economic activities

David Ricardo's theory of comparative advantage, which attributes the differences in productivity to the economic environment, i.e. differences in the availability of land, labour force, natural resources, capital, etc., is nowadays one of the most widespread ways of describing international trade. According to this theory, it is the different productivity in producing certain goods that forms a basis for different specialisation of various economies and thus, for international trade (Ricardo 1817).

In the middle of the 20th century economists became increasingly interested in cross-country comparative research, which attempted to understand the most important factors that influence economic development. When studying the sources of economic growth experienced in the U.S., Robert Solow noticed that more than half of the actual growth had arisen from 'other reasons,' outside the standard explanations offered by classical economic theory, i.e. outside the contributions of the growth of labour force and capital investment. The component remaining outside the explanatory strength of the classical economic theory was *technological development* (Solow 1957, Abramovitz 1956).

In other words, the difference in the productivity of the labour force and economy of rich and poor countries and thus in the living standards arises from the different knowledge and technology intensities of various economies. Economic development does not only depend on static comparative advantages described by Ricardo. Systematic investments into dynamic, knowledge and technology-based competitive advantages are of equal importance. Modern economic thought therefore sees the need for coordinated public and private sector investments in shaping such an economic environment, which would encourage industry to obtain in a certain area as large a global market share as possible, relying on the high knowledge-intensity and quality of its products (or services) (Porter 1990, OECD 1999, Lundvall et al. 2002, Freeman 2002, Cooke 1992, Malerba 2002).

The factors contributing to long-term economic development highlighted by various modern economic theories, such as a stable economic environment, well-functioning public service, social capital, investments in education, private sector's technological efforts, etc., are quite similar. Yet, catching up with rich countries in living standards is still quite complicated and, historically speaking, an exception rather than the rule (Gerschenkron 1962 and Abramovitz 1986).

From the 15th to 18th century the Netherlands were the most rapidly developing country in Europe, largely thanks to the trade developed in Northern Europe and successful introduction of hydraulics in agriculture. During the 17th and 18th centuries the Netherlands became the wealthiest country in the world. The Dutch economy was extremely specialised: while most of the food reserves were imported and wars were fought with the help of mercenaries, the population in cities concentrated on highly productive economic sectors.

The industrial revolution arriving at the end of the 18th century allowed England to overtake the Netherlands in terms of GDP per capital, but did not bring about a simultaneous economic development leap throughout Europe. When many countries tried to create their 'own Manchester' by copying foreign success, Western Europe industrialised gradually and unevenly. New technology and new ways of organising work spread first at the beginning of the 19th century to neighbouring countries (the Netherlands, Belgium, etc.) and from there to Prussia, Austria, etc. In modernising the infrastructure, banks established by foreign investors in *catching-up* countries played a crucial role by starting to invest in the development of railways, etc.

Among others also Sweden, where in 1870 the living standard was less than a half of that of England and $\frac{3}{4}$ of the population subsisted on agriculture, witnessed

rapid economic growth based on the growth of exports and technological development in the last decades of the century (de Vylder 1996).

In spite of rapid globalisation, which occurred in the 19th century owing to rapid development of the shipping trade and railway network, Switzerland as well as most Central and Eastern European countries and Russia remained primarily agricultural countries, which were relatively little touched by industrialisation (Maddison 2001, Pollard 1973, Berend 1998, Owen 1985, Mandelbaum 1945).

However, the United States, relying on its enormous internal market and being the first true consumer society, managed to catch up by the end of the 19th century in technological capability with Europe and even take over the global leadership (Nelson and Wright 1992).

In the second half of the 20th century, the flying geese metaphor was taken into use to explain the rapid development observed in Japan and thereafter in a number of countries in Southeast Asia. According to the metaphor, dynamic economic development in a developed country and gradual transfer of economic activities to the neighbouring countries promotes the economic development of the latter as well (Akamatsu 1935, Kojima 2000, Damijan and Rojec 2004).

Thus, long-term economic development takes place in waves, whereas the transfer of economic activities largely depends on the global spread of knowledge and technologies. Over time, market competition relying on dynamic knowledge-based comparative advantages in developed industries will be replaced by static, cost-based and resource-based comparative advantages described by Ricardo. Hence, upon the disappearance of relative cost advantages economic activities which require lower knowledge and technological intensity must be abandoned for preserving and increasing the living standard (Vernon 1966 and Wells 1972, Pérez 2002). (Figure 1)

Knowledge and skills that are important for the emergence of new industries are usually available in several places around the world. The fact that during the industrial revolution England was not the world's leading country in terms of research indicates that a country's socio-economic development does not depend only on technological development and the supply side of the economy, but just as much on the development of the demand side of the economy.

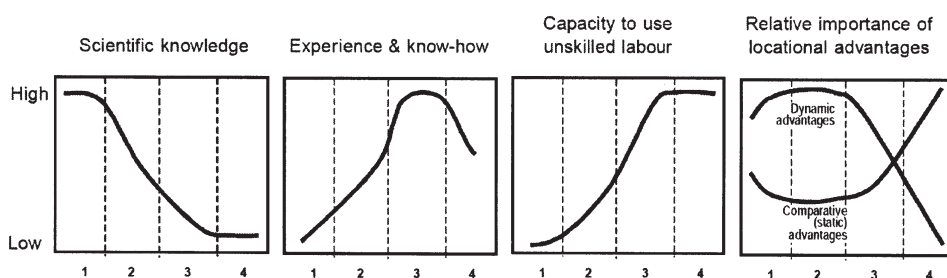


Figure 1. Changing entry requirements as technologies evolve to maturity.

Source: Pérez 2001:112.

Although technology and capital play an important role in socio-economic development, it is the entire institutional environment of the country that makes the difference. New industries emerge in countries where the technological capacity, market demand, market rules, social attitudes, etc., are the most favourable.

3. Small countries in global production networks²

The production networks of the global economy are not only international, but also rather concentrated. 30–40% of the global trade takes place within multinational corporations, i.e. either between headquarters and affiliates or between different affiliates of MNCs. Such internalised trade accounts for the most knowledge-intensive and dynamic part of international production where international firms place their R&D activities and various phases of production in different countries according to the advantages of specific locations (Lall 2002:49).

Multinational corporations gain their economic power largely from their ability to control resources which are of crucial importance in terms of further development of products and production processes, the ability to coordinate business operations and the transfer of knowledge and technologies between different parts of the network. While higher tier suppliers are in such a network responsible for co-ordination of smaller sub-networks, the low-end sub-contractors compete predominantly with the (low) cost, delivery speed and flexibility. The suppliers who rely solely on the cost advantage are typically used for pushing down the market price or are used as a reserve required for achieving a sufficient production capacity, which may be abandoned upon the change of economic environment very rapidly.

In developing the knowledge-based economy, most small countries are, in comparison with larger countries under dual pressure. On the one hand, limited resources and the increasing complexity of new technologies prevent small countries from developing an R&D infrastructure of sufficient strength. At the same time, due to smaller-scale production and relatively higher concurrent transaction costs smaller countries have difficulties in competing in low-tech and mid-tech segments of the world market which are increasingly dominated by Asian tigers' with their scale and cost advantages, and relative technological strength. In small countries, this forces industries of an otherwise similar level of development to find export opportunities and/or establish production bases abroad relatively earlier in comparison with larger countries. Relatively low share of global R&D and pressure for rapid internationalisation of domestic companies should not therefore be considered a weakness of the national innovation system, but a logical result of being small (van Beers 2003, Walsh 1987).

² There is no common definition of a small country. In different approaches the size of countries is compared based on the population, territory, GDP and other indicators. See also: Brigunglio 1998.

Approx. 90% of all R&D investments in the world is made in OECD countries. However, R&D investments are rather concentrated even within OECD countries. 90% of global private sector R&D takes place in seven countries, incl. 40% in the United States. The R&D investments are also extremely concentrated by companies: the investments of 700 larger multinational corporations constitute the bulk of all private sector R&D investments worldwide (Lall 2002:49). (Table 1)

Table 1. Private sector investments in R&D, 2004

	700 large corporations	US	Europe	Rest of the world
No. of corporations	700	306 (USA = 294)	215	179 (Japan = 154)
R&D investments (bln £)	204.6	80.8	73.4	50.3

	Europe	Germany	France	United Kingdom	Switzerland
No. of corporations	215	54	36	41	20
R&D investments (bln £)	73.4	25.8	13.3	10.6	6.8

Source: DTI 2004.

Next to Germany, France and the United Kingdom smaller European countries such as the Netherlands and Switzerland are the location of headquarters of various multinational corporations. However, the highest number of headquarters of multinational corporations per capita is in Sweden. Likewise, the Finnish quick recovery from the economic crisis at the beginning of the 1990s and its success in the field of information and communications technologies is largely attributable to the success of a single company – Nokia – in international markets. At that, Nokia's investments in R&D have amounted over recent years to approx. 1% of the Finnish GDP.

For smaller European countries such as the Netherlands, Sweden or Finland it is thus one of the main economic policy choices whether to continue supporting the strategy of their multinational corporations, etc., or risk seeing them move elsewhere.

The rapid internationalisation of production and R&D, which has taken place over the last decades, has been primarily driven by the desire of MNCs to gain access to new markets and/or technologies. Usually, small countries find it quite difficult to attract technologically oriented foreign investments, because it requires the existence of a high-level research and technological infrastructure (i.e. science, higher education, science parks, etc.) in the country. From the point of view of integration of the innovation and foreign investment strategy, small countries should take more interest in companies whose expansion decisions are led by the desire to gain access to new markets as well as companies with a global strategy (von Zedtwitz and Gassmann 2002:576). (Figure 2)

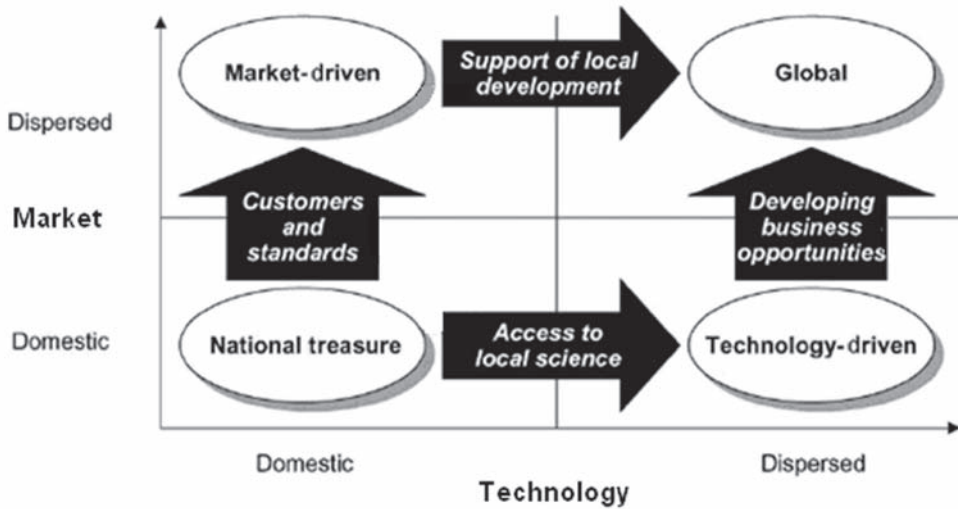


Figure 2. Main factors in internationalisation of technology-intensive businesses.
Source: Adapted from von Zedtwitz and Gassmann 2002.

Small countries are inevitably forced to acquire most of the new technologies from larger and technologically more advanced countries. It is therefore not that important for a small country to be in the absolute forefront of emerging radically new industries. It is far more important to ensure that they are able to host certain parts of the global production and that the respective international businesses are surrounded by a broad cluster of domestic supporting activities of the highest possible knowledge and technology intensity. Nonetheless, constant upgrading should take place not only in high-tech activities, but also in traditional industries.

Thus, for a small country one of the main issues of the economic development strategy is how to identify potentially rapidly growing new markets and companies taking positions there, providing thereafter the respective fast growing companies with an environment which is suitable for expansion, incl. access to new or bigger market, qualified labour, strong domestic suppliers and service providers, etc.

4. Estonia's attractiveness as a foreign investment destination

In spite of the rapid growth of the volume of foreign direct investments attracted by developing countries (on average USD 37 bln 1989–1991 versus USD 223 bln 1999–2001) these flows are extremely concentrated. In recent years, the 10 countries that have attracted most investments have received 80%, and 25 countries that have attracted most investments have received 90% of the entire foreign investment flows through 1999–2001 (Lall 2002:70–71). More recently, in 2004 and 2005, we have witnessed after the decline in 2002–2003 once again

strong increase of global FDI flows fuelled by an upsurge of cross-border mergers and acquisitions between developed countries, and emerging markets boom driven by relatively low interest rates in developed countries (UNCTAD 2006).

Deep integration into global production networks, which reaches beyond trade relations, still covers a relatively limited number of countries in spite of the liberalisation of financial markets and considerable reduction of trade barriers. In addition to many rapidly developing Asian countries (e.g. South Korea, Taiwan, Singapore, China, Malaysia, Thailand, India) this applies first and foremost to the border regions of Europe (e.g. Ireland, EU new member states, Russia), Brazil, Mexico and Argentina in Latin America and a few other places around the globe (Ernst and Kim 2002).

Previous direct investments in the 10 new member states who joined the European Union in May 2004 have been concentrated as well. As of 2005 in absolute terms nearly 80% of the direct investments made in the region had been made in the Czech Republic, Hungary and Poland. The foreign direct investments attracted by the Baltic states are in *per capita* terms rather high, but in absolute terms relatively modest, amounting to approx. 9% of the foreign direct investments made in the region (FDI 2007).

The new member states do not differ only in terms of the current FDI stock, but also in the sectoral division of investments, technology-intensity, geographical location, ownership relations and investment management. In Central European countries which have attracted the largest investment in absolute figures, one of the main target sectors has been industry. Until recently, the service sector has dominated in FDI flows to the Baltic states and Cyprus (Eurostat 2005, Galego et al. 2004:76, Hunya 2004a).

At the end of 2006 real estate, rental and commercial activities held the most important position among foreign direct investments made to Estonia with 30%, followed by financial intermediation with 28%, manufacturing industry with 18% and wholesale and retail trade with 10%. Similarly, Estonia's outward foreign direct investments were dominated by financial intermediation with 38%, real estate, rental and business operations with 32%, transportation, warehousing and communications with 10%, whereas the share of the manufacturing industry was only 4%. (BOE 2007)

In the manufacturing industry in Estonia the following fields have received the most foreign direct investments: wood and food processing (22%); food and beverages (19%); non-metallic mineral products (11%); pulp, paper and paper products; publishing and printing (10%), electrical and optical equipment (9%) (Tiits 2007:15).

Investments originating from other countries of the Baltic Sea region account for 77% of Estonia's inward FDI position. Both in Estonia as well as in Finland one of the main investors is Sweden. The Swedish investments account for approximately ½ of Estonia's inward FDI position. (Table 2)

Table 2. FDI positions between countries of the Baltic Sea region, 2004 or the most recent year available

	FDI destination								
	EE	LV	LT	PL	SE	DE	FI	DK	RU
Estonia	***	8%	8%						
Latvia	1%	***	2%						
Lithuania		1%	***						
Poland			1%	***					
Sweden	46%	11%	15%	5%	***	2%	54%	20%	
Germany	2%	15%	11%	13%	6%	***	5%	4%	11%
Finland	24%	8%	8%	1%	16%	2%	***	2%	
Denmark	2%	8%	15%	3%	3%	1%	4%	***	
Russia	2%	7%	8%	1%			1%		***
Total	77%	59%	68%	21%	26%	5%	64%	27%	11%

Source: BRE 2005.

In the early 1990s privatisation was in Estonia one of the primary drivers of the inflow of FDIs and one of the most important sources of foreign exchange income, but over time market-seeking and Estonia's relatively less expensive production inputs (labour, energy, etc.) have become some of the main investment arguments (Varblane et al. 2003, Varblane 2001, Johansen 2000).

Between 1997 and 2001 approx 2/3 of the foreign companies which invested in Estonia were primarily interested in access to Estonian and other Baltic markets, another 1/5 of foreign investment companies were interested in optimisation of costs. More recently, takeovers of foreign takeovers of domestic banks and indigenous industry, and relocation of production from Nordic countries have dominated the foreign domestic investment to Estonia and other Baltic states (Tiits 2007, Tiits 2006).

It is typically expected by the economists and policy-makers that the initial current account deficit which appears after liberalisation of markets due to the influx of foreign capital is covered with the increase of exports. In Central and Eastern Europe inward FDI has definitely played a significant role in balancing the trade and current account deficits, which remain nonetheless dangerously high. The economic standstill and low interest rates in developed countries have, however, produced a stock exchange and real estate boom, which together with exorbitant domestic consumption have become one of the main destabilising factors in the region (Economist 2005, Tiits 2005).

5. International dimension of Estonian innovation policy

Domestic and foreign investors active in Estonia both agree that one of the major problems of the Estonian economic environment is the lack of qualified labour and weak vocational education, in-service training and retaining system

(Tiits 2007). This is by no means a uniquely Estonian problem. According to multinational companies, Central and Eastern European countries have been in general relatively incapable of providing local input suitable for international production networks. In the short-term perspective this is reflected mainly in the difference of productivity, export, wages and other indicators between foreign and domestic capital-based companies, in the inability of entrepreneurs to move to new fields of endeavour that would render a higher value added as well as in the high unemployment (of young people), etc. However, the less foreign investment enterprises depend on local inputs (besides cheap labour, etc.), the more mobile and ready to leave the country they will be if the economic climate would worsen (Dyker 2004).

The comparison of the recent experiences of Asian ‘new tigers’ such as Malaysia and the Philippines with slightly earlier developments both in East Asia as well as in Central and Eastern Europe, and Latin America shows that the inflow of foreign investments into (nominally) high-tech sectors may very well take place without any special strategy, simply as a result of good luck. Nevertheless, the rapid increase of the importance of local input has been in the Southeast Asian successful ‘tiger economies’ primarily the result of very strong and selective public policy (Lall 2000). This requires efficient coordination of the government policy as well as an active role of the state in developing the qualifications that are of importance for the future. The modern innovation policy is therefore primarily a horizontal policy, which should function as an interface between different sub-policies (education, research, competition, enterprise, employment, regional development, environmental and other policies) (OECD 2005 and EC 2002).

The development of the domestic supporting industries, which would be able to offer bigger foreign investment enterprises sufficiently high quality services, is always quite a challenge for small countries. Since not all international markets are alike and the development of domestic capacity is time-consuming, the activities of foreign investment agencies are increasingly characterised by greater focusing of their activities. Thereby, it is one of the main issues of the economic development strategy both in Estonia as well as elsewhere in catching-up economies to see which unique competitive advantages are available and how new ones could be created – in other words, what could be the future international specialisation of the given economy. There are no analytically neutral ‘correct answers’ to this type of questions.

The skills development decisions, and thereby decisions about possible future specialisation of an economy depend largely on the existence of a comprehensive shared vision of a country’s future. Even though it is clear from economic theory that it is more beneficial to specialise in rapidly growing high productivity industries, making these choices assumes very high risks and is thus closely related to the value judgements and legitimacy of the public policy decisions in general.

6.1. Relocation of economic activities in Europe

Which are the fastest growing markets in today's world? Although the service sector accounts for approx. 75% of the GDP of developed countries, the share of services in international trade remains relatively modest. Manufactured goods account for approx. 80% of the world's import-export volumes. The exports of high-tech products have been most rapidly growing part of the trade of manufactures through 1985–2000. In 1985 modern high-tech products amounted to approx. 12% of the world's export volumes, but by 2000 the respective figure had risen to 23%. The share of information and communication technologies (ICT) grew at the same time from 5% to 14% (WTO 2004 and Lall 2002:56–57).

Now that North American and European markets have gone through the first the most rapid growth phase of introducing information technology, the emerging markets in Asia and elsewhere continue to witness a relatively rapid growth. The increasing capital-intensity and price competition forces the industry to consolidate and look for new lower cost production locations near Asian rapidly growing markets and elsewhere (Economist 2004, Kelly et al 2004, Hemerling et al 2003, Jin 2004).

The on-going global relocation of economic activities does not concern only ICTs, but is a much broader process. Various West European companies have relocated parts of their production to Central and Eastern Europe and are expanding rapidly their activities in developing Asian markets. Equally, the U.S. ICT and pharmaceutical companies are about to move a considerable portion of their operations from Ireland to China and elsewhere, etc (Forfas 2005).

Since the Western European economies are dominated by capital-intensive mid-tech industries such as chemical industry, machinery or car manufacturing where cost cutting and maximising the economies of scale has become increasingly important, relocation of these economic activities from Western Europe is likely to continue. Along these lines the recent UNCTAD expert survey and the analysis of the *Boston Consulting Group* highlight business and ICT services, education and medical services as the likely main FDI target sectors for Central and Eastern Europe in the coming years. In manufacturing, continued relocation of electronics manufacturing, metal processing, car manufacturing and machine engineering related activities is foreseen (GIPA 2004:37, Waddell 2005).

In this context specialisation in servicing Western Europe is clearly one of the most obvious strategic choices for Central and Eastern European countries. However, Central and Eastern Europe is by far not a homogenous region and the geographical locations of individual countries play quite an important role in the actual development of FDI flows. While German investors are relatively active throughout Europe, smaller European countries tend to turn their eyes mainly to investment opportunities in neighbouring countries. Austrian investors account for quite a large share of the FDI position of Slovakia and Slovenia, Sweden has been quite active in the Baltic Sea countries, Finland has been more active in Estonia and in North-western Russia, etc.

Over the last dozen years the Estonian economy has been integrated very closely with the Nordic countries and become a part of the cross-border economic clusters in the Baltic Sea region (banking and insurance, electronics and telecommunications, wood and wood products, metal, machinery and means of transport, etc.). Estonia has thereby become quite dependent on the developments in Scandinavia, including the respective location decisions affecting the Baltic states and Poland (Tiits 2007).

Expansion of Estonia's export markets beyond the Nordic countries to Western Europe has so far not worked out very well, and the early 1990s vision of Estonia as the Hong Kong style 'gateway to Russia' has failed to materialise as well. The continuing dependence on the Nordic countries is likely to give Estonia in the short-term and mid-term perspective quite a straightforward opportunity for creating and sustaining high employment levels in the export sector. The main risks of such a development scenario for Estonia derive from possible excessive focussing on the Nordic countries as its main business partners and export markets.

5.2. Europe in global economic competition

The economic success of Ireland in the 1990s can be largely attributed to the investments of U.S. information and communication technology and pharmaceutical companies for establishing a production base oriented to the European single market. Ireland, which had suffered a long economic crisis, mainly hoped to create new jobs when it made the U-turn in the economic policy and offered a production base for foreign investors.

Similarly to the US companies' investments in Ireland, Russian investments in Europe have been largely motivated by the desire to increase the profit earned on goods sold in the European market. However, larger Russian internationalising companies are not high-tech, but export natural resources (oil, gas, metal, etc.). The large and increasing share of the export of natural resources in Russian export raises the issue of preventing the classical 'Dutch disease' in the event of a fall in the prices of oil and other commodities in the world market (AFP 2004).

The opportunities beyond Estonia's immediate neighbourhood look much more promising. According to UNCTAD, in the coming years the US will remain the largest foreign investor in the world, followed by the United Kingdom, Germany and China. It is quite remarkable that in addition to China, the top 15 investors include a number of developing countries such as the Republic of South Africa, India, Brazil, Malaysia and South Korea. Some of these countries are important predominantly due to their direct neighbours, but in general the international companies of the developing countries are becoming increasingly important global players (UNCTAD 2005, UNCTAD 2006).

The Asian companies, which started out in the global division of labour with simple assembly work and thereafter gradually assumed more product design related responsibilities, are now overtaking North American and West European

well-known trademarks and, whenever possible, acquire the latest technologies controlled by the companies which had formerly conquered the Asian markets. The Chinese ‘technology for market’ policy is in this context particularly noteworthy (BBC 2004, BBC 2005, EC 2005, Lei 2007).

Learning from Ireland’s and Singapore’s success, Estonia should be foremost interested in attracting direct investments related to new emerging industries. Yet, the main complexity of such an approach lies in the fact that radically new industries are not beforehand readily identifiable in the mainstream economic statistics, market surveys, etc.

The sectoral division of worldwide corporate R&D investments shows, however, the leading role of the pharmaceutical industry and biotechnology, information and communication technology and electronics in the knowledge-based economy. Similarly to the 1970s the high prices of fossil fuels in the world market have put alternative energy technologies strongly on the agenda. Also, several countries have increased their investments in nanotechnology in recent years (Tiits et al. 2005).

Although the priorities and volumes of R&D investments offer a certain advance indication of the possible future technological breakthroughs, one should not take the world in a technological and deterministic manner. The growth in research funding and the number of publications indicates, to a certain extent, possible future breakthroughs in one or another technological field. It is, nonetheless, often quite impossible to know in which branches of the economy the new technological solutions will have the strongest economic effect. The development of research and technology inevitably results in opportunities and threats and the future is born in the mutual effect of technology, society and economic development, where people’s readiness for adoption of one or another technology plays the most crucial role.

Predicting the future dynamics of an industry is a very complicated task. The governments **must be** nonetheless aware of main development trends, challenges and the likely reactions of companies in their key industries. Not being informed about the industrial dynamics leads very easily to a significant waste of resources, e.g. in development of human resources and technological capabilities or in trying to attract FDI into industries where there is no chance of success.

Since a lot depends on the research activities of larger countries and multinational corporations, any strategy for attracting technology-intensive foreign investments will remain inevitably relatively eclectic, and eventually professional day-to-day work with potentially interesting foreign investors will end up being the most crucial success factor.

6. Summary and policy recommendations

In spite of the rapid globalisation observed over the last few decades the living standards have not risen in a number of countries around the world. Globalisation

exerts strong pressure for change, provides ample opportunities for more efficient specialisation and thus a rise of the living standards, but the realisation of new opportunities arising from the opening-up of markets depends nevertheless on the steps taken in a specific country to support the economic development.

Obviously, an economy that is losing its cost advantages can counter the increasing international competition pressure by reducing the cost of labour: for instance, through opening the market for low-paid immigrants, reducing taxes on labour force, reducing the cost of production inputs through devaluation of the currency, etc. Although such a policy may render a seemingly positive effect in the short-term perspective (e.g. through temporary preservation of employment, etc.), it does not help to increase the living standards in the country. To the contrary, it only favours continued specialisation to the low-income activities.

The objective of the *Knowledge-based Estonia* strategy (KBE 2007) to increase Estonia's R&D investments by 2014 to 3% of the GDP cannot be achieved by simply increasing the public sector appropriations for R&D investments. The nature of market competition and corporate action strategies are very different in different industries, whereas the R&D intensity of traditional industries, which are dominant in the current structure of the Estonian economy, is everywhere the world fairly low (DTI 2004). The corporate R&D investments in Estonia can be increased by several-fold only if the corporate business models and the entire structure of the economy are considerably modernised.³

Characteristically to small countries, in developing the knowledge-based economy in comparison with larger countries, Estonia is under dual pressure. The increasing market share of China, India and other rapidly developing Asian countries in low-tech and mid-tech fields and limited domestic market makes it difficult to compete in these areas. Limited resources do not allow either to invest sufficiently in R&D or development of new high-tech solutions in order to compete with multinational corporations, which dominate the most rapidly growing high-tech markets.

While Denmark is an example of a successful small country whose economic success is based on very strong design and continuous updating of low-tech and mid-tech sectors, the experience of such small countries as Ireland, Singapore, etc. indicates that in a small country with an open economy the strongest and virtually the only possibility to considerably increase the knowledge-intensity of the economy is to implement a targeted foreign investment strategy (O'Connor 2001, Shin 2005, van Grunsven and van Egeraat 1999).

³ In the 1970s Finland, which had a relatively low-tech economy, established an analogous political goal to considerably increase the level of R&D investments. disappointingly, this goal was not achieved. However, Finland of the 1990s is an example of how the success in the rapidly growing telecommunications equipment market forces Nokia to sell virtually all its earlier operations for the purpose of accumulation of resources. But the local authorities and the Finnish state keep investing. See: Lemola 2003.

6.1. Proactive strategy for attracting technology-intensive foreign investments of strategic importance for Estonia

Although the technology transfer arising from the inflow of foreign investments, introduction of new technologies and work organisation have been the main driving forces behind the economic development in Estonia and other Baltic states over the last 10–15 years, the implementation of a targeted foreign investment strategy has, unlike in Ireland and Singapore or even the Czech Republic and Hungary, been considered relatively unimportant (Hunya 2004b:106).

Estonia should start implementing a more proactive foreign investment strategy, paying special attention to attracting ICT, biotechnology and nanotechnology related investments. This should be done with regard to radically new industries (e.g. biotechnology-based pharmaceutical industry, bio- and nano-electronics, etc.) as well as through modernising the traditional areas dominant in the current Estonian economy (e.g. usage of IT or biotechnology in wood processing, food processing, textile or chemical industry, etc.).

6.2. Modernising the labour supply structure and life-long learning system

Although transportation, communications and other physical infrastructures as well as the general level of education of the population are all important from the point of view of the dynamics of the economic development and foreign investment strategy, the current analysis indicates that the most critical factor for Estonia has been its ability to provide both foreign investment enterprises and local companies with qualified labour.

Estonia has reached a development phase where the attraction of the economic environment is increasingly dependent on investments in modernising education and research, including in-service training and retraining employees and active labour market measures. But not all branches of the economy are alike and one of the main complications of this process is setting education and research financing priorities, which must take into account both local developments as well as the dynamics of global markets (Dunning 2000, Shin 2005, Tiits 2007).

In the broader context of the Baltic Sea region, establishing an international science and technology co-operation programme, which would help Estonian companies train their employees and update their technological base necessary for moving up along the global value chains, would be most welcome.

6.3. Efficient coordination of the public policy

The development of new technology-intensive markets or market competition in specific areas over the next 5–10 years cannot be predicted in great detail. Equally, structural change in an economy and development of knowledge-based economy is never the result of a single political decision, but should be rather seen as the result of continued longer term process which builds both on adequate public policy and a series of strategic choices made by various private sector actors.

The modern innovation policy should thus be seen as a horizontal policy, which must ensure stimuli and an ability of the private sector to grasp the possibilities of dynamic knowledge-based economy.

Acknowledgements

This article has been prepared in the framework of the Estonian eVikings II (2002–2005) and INDEUNIS (2005–2007) projects part-funded by the European Commission. The author expresses his gratitude to Peter Havlik, Rainer Kattel, Jaan Penjam, Tarmo Pihl, Silver Toomla and anonymous referee(s) for their help and remarks on earlier versions of this article.

Address:

Marek Tiits
Institute of Baltic Studies
Lai 30
51005 Tartu, Estonia

E-mail: marek@ibs.ee

References

- Abramovitz, Moses (1956) "Resource and output trends in the United States since 1870". *American Economic Review* 46, 5–23.
- Abramovitz, Moses (1986) "Catching up, forging ahead, and falling behind". *Journal of Economic History* 46, 2, 385–406.
- ADO (2004) *Asian development outlook 2004*, Oxford University Press.
- AFP (2004) "IMF tells Russia to focus on inflation, not growth". *Agence France Press*, 17 November.
- Akamatsu, Kaname (1935) "Waga kuni yomo kogyohin no susei". [Trend of Japanese Trade in Woolen Goods], *Shogyo Keizai Ronso* 13, 129–212.
- Barry, Frank (2002) *EU Accession and FDI flows to CEE countries: Lessons from the Irish experience*. University College Dublin.
- BBC (2004) "Chinese firm buys IBM PC business". BBC News, 8 December.
- BBC (2005) "Rover sold to Nanjing Automobile". BBC News, 23 July.
- van Beers, Cees (2003) *The role of foreign direct investment on small countries' competitive and technological position*. Government Institute of Economic Research, Helsinki, <http://extranet.vatt.fi/knogg/Reports/t100.pdf>
- Berend, Ivan T. (1998) *Decades of crisis: Central and Eastern Europe before World War II*. Berkeley, Los Angeles & London: University of California Press.
- BOE (2007) *Position of direct investments by fields of activity*. Bank of Estonia, <http://www.eestipank.info>
- BRE (2005) *Baltic Rim economies. Bimonthly review 2/2005*, 28 April.
- Briguglio, Lino Pascal (1998) Small country size and returns to scale in manufacturing *world development* 26, 3, 507–515.
- Cooke, Philip (1992) "Regional innovation systems: competitive regulation in the new Europe". *Geoforum* 23, 365–382.

- Damijan, Jože P. and Matija Rojec (2004) *Foreign direct investment and the catching-up process in new EU member states: is there a flying geese pattern?*. WIIW Research Reports 310.
- DTI (2004) The 2004 R&D scoreboard. London: Department of Trade and Industry, <http://www.dti.gov.uk>
- Dunning, John H. (2000) "The eclectic paradigm as an envelope for economic and business theories of MNE activity". *International Business Review* 9, 163–190.
- Dyker, David (2004) "Closing the productivity gap between eastern and western Europe: the role of foreign direct investment". *Science and Public Policy* 31, 3, 279–287.
- EC (2002) *Innovation tomorrow*. (Innovation Papers, 28.) Luxembourg: European Commission DG Enterprise, http://www.cordis.lu/innovation-policy/studies/gen_study7.htm
- EC (2005) "Commission clears BenQ's acquisition of Siemens mobile device business". European Commission, IP/05/1107, 8 September.
- Economist (2004) "The new jobs migration". *The Economist*, 21 February.
- Economist (2005) "The global housing boom: In come the waves". *The Economist*, 16 June.
- Einhorn, Bruce et al. (2005) "Why Taiwan matters". *BusinessWeek*, 16 May.
- Ernst, Dieter and Linsu Kim (2002) "Global production networks, knowledge diffusion, and local capability formation". *Research Policy* 31, 8–9, 1417–1429.
- Eurostat (2005) *NewCronos*. Eurostat, June.
- Ewing, Jack and Dexter Roberts (2005) "The Chinese are coming...o Germany". *Business Week*, 21 February.
- FDI (2007) UNCTAD *FDI Database*, August.
- Finegold, David et al. (2004) "Adapting a Foreign Direct Investment Strategy to the Knowledge Economy: The Case of Singapore's Emerging Biotechnology Cluster". *European Planning Studies* 12, 7.
- Forfas (2005) *International trade & investment report 2004*. Forfas, Dublin.
- Freeman, Chris (2002) "Continental, national and sub-national innovation systems: complementarity and economic growth". *Research Policy* 31, 2, 191–211.
- Galego, Aurora et al. (2004) "The CEEC as FDI attractors: a menace to the EU periphery?" *Emerging Markets Finance and Trade* 40, 5, 74–91.
- Gerschenkron, Alexander (1962) *Economic backwardness in historical perspective*. Cambridge, Massachusetts: Harvard University Press.
- GIPA (2004) *Global investment prospects assessment*. UNCTAD, <http://www.unctad.org/fdiprospects>
- Graham, Edward M. and Paul R. Krugman (1993) "The surge in foreign direct investment in the 1980s". In *Foreign direct investment*. Kenneth A. Froot, ed. Chicago: University of Chicago Press.
- van Grunsven, Leo and Chris van Egeraat (1999) "Achievements of the industrial 'high-road' and clustering strategies in Singapore and their relevance to European peripheral economies". *European Planning Studies* 7, 2.
- Hemerling, Jim et al. (2003) *Made in China*. Boston Consulting Group.
- Hunya, Gábor (2004a) "Manufacturing FDI in new EU member states – foreign penetration and location shifts between 1998 and 2002". *WIIW Research Report* 311.
- Hunya, Gábor (2004b) "DI in small countries: the Baltic states." *EIB papers* 9, 2, 92–114.
- IMF (1977) *IMF Balance of payments manual*, 4th ed. IMF.
- Jin, Zhang (2004) "China becomes global 'brain'". *China Daily*, http://www2.chinadaily.com.cn/english/doc/2004-04/13/content_322876.htm
- Johansen, Harley (2000) "Nordic investments in the former Soviet Baltic frontier: a survey of firms and selected case studies." *Geografiska Annaler. Series B Human Geography* 82, 4.
- KBE (2007) *Estonian research and development strategy 2007-2013. Knowledge-based Estonia*. RTI 22 February, 16, 78.
- Kelley, Charles et al. (2004), *High-technology manufacturing and U.S. competitiveness*. RAND Corporation.
- Kojima, Kiyoshi (2000) "The 'flying geese' model of Asian economic development: origin, theoretical foundations, and regional policy implications". *Journal of Asian Economics* 11, 375–401.

- Lall, Sanjaya (2000) *Export performance, technological upgrading and foreign direct investment strategies in the Asian newly industrializing economies. With special reference to Singapore.* (ECLAC desarrollo productivo serie, 88.) United Nations.
- Lall, Sanjaya (2002) "Linking FDI and technology development for capacity building and strategic competitiveness". *Transnational Corporations* 11, 3, 39–88.
- Lei, David (2007), "Outsourcing and China's rising economic power". *Orbis* 51, 1, 21–39.
- Lemola, Tarmo (2003) "Transformation of the Finnish science and technology policy". *Science Studies* 1, 52–67.
- Lundvall, Bengt-Ake et al. (2002) "National systems of production, innovation and competence building". *Research Policy* 31, 213–231.
- Maddison, Angus (2001) *The world economy. A millennial perspective.* Paris: OECD.
- Malairaja, Chandra and Girma Zawdie (2004) "The 'Black Box' syndrome in technology transfer and the challenge of innovation in developing countries: the case of international joint ventures in Malaysia". *International Journal of Technology Management and Sustainable Development* 3, 3, 233–251.
- Malerba, Franco (2002) Sectoral systems of innovation and production. *Research Policy* 31, 2, 247–264.
- Mandelbaum, Kurt (1945) *The industrialisation of backward areas.* Oxford: Blackwell.
- Mayhew, Alan (1998) *Recreating Europe. The European Union's policy towards central and eastern Europe.* Cambridge University Press.
- Nelson, Richard and Gavin Wright (1992) "The raise and fall of American technological leadership: the postwar era in historical perspective". *Journal of Economic Literature* 30, 1931–1964.
- Nurkse, Ragnar (1953) *Problems of capital formation in underdeveloped countries.* Oxford: Oxford University Press.
- O'Connor, Tom (2001) "Foreign direct investment and indigenous industry in Ireland: Review of evidence". *One Europe or Several? One-Europe Programme. Working Papers* 22.
- OECD (1999) *Managing national innovation systems.* Paris: OECD.
- OECD (2005) *Governance of innovation systems. Vol. 1: Synthesis Report.* Paris: OECD.
- Owen, Thomas C. (1985) "The Russian industrial society and tsarist economic policy, 1867–1905". *Journal of Economic History* 45, 3, 1985.
- Pérez, Carlota (2001) "Technological change and opportunities for development as a moving target," *CEPAL Review* 75, 109–130.
- Pérez, Carlota (2002) *Technological revolutions and financial capital: the dynamics of bubbles and golden ages.* Cheltenham - Northampton, MA: Edward Elgar Publishing.
- Porter, Michael E. (1990) *The competitive advantage of nations.* London: Macmillan.
- Prebisch, Raúl (1959) "Commercial policy in the underdeveloped countries". *American Economic Review. Papers and Proceedings* 49, 251–273.
- Ricardo, David (1817) *The principles of political economy and taxation.* London: John Murray, Albemarle-Street.
- Shin, Jang-Sup (2005) "The role of the state in increasingly globalized economy: implications for Singapore". *The Singapore Economic Review* 50, 1, 1–13.
- Singer, Hans W. (1959) "The distribution of gains between investing and borrowing countries". *American Economic Review. Papers and Proceedings* 40, 473–485.
- Solow, Robert (1957) "Technical change and the aggregate production function". *Review of Economic Studies* 39, 312–330.
- Tiits, Marek et al. (2005) *Made in Estonia.* Tartu: Institute of Baltic Studies.
- Tiits, Marek (2006) *Industrial and trade dynamics in the Baltic Sea region – the last two waves of European Union enlargement from a historic perspective.* Institute of Baltic Studies, Working Paper 1.
- Tiits, Marek, ed. (2007) *Kaupmeeste riik.* [The nation of merchants.] Tallinn: Estonian Academy of Sciences.
- UNCTAD (2005) *New UNCTAD surveys: foreign direct investment prospects promising for 2005–2008.* UNCTAD Press Release, 5 September.
- UNCTAD (2006) *World investment report 2006.* New York and Geneva: UNCTAD.

- Vernon, Raymond (1966) "International investment and international trade in the product cycle". *The Quarterly Journal of Economics* 80, 2, 190–207.
- Varblane, Urmas, ed. (2001) *Foreign direct investments in the Estonian economy*, Tartu:University of Tartu Press.
- Varblane, Urmas et al. (2003) *Mechanisms of productivity growth through inward foreign direct investment: Estonia – country report*. Faculty of Economics and Business Administration, University of Tartu.
- de Vylder, Stefan (1996) *The rise and fall of the "Swedish model"*. UNDP Occasional Paper 26, http://hdr.undp.org/docs/publications/ocational_papers/oc26a.htm
- Waddell, Kevin (2005) *The central and eastern European opportunity: creating global advantage in serving Western Europe*. Boston Consulting Group.
- Walsh, Vivien (1987) *Technology, competitiveness and the special problems of small countries*. OECD. STI Review 81–133.
- Wells, Louis (ed) (1972) *The product life cycle and international trade*. Boston: Harvard University.
- WTO (2004) *International trade statistics 2004*. World Trade Organization, http://www.wto.org/english/res_e/statis_e/its2004_e/its04_toc_e.htm
- von Zedtwitz, Maximilian and Oliver Gassmann (2002) "Market versus technology drive in R&D internationalization: four different patterns of managing research and development". *Research Policy* 31, 569–588.

Article III

Marek Tiits. 2008. "Estonia's Economic Integration into Cross-Border Production Networks of the Baltic Sea Region." In Ruslan Grinberg, Peter Havlik and Oleh Havrylyshyn (eds). *Economic Restructuring and Integration in Eastern Europe: Experiences and Policy Implications*. Baden-Baden: Nomos, 281-296.

Estonia's Economic Integration into Cross-Border Production Networks of the Baltic Sea Region

Marek Tiits

Productivity and the growth of living standards

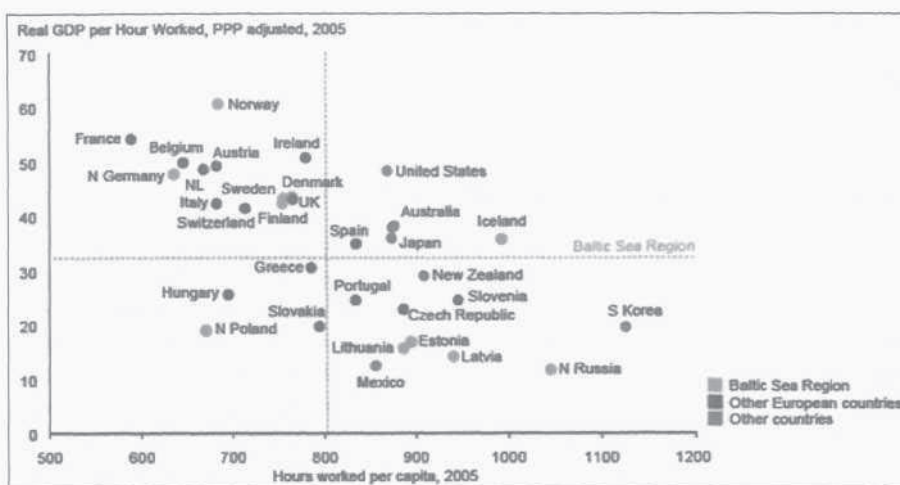
In recent years, the Estonian economy has experienced a pace of growth that far exceeds the average growth rate of Western Europe as well as that of the United States, which is generally viewed as the engine of the global economy. Rapid economic growth has, however, been accompanied by a shortage of labour and by an increase in salaries averaging 10-15% a year. Rapidly escalating salaries generate favourable conditions for Estonia to quickly catch up with the average standard of living in Europe, yet also raise a critical question - are local enterprises capable of restructuring their activities in a manner that allows them to remain profitable irrespective of the swiftly increasing costs?

Economic theory states that an increase in the standard of living and in salaries is limited by the total value added in that country. Favourable external factors may create a temporary situation where the inflow of foreign capital balances out the consumption in excess of the total value added generated in the country. However, in the long term, neither public nor private sector debt burden can grow endlessly. In the end, any increase in the standard of living and in salaries is only possible on account of rising labour productivity, usually measured as value added by a worker per hour worked. Consequently, the core issue in increasing the competitiveness of an economy is how to generate productivity growth that allows sustained increase of manufactured exports in the light of rising salaries and other costs.¹

Figure 1 reveals that although the average workload in Estonia is significantly higher than in the Nordic countries and is comparable to that in the US or Japan, the value added per hour is in the Baltic states significantly lower than in the majority of the European states. The labour costs of Estonia are not that low. The ratio of labour costs to productivity in Estonia is on the average level of the enlarged European Union and even exceeds the unit labour costs of Finland, which has by far a higher living standard. (Table 1)

¹ Bruce R. Scott (1985), *U.S. Competitiveness and the World Economy*, Harvard Business School Press; Vivien Walsh (1992), *Technology and the economy - the key relationships*, OECD, Paris; Marek Tiits et al. (2006), *Made in Estonia*, Institute of Baltic Studies, Tartu.

Figure 1: Gross domestic product per hour worked, PPP-adjusted, 2005



Source: Christian Ketels and Orjan Solvell (2006), *State of the Region Report 2006*, Baltic Development Forum.

Table 1: Share of labour costs in value added per worker in the manufacturing industry in 2000-2004

	2000	2001	2002	2003	2004
Denmark	67%	67%	68%	69%	69%
Estonia	64%	62%	62%	62%	63%
Finland	50%	52%	56%	56%	57%
Germany	76%	75%	78%	77%	75%
Latvia	51%	35%	47%	46%	49%
Lithuania	72%	65%	65%	60%	55%
Poland	48%	36%	72%	38%	35%
Sweden	66%	73%	74%	.	67%
European Union (EU-25 average)	64%	65%	67%	66%	.

Source: Eurostat, December 2006.

Since Adam Smith, economic theory is clear on the fact that specialization is one of the main sources of the increase of value added.² It is specialization that enables gaining supplementary knowledge, creation of new technologies, elaboration of new higher-quality products and services, etc. The advantages which have so far been

² Adam Smith ([1776] 1991), *The Wealth of Nations*, Campbell, Book I, VIII, London.

available to Estonia, such as relatively cheaper production inputs, are on the wane due to rapid increase of costs. To maintain their competitiveness, Estonian companies must therefore specialize more and start to compete in foreign markets with the quality of their products rather than with price.

The state can and should support such change in business models of companies through relevant public policies, because the 'no-intervention policy' on the part of the state would mean giving deliberately advantages to those countries and/or economic areas where relatively favourable conditions have been created for the development of knowledge- and technology-intensive activities. Ensuring availability of quality education and the like serve as examples of areas where the private sector alone will never invest in the volume optimal from the point of view of society development.³

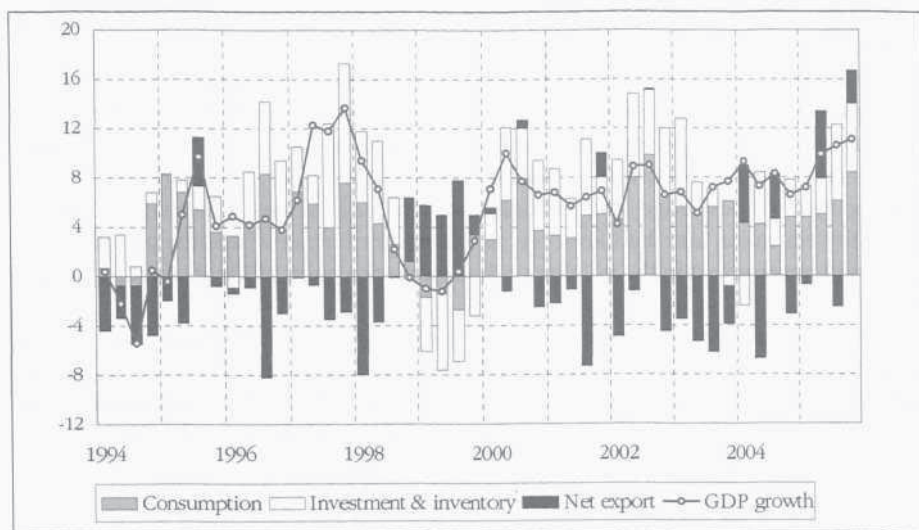
Economic activities are, however, not the same, neither in their potential for growth in productivity nor in their importance to the Estonian economy. In the following, we undertake to identify which are the most promising branches of the Estonian economy from the value added and employment point of view and what are the development needs of companies operating in these industries.

Estonia's specialization in the international division of labour

Estonian exports have steadily increased since 1990 with the sole exception of 1999, when the production and export volumes of manufacturing decreased in the backwash of economic crises in East Asia and Russia. Although the Estonian export volumes have displayed a steady rise, the excess of imports of manufactured goods over exports continues to be the predominant source of Estonian trade balance and current account deficits (Figure 2).

³ See Michael E. Porter (1990), *Competitive Advantage of Nations*, Free Press. The roots of Porter's cluster-based competitiveness theory reach back to Alfred Marshall's works on industrial districts. Rather similar approaches are also offered by a modern innovation systems theory. See e.g. Bengt-Ake Lundvall (ed.) (1992), *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*, Pinter, London; Philip Cooke, Martin Heidenreich and Hans-Joachim Braczyk (eds) (1992), *Regional Innovation Systems*, UCL Press, London; OECD (1997), *National Innovation Systems*, Paris; Franco Malerba (ed.) (2004), *Sectoral Systems of Innovation*, Cambridge University Press.

Figure 2: Contribution of domestic and foreign demand to economic growth of Estonia, % per year



Source: Statistics Estonia, 2007.

Advancement of manufacturing exports of highest possible value added is one of the most direct ways to support the economic development. Consequently, we analyse the Estonian trade and industrial dynamics of the recent years more closely.

In the 1990s, the Baltic Sea region countries became the main destination of Estonian exports (nearly two thirds of the total). The most important destination markets are Finland and Sweden, which receive nearly half of the Estonian exports (Figure 3).

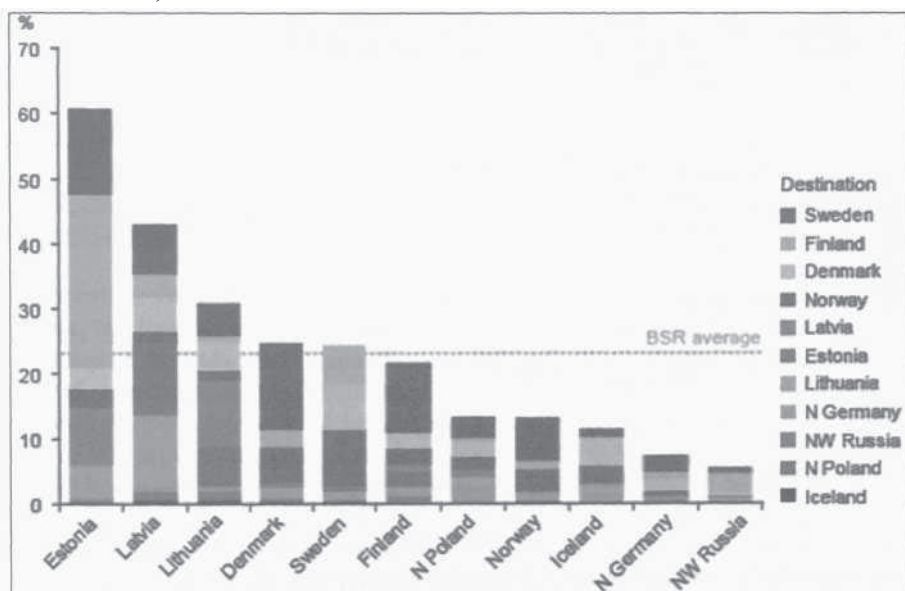
Estonian exports are very concentrated also in terms of commodity groups. The 25 biggest commodity groups (out of 228 at the 3-digit SITC disaggregation level) constitute 77% of Estonian exports to Finland, Sweden, Denmark and Germany; the higher the capital intensity of an industry, the higher is the share of intra-industry trade in the respective commodity group. These commodity groups represent the bulk of Estonian industry's imported production inputs and the bulk of its exports. (Figure 4.)

Telecommunications equipment stands apart from other commodity groups presented in Figure 4 not only by its significantly larger volume, but also by the fact that while imports and exports expressed in kilograms are essentially equal, the unit price of exported goods is more than double the unit price of the imported goods. Such a huge disparity in unit prices reveals the low competitiveness of the Estonian electronics industry in the world market, but it seems to derive from use of transfer pricing between associated companies and the possible tax optimization by international companies.⁴

4 Marek Tiits and Juhan Juriado (2006), 'Intra-industry Trade in the Baltic Sea Region', *IBS Working Paper 2/2006*, <http://www.ibs.ee>.

The economic specialization of individual Nordic countries is, given their long-standing tradition for cooperation, relatively similar. Their strong competitive position in the world markets stems often from synergy derived from a combination of competitive advantages of individual countries. The rapid growth of intra-industry trade between Nordic countries and the Baltic states and Poland in the 1990s suggests the formation of strong cross-border production networks in the Baltic Sea region. Thus, Estonian industrial production reaches the world market through its economically more advanced neighbours. It is therefore essential to take into account the development dynamics in the wider Baltic Sea region in order to understand the development dynamics of the Estonian economy of the past 10-15 years and to assess its future prospects (Figure 5).

Figure 3: Exports of the Baltic Sea region countries, by destination country, in %, 2005⁵

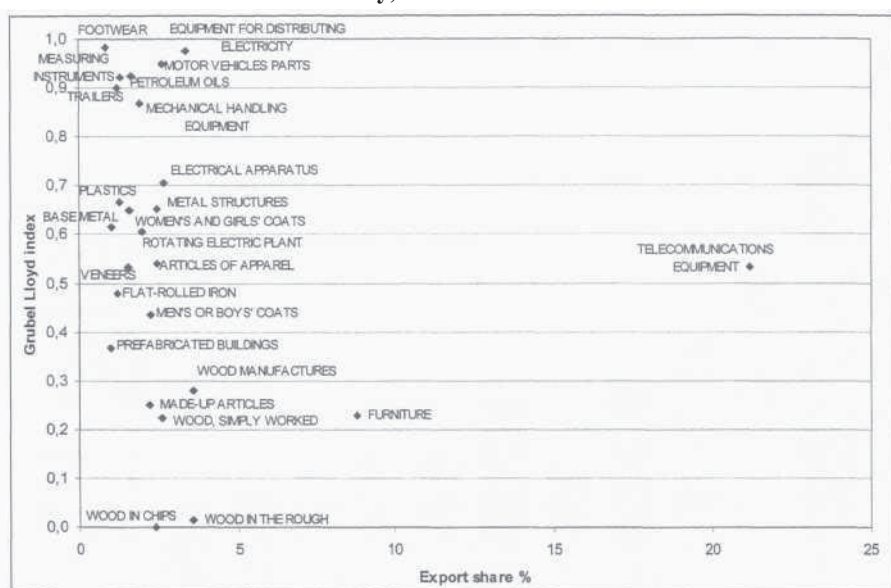


Source: Christian Ketels and Örjan Sölvell (2006), *State of the Region Report 2006*, Baltic Development Forum.

⁵ The Baltic Sea Region has been delineated, subject to availability of data and given the author's discretion, in a somewhat arbitrary way. In some cases, Norway and Iceland are considered as part of the region despite the fact that they do not border directly on the Baltic Sea. Germany and Russia are considered as belonging to the region as a whole in some cases, but only their regions directly bordering on the sea in other cases. Such differences in definitions do not, however, drastically alter the paper's main argument as regards the Estonian economy.

Germany and Sweden are the largest exporters in the Baltic Sea region. Germany's main strengths are in the automotive, aerospace and information and communication technologies. Sweden's export specialization, relative to the region's average, consists predominantly of aerospace engines, biopharmaceuticals, automotive, and forest products. The main strengths of Finland are in forest products and related equipment, telecommunication and marine equipment. Denmark's strengths are in food products, biopharmaceuticals, power generation (wind energy) and footwear. Iceland has an advantage in fishing products and energy-intensive activities such as the production of aluminium. Norway is strong in petrochemicals, fishing products and marine equipment.⁶

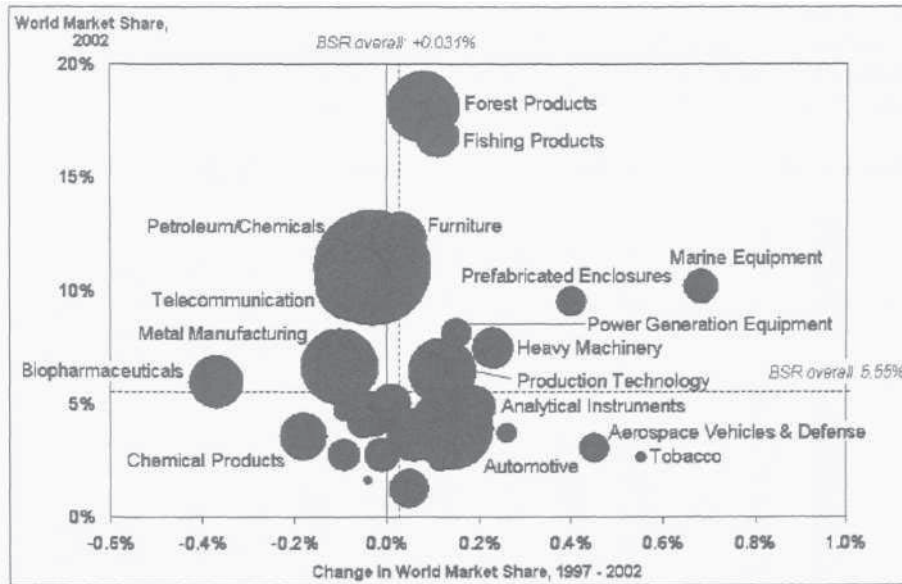
Figure 4: Intra-industry trade between Estonia and Finland, Sweden, Denmark and Germany, 2004⁷



Note: The Grubel-Lloyd index has been calculated by monetary value of goods. Source: Eurostat 2006; IBS (Institute of Baltic Studies, Tartu, Estonia) calculations.

- 6 Christian Ketels, Orjan Solvell et al. (2005), *State of the Region Report 2005: Competitiveness and Cooperation in Baltic Sea Region*, Baltic Development Forum, 44; Marek Tiits (2006), 'Industrial and trade dynamics in the Baltic Sea Region since 1990s', in Tarmo Kalvet and Rainer Kattel (eds) (2006), *Creative destruction management: Meeting the challenges of the technoeconomic paradigm shift*, PRAXIS Center for Policy Studies, Tallinn, pp. 101-118.
- 7 The Grubel-Lloyd index, the most widely used measure of intra-industry trade, is calculated $GL = 1 - |X_i - M_i| / (X_i + M_i)$, where X_i is volume of export and M_i volume of import of commodity group i . See Herbert G. Grubel and Peter J. Lloyd (1975), *Intra-industry Trade: The Theory and Measurement of International Trade in Differentiated Products*, Wiley, New York.

Figure 5: World market share of the Baltic Sea region, by commodity group



Source: Christian Ketels, Orjan Solvell et al (2005), *State of the Region Report 2005: Competitiveness and Cooperation in Baltic Sea region*, Baltic Development Forum, 43.

Export to the Baltic Sea region constitutes a very small share of the total exports of Russia, but Russia has always been a significant neighbour for the majority of the countries of the Baltic Sea region. Russian export to the Baltic Sea region has in the past 15 years been mainly dominated by oil products (approximately two thirds of exports). However, it would be rather short-sighted to treat Russia in the longer term only as a next-door supplier of raw materials. The North-Western region of Russia is one of the most industrially developed and is specializing on energy production, wood processing, metals and machinery (energy technology, marine transport equipment), food processing, ICT and electronics.⁸

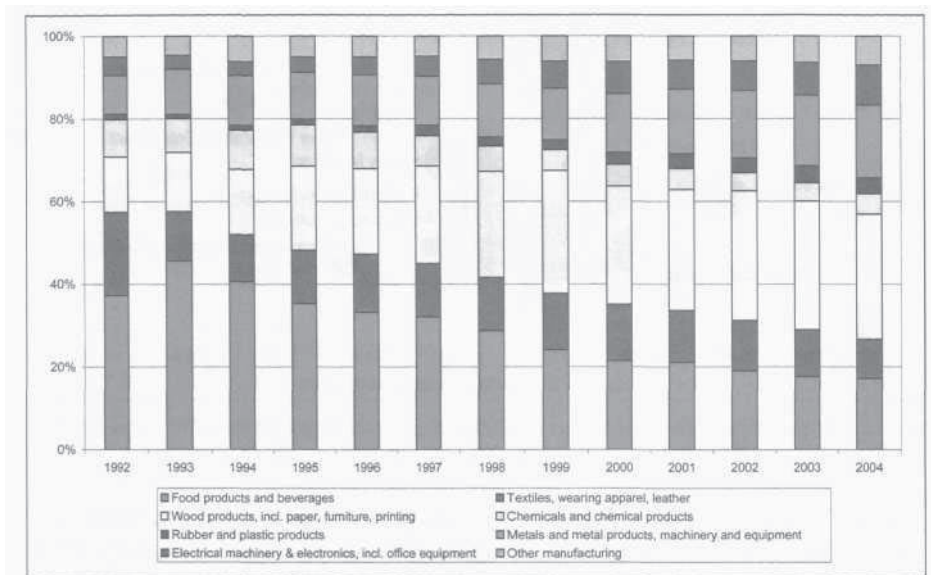
Oil from Russia is also an important part of the exports of the Baltic states, although Russia is increasingly seeking to reduce its dependency on these transit countries. Lithuania's strength lies, besides processing Russian oil, in the manufacturing of transport (railway carriages) and marine equipment. Latvia's strengths are in wood and furniture, food and textiles. Poland specializes in the manufacture of trans-

⁸ Grigory Dudarev et al. (2004), *Advantage Northwest Russia: The New Growth Centre of Europe?*, SITRA, Helsinki; Grigory Dudarev, Hannu Hernesniemi and Pavel Filippov (2002), *Emerging Clusters of the Northern Dimension: Competitive Analysis of the Northwest Russia*, ELTA, Helsinki.

port equipment and parts thereof (diesel engines), wood and furniture; also coal is an important export article.⁹

A decrease of the share of food processing and an increase of the share of various wood processing-related activities have been the most significant changes in the structure of Estonian industrial production in the past ten years. (Figure 6)

Figure 6: Estonian industrial production by branch in 1992-2004



Source: *Statistical Database*, Statistics Estonia, 2006; author's calculations.

By now, in Estonia more than half of the industrial value added is generated in wood processing-related industries, including manufacturing of furniture and paper, printing, etc. The share of metal products and machinery has been rather stable at around one fifth of the industrial value added. The share of textiles and wearing apparel in industrial value added has declined. (Table 2)

⁹ *Nordic Cluster Mapping*, Oxford Research, January 2002; Hannu Hernesniemi et al. (2001), *Finnish Key Clusters and their Projected Future*, ETLA, Helsinki; Sakari Luukkainen (2001), 'Industrial Clusters in the Finnish Economy', Ch. 13 in *Innovative Clusters: Drivers of National Innovation Systems* (Enterprise, Industry and Services), OECD, Paris; Orjan Solvell et al. (1993), *Advantage Sweden*, Macmillan Press, Hampshire and London; Hans Tson Soderstrom et al. (2001), *kluster.se. Sverige i den nya ekonomiska geografin*, Ekonomiradets rapport, SNS Forlag, Stockholm; Torger Reve and Erik W. Jakobsen (2001), *Et verdiskapende Norge*, Universitetsforlaget, Norge; *Kompetenceklynger i dansk erhvervsliv* (2001), Erhvervsfremme Styrelsen.

Table 2: Structure of value added of manufacturing industry in 1993 and 2003, by country, in %

	Estonia		Latvia		Lithuania		Poland		Germany		Finland		Sweden		Denmark	
	1993	2003	1993	2003	1993	2003	1993	2003	1993	2003	1993	2003	1993	2003	1993	2003
Food products and beverages	21.2	7.5	32.6	29.2	32.8	22.6	19	14.6	8.1	7.7	10.6	6.9	8.7	6.2	21.3	18.6
Information & communication technology and electronics equipment	3.3	2.2	2.8	1.4	4.8	10.6	1.8	2.9	2.9	4.5	4.3	21.2	6.3	6.5	2.6	3.8
Wood processing, incl. furniture, publishing	37.0	52.2	14.6	27.9	13.6	20.0	14.1	19.7	13.3	10.2	37.1	28.1	25.1	19.5	19.0	17.4
Metal-working and machine-building, incl. transport vehicles	18.8	22.1	22.1	24.9	26.5	21.1	31	26.6	31	28.4	24.8	24.9	20	18.4	28.8	26.5
Textile and garments	11.4	9.9	11.8	9.6	18.2	14.6	10.7	6.4	3.5	1.6	3.2	5.6	1.5	0.9	4.1	2.6
Total of the above 5 areas	91.7	93.9	83.9	93	95.9	88.9	76.6	70.2	58.8	52.4	80	86.7	61.6	51.5	75.8	68.9

Source: UNIDO statistics database, www.unido.org (update of data 22 August 2005); author's calculations.

Table 3: Foreign direct investment position of the Estonian manufacturing industry in 1997-2006, kroon (EEK) thousand

	31.12.1997	31.12.1998	31.12.1999	31.12.2000	31.12.2001	31.12.2002	31.12.2003	31.12.2004	31.12.2005	30.06.2006
Manufacture of food products, beverages, tobacco	1 230 755	2 207 288	1 879 223	1 644 969	1 914 759	1 933 579	3 131 193	2 831 434	4 018 607	4 332 397
Manufacture of textile and textile products	476 514	720 073	940 334	1 478 287	1 281 602	1 098 028	1 155 041	1 162 582	1 363 687	1 458 137
Manufacture of leather and leather products	.	.	.	19 417	18 809	.	23 644	65 586	30 874	27 909
Manufacture of wood and wood products	430 782	551 829	718 447	766 279	1 068 190	1 505 442	1 815 190	4 924 842	5 254 616	5 165 484
Manufacture of paper products; publishing	453 844	500 305	473 870	667 766	857 896	927 252	1 005 230	2 033 394	2 187 256	2 281 339
Manufacture of coke, refined oil products and nuclear fuel	.	.	.	541	445	.	2 935	2 150	0	0
Manufacture of chemicals and chemistry products	1 239 712	1 402 156	1 163 998	820 150	850 650	967 015	979 879	1 045 367	1 448 507	1 359 622
Manufacture of rubber and plastic products	101 061	129 070	200 918	242 559	386 336	296 508	392 349	451 223	552 716	569 425
Manufacture of other non-metallic mineral products	762 619	1 123 142	1 051 351	1 314 542	1 547 221	1 738 831	1 836 432	1 999 937	2 153 170	2 550 265
Manufacture of metals and metal products	270 073	463 729	305 776	408 316	528 295	1 151 326	921 185	1 077 347	1 175 637	1 380 311
Manufacture of machinery and equipment	59 092	108 575	123 397	211 257	286 537	279 171	252 580	250 965	337 052	337 309
Manufacture of electrical and optical instruments	217 081	262 734	266 588	581 857	784 377	880 681	1 112 815	1 684 631	1 876 839	2 116 539
Manufacture of means of transportation	122 725	240 789	573 514	677 577	770 416	558 882	1 209 410	928 362	946 167	904 045
Other manufacturing, n.e.c.	169 418	510 911	384 772	414 662	514 066	607 810	854 848	864 026	975 304	865 021
TOTAL	5 542 228	8 231 443	8 094 259	9 248 178	10 809 599	11 965 607	14 692 731	19 321 846	22 320 432	23 347 803

Source: Bank of Estonia, November 2006.

The structural change in Estonia's manufacturing industry reflects essentially the ability of various industries to re-orient from the previously dominant Eastern markets, which were in crisis until 2000, to the relatively more stable Nordic and Western European markets, which possess also a greater purchasing power. The very close trade relations that have evolved between Estonia and Nordic countries are based on geographic proximity and the recent foreign direct investment flows - Sweden and Finland account for nearly two thirds of Estonia's inward FDI.¹⁰ The majority of FDI were absorbed by various service sectors, such as wholesale and retail trade and banking, while manufacturing took a modest share. In recent years, however, in connection with increasing global relocation of economic activities and as a natural follow-up to the ongoing economic integration in the Baltic Sea region, inward FDI has gained impetus also in manufacturing (Table 3).

While the decline of the number of jobs was characteristic of almost all branches of Estonian manufacturing in the 1990s, in recent years that trend has reversed. Wood and metal processing industries, which are extremely significant in the structure of

Table 4: Number of persons employed in Estonian manufacturing industry in 2000-2004 by branch, average for the year

	2000	2001	2002	2003	2004
Manufacture of food products and beverages	20307	19952	19469	18629	17870
Manufacture of textile and textile products	22531	24299	24940	24507	23543
Manufacture of leather and leather products	.	.	2490	2473	2140
Manufacture of wood and wood products	14379	15156	17434	18140	18905
Manufacture of pulp, paper and paper products; publishing	7089	7057	7468	7415	7688
Manufacture of coke, refined petroleum products, nuclear fuel	.	.	1005	994	996
Manufacture of chemicals and chemical products	3180	3087	2940	2748	2815
Manufacture of rubber and plastic products	2939	3306	3383	3707	4220
Manufacture of other non-metallic mineral products	4196	4332	4396	4660	4887
Manufacture of basic metals and fabricated metal products	8978	9593	10168	10670	11745
Manufacture of other machinery and equipment	5135	4986	5316	5037	5143
Manufacture of electrical and optical equipment	11099	10738	10605	10860	12259
Manufacture of transport equipment	3962	3639	4211	4456	4846
Other manufacturing	12231	13194	13709	14002	13372
Total manufacturing	119743	123046	127535	128298	130429

Source: *Statistical database*, Statistics Estonia, 2007.

¹⁰ Sweden, while being a major financial centre and one of the biggest investors in the region, attracts almost half of the foreign direct investments made to the region from elsewhere in the world.

industrial value added, are now recording very rapid growth in employment, while employment in the textile and garment industry has remained stable. Employment in the manufacturing of food and chemical products, which occupy a relatively modest position in industrial value added, has declined slightly (Table 4).

The above positive developments in the manufacturing industry are certainly most welcome and necessary, as the economic integration which has taken place in the past 10-15 years in the Baltic Sea region has occurred mainly in the form of trade integration and has not yet brought about in Estonia and other Baltic states a significant qualitative industrial development.¹¹

For many years one of the main goals of the Finnish economic policy was to diversify away from resource-intensive forest products and establish competitive advantages in newly developed high-tech activities. The vast majority of Western European countries have set similar priorities. The Baltic states and Poland, on the contrary, have not managed to develop systematically their industries. It is not, therefore, altogether surprising that the dynamics of industry of the Nordic countries and Germany reveals a strengthening of their competitive advantages in knowledge- and technology-intensive industries, while the Baltic states and Poland have witnessed a devolution of their industrial structure and increasing specialization in resource- and labour-intensive activities. *²

Although Estonian entrepreneurs regard labour shortage and the rapid increase in (labour) costs as a major challenge to the growth of their enterprises, so far they have made no major changes to their business strategies. Enterprises in most sectors respond to the rapid growth of demand from domestic and neighbouring markets by increasing their production volume without simultaneous advances in their technological level or market orientation.¹³

Yet, as the economic boom is coming to an end, the decline of the inflow of foreign debt financing and domestic consumption will intensify pressures for the restructuring of Estonia's economy. Thus, one of the main issues for Estonia's economic development is how to amend the economic environment in such a way that the Estonian enterprises would find it easier to move in cross-border value chains to more knowledge- and technology-intensive, and thereby potentially also more profitable, activities.

11 See e.g. Marek Tiits et al. (2003), *Competitiveness and future outlooks of the Estonian economy*, State Chancellery, Tallinn; Marek Tiits et al. (2006), *Made in Estonia*, Institute of Baltic Studies, Tartu.

12 Marek Tiits and Juhan Juriado (2006), 'Intra-Industry Trade in the Baltic Sea Region', *IBS Working Paper 2/2006*, <http://www.ibs.ee>.

13 For more reviews of the strategies of major companies in Estonian key industries see Marek Tiits (ed.) (2007), *Kaupmeeste riik* (The nation of merchants), Estonian Academy of Sciences, Tallinn.

Policy recommendations

To distinguish between short- and long-term economic developments may not be always simple. The Estonian economy, fuelled by the influx of capital and a boom in domestic consumption, has grown very rapidly in recent years. Nothing, however, guarantees an automatic continuation of this growth. The growth of welfare of a small country is not based on the feeling of comfort taken 'on loan' from the tomorrow or the booming domestic consumption, but on venturesome entrepreneurial people and a developed industry, extensive trade of domestic goods in foreign markets, and an efficient government letting all that happen.¹⁴ When David Ricardo put down in the 19th century his theory of comparative advantage, he acknowledged a clear common logic: in a free market, in a longer perspective those entrepreneurs turn out more successful who manage to combine their business most effectively both with the moves of other market participants and with the public policy.

Specialization of Estonia in economic clusters of the Baltic Sea region

The Estonian economy is very closely integrated into the Baltic Sea economic region. In this way, it participates in global economic competition with other economic areas of comparable size, such as the Pearl River Delta region of approximately 100 million people in China. Asia, with its relatively cheap production inputs, is globally one of the most preferred areas for the low-cost mass production. One of the most important strategic advantages of the Baltic Sea region derives, however, from the opportunity to combine the knowledge- and technology-intensive production in the Nordic countries with cheap production inputs coming from the Baltic states and Poland.¹⁵

Strong cross-border economic clusters have evolved in the Baltic Sea region. The dynamics of these clusters is predominantly set by larger enterprises of the Nordic countries. The main role of the Baltic states in the global supply chain has, however, become the production of small-scale and not overly complicated consignments presupposing quick delivery and supply of local raw materials. At that, the Estonian production inputs are rapidly appreciating, and the cost competition is stepping up in a number of areas. One of the main issues facing Estonian economic policy is therefore how the enterprises can keep pace with changes taking place in the markets and

14 This understanding, originally formulated by Antonio Serra, has been repeated by various classical authors from slightly different perspectives. See Antonio Serra (1803), *Breve trattato delle cause che possono far abbondare li regni d'oro e argento dove non sono miniere*, Destefanis, Milan; Robert Heilbroner (1953), *The Worldly Philosophers: The Lives, Times and Ideas of the Great Economic Thinkers*, Simon & Schuster.

15 A similar division of labour is observed for instance between Hong Kong and China. See Michael Enright et al. (2002), *Hong Kong and the Pearl River Delta: The Economic Interaction*, A project sponsored by the 2022 Foundation; Judith Hollows (1999), 'Historical Trajectories of Innovation and Competitiveness: Hong Kong Firms and their China Linkages', *Creativity and Innovation Management*, Vol. 8, No. 1.

how they are able to shift in international production networks to higher value added roles, i.e. from primary processing of raw materials closer to final consumers.¹⁶

For stronger, often foreign-owned companies Estonia suits for business development rather well. Relocation of production from the Nordic countries to Estonia allows such a company to retain the majority of its hitherto competitive advantages, while strengthening the cost advantages. The increase in salaries in Estonia and the rising cost of other production inputs are not going to be a problem to such companies in the near future. Such companies, who possess typically a greater market power and coordinate the production activities in low- and medium-technology sectors, would be ready to procure from Estonia more production inputs, including the components of certain larger products, maintenance of equipment, etc. The problem here however lies in the weakness of local suppliers and service providers.

Several smaller enterprises which until now have acted mainly on the Estonian market are experiencing a rapid increase of costs. The equipment used in such, mostly indigenous, companies is not quite suitable to any specific product, yet the inability to specialize more narrowly and to increase decisively the production volumes does not allow for any substantial increase of their technological level either.

Rapidly growing costs force the enterprises to increase their productivity by strengthening their competences in production management, technology and design. Therefore it is not surprising that the entrepreneurs expect from the government more active steps in increasing the quality of education and in providing more support to technological development.

Conclusions on economic policy of Estonia

Structural factors, competitive advantages and market dynamics vary significantly in the individual branches of the economy, and so do the specific development needs of enterprises. The impact of universal policy measures designed to meet the needs of every enterprise will, therefore, inevitably turn out unforeseeable and limited. This is why Estonia needs a strong cluster-based economic policy, which would take the diverse dynamics of various industries and their different needs for development in practical policy implementation into account.¹⁷

Dominant clusters in Estonia and the Baltic Sea region can rather well be described through daily practical cooperation of entrepreneurs, their clients and suppliers and various servicing sectors. For the large part of Estonian exporters, the primary market is bigger companies in neighbouring countries, for whom they produce components of

16 Dieter Ernst (2002), 'Global Production Networks and the Changing Geography of Innovation Systems: Implications for Developing Countries', *Economics of Innovation and New Technology*, Vol. 1, No. 6, January, pp. 497-523.

17 See also Marek Tiits et al. (2003), *Competitiveness and future outlooks of the Estonian economy*, State Chancellery, Tallinn; Marek Tiits et al. (2006), *Made in Estonia*, Institute of Baltic Studies, Tartu.

certain end products etc. The further development of the competitive edge of Estonian industry depends, thus, in the first place on strengthening the supply of qualified labour and engineering services of the domestic subcontractors, which will enable them to move step-by-step from provision of manufacturing services to own-design manufacturing etc. Strengthening of the domestic supply will also bind the local affiliates of foreign investment enterprises more strongly to Estonia and will boost their positive effect on the economic development of Estonia.¹⁸

Setting the priorities of education, research and technology policies is not a trivial task, and simple extrapolation of the hitherto development trends of Estonia is not necessarily the best way for describing the future labour needs of the companies. Strengthening of the education system presupposes a more active dialogue between the associations of entrepreneurs and the government, as well as a systematic analysis of the dynamics of the global economy. The future roadmaps for five to ten years, composed in sufficient detail by industry associations, each for their domain, both on the Estonian and the European levels, could therefore play a critically important role in deciding on future priorities of education and research and technology policies.

In several medium- and low-technology sectors the smaller companies experience major difficulties in acquisition of new equipment already today. Eventually, with the decline of demand in the domestic market, the situation will become quite complicated for such enterprises. In certain cases, public intervention may become necessary in one form or another. Public sector support for renewal of the equipment stock may, however, easily amount to subsidizing unfeasible and in the longer perspective unsustainable businesses, unless problem-ridden enterprises are restructured. Therefore, the state should rather seek for opportunities for joint operations with investment banks or funds, who would conjointly assume a significant role in rethinking the strategies of the troubled companies. The state would, on its part, support the restructuring of such companies by offering continuous education or retraining of labour etc. as needed.

Regional disparities in the standard of living within Estonia essentially reflect variations in economic specialization and differences in employment levels in quite the same way as the comparison between Estonia and its neighbouring countries does. The above also highlights the need for much stronger coordination of education, entrepreneurship, regional development and labour market policies. Creation of new jobs in regions of high unemployment is not to be solved by solely providing start-up aid to beginning entrepreneurs. Putting such a region 'on move' presupposes large (foreign) investment into a certain pivotal enterprise or infrastructure, which would create a new market for smaller local suppliers. Given the extremely limited adminis-

¹⁸ A closer cooperation with Nordic countries is essential to Estonia not only with regard to relocation of industries, but equally with respect to new research- and technology-intensive industries coming to the country. In this work, we occupy ourselves with Estonia's current economic specialization and strengthening the existing competitive advantages. On strategies for entering new high-tech industries, see for instance Marek Tiits et al. (2006), *Made in Estonia*, Institute of Baltic Studies, Tartu.

trative and financial capacity of Estonian municipalities, any major change(s) will remain in this respect subject to the initiative of the central government.

The economic policy of independent Estonia has focused during the past 10-15 years on the promotion of free trade. That is in every way a suitable policy for a small country, however, it is not enough. To allow for a further increase in the living standard, Estonia is to become a truly industrialised economy.

Endnotes:

This chapter builds on Marek Tiits (ed.) (2007), *Kaupmeeste riik* (The nation of merchants), Estonian Academy of Sciences, Tallinn.

For a more detailed review of trade reorientation and industrial restructuring in the Baltic States in the 1990s, please consult Marek Tiits (2006), 'Industrial and Trade Dynamics in the Baltic Sea Region Since 1990s' in Rainer Kattel and Tarmo Kalvet (eds), *Creative Destruction Management: Meeting the Challenges of the Techno-Economic Paradigm Shift*, PRAXIS Center for Policy Studies, Tallinn, pp. 101-118.

Article IV

Marek Tiits, Rainer Kattel, Tarmo Kalvet and Dorel Tamm. 2008. "Catching up, Forging ahead or Falling behind? Central and Eastern European Development in 1990-2005." *Innovation: The European Journal of Social Science Research* 21 (1), 65-85.

RESEARCH ARTICLE

Catching up, forging ahead or falling behind? Central and Eastern European development in 1990–2005

Marek Tiits*, Rainer Kattel, Tarmo Kalvet, and Dorel Tamm

Institute of Baltic Studies, Tartu, Estonia

(Received 15 October 2007; final version received 2 November 2007)

This paper aims to assess the economic development and development policies in the Central and Eastern European (CEE) countries in 1990–2005, from the collapse of the USSR to the enlargement of the European Union. A great number of authors have generally seen the transition as a very positive process. They have concluded that the reform policies focusing on macroeconomic and price stability have been the key to success for CEE economies. A reliable economic environment is, of course, instrumental for longer-term economic success, as exemplified by the prolonged crisis in most of the former Soviet Union. Our analysis of the economic development and competitive advantages in the region, however, leads to the conclusion that the specific approach to transition that the Central and Eastern European countries followed came at a rather high cost. Comparative neglect and weakness of a set of policies crucial for longer-term development, such as science, technology and innovation policies, has led to deterioration in the last decade rather than the strengthening of the competitive advantages of Central and Eastern European economies. Furthermore, we argue that, in most cases, CEE countries have unfortunately overlooked or misjudged a number of development challenges, and have thus implemented policies that have generated growth at the cost of rapidly increasing risks. This is how the financial fragility of several Central and Eastern European countries has recently increased drastically, and the region seems to have virtually arrived at the brink of economic collapse. Since the CEE countries joined the European Union, the CEE governments have gradually moved towards acquiring a more active role in economic development. These policies need, however, to be strengthened considerably and reinforced by macroeconomic policies that curb current excessive dependence on foreign-financed growth.

Keywords: Central and Eastern Europe; industrial dynamics; innovation policy; financial fragility

Introduction

Economic development in the Central and Eastern European countries (CEE)¹ during the last decade is seen as a largely positive, if not very positive, process by both academic and policy circles. To use terms from Abramovitz's (1986) framework, CEE countries are seen not only to catch up, but possibly even to forge ahead. The

*Corresponding author. E-mail: marek@ibs.ee

economic difficulties of the early 1990s largely belong to the past, and several countries of the region have experienced even faster GDP growth rates than most of the developed nations in recent years, in the context of EU enlargement.

It appears however, as we demonstrate in the following section, that judgement on the success of transition in CEE strongly depends on the selection of the period under observation. Furthermore, we show that developments in CEE countries in the 1990s are marked by different, sometimes seemingly contradicting trends: rapid economic growth accompanied by deepening regional and social inequalities; large inflow of foreign direct investments (FDI) accompanied by financial fragility in terms of negative current account balance and extremely rapidly growing private and public debts; rapidly growing research and development (R&D) costs, albeit from a very low base, accompanied by the deterioration of economic structure.

This article sets out to explore why this is the case. We look at the changes in industrial dynamics in CEE countries during the 1990s, and juxtapose these with actual policy responses and actions to surpass or alleviate emerging problems. We argue that, in most cases, CEE countries have overlooked or misjudged certain economic and industrial challenges (changes) and thus responded with policies that could not ease the problems they were supposed to.

The following discussion is divided into four distinct sections. The first section encompasses a literature review on transition strategies and immediate crisis management in CEE. Then we analyse the impact of the transition crisis, following policy responses and the competitiveness² of CEE economies, seeking to assess the longer-term development prospects of the region. Finally, we highlight some of the signs of increasing financial fragility in CEE, and draw conclusions for the future.

Collapse of the USSR, transition crisis and stabilization in the 1990s

It is now almost two decades since the collapse of the “Soviet bloc”, but the answer to the question “why did socialism fail?” still remains largely debatable, except for some of the obvious aspects like low productivity growth and rigidities in the economic structure. Thus, from the current viewpoint, there was no single dominant economic reason for the failure, as various authors have identified problems in almost every aspect of economic development and governance.

Campos and Coricelli (2002) have demonstrated that the economic growth in Eastern Europe ran out of steam over a prolonged period of time, as the growth rates declined continuously from the 1960s onwards. The Soviet-style central planning system had an increasing number of incorporated rigidities, and the dominant expansive growth imperative favoured accumulation instead of “intensive growth”, which is achieved by means of technological and organizational change (Ofer 1987). Hence, the failure of the USSR was essentially an innovation policy failure, or as expressed in Carlota Pérez’s terms, an outcome of the inability to follow the techno-economic paradigm shift from the age of mass production to the age of information and communication technologies, the impellents of the latter being directly at odds with the very foundations of the Soviet system (see Freeman 1995, Pérez 2002).

The vast majority of CEE countries started implementing reform policies in the early 1990s, which emphasized the liberalization of markets, wage and price stability, containing public deficits, minimizing the tax burden, and strong market orientation in all socio-economic sectors.³ The transition strategies generally built on the

assumption that state ownership as such is always unwanted, since the private sector would in each and every case be capable of demonstrating productivity levels superior to those of the public sector. Rapidly handing over as much decision-making power as possible to the private sector therefore became the focal point of the reforms. Liberalization as an elegant antithesis of an all-embracing state controlled system was met with great enthusiasm. Liberalization of prices, dismantling of trade barriers and elimination of pervasive state intervention in the early 1990s, which was expected to result in large efficiency gains, brought instead the collapse of outputs and an unexpectedly harsh and prolonged crisis, to the surprise of many.

In the early 1990s, most CEE countries saw their GDP *per capita* drop one-third or more in real terms. With Hungary as a notable exception, the rest of CEE regained their 1990 GDP *per capita* levels only 10 years later, i.e. at the turn of the century. The developments in CEE, nonetheless, still represent a relative success, considering the even more prolonged transition crisis in most of the former USSR (newly independent states, NIS). Even by 2005, countries like Russia and Ukraine had not regained their 1990 level of GDP *per capita*, and some of the NIS, like Moldova, are still below 50% of their 1990 GDP *per capita*.⁴ Eventually, the 1990s proved a “lost decade” for most of the CEE countries in terms of GDP *per capita* (Figure 1).

In their initial analysis, some observers attempted to explain the collapse of outputs with a simple Keynesian recession, driven by a fall in consumer demand (see, e.g., Blanchard *et al.* 1991, Berg and Sachs 1992). Calvo and Coricelli (1992) were probably the first to argue that it was not, given the timing and magnitude of the economic collapse, a Keynesian recession, but a “trade implosion” – a phenomenon

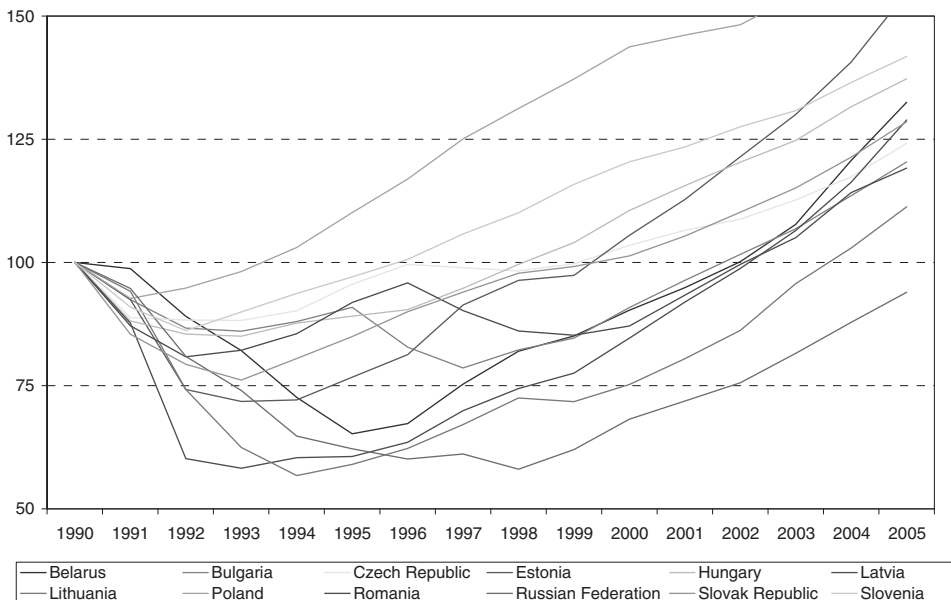


Figure 1. GDP *per capita* in CEE and NIS countries 1990–2005 (constant 2000 US\$), 1990 = 100. Source: World Bank (2007a).

ascribed to the break-up of the old system of coordination of production and exchange. This, in turn, gave rise to a theory of optimal (speed of) transition (see, e.g., Aghion and Blanchard 1994).

For planning and management purposes, a lot of Soviet industry developed into large complexes in a specific geographical area, forming something akin to the phenomena which Alfred Marshall called industrial districts (Marshall, 1890), or what we today call regional innovation systems (Cooke 1992) or clusters (Porter 1990). If one produced carpets, one often also produced machinery for carpet production. Such very strong vertical integration meant that the most successful and progressive Soviet companies often built their own ICT laboratories (however rudimentary) or had already invested in early biotechnologies in the late 1980s. This extreme vertical integration created huge interdependencies between different actors within the system. As a consequence, collapse of one part of the value chain brought down the entire chain.

We see transition, for the purposes of the following, as a process of *creative destruction* (Schumpeter 1942, Drechsler *et al.* 2006) in which an old production system is about to be replaced with a new, more knowledge-intensive, and thereby also more productive one. In this process, liberalization clearly contributed to the *destruction* of old, often rather rigid political, economic and social structures. *Creation* of new competitive strengths has, however, proved much more difficult in CEE than expected. We hold the view that various policies aiming at macroeconomic stabilization, such as controlling inflation or introducing currency boards, are not likely to be the root cause of the prolonged crisis. Credit contraction during the stabilization process may have made the impact of the crisis even harsher, but did not cause it.

It was the hastiness of transition itself, which did not allow enough room for gradual replacement of former credit allocation and production systems with new ones, that triggered the collapse of the entire system. This implies that the countries which were not in the position to opt for a radical transition to a liberalized market and started with a piecemeal step-by-step approach may have been in some ways better positioned, since they allowed their economic agents and systems of economic coordination more time for adjustment. One could, however, also argue that the choice of the speed of transition in CEE was a historic political necessity, and if no rapid changes had been undertaken the region would have fallen into prolonged stagnation, as has happened to most of the ex-USSR. Furthermore, as the experiences of Russia, Ukraine and Moldova exemplify (see above), postponement of reforms does not guarantee successful transition either.

Quality of economic change in CEE

By the 1980s, most of the CEE countries were relatively highly industrialized, but still lagged significantly behind the Western European average.⁵ For instance, in 1985, Latvia, Portugal and South Korea all had similar levels of industrial value added *per capita*, but since then, these countries' development paths have been very different in comparison to the European average. South Korea has experienced a remarkable increase in industrial value added *per capita*. The increase of Portugal's industrial value added has, at the same time, been quite modest, and in the early 1990s, the

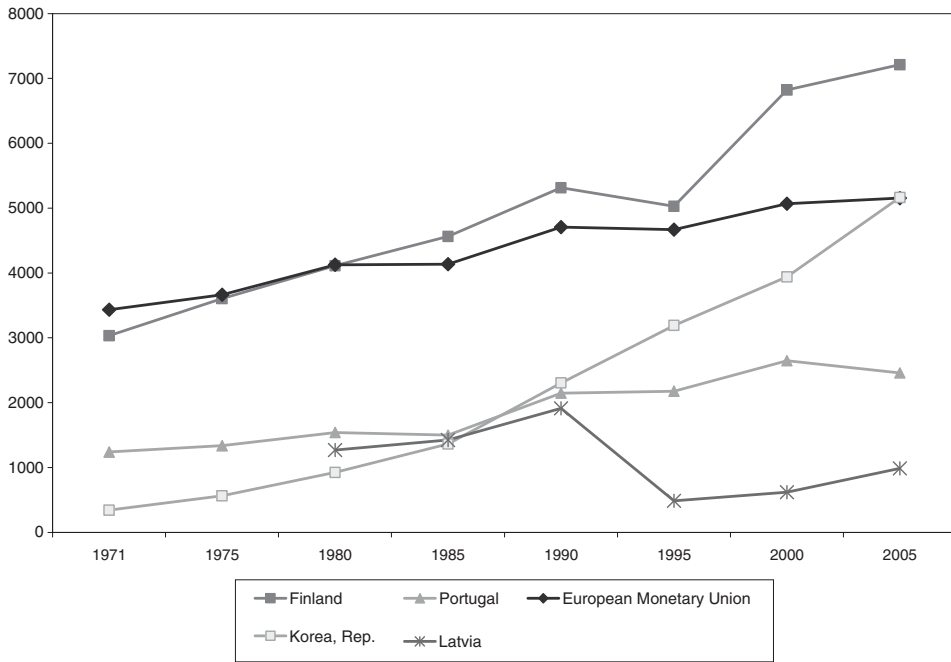


Figure 2. International comparison of industrial value added *per capita* (millions; constant 2000 US\$), 1971–2005. Source: World Bank (2007a) and authors’ calculations.

industrial value added *per capita* was marked by a rather drastic collapse of industry in Latvia (Figure 2).

Latvia’s case is, however, by no means unique. In the aftermath of the fall of the Berlin Wall, industry collapsed virtually all across Central and Eastern Europe. Most CEE countries saw steady growth in industrial value added up to 1990, after which there was a dramatic decline and countries like Estonia, Romania and the Czech Republic only recovered to their 1990 levels by 2004–2005 (Figure 3).

Inevitably, dynamic changes in the value added are also reflected in changing employment structures of economies, and in different sectors’ changing share of value added in GDP. While industrial employment declined only 5–10% in CEE in 1990–2005, the share of industrial value added in GDP dropped dramatically.⁶ These changes were accompanied by major gains in service employment, e.g. from 36 to 53% of total employment in Poland, and from 37 to 57% in Bulgaria from 1990 to 2005. Similarly, the share of services value added as a percentage of GDP rose very quickly in CEE countries in the period 1985–2005 (World Bank 2007a; Table 1).

It could be argued that the decline of industry in CEE was expected, as the pre-1990 economic specialization of CEE countries, and especially their high level of industrialization, was artificial. It could be argued that it was created by plans, not by market forces; that it was created by military and strategic needs, rather than existing comparative advantages in foreign trade, and thereby the decline was simply about return to equilibrium. However, one can still argue equally easily that the industrialization of East Asian economies in the second half of the twentieth century and the technological rise of the US west coast during the Cold War followed a very similar, largely military, strategic logic (see Wade 2004, Markusen 1999, respectively).

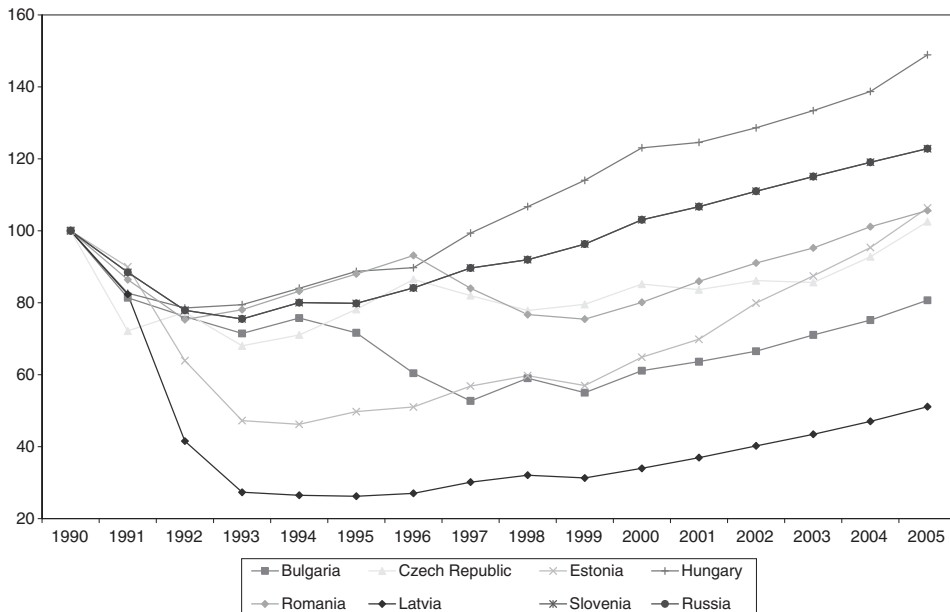


Figure 3. Industrial value added in selected CEE, NIS, European and Asian economies 1980–2005 (constant 2000 US\$), 1990 = 100. Note: The data for Lithuania, Poland and Slovakia are not available. Source: World Bank (2007a) and authors' calculations.

Alternatively, it can be argued that the rapid de-industrialization witnessed in most CEE countries (and, much more drastically, in all of the former Soviet Union) after 1990 was, at least partially, a process of natural de-industrialization, reflecting the nature of modern economic development, by which industrial jobs move to lower-cost locations and are replaced by relatively higher value added service jobs.⁷

Indeed, successful catching-up can be seen as “flying geese” development, whereby rapid economic development in a developed country and the gradual relocation of its economic activities to neighbouring countries, facilitates development of the latter. As the standard of living increases and the relative cost advantages fade away, the country catching up will start to abandon the less knowledge- and technology-intensive economic activities (Akamatsu 1935). This is how Western Europe industrialized step by step in the nineteenth century (Pollard 1987), and Japan and the East Asian “tigers” have done the same in the second half of the twentieth century.

Developments in CEE in the 1990s do not, however, seem to fit such a pattern very well. The above-mentioned “flying geese” development would imply rapidly increasing living standards which trigger the relocation of economic activities to lower cost locations, yet this is not what we have seen in CEE. Instead, the service sector in CEE countries by and large witnessed a similar development in the 1990s to industry: collapse in the early 1990s and recovery from the mid-1990s onwards. The main difference seems to be that the recovery in services was quicker: many CEE countries had already regained their 1990s levels of services value added by the late 1990s⁸ (Figure 4).

Both the industrial and services value added in Central and Eastern Europe remain, however, much lower than the Western European average in absolute terms.

Table 1. Value added in industry and services, percentage of GDP.

	1985		1990		1995		2000		2005	
	Industry	Services	Industry	Services	Industry	Services	Industry	Services	Industry	Services
	Bulgaria	62.8	25.3	49.2	33.8	35.5	50.0	30.7	55.1	31.6	58.7
Czech Republic			48.8	45.0	38.3	56.7	38.1	58.0	37.2	59.8
Estonia ^a	43.6	35.5	49.7	33.7	29.3	62.7	26.5	68.0	29.4	66.6
Hungary ^b	47.0	35.2	39.1	46.4	32.3	60.6	33.5	62.1	31.1	65.1
Latvia	43.2	35.2	46.2	31.9	29.8	61.2	23.6	71.8	22.1	73.8
Lithuania			30.9	42.1	33.7	54.7	29.6	62.5	33.5	60.8
Poland	51.4	34.0	50.1	41.6	35.2	56.8	31.7	63.3	30.7	64.5
Romania			49.9	26.3	42.7	35.8	36.4	51.1	35.0	54.9
Slovakia	61.6	31.9	59.1	33.5	34.9	59.7	30.3	65.5	29.4	67.2
High income ^b	34.7	62.0	32.4	64.8	29.7	68.0	28.0	70.2	25.9	72.4

Notes: ^aThe earliest data available for Estonia is from 1997; ^bthe latest data available for Hungary and the group of high income countries is from 2004. Source: World Bank (2007a).

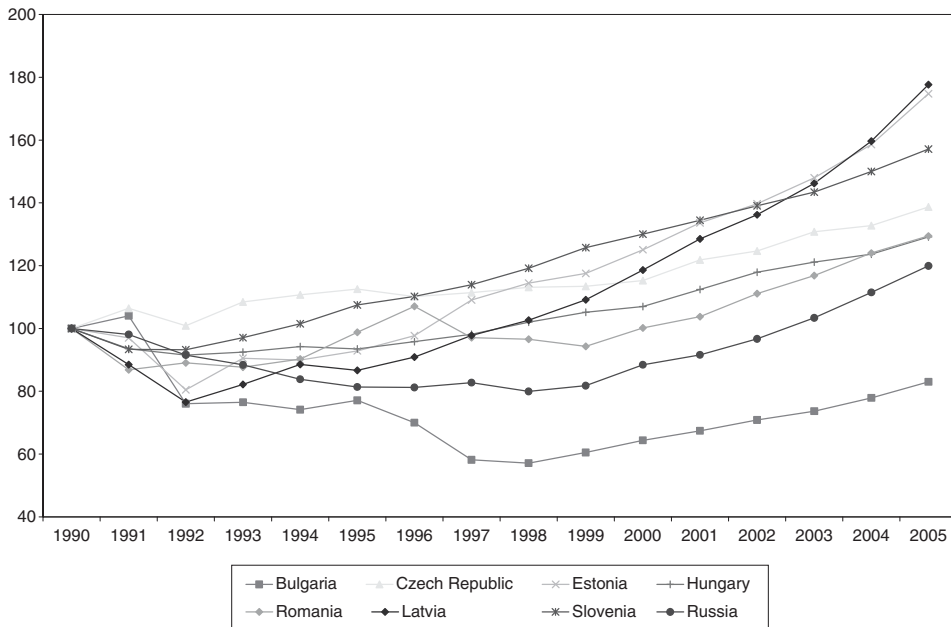


Figure 4. Services value added in selected CEE, NIS, European and Asian economies 1980–2005 (constant 2000 US\$), 1990 = 100. Note: The data for Lithuania, Poland and Slovakia are not available. Source: World Bank (2007a) and authors' calculations.

Even though the 2000s have led to a significant increase of value added in CEE countries both in industry and services, it is difficult to talk about the last decades as a period of strong catching up.

Successful catching up would encompass a gradual increase in the knowledge and technology intensity of industry (and internationally tradeable services; see Abramovitz 1986, Tiits *et al.* 2006), but this is not what we see in CEE. A closer look at the change in the share of medium- and high-level technology in manufactured exports (reflecting international competitiveness) and at industrial value added (reflecting the quality of the industrial structure) reveals that the new EU member states were more competitive in 1980 in terms of their production capabilities than in 2000. During the two decades, the East Asian “tigers” have caught up and bypassed old EU member states, while the CEE countries fell considerably behind in the 1990s and since then have not managed to improve their competitive position very much (Figure 5).

It should be noted here that dismantling the former planning system did not only demolish supply chains, but also cut off the (formerly) state-owned enterprises from their credit markets, as allocation of both production inputs and credits was an important element of the central planning system. During the transition period, financial transfers by the state from the Soviet period to the industrial companies were transformed into loans to the same companies by newly founded banks. Most of the companies were privatized. This increased the liabilities of already ailing companies, complicated restructuring of industry and increased risks in the banking sector. Thus, the approach to transition was prone to crisis from the very beginning.

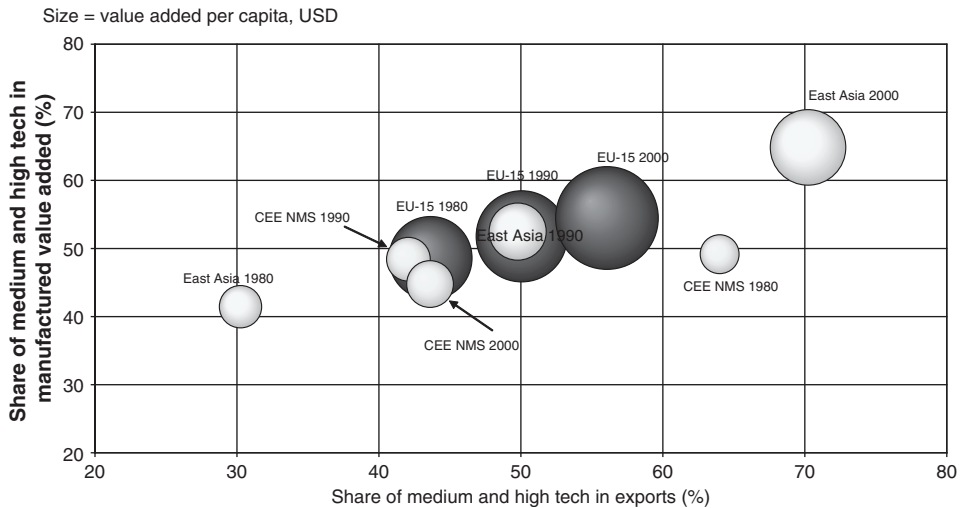


Figure 5. Quality of industrial change in selected world regions, 1980–2000. Source: UNIDO (2004) and authors’ calculations⁹

Eventually, only companies with previous experience in Western markets and which possibly were already integrated in some way into Western production networks managed to restructure and survive (a good case study is Radošević and Yoruk 2001).

Denial of access to finance, along with the speed of transition to the market economy, was perhaps the most crucial policy mistake made in CEE during transition. Rapid liberalization of markets and prices meant that for many domestic companies demand was cut down, and thus companies with highest relative fixed costs to variable costs (these tend also to be the most technologically advanced) were hardest hit as their balance sheets deteriorated very quickly. If a company has a lot of machinery and equipment to be amortized, i.e. where there have been recent investments for upgrading, the company is then hit particularly harshly if its demand drops and if it is under financial stress because of liabilities to newly founded banks. Thus, the most advanced industries are hit first by rapid liberalization, and also the hardest. This is called the Vanek–Reinert effect (Reinert 1980), and was observed in Latin America in the 1980s and again in the 1990s in CEE countries.

It is interesting to note in this context that, particularly since the latter half of the 1990s, CEE countries seem to be doing relatively well in terms of increasing the in share of medium- and high-technology exports (Havlik 2006). This has been largely driven by foreign direct investment inflows to these economies, and these investments are usually relocations of production from Western Europe to CEE (e.g. metal processing and automotive industry in the Czech Republic, Slovakia and Poland; assembly of telecommunications equipment in Hungary and Estonia; see Tiits 2006).

The above has given ground to very positive assessments of the CEE’s recent growth experience. It appears, however, that the extensive intra-industry trade between “old” and “new” EU countries is characterized by sustained dominance of vertical trade with distribution of quality differences in favour of the “old” EU, whereby quality advantages of the CEE candidate countries have tended to diminish (Gabrisch and Segnana 2003, p. 18). Moreover, it can be argued that

foreign direct investment in candidate countries [CEE; authors' note] seems to have had an almost negligible impact on change toward horizontal trade structures. This should trigger off a more moderate view on the role of foreign direct investment, which is too often seen as overly optimistic to contribute to catching-up in terms of quality and technology whenever trade has been liberalised (*ibid.*, p. 32).

In other words, recent relocation of production from "old" to "new" EU countries has not compensated for the loss of most knowledge- and technology-intensive industries in CEE in the early 1990s. Landabaso (1997) concluded in his earlier analysis of cross-country economic variations in the "old" EU that "there is a 'technology gap' twice as great as the so-called 'cohesion gap' (measured in terms of inter-regional differences in income, productivity and employment) between the developed and the less developed regions of the European Union". The technology gap in the enlarged European Union is, however, even wider than the variation between most of the EU's old member states. Furthermore, the increasing knowledge intensity of developed economies, intensifying global market competition and shortening technology life cycles contribute to widening, rather than lessening, such a technology gap.

Innovation and innovation policy in CEE

Perhaps the longest-lasting effect of the transition in the CEE described in previous sections appears in the education and R&D sectors. While the changes in industry and services described in the previous section were very rapid and often disruptive, education and R&D systems were left to their own devices in most CEE and NIS countries and with no significant structural change or resources for upgrading.¹⁰

Enterprises in CEE are typically in the lower end of the global value chain and the innovations they introduce are typically less knowledge-intensive – the role of practical experiences and related tacit knowledge is much higher than that of formal R&D, owing to their industrial specialization (for theoretical argument see, e.g., Pérez 2001). Although the share of R&D financed by the business enterprise sector has grown in some countries (e.g. the Czech Republic, Hungary, Estonia) rather rapidly in recent years, industrial R&D investment in 2005 still remained around a modest 0.2–0.4% of GDP¹¹ in most CEE countries (Eurostat 2007).

Many new companies in CEE have in fact been highly innovative in finding creative new ways to apply existing technologies, despite low formal R&D investment, by offering themselves, e.g., as cost-effective and reliable partners for outsource production. One of the most fundamental characteristics of CEE industry (and services) since 1990 has been that the majority of companies who have engaged predominantly in process innovation and have sought to become more and more cost-effective in the new market place while gaining quality advantages through the development of new products with market potential, have remained largely unsuccessful.

Both the cost of acquisition of machinery and private R&D investment, and thereby also innovation expenditure of enterprises, are of course very closely dependent on the structure of the industry of a given country. Science-based industries, such as bio-pharmaceuticals, ICT and electronics quite obviously demonstrate high R&D investment. Yet private R&D investments in countries with a limited science-based industry also appear low. Similarly, one would expect

scale-intensive and supplier-dominated industries, such as, for example, the production of metals and machinery, to demonstrate higher than average investment in equipment (Pavitt *et al.* 1989).

Given the structure of CEE industry, it is not at all surprising that research and development and innovation expenditures of enterprises in CEE are, in *per capita* terms, many times lower than their counterparts in the “old” EU, and that innovation expenditure consists largely of the acquisition of equipment and machinery¹² (Figure 6).

The *Community Innovation Survey 4* (CIS4) highlights lack of funds and high risks as the main factors that hamper innovation activities in CEE. Access to technology and markets is not seen to be a problem. Thus, not surprisingly, the *European Innovation Scoreboard* indicates that the number of science and engineering (S&E) graduates in CEE is below the EU average.¹³ It seems at first glance, given the record low interest rates experienced in Europe during the last few years, that the respondents of the Eurostat CIS4 survey have underestimated the difficulty of gaining reliable technology and market information, while overestimating their own strength (Table 2).

The CEE economic specialization on the low-end parts of the scale-intensive, supplier-dominated industries (with a limited number of well-known clients) seems to explain rather well why cost cutting, rather than increasing knowledge intensity, has become the underlying principle in CEE industry. The above also explains why CEE industry has demanded relatively little formalized education and learning, and why there has been, until recently, relatively little market demand to reform public education and R&D systems.

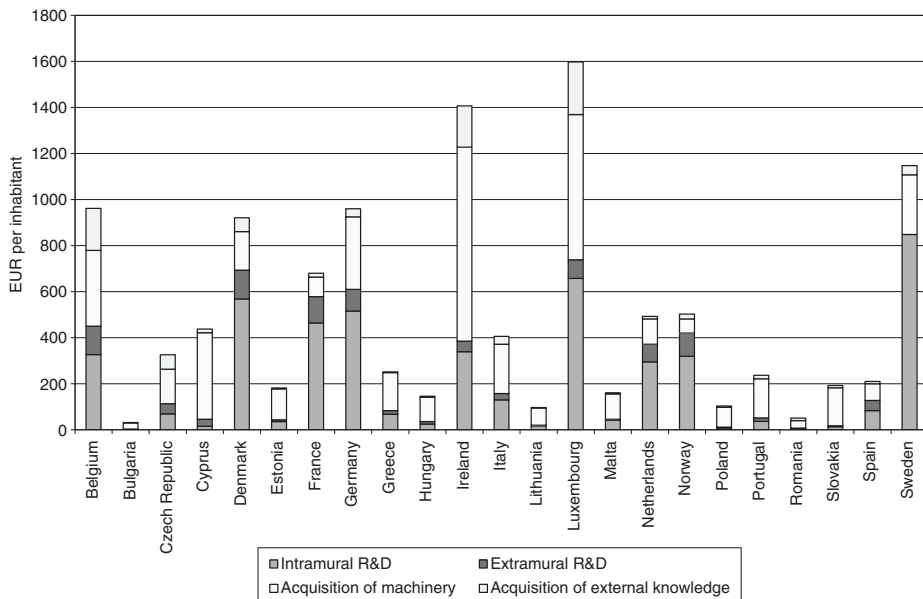


Figure 6. Innovation expenditure *per capita* in selected European countries, 2004. Note: No data on extramural R&D expenditure in Sweden is available. Source: Eurostat (2007).

Table 2. Hampered innovation activities: percentage of enterprises with innovation activities, 2004.

	BG	CZ	EE	LV	LT	HU	PL	RO	SI	SK
Lack of funds within your enterprise or enterprise group	24%	22%	28%	68%	25%	27%	31%	8%	31%	24%
Lack of finance from sources outside your enterprise	21%	12%	19%	58%	19%	20%	26%	30%	24%	16%
Innovation costs too high	26%	18%	21%	72%	22%	26%	32%	30%	24%	21%
Lack of qualified personnel	9%	10%	23%	72%	14%	7%	7%	14%	20%	8%
Lack of information on technology	6%	2%	4%	67%	7%	2%	5%	7%	5%	2%
Lack of information on markets	6%	4%	3%	64%	8%	3%	5%	0%	9%	4%
Difficulty in finding cooperation partners for innovation	11%	3%	6%	58%	8%	5%		16%	11%	7%
Markets dominated by established enterprises	15%	19%	16%	68%	19%	15%		21%	26%	14%
Uncertain demand for innovative goods or services	15%	12%	11%	62%	11%	15%	17%	16%	9%	12%
No need to innovate due to prior innovations	4%	3%	5%	37%	5%	2%		5%	1%	:
No need to innovate because no demand for innovations	5%	3%	6%	43%	2%	3%		4%	5%	:

Note: Latvia has been excluded due to obvious problems with quality of data.
Source: Eurostat (2007).

Until the early 2000s, scientists remained almost the only protagonists of science and technology policy in CEE. This is also probably why the R&D and innovation policies emerging in CEE in the late 1990s, and in particular with looming EU accession in the early 2000s, were rife with a quite specific, and often mystified, way of understanding innovation. Innovation was seen, in line with the post-World War II tradition, as a phenomenon close to science, believing that there is a more or less linear correspondence between scientific discovery and high innovation performance. Therefore, the technology push linear innovation models prevailed. Limited market demand for domestic science and technology competence was, however, taken as the inability of the public R&D sector to cooperate and commercialize research results and cater to the needs of private enterprises. Much of the policy learning in CEE was inspired by the ideas circulating among Western European policy-makers. It was thus understood that CEE was experiencing its own version of the “European paradox”: good public research and high levels of education, but little commercialization of research results in the private sector.¹⁴

We can see how CEE innovation policies attempting to imitate those of advanced industrial economies have concentrated on R&D-related activities, such as the commercialization of public research and the development of technology parks for research-intensive start-ups, etc., and have left the bulk of local industry simply out of consideration (see a very good summary in Radošević and Reid 2006).

Havlik *et al.* (2001) demonstrate at the same time that the adoption of the EU *acquis communautaire* has had a much stronger impact on the modernization of CEE industry than official innovation policy. Here, we see essentially a form of “unconscious innovation policy”, whereby, with the introduction of new regulation,

the industry is made to choose either to modernize their products and production facilities rather drastically, to subject themselves to mergers with bigger players with greater economies of scale, or to close down altogether. In addition, such harmonization with Western European standards made outsourcing and relocation of production much easier.

In some countries, for instance Estonia, EU accession triggered a very significant policy change which brought innovation policy onto the agenda very strongly; in others, for instance in Slovenia and Hungary, the changes in policy focus occurred earlier and were more vocal. However, the changes were and are often accompanied by relatively little increase in actual funding and, as importantly, by relatively little public attention and discussion of policy strategy. The existing case studies seem to also reveal that the *Regional Innovation Strategy* initiatives have had an equally limited impact on the economic development of target regions. All in all, the policy analysis and strategic planning capacity existing in CEE at the regional level seem to be even weaker than policy intelligence at the national level (Euro-Coop 2007).

The few policy and academic debates on R&D and innovation in CEE in the early and mid-1990s were largely plagued by a simple misunderstanding of innovation as something normatively and economically always positive. It is of course true that successful introduction of new products and services allows an enterprise with a relatively strong market position to sustain and strengthen its competitive position by commanding supreme prices in a specific market. Yet since Hans Singer's (1950) work, it is quite clear that innovation can also have a negative impact, especially when one operates in a sub-contracting or services industry facing severe cost competition and diminishing returns. In fact, this is why developing countries mostly experience globalization, in essence, as a process that brings more competition, lower prices and commodification. Particularly in agriculture and simpler services, innovation is often an emulation of competitors (e.g. using similar machinery) or a process readily available to all (e.g. ICT in the hotel industry). These bring lower prices to consumers, but also a so-called "commodity hell" to many companies, to their wages and profits.

On the other hand, there are clearly innovations that have the opposite effect: they bring new products, services and processes that are difficult to copy (or are protected with intellectual property rights), and thus bring higher profits and wages. This very often has to do with technological change and scale economies or, as Schumpeter put it, with historical increasing returns that lead to quickly rising market power and often to near-monopolistic competition (think of Microsoft).

We argue that in many CEE countries there are strong changes towards a more active role of the state in supporting the existing industry since EU accession, and that such changes have often taken place in policy discussions and coordination with EU officials rather than in local policy debates. More importantly, CEE innovation and industrial policy changes take place in a macroeconomic policy environment that has not really changed since the early 1990s. This environment is still based on the assumption that most of the industrial change that took place in the 1990s in CEE increased the competitiveness of these countries, and that the reasons for this lay in neoliberal policies that should be reinforced again today: lower taxes, balanced budgets and lower inflation that should result in the price and fiscal stability required for Euro accession. Such a policy environment has little to do with the industrial realities of many CEE companies; in fact, this policy environment reinforces the

economic specialization established during the 1990s, and brings with it almost no incentives for modernization of CEE education and R&D systems, which would allow for the gradual upgrading of competitive advantages of CEE economies.

Increasing financial fragility in CEE

Financial deepening or capital accumulation has classically been seen by economists as the main source of economic development (see e.g. Marx, 1867, Friedman and Friedman 1980). It is certainly one way of explaining the recent growth in CEE. Additionally, analysts focusing on the developments in the supply side of the CEE economies have highlighted one-off structural change related to trade reorientation, inflow of FDI and relocation of production as the main factors behind rapid growth in CEE countries since 1995 (see most recently Stephan 2003, Piech and Radošević 2006). However, rapid GDP growth and industrial change have not so far brought an increase of competitiveness to the CEE economies, but a deterioration of production systems. This can be seen both in the quality of industrial change and from the weakness of innovation systems in these economies.

Furthermore, recent developments in the most vulnerable CEE countries seem increasingly similar to pre-crisis developments in Finland and Sweden in the early 1990s, or in East Asia in the late 1990s (Kokko and Suzuki 2002). As on earlier occasions, the observed developments have seemed rational, as the CEE economies have been growing comparatively faster than those of the “old” EU. Rapid growth of foreign financing, including record high inflows of foreign direct investment (EIU 2007) sparked by relocation of production within Europe, have led to booming stock and real estate markets and bank lending (Figure 7). It has been easy to describe the rapid growth of asset prices in CEE, among other explanations, as a process of “natural economic convergence” and not an increasingly risky development pattern. This, in turn, has attracted more foreign funding, which has led to further deterioration of the CEE countries’ external positions.

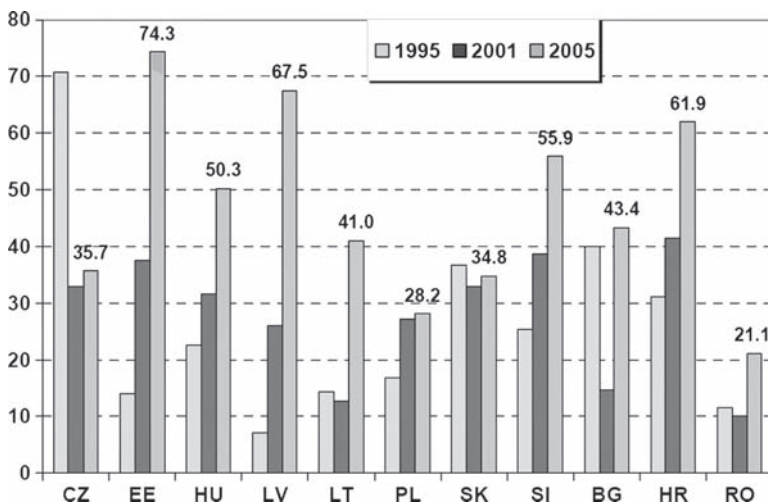


Figure 7. Bank credit to private sector, percentage of GDP, 1995–2005. Source: World Bank (2007b, p. 4).

The countries with fastest growth of private debt also experienced the greatest trade deficits in 2006, reaching 20% of GDP in Latvia and Bulgaria and 10% of GDP in Estonia, Lithuania and Romania (Eurostat 2007). Housing loans alone increased in Bulgaria between 2004 and 2005 by more than 95%, in Latvia and Lithuania by 90%, in Estonia by 75%, and in Poland, the Czech Republic and Slovakia by around 35–40%. As it happens, the most peripheral new EU member states which have experienced the fastest credit growth tend to be the least favourably integrated into European production networks and have the smallest foreign exchange reserves (Eurostat 2007); their commercial banks have the smallest loan loss reserves, reaching only 1% of gross loans in the Baltic States and about 2% in Romania and Bulgaria (for a detailed review, see, e.g., World Bank 2007b).

Since the early 1990s most of the CEE countries have experienced current account deficits resulting from the weakness of their industry, which has not allowed CEE countries to close their trade deficits. Modest current account deficits are usual in a catching-up environment, as a developing economy may need foreign technologies and other inputs to be able to do this successfully. However, as we have shown above, over the last 10–15 years CEE countries have experienced primitivization rather than strengthening of their competitive advantages and no significant bettering of external balances has taken place. Instead, recent foreign-financed growth has led to further worsening of current account deficits (Figure 8).

Some CEE countries, like Estonia and Latvia, have already witnessed the lowering of their credit risk ratings by various rating agencies, while a number of others, e.g. Hungary, Bulgaria and Romania, have become the subject of constant concern by the same rating agencies (see, e.g., Fitch 2007a–c). Similarly, the IMF, the World Bank and others have issued a number of warnings (Hilbers *et al.* 2005, World Bank 2007b). Equally, CEE policy makers have in recent years issued a number of public statements on increasing risks, attempting in this way to persuade consumers

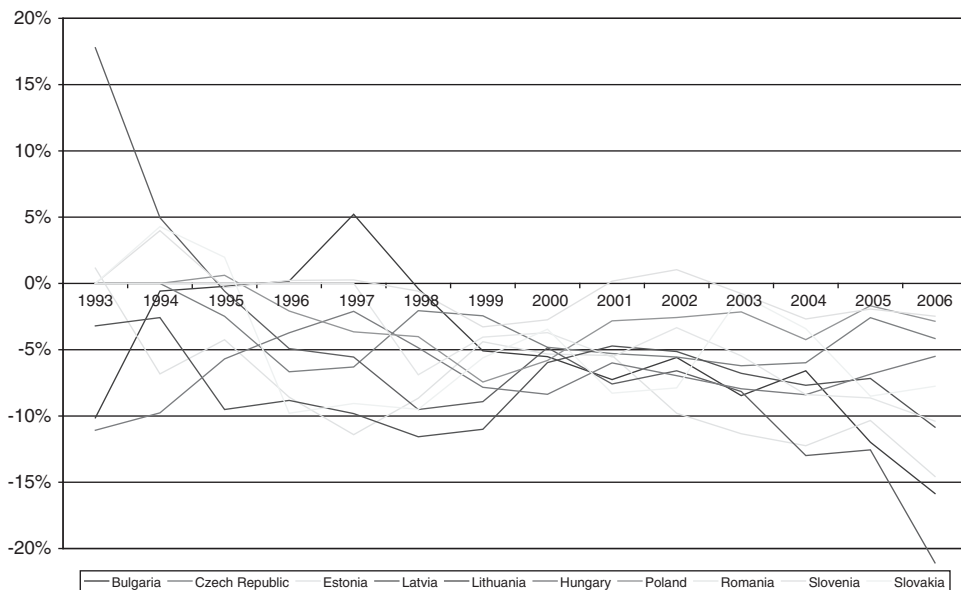


Figure 8. Current account balance 1993–2006. Source: Eurostat (2007).

against much stronger economic incentives to limit their long-term borrowing. Increasing the reserve requirements and maintaining a modest surplus on government budgets have perhaps been the strongest policy responses undertaken, but as shown above, these are clearly insufficient. Finally, CEE policy makers have missed the right moment to intervene effectively in the financial markets by restraining excessive credit growth. Therefore, excessive dependence on foreign funding and/or inability to mobilize adequate domestic savings have increased the financial fragility of the CEE economies (see also Nurkse 1952, on the role of the mobilization of domestic savings).

Speculative economic growth fuelled by domestic consumption based on foreign borrowing can, however, only be sustained as long as markets believe that these funds will yield higher expected returns than will be required to service them. As soon as this confidence is lost, massive outflow of funds from the country follows (see, e.g., Kregel 2004, Furman and Stiglitz 1998). This is the pattern we have witnessed in the last decades in a number of emerging economies. It is, however, perhaps the main difference from the financial crises witnessed in the last decades that, this time, excessive borrowing and booming asset markets are characteristic not only of CEE countries, but of a much broader set of both developed and emerging economies.

It is important to note that, in the context of the fragility of CEE economies, global financial issues and instabilities play only a secondary role. The difficulties of CEE economies in maintaining their external balances are still first and foremost a result of domestically chosen transition environments that enabled quick industrial restructuring with significant loss of skill and complexity; this has been reinforced further by recent speculative growth. Thus, we summarize our review with the realization that the CEE countries have counted too much on automatic developmental effects of market forces, and need not only to rethink and reinforce the role of the state and public funding in innovation and industrial policies, but moreover, their macroeconomic policies.

Conclusion

Developments in CEE countries since the early 1990s have been marked by different, sometimes seemingly contradictory, trends. While the short-term economic outlook in general still seems good, there are increasing concerns about the long-term sustainability of the current development pattern of CEE countries. Our analysis of the competitiveness of the CEE economies shows that they have not been catching up with, and in fact are falling behind, industrialized economies. The 1990s were, for most CEE countries, largely a “lost decade” in terms of GDP *per capita* growth.

The vast majority of the CEE countries implemented transition strategies which predominantly emphasized liberalization of markets, wage and price stability, containing public deficits, minimizing the tax burden, and strong market orientation in all socio-economic sectors. While some of these steps were of the utmost importance to enable the private sector to develop at all, it was mostly only companies with previous experience in Western markets and possibly already integrated in some way into Western production networks that managed to restructure and survive. Alongside changes in industry and services that were very rapid and often disruptive, education and R&D systems were at the same time left to

their own devices in most CEE and NIS countries with no significant structural change nor resources for upgrading. Emergence of R&D and innovation policies became noticeable only in the late 1990s, and in particular, with looming EU accession in the early 2000s. Previously, innovation was viewed in a linear way, and applied innovation policies were actually research policies that had little to do with the average enterprise.

In spite of the fact that the share of R&D financed by the business enterprise sector is very small, many companies in CEE have in fact been highly innovative in finding creative new ways to apply existing technologies, by offering themselves as cost-effective and reliable partners to outsource production, and so forth. It has been one of the most fundamental characteristics of CEE industry (and services) since 1990 that the majority of companies predominantly engaged in process innovation have sought to become more and more cost-effective in the new market place, while gaining quality advantages by developing new products with supreme characteristics; however, these companies have remained largely unsuccessful.

At the same time, CEE countries have profited from trading with European economies, which has often brought the need to manage production (in an outsourcing factory, for instance) in terms acceptable to Western partners, particularly in terms of quality. What has essentially happened is that CEE countries have specialized in industrial (and often also service) activities where Western Europe has lost its cost competitiveness. Thus, the loss of skill in the 1990s can be easily overlooked, as with the relocation of production – new “Zara” or “Ikea” factories keep popping up all over the CEE.

However, one-off developmental resources stemming from market liberalization and privatization, the boosting of the private entrepreneurial spirit and the reorganization of the existing production system seem to be largely exhausted. CEE countries mistook initial and continuing rapid growth for a response to their development policies. In reality, large parts of this success are attributable to two factors: techno-economic paradigm change and globalization with liberalization of markets. Technological revolution in information and communications technologies has indeed unleashed very powerful economic dynamics in the form of outsourcing and general mobility of industries and within industries. These aspects strongly enabled inflow of FDI and have allowed CEE to replace Soviet-style factories with modern industries, from mobile phones and ICT to designer clothing and furniture, giving the illusion of managing the economy and doing things right.

In 1980, CEE countries had qualitatively better industrial structures and were more similar to the East Asian economies than they are today. However, by 2000 the difference between these two groups of countries was remarkable. The quality of industrial change in the CEE countries in the 1990s indicates that the incentives created by the transition architecture for the private sector have not changed significantly over time, nor have these incentives significantly increased productivity of labour and, consequently, more income has not been generated.

Furthermore, recent foreign-funded speculative growth has led to a considerable weakening of the external positions of the CEE economies, and the region seems to have virtually arrived at the brink of economic collapse. The East Asian crisis forced Asian policy makers to rethink the risks related to excessive foreign currency-denominated borrowing and increased the volatility of global financial markets stemming from the liberalization of capital markets. The same also seems to be in

store for the CEE. Since joining the European Union, the CEE countries have gradually moved towards a more active role of the state in economic development. These policies, however, need to be strengthened considerably and reinforced by macroeconomic policies that curb current excessive dependence on foreign-financed growth.

Acknowledgements

The research for this paper was partially supported by European Commission EURO-COOP project, and Estonia Science Foundation grant no 6703.

Notes

1. In the context of this article, Central and Eastern European countries are the following 10 new member states of the European Union: Bulgaria, the Czech Republic, Hungary, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.
2. Competitiveness is understood hereafter as the ability “to produce internationally competitive products and services (export), while at the same time maintaining or increasing the actual income of people” (OECD, 1992).
3. In particular, the Washington institutions (the World Bank and the IMF) have been strong advocates of such policies. However, also within academic discourse, such analysis abounds; see Broadman *et al.* (2005), for a recent example from numerous studies.
4. For a more detailed account, see, for example, Havlik (2006) and Bracho and López (2005).
5. This section builds partially on Reinert and Kattel (2007).
6. As a result, the share of CEE and NIS manufacturing in world manufacturing[0] plummeted from 19.3% in 1980 to 2.7% in 2001 (UNCTAD 2004, p. 89).
7. This is how today’s developed countries benefit from globalization, by shifting manufacturing to various low-cost locations while maintaining control over product development, coordination of offshore production networks, marketing, etc. Vernon’s (1966) work on interrelations of industry life cycles and evolution of international trade is a good way of explaining this.
8. We use here statistical definitions given by the World Bank WDI online database: services correspond to ISIC divisions 50–99. They include wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional and personal services such as education, health care and real estate services.
9. The calculations are based on averages. For some CEE countries, data is missing; however, most of the larger CEE economies like Hungary, Poland, Bulgaria and Romania are well represented, as are the Baltic States. East Asia includes South Korea, Singapore, Malaysia and Thailand.
10. Radošević (1999) uses the term “gradualism without therapy”, and for some countries even “shock without therapy” to describe the patterns of restructuring of R&D systems in CEE.
11. The Czech Republic and Slovenia, with their business sector R&D investment reaching 0.9% of GDP, are exceptions here.
12. There are a number of methodological problems with the Community Innovation Survey that make cross-national comparison difficult: for a small or medium-size subcontracting company in the low end of global production networks, each new contract may bring about new products or services and virtually complete reorganization of production, which CIS would record as “innovative activity”.
13. The case study by Kattel and Kalvet (2006) reveals that, besides the problems of quantity of labour, there are also problems with quality.

14. As it currently seems, the high quality of European science and education is largely a myth (Dosi *et al.*, 2006). CEE scientific output is, in comparison to leading European countries like Sweden and Finland, dwarfed (see Must, 2006).

References

- Abramovitz, M., 1986. Catching up, forging ahead, and falling behind. *Journal of economic history*, 46 (2), 385–406.
- Aghion, P. and Blanchard, O., 1994. On the speed of transition in Central Europe. In: S. Fischer and J. Rotemberg, eds. *NBER macroeconomics annual 1994*. Cambridge, MA: MIT Press.
- Akamatsu, K., 1935. Waga kuni yomo kogyohin no susei [Trend of Japanese Trade in Woolen Goods]. *Shogyo keizai ronso*, 13, 129–212.
- Berg, A. and Sachs, J., 1992. Structural adjustment in international trade in Eastern Europe: the case of Poland. *Economic policy*, 7 (14) (Eastern Europe), 117–173.
- Blanchard, O., Rudiger D., Krugman, P., Layard, R., and Summers, L., 1991. *Reform in Eastern Europe*. Cambridge, MA: MIT Press.
- Bracho, G. and López, J., 2005. *The economic collapse of Russia*, November 2005. Available from: http://www.ideaswebsite.org/featart/nov2005/fall_Economic_Collapse.htm [Accessed March 2008].
- Broadman, H.G., Paas, T., and Welfens, P.J.J., eds 2005. *Economic liberalization and integration policy. Options for Eastern Europe and Russia*. Berlin: Springer.
- Calvo, G. and Coricelli, F., 1992. *Output collapse in Eastern Europe: the role of credit*. IMF Staff Paper no 92/64, August.
- Campos, N. and Coricelli, F., 2002. Growth in transition: what we know, what we don't and what we should. *Journal of economic literature*, 40, 793–836.
- Cooke, P., 1992. Regional innovation systems: competitive regulation in the new Europe. *Geoforum*, 23, 365–382.
- Dosi, G., Llerena, P., and Labini, M., 2006. The relationships between science, technologies and their exploitation: an illustration through the myths and realities of the so-called “European paradox”. *Research policy*, 35, 1450–1464.
- Drechsler, W., Backhaus, J.G., Burlamaqui, L., Chang, H.-J., Kalvet, T., Kattel, R., Kregel, J., and Reinert, E.S., 2006. Creative destruction management in Central and Eastern Europe: meeting the challenges of the techno-economic paradigm shift. In: T. Kalvet and R. Kattel, eds. *Creative destruction management: meeting the challenges of the techno-economic paradigm shift*. Tallinn: PRAXIS Center for Policy Studies, 15–30.
- EIU, 2007. Over the hill?, *Economist Intelligence Unit viewswire*, 25 July.
- Euro-Coop, 2007. *Report about data collection in the partner regions*, June. Available from: <http://www.iccr-international.org/euro-coop/>
- European Innovation Scoreboard*, 2006. Available from: http://www.proinno-europe.eu/doc/EIS2006_final.pdf.
- Eurostat, 2007. *Eurostat on-line database*. Available from: <http://ec.europa.eu/eurostat> [Accessed September 2007].
- Fitch, 2007a. *Risks rising in the Baltic States?* Special report, 6 March.
- Fitch, 2007b. *Bulgaria, Croatia, Romania – how sustainable are external imbalances?* Special report, 20 March.
- Fitch, 2007c. *The Baltic states: risks rising in the trailblazers of emerging Europe?* Special report, 8 June.
- Freeman, C., 1995. The “National System of Innovation” in historical perspective. *Cambridge journal of economics*, 19, 5–24.
- Friedman, M. and Friedman, R., 1980. *Free to choose*. London: Harcourt.

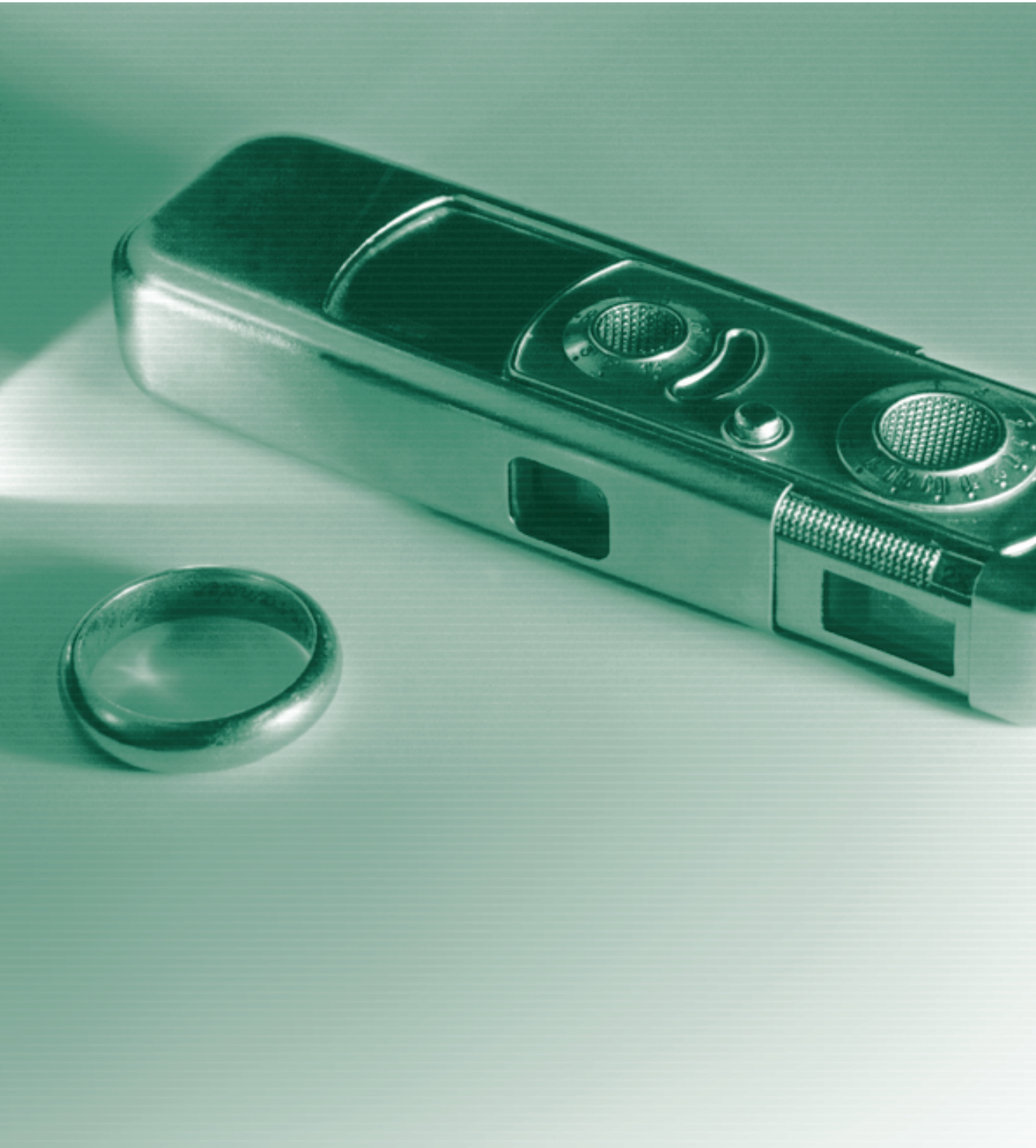
- Furman, J. and Stiglitz, J.E., 1998. *Economic crises: evidence and insights from East Asia*. Brookings Papers on Economic Activity, no 2.
- Gabrisch, H. and Segnana M.L., 2003. *Vertical and horizontal patterns of intra-industry trade between EU and candidate countries*. Halle: Institut für Wirtschaftsforschung Halle. Available from: http://www.iwh-halle.de/projects/productivity-gap/publications/Report_WP2.pdf.
- Havlik, P., 2006. *Macroeconomic restructuring in the new EU Member States and selected newly independent states: effects on growth, employment and productivity*. IndeuNIS Papers, February. Available from: <http://indeunis.wiiv.ac.at>.
- Havlik, P., Landesmann, M., Stehrer, R., Römisch, R., and Gilsätter, B., 2001. *Competitiveness of industry in CEE candidate countries: composite paper*. Vienna: Vienna Institute for International Economic Studies.
- Hilbers, P., Otter-Robe, I., Pasarbasioglu, C., and Jonsen, G., 2005. *Assessing and managing rapid credit growth and the role of supervisory and prudential policies*. IMF Working Paper 05/151, July.
- Kattel, R. and Kalvet, T., 2006. *Knowledge-based economy and ICT-related education: overview of the current situation and challenges for the education system*. Tallinn: PRAXIS Center for Policy Studies.
- Kokko, A. and Suzuki, K., 2002. The Nordic and Asian crises – common causes, different outcomes, October, manuscript.
- Kregel, J., 2004. *External financing for development and international financial instability*. G-24 Discussion Paper Series, United Nations. Available from: http://www.unctad.org/en/docs/gdsmdpbg2420048_en.pdf.
- Landabaso, M., 1997. The promotion of innovation in regional policy: proposals for a regional innovation strategy. *Entrepreneurship and regional development*, 9 (January–March).
- Markusen, A., 1999. National contexts and the emergence of second tier cities. In: A. Markusen et al., eds. *Second tier cities. Rapid growth beyond the metropolis*. Minneapolis, MN: University of Minnesota Press, 65–94.
- Marshall, A., 1890. *Principles of economics*. London: Macmillan.
- Marx, K., 1867. *Das Kapital*. Hamburg: Verlag von Otto Meissner.
- Must, Ü., 2006. ‘New’ countries in Europe – research, development and innovation strategies vs. bibliometric data. *Scientometrics*, 66 (2), 241–248.
- Nurkse, R., 1952. Some international aspects of the problem of economic development. *The American economic review*, 42 (2), 571–583.
- OECD, 1992. *Technology and the economy, the key relationships*. Paris: OECD.
- Ofer, G., 1987. Soviet economic growth: 1928–85. *Journal of economic literature*, 25 (4), 1767–1833.
- Pavitt, P., Robson, M., and Townsend, J., 1989. Technological accumulation, diversification and organisation in UK companies, 1945–1983. *Management science*, 35 (1), 81–98.
- Pérez, C., 2001. Technological change and opportunities for development as a moving target. *CEPAL review*, 75, 109–130.
- Pérez, C., 2002. *Technological revolutions and financial capital: the dynamics of bubbles and golden ages*. Cheltenham: Edward Elgar.
- Piech, K. and Radošević, S., eds, 2006. *The knowledge-based economy in Central and Eastern Europe: countries and industries in a process of change*. London: Palgrave Macmillan.
- Pollard, S., 1987. *Peaceful conquest: the industrialization of Europe, 1760–1970*. Oxford: Oxford University Press.
- Porter, M.E., 1990. *The competitive advantage of nations*. London: Macmillan.
- Radošević, S., 1999. *Restructuring and reintegration of science and technology systems in economies in transition*. Final Report of the TSER Project, contract no. SOE1-CT95-1008.
- Radošević, S. and Reid, A., 2006. Innovation policy for a knowledge-based economy in central and Eastern Europe: driver of growth or new layer of bureaucracy? In: Piech, K. and

- Radošević, S., eds. *The knowledge-based economy in Central and East European countries; countries and industries in a process of change*. London: Palgrave Macmillan, 295–313.
- Radošević, S. and Yoruk, D.E., 2001. *Videoton: the growth of enterprise through entrepreneurship and network alignment*. London: University College London, Center for the Study of Economic and Social Change in Europe, Working Paper no. 3.
- Reinert, E.S., 1980. *International trade and the economic mechanisms of underdevelopment*. PhD Thesis, Cornell University. Ann Arbor, MI, University Microfilms.
- Reinert, E.S. and Kattel, R., 2007. *European Eastern enlargement as Europe's attempted economic suicide? The Other Canon and Tallinn University of Technology Working Papers in Technology Governance and Economic Dynamics*, no. 14.
- Schumpeter, J., 1942. *Capitalism, socialism and democracy*. New York: Harper, 1975. [Originally published 1942.]
- Singer, H., 1950. The distribution of gains between investing and borrowing countries. *American economic review*, 40 (2), 473–485.
- Stephan, J., 2003. *Evolving structural patterns in the enlarging European division of labour: sectoral and branch specialisation and the potentials for closing the productivity gap*. Halle: Institut für Wirtschaftsforschung Halle.
- Tiits, M., Kattel, R., and Tarmo, K., 2006. *Made in Estonia*. Tartu: Institute of Baltic Studies.
- Tiits, M., 2006. Industrial and trade dynamics in the Baltic Sea Region since 1990s. In: R. Kattel and T. Kalvet, *Creative destruction management: meeting the challenges of the techno-economic paradigm shift*. Tallinn: PRAXIS Center for Policy Studies, 101–118.
- UNCTAD, 2004. *Development and globalization: facts and figures*. New York and Geneva: United Nations.
- UNIDO, 2004. *Industrial development report 2004. Industrialization, environment and the Millennium Development Goals in sub-Saharan Africa*. Vienna: UNIDO.
- Vernon, R., 1966. International investment and international trade in the product cycle. *The quarterly journal of economics*, 80(2), 190–207.
- Wade, R., 2004. *Governing the market. Economic theory and the role of government in East Asian industrialization*, 2nd edn. Princeton, NJ: Princeton University Press.
- World Bank, 2007a. *WDI online database*. Available from: <http://publications.worldbank.org/WDI> [Accessed June 2007].
- World Bank, 2007b. *Credit expansion in emerging Europe: a cause for concern?* World Bank EU8+2 Regular Economic Report, Part II, January.

APPENDIX (Article V)

Article V

Marek Tiits, Rainer Kattel and Tarmo Kalvet. 2005. *Made in Estonia*. Tartu: Institute of Baltic Studies. (English version was published in 2006.)



MADE IN ESTONIA

MAREK TIITS, RAINER KATTEL, TARMO KALVET



Front cover depicts the famous Minox camera by Walter Zapp.

Walter Zapp was born on 4th September 1905 in Riga. In the 1920s, when he was already living in Estonia, Walter Zapp became fascinated with the idea of developing a small precision camera that would produce pictures with no lesser quality than the considerably bigger cameras. A decade later, in 1936 the first Minox camera prototype was ready. Unfortunately, no producer in Estonia was interested in his invention, and thus the series manufacture was launched in Riga.

Walter Zapp later wrote the following about the birth of Minox: "It is by far not enough to just have an idea, because its realisation takes a whole set of favourable conditions to be provided by the environment and the contemporaries. I am much indebted to Estonia for these favourable conditions."

MADE IN ESTONIA

MAREK TIITS, RAINER KATTEL, TARMO KALVET

Institute of Baltic Studies

Tartu 2006

About the authors:

Marek Tiits is the Chairman of the Board of the Institute of Baltic Studies.

Rainer Kattel is a professor at Tallinn University of Technology and a Senior Research Fellow at PRAXIS Center for Policy Studies.

Tarmo Kalvet is the Program Director of Innovation Policy Program at PRAXIS Center for Policy Studies.



Institute of Baltic Studies (IBS) is an independent non-profit research and development centre that aims to assist the development of public policy in the Baltic Sea area by providing high-quality socio-economic analysis.



PRAXIS Center for Policy Studies is an independent non-profit think tank that aims to contribute to better public policy making process and to enhance general participation in public debate. PRAXIS offers innovative and high-quality analysis, studies and enhanced public participation to help identify and tackle key problems in the society.

The authors extend their special gratitude to Carlota Pérez who found the opportunity to conduct a series of inspiring seminars in Tallinn.

We also thank Jaak Aaviksoo, Wolfgang Drechsler, Jüri Engelbrecht, Kristi Hakkaja, Teet Jagomägi, Anne Jürgenson, Marco Kirm, Kadri Kristjuhan, Ülle Must, Mall Parmas, Tarmo Pihl, Erik S. Reinert, Tiit Talpsepp, Silver Toomla and Rene Tönnisson for their assistance and advice.

This study is prepared with the support of the European Commission.

Translation: Kristi Hakkaja

Photo on the front cover: Photo collection of Tallinn City Museum



ISBN 9985-9658-0-9 (paperback)

ISBN 9985-9658-2-5 (PDF)

Institute of Baltic Studies

Tartu

2006

Contents

Contents	3
Introduction	4
Executive summary	5
1. Foundations of knowledge-based economic policy	
1.1. Competitiveness and the structure of industry	7
1.2. Socio-economic development and techno-economic paradigms	10
1.3. Innovation and cluster-based economic policy	14
1.4. Varying policy needs of countries in different stages of development.	18
1.5. Specifics of the catching-up strategy in small states	20
2. Key areas of research and technology	
2.1. Future visions for information, bio- and nanotechnology – 2015-2020	22
2.2. Development of information technology and information society	26
2.3. Biotechnology.	29
2.4. Nanotechnology	38
2.5. Convergence of information, bio- and nanotechnologies	46
3. Socio-economic challenges facing Estonia	
3.1. External balance	51
3.2. Productivity growth and economic development	54
3.3. <i>Acquis communautaire</i> and innovation.	59
3.4. Human resources, employment and social sustainability	61
4. Estonia's competitive position in Europe	
4.1. About the economic opportunities of our children	68
4.2. European Union and shifts in international division of labour	71
4.3. Scenario I: Scandinavian periphery	74
4.4. Scenario II: Vigorous modernisation of traditional sectors	81
4.5. Scenario III: Venturing into new high technology economic sectors	86
5. Policy recommendations	
5.1. Cluster-based economic policy	92
5.2. More effective policy coordination in the Baltic Sea region	93
5.3. Developing infrastructure for knowledge and technology	93
6. Appendices	94

Introduction

The 1990s have certainly been very progressive for Estonia that is now a member of the European Union and NATO, and rather successful for many of its active citizens. At the same time, in today's Estonia it is increasingly difficult for an entrepreneur to find qualified labour force and to remain competitive on the basis of its existing advantages. Political rhetorics that follows the *Lisbon strategy*¹ of the European Union aspires for large-scale private sector investments into research and development. These ambitions, however, seem to exceed our capacity. Constant level of record high current account deficit is endangering the economic stability. This all compels Estonia to pay ever more attention to next generation policies that would ensure not only the stability of business environment, but would also provide the premises for successful long-term development.

What kind of long-term investments would be most beneficial for the entrepreneurs in Estonia? What should the government do to secure growth in the real income of its citizens and in the export capacity of its entrepreneurs? What kind of policies should public sector follow in order to enable the entrepreneurs to employ business strategies that are not based on cheap labour and natural resources like they have been so far? What choices are there for a small transition country like Estonia that cannot afford major investments into multiple sectors? While thinking about future it is always useful to look back into the history.

There are surprisingly many similarities between Estonia's developments in the past decade and those of the young republic of the 1920s. While in exile Karl Selter analysed Estonia's experiences and perspectives for rebuilding the economy once independence is regained. He observed: *"Industry can be of support to advanced agriculture. Growth of industry and towns and increase in the total sum of salaries in industry is a vital footing that the rise of our agriculture should be based on. As bizarre as it seems, political circles of independent Estonia did not comprehend this link between industry and agriculture. Some politicians had an unfriendly standing towards industry, others were permissive, but none of the parties adopted the enlargement of industry as a goal of their programme. The reason for such attitude may have resided in the fact that the majority of big industry was owned by citizens of non-Estonian descent, and their concerns remained distant to the wider population."*²

It is precisely the advances in industry that created the preconditions for the expansion of service sector and for the development of rural life as well as for the increase in the living standard of the whole society. Although the future outlook presented in this book is clearly centered on technological development, industry and economic competitiveness, by no means do the authors consider a discussion on the development of a broader environment and society of any less importance. Progress in Estonia is, of course, not merely dependent upon the advances in industry or the investments in education, research and technology development; social policy, labour market development, competition, environment and rural policies – in other words, the functioning of the state as such – are equally important.

But should we prefer one or another type of investment, institution, strategy, policy, and on what grounds? This book draws on two assumptions: first, it is the task of public policy to decide between various options, and secondly, these decisions must be based on a solid analysis of existing circumstances and needs. Lack of a clear long-term target and the painfulness of structural changes that the society has to deal with are, however, among the major reasons why the efforts to develop knowledge-based economy have not resulted in much progress despite all the talk in Estonia as well as Europe.

Today Estonia still does not, regrettably, have a consistent, truly forward-looking long-term development strategy. A broadly accepted strategy of this sort cannot emerge from behind government's closed doors. Hence, the following analysis also aims at posing some questions that require serious deliberation and discussion in our society rather than trying to offer any ultimate solutions.

¹ "A new start for the Lisbon Strategy", European Commission, http://europa.eu.int/growthandjobs/index_en.htm.

² Karl Selter (1898-1958) was Minister of Economic Affairs of the Republic of Estonia in the years 1933-1938. He was charged with drafting both the smallest ever national budget in the crisis years of 1934/35 as well as the nearly biggest budget of the first Republic of Estonia in 1938/39. See also Karl Selter, "Eesti ülesehitamise probleemid" ("Problems in rebuilding Estonia"), *Korporatsioon Vironia 1900-2000, manuscript.*

Executive summary

Starting with the rise of the city states of Italian renaissance and the 16th-17th century Dutch and German towns the concept as well as the social and economic success of modern state has been based on geographic boundaries. These boundaries are the very element that facilitate the process of specialisation or the emergence of welfare raising economic clusters. Then again, economic theory has essentially always followed Adam Smith's famous principle of the positive link between welfare and market size since bigger market is supposed to allow for more specialisation and, thereby, for growth in productivity and standard of living.

Rapid evolution of information and communication technologies as well as liberalisation of markets over the past decades have significantly changed the meaning and role of geography and proximity of destination markets in the socio-economic development. Value chains of global economy are no more shaped by geographic borders. Instead, they are increasingly formed within the boundaries of specific industries. Simultaneously, more and more economic units are established and relocated into countries and regions with most favourable socio-economic conditions for the respective stage in production. This means that the more basic production functions move into areas with cheaper labour force and relatively higher productivity, while the more complex and costly parts of development process remain in countries with higher standard of living. The situation is most problematic for those areas that can offer neither knowledge-based development activities nor cheaper skilled labour force with relatively higher productivity levels.

It follows from previous that the enhancement of the competitiveness of local companies as well as the choice of location for foreign investments is progressively more tied to specific economic and technology sectors. Diminishing opportunities for treating different economic sectors and technologies on equal grounds complicate not only the formulation of business strategies. Likewise, the development of policies and strategies that facilitate economic growth has become even more intricate. At the same time it is clear that in a race for generating more and more value-adding technologies a (small) developing state can only hope to be successful if it constantly and vigorously modernises its economy.³

Estonia's socio-economic development in the open global economy is by no means "a zero sum game" with its main focus limited to internal redistribution of revenues or determining the level of tax burden. As a member of the European Union, Estonian is in a completely different economic and political environment. Expected economic convergence will now replace the previous process of fairly technical adoption of *acquis communautaire* with a much more significant role for Estonia's actual specialisation on the common market and for the introduction of a supporting development strategy.

In which direction might Estonia's role in the changing international distribution of labour move in the coming decade? Social (or economic) changes do not happen overnight. This means that the developments in the past decade offer pretty good insights into how and which kind of technological structure Estonia's economy will evolve towards in the coming 5-10 years. Analysis of Estonia's past development shows that the technological structure of industry is not growing more knowledge intensive and complex, quite the opposite – distribution of labour is decreasing, so is specialisation, skills and quantity of skilled labour force; capacity to exploit new and emerging technologies is also on decline. While Western Europe competes with USA and the newly industrialised countries of South-East Asia in terms of their income, labour productivity, and knowledge and technology intensity of economy, it is China, India, Latin American countries and Russia that are the primary economic rivals to the new member states of the European Union.

A look at the data on export structure and industrial competitiveness reveals that Estonia is currently almost entirely specialised on wood processing activities (incl. furniture, printing and paper industries). Second position in the structure of exports is occupied by certain low value-adding functions of Scandinavian

³ Since the publication of David Ricardo's work it has been widely accepted that it is only rational for an entrepreneur operating in a specific location to primarily focus on those sectors for which the existing environment offers at least some sort of advantages. Contemporary economic treatises do not, however, see these advantages as occurring by themselves. Instead, the entrepreneurial environment established by the government has a decisive role in the emergence of specialisations. See i.e. Charles King, *The British Merchant or Commerce Preserv'd*, London, John Darby, 1721; David Ricardo, *The Principles of Political Economy and Taxation*, London: John Murray, [1817] 1821; Paul M. Romer, „Increasing Returns and Long-Run Growth“, *Journal of Political Economy*, 1986, 94, 5 (October 1986), 1002-1037; Francis Fukuyama, *State Building: Governance and World Order in the Twenty-first Century*, Profile Books 2004.

information technology and electronics clusters. Over the past 10 years Estonia's rapidly developing wood processing sectors that belong in the Scandinavian wood cluster have become the most important sources of productivity (and thereby also income) growth in Estonia's economy.

Existing, relatively low-technology based structure of Estonia's economy can bring no automatic resolutions for the future nor direct the creation of new knowledge and ideas. It is equally unrealistic to attempt at reconstructing the Soviet time light industry, machinery and other sectors of industry that are nowadays extremely labour and capital intensive. Instead, Estonia should focus on modernising its currently rather efficient resource and low-technology based sectors, on the one hand, and, at the same time, expand its presence in the new generation of high and medium technology sectors starting with the value chains of information, bio- and nanotechnologies. The process of cultivating these new high-technology sectors must be properly intertwined with the existing structure and specialisation of Estonian economy. Otherwise the actual contribution of the new high-technology sectors to the growth of Estonia's standard of living will remain moderate despite the success of individual companies.

In the 1990s Estonian economy has gone through major structural changes and has seen a reduction in the number of jobs resulting from technological innovation. Nearly all sectors of industry (besides wood processing) have faced decline in employment and increase in social stratification that usually accompany technological and organisational advances. Too many poor people, however, can never be good for a country either in social or economic terms. This was noted already by Adam Smith in his *Wealth of Nations*.⁴

Creation of new jobs is, however, directly dependent upon the compatibility of existing skills and knowledge base as well as those offered by the educational and research system with the technological developments in the wider world and with the future structural changes in Estonia's economy. According to this logic the policies for modernising industry, educational and research system should, on the one hand, be sector specific. At the same time, they must also be very well coordinated in regard to each other. Establishing an effective system of vocational and continuing education and retraining as well as increasing funding for research and development are of equally critical value to the process of creating new jobs. Even so, none of these elements alone is able to bring about the structural changes needed in the society in order to shift towards knowledge-based economy.

Striving towards increased standard of living Estonia basically has to solve one of the core issues of development economics: how to make sure that the system for coordinating public and private sector investments take much better account of the global trends and long-term visions for Estonia's future than it has so far.⁵

⁴ Adam Smith, *The Wealth of Nations*, London, Campbell, [1776] 1991, Book I, VIII; American economist Arthur Okun noticed in his analysis of empirical data from 1960s that there was a virtually linear relation between the change in employment rates and real growth of economy expressed as gross national income (gross national product, GNP). A simple *Okun's law* based calculation shows that decreasing the number of unemployed in Estonia by roughly half (i.e. from the 2003 level of 10% down to 5%) would lead to a 15% increase in the gross national income. Measured in Estonia's 2003 indicators this would have meant nearly 16 billion EEK. See Arthur M. Okun, "Potential GNP: Its Measurement and Significance", American Statistical Association, Proceedings of the Business and Economics Section, 1962, 98-103.

⁵ See Ragnar Nurkse, „Some international aspects of the problem of economic development”, *The American Economic Review*, 42, 2, May 1952, 571-583.

1. Foundations of knowledge-based economic policy

1.1. Competitiveness and the structure of industry

Antonio Serra from Naples is apparently one of the first researchers to give an extensive explanation of the foundations of economic development. It is worth noting that even the title of his work published in 1613 is close in concept to what Estonia is interested in today: *A brief overview of reasons that may bring a lot of gold and silver to kingdoms where there are no mines*.⁶ How to secure welfare in a state that is small and does not have essential natural resources?

In slash and burn agriculture, even today's simplest Estonian horticulturist would be a great monopolist with an extremely large profit margin. With modern technologies, today's Estonian wood processors and clothing industries would have been very prosperous just one or a few centuries ago, but now they have to lay off more and more employees in the name of survival, which, in turn, creates new social problems. It is easy to predict that growing potatoes and sawing timber can be done in almost all countries of the world — we are on a perfectly competitive market where the primary components of competitive advantage are the relatively inexpensive labour and other production inputs, including natural resources.

Just like Serra, John Stuart Mill⁷, a classic liberal, and several other economists have also shown that agriculture (and service sector) can only flourish in a country that has a successful industry. The reasons are simple: **economic activities are not alike in terms of quality, and their quality decreases in time. In industry, just like in certain knowledge-intensive services, it is possible to achieve such returns to scale that are difficult or impossible to compete with in other sectors of economy.**⁸

The quality of economic activity or the possibility to receive income from it depends on its intensity in terms of knowledge, technology and skills. This gives rise to dynamic competition the primary characteristic of which is the asymmetry of market. In simple terms, this means that competing entrepreneurs do not know exactly how one or the other generates its product. This (partial) lack of information on the competitor's side gives a manufacturer its competitive advantage — he can penetrate larger markets and even achieve a monopoly status in certain markets or market segments for a limited period of time. This, in turn, allows him to dictate high prices on the market (since they are not determined by competition).⁹

Therefore, in the long term, economy does not develop aimlessly in a random direction, but moves step by step towards increasing productivity or economic activities with higher levels of quality. Growing economic competitiveness is, however, not only about creating the so-called high-technology sectors, but also about utilising the specific competitive advantages of that country and its economy, and about continued renewal of its existing industry.

Milk can be produced “manually” at a farmhouse, but when there is a dairy factory within the distance of 10 km, we can be quite sure that the farmhouse has no chance of being competitive, unless the local people are extremely environmentally sensitive or there are massive subsidies granted. At the same time, dairy industry has been the one sector with the largest productivity growth in the post-war Europe. A simple survey proves, however, that it is not the dairy producers, but the companies that manufacture dairy processing equipment that are the wealthiest. In fact, the better part of profits from the technological renewal in the dairy industry goes to technology manufacturers instead of dairy producers. Dairy producers compete on a highly competitive market, because milk itself is not a scarce resource and this is what makes producers

⁶ Antonio Serra, *Breve trattato delle cause che possono far abbondare li regni d'oro e argento dove non sono miniere*, Naples, Lazzaro Scoriggio, 1613; Sophus A. Reinert, Erik S. Reinert, „Early National Innovation System: The Case of Antonio Serra's 1613 *Breve Trattato*”, *Institutions and Economic Development/Istituzioni e Sviluppo Economico*, 1, 3, 2003.

⁷ John Stuart Mill, *Principles of Political Economy*, Oxford, Oxford University Press, [1848] 1998; Charles King, *The British Merchant or Commerce Preserv'd*, London, John Darby, 1721.

⁸ Erik S. Reinert, „The Role of the State in Economic Growth”, *Journal of Economic Studies*, 1999, 26, 4/5, 268-326.

⁹ This is the reason why the competition policies of both USA and the European Union that are otherwise extremely hostile to cartels still protect the companies that have today achieved a short-term monopoly status on the market via research and development. Without such protection of intellectual property, there would be no development. At the same time, no entrepreneur would want to rely on mere expectations that its competitors would agree to respect each other's intellectual property simply out of good will. This kind of respect can be enforced only by the state. In other words, the state motivates, via the protection of intellectual property, entrepreneurs to take on very high risks (product that is being developed might prove to be bad or unsuitable for consumers, etc) in order to engender as many companies as possible that have significant market power and competitive advantages.

increase their productivity. Since competition on this market is fierce, milk producers cannot “extract” income from the increased productivity by imposing higher prices on the market; instead, they have to cut costs and reduce prices.

This rationale is explicable by experience rather than theory: technological development that takes place in manufacturing industry leads to higher income; technological development in service sector and agriculture, on the other hand, leads to lower prices. An important reason for this phenomenon lies in the fact that in services and agricultural sectors technological advances are merely one of the inputs (in the form of new production equipment) that provides a competitive advantage just for a very limited time since the same input is easily available to other competitors. In industry, however, this very same technological solution is usually well protected by various means like patents, for instance, as the most typical protection mechanisms. Services and agricultural sectors are therefore characterised by fierce price competition, which, in turn, compels the developed countries to provide very high subsidies to their agricultural sectors.

Competition in industry, on the other hand, is significantly more dynamic and competitive advantages are much more profound in nature since they call for the presence of intensive development activities, broad educational basis, close interaction with and connections to subcontractors etc. In other words, while industry needs extensive specialisation or division of labour for its own development purposes, it simultaneously facilitates this process. If there is no suitable environment for industry to engender new value-added sub-elements (because, for example, there are not enough well-educated engineers) then industry itself will not evolve. This abstract industry might be very efficient and display vast export volumes, but in a situation like this it has become a mere link in the value-adding chain of some foreign cluster.

Since continued distribution of labour is also a precondition for further progress and since products can be protected against competitors, then competition in industry will not head towards price competition. Instead, it often shifts towards the opposite direction of so-called pay competition where progress provides opportunity as well as need to pay higher salaries to employees. Presence or emergence of a sufficient amount of such clustered industries will then lead to an overall rise in living standards. On the theoretical level economics has nearly always considered further distribution of labour as a source of economic growth.

Technological foundations of industry are in a constant state of evolution. This means that the economic characteristics of a certain technology change in time – a distinction is commonly made between high, medium and low technology in order to express this change of technology in time. The lower the level of technology the more important price competition becomes and the other way round: the higher the level of technology the more important are environment, education, development or, in other words, pay competition.

Based on the above, two observations are particularly important for Estonia:

- 1) Renewal of existing industry takes place on account of and through high technology, and it is in high-technology sectors where a large part of innovative profit (which is very large indeed) remains. Thus, if the renewal of existing industry is supported by high-technology sectors of the same country, a cluster-creating **virtuous circle** emerges where both existing industry and high-technology sectors earn more money. This, in turn, leads to an increased standard of living. If high technology, however, enters exploitation cycle via import, then it is the living standard of the exporting country that increases most. Traditional industries of the importing country become, indeed, more efficient, but not very sustainable, since the positive effect lies in the reduction of costs (for example, on account of labour force), which does not support an increase in the living standards of that country.

This is a typical development path that developing countries have been experiencing over the past twenty years with economic growth derived from one or two sectors that are usually intensive on either natural resource or low-cost labour, and, thus, no wide-scale increase in living standard is achieved.¹⁰ China, India, Taiwan, also Korea constitute a set of exceptions to this pattern. These countries often just

¹⁰ See, for instance, Vladimir Tikhomirov, „The 2nd Collapse of the Soviet Economy: Myths and Realities of the Russian Reform“, *Europe-Asia Studies*, 52, 2, 2000, 207-236; and Mario Cimoli and Marina Della Giusta, „A New Dualism Dimension in Processes of Economic Development: Loyalty or Voice for Latin America?“, Paper prepared for the Conference of the European Association for Evolutionary Political Economy “Comparing Economic Institutions”, Siena, Italy 8 – 11th November 2001, manuscript.

“ignore” the regulations of free market and copyright protection. However, this type of policy is becoming increasingly impossible in the world of globalising trade.¹¹

- 2) The lower the technological level of existing industry the tighter, nearly perfect, is competition on the market where this industry operates. All companies have essentially the same technology and knowledge base and no one can afford the extra costs of research and technology development. This leads to a situation where there is influx of modern (high) technology via import, and industry is, indeed, somewhat more efficient, but the living standard in the country hardly ever increases. The share of such low technology based industry is large in Estonia and a number of other Central and Eastern European countries.¹²

The general level of knowledge base (education, science) in countries with mostly low technology industry is usually also similar, i.e. rather weak. This means that domestic capacity to renew existing industry is low, too. If an effort is made to cultivate a modern high technology sector (for example, information technology or biotechnology etc) in a country like this, then the primary market for that sector is inevitably a foreign market. Although it is very beneficial to that particular high technology sector, it does not have much impact on the general economic development of the country. Unless strong domestic virtuous circles are created between the existing industry and a new high technology sector (for example, IT and biotechnology), it is essentially a state of simple export of the main “natural resource” of the 21st century – the brains – with no increase in the living standard of that country resulting from it.

These policies for modernising the structure of economy (i.e. industrial policy) are found not only among the historical and contemporary policies of all developed countries. They are just as much present in the postulates of *Self-Governing Estonia (Isemajandav Eesti - IME)* that was once enacted as a law, and thus makes them as valid in today’s legal framework. IME document was instigated in 1987 by Siim Kallas, Tiit Made, Edgar Savisaar and Mikk Titma in a yearning for independence from the Soviet Union, and it advocated the principles of modern market economy.¹³ Besides the introduction of national currency, IME document also postulated the vital goal of prioritising the development of high technology and knowledge and skills intensive sectors of production, quite the same way that all today’s developed countries once got engaged in systematic cultivation of skills intensive sectors of production. These views resemble the policies systematically pursued by the European Union in its implementation of the Lisbon strategy and establishment of new innovation and industrial policies for the enlarged Europe.¹⁴ Evidently these must be the universal principles of economic policy.

It is not the least surprising that the European Union assigned Estonia the task to develop and start implementing a coherent industrial policy already before the accession: “*There is still a need to complete the development of a comprehensive industrial policy, and to define and implement specific measures in this framework. Estonia should continue its efforts and set clear priorities in collaboration with the business community, the financial sector and other relevant stakeholders.*”¹⁵ Since this policy belongs to the domain where the European Union’s competence is limited to the open method of coordination and main responsibility for devising and implementing policies rests with the member countries, the absence of such policies did not hinder Estonia’s becoming a member of the European Union. The only problem lies in the fact that without this policy and with the continuation of current specialisation trends, Estonia is unlikely to ever catch up with the level of economic development in the European Union, the US or the “Asian Tigers”.¹⁶

¹¹ For further reading, see Sanjaya Lall, „Industrial success and failure in a globalized world“, 2003, manuscript.

¹² Peter Havlik, *Productivity Catch-up and Export Specialisation in CEE Manufacturing Industry*, WIIW, May 2001.

¹³ See the Act “Principles of Self-Governing Estonia”, ÜVT 1989, 18, 223, <http://seadus.ibs.ee/aktid/%FCn.s.19890518.1922.19890518.html> (in Estonian); Adalbert Knöbl, Andres Sutt, Basil Zavoico, *The Estonian Currency Board: Its Introduction and Role in the Early Success of Estonia’s Transition to a Market Economy*, IMF Working Papers, WP/02/96.

¹⁴ *Industrial Policy in an Enlarged Europe*, Commission of the European Communities, Brussels, COM(2002) 714 final.

¹⁵ *2002 Regular report on Estonia’s progress towards accession*, Commission of European Communities, COM(2002) 700 final, http://europa.eu.int/comm/enlargement/report2002/ee_en.pdf. The same position was repeated in the report published by the European Commission on 5.11.2003: *Comprehensive monitoring report on Estonia’s preparations for membership*.

¹⁶ Johannes Stephan, *Industrial specialization and productivity catch-up in CEECs, patterns and prospects*, IWH, June 2002, 16, <http://www.iwh-halle.de/projects/productivity-gap/>.

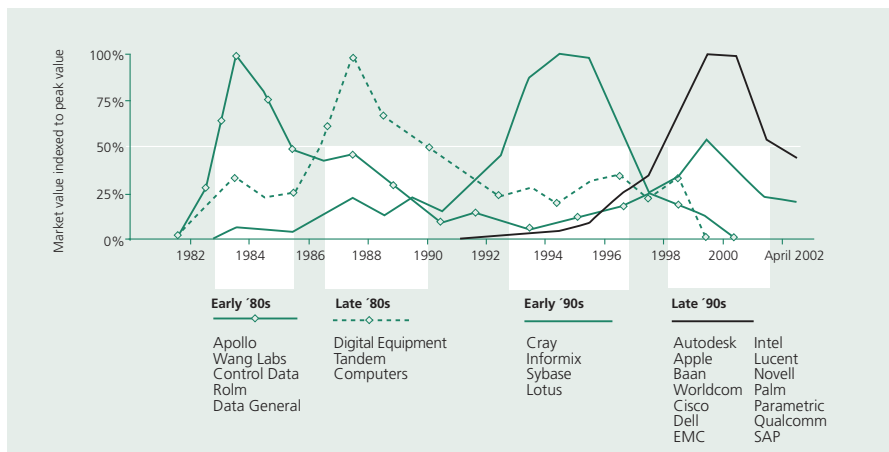
1.2. Socio-economic development and techno-economic paradigms

Economic development is not smooth and linear, but proceeds dynamically with sudden leaps. In the second half of the 19th century, analysis of business cycles was one of the favourite pursuits of many economists. The concept of business cycle is based on the knowledge, obtained through relatively uncomplicated observations, that economic growth is not linear. Instead, economic growth slows down after each 5–6 year period and then continues in a fresh frenzy. Karl Marx explained this with overproduction, but the first one who attempted to give a comprehensive explanation of a business cycle was Ukrainian-born economist Mikhail Tugan-Baranovski.¹⁷ He explained the business cycle in terms of interplay between financial sector and production sector, where financial capital always seeks economic activities with ever higher quality since distribution of knowledge makes competitive advantages derived from research diminish quickly.¹⁸

Despite the infinite faith into „the new economy” that overtook the world in the end of the 1990s, the value of the historic wisdom described above has by no means faded.¹⁹ Analysis of the developments in the last decades of the 20th century continues to illustrate that virtually all high technology companies, even the biggest market leaders, who focus on one specific product have to face extremely short lifecycles.

Most high technology companies experience 3 or 4 years of miraculous growth and profits, which is often followed by a no less remarkable collapse. In the second half of the 1980s, for instance, it was *Digital Equipment Corporation, Wang, Control Data* and *Tandem* that were the true world leaders in information technology; *Cray, Sybase* and *Informix* all managed to both rise and fall within the first half of the 1990s. By the end of the decade *Lucent, Palm, Parametric, Novell* and others had taken over as market leaders. (Figure 1)

Figure 1. Technological development and economic cycles.



Source: Mercer Management Consulting, December 2003, http://www.mercermc.com/Books/HowToGrow/traditional_techtrouble.asp.

It is important to note that the fate of specific companies does not necessarily quite coincide with economic business cycles or fluctuations in stock exchange prices. Instead, changes in the market value of a company are related to the saturation of its product market, competitors' attacks and shifts in the priorities of its

¹⁷ Tugan-Baranovski, *Osnovõ polititseskoï ekonomii*, 3rd ed., St. Petersburg, 1915; see also Vincent Barnett, „Tugan-Baranovski as a Pioneer of Trade Cycle Analysis”, *Journal of the History of Economic Thought*, 23, 4, 2001.

¹⁸ John Maynar Keynes' demand driven economic policy is actually an extension of this very reasoning. According to his theory, government should be investing precisely during the downfall phase of business cycle in order to keep the economy from descending into crisis.

¹⁹ A similar stock market bubble and the following crash in the USA of late 1920s was later even the subject of many mordant jokes – everyone buying stocks supposedly received a revolver for free, and hotel owners enquired while booking rooms: „to sleep or jump?” (sic), see Robert Heilbroner, *The worldly philosophers. The lives, times, and ideas of the great economic thinkers*, Touchstone Books, 7th ed., 1999, 250.

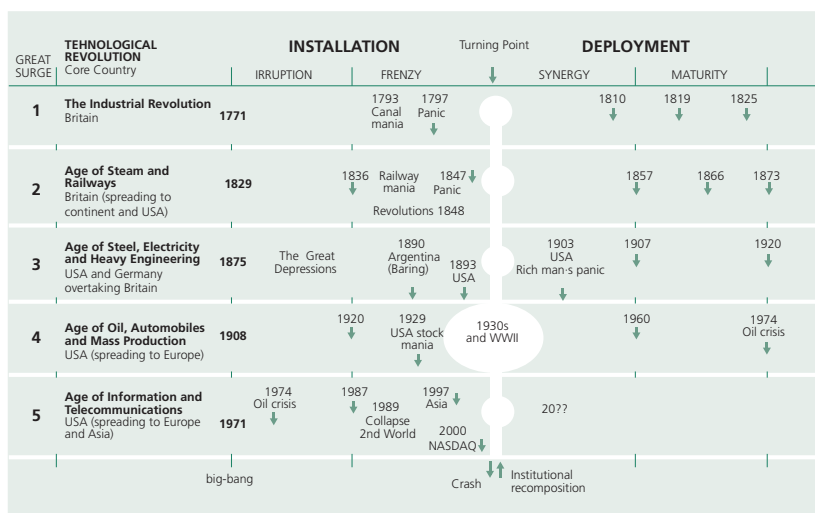
clients. It is thus important to learn from the above that a business relying on (high) technology product development is extremely unstable by nature and requires a strong strategy.²⁰

Technological advantages once gained will disappear within a relatively short time period. Every new generation of a product is based on small incremental improvements. At the same time, this whole business is essentially jeopardised by new technologies. Tape cassette replacing record (LP) in the music industry, for instance, illustrates these developments. CDs and DVDs took over later, and now they, in turn, are threatened by completely different internet based dissemination and sales systems.

This shift between product generations driven by new knowledge and values, and, in turn, demanding change in the broader institutional environment, is what causes the cyclic nature of socio-economic development.²¹ Contemporary economics shows that business cycles, again, converge into longer waves that have their own internal structural logic and last for about half a century. These waves are called techno-economic paradigms.²² Paradigms emerge as a result of certain radical scientific inventions and enormously massive investments made towards their commercialisation and wide-scale utilisation of their corresponding productivity increasing technologies.²³

Foundations to the explosively rapid development of the past couple of hundred years of the capitalist economy²⁴ were laid by the British industrial revolution (1790-1840s), which was followed by the age of steam and railways (1840-1890s), the age of electricity and steel (1890-1940s) and the so-called Fordism or the age of mass production (1940-1990s). The techno-economic paradigm of information technology that was going through rapid development in the 1990s has thus reached the turning point that comes right after the burst of a financial bubble. (Figure 2)

Figure 2. Evolution of techno-economic paradigms and economic crises.



Source: Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, Cheltenham - Northampton, MA, Edward Elgar Publishers, 2002.

²⁰ Michael E. Porter, *Competitive strategy*, Free Press, 1998.

²¹ 2004 Nobel prize laureates in economics Edward Prescott and Finn Kydland have demonstrated that 70% of the cyclic nature of American economy in the period after the Second World War resulted from technological developments.

²² The first one to prove this was Nikolai Kondratjev, a student of Tugan-Baranovski; see „Die langen Wellen der Konjunktur“, *Archiv für Sozialwissenschaft und Sozialpolitik*, 56, 3, 1926, 573-609 and „The long waves in economic life“, *Readings in Business Cycle Theory*, Philadelphia – Toronto, Blakiston, 1944, 20-42. See also Christopher Freeman and Francisco Louçã, *As time goes by – From the Industrial Revolutions to the Information Revolution*, Oxford, Oxford University Press, 2001; Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, Cheltenham - Northampton, MA, Edward Elgar Publishers, 2002.

²³ For a brief overview see the video recording of a presentation given by Carlota Perez at a seminar held on 27th September 2002 in Tallinn, at the Ministry of Economic Affairs and Communications <http://www.praxis.ee/innovation/workshop/>.

²⁴ Angus Madisson, *The World Economy: Millennial Perspective*, OECD, Paris 2001.

The most important lesson we can learn at this point from the above historic experience is that information and communication technologies based productivity growth and economic development are by no means exhausted yet. Events that took place a few years ago in this technology sector resemble the crash of the canal building mania in England and elsewhere during the first half of the industrial revolution; by 1847-1848 railroad construction boom had led England and the US into a comparable situation.

These episodes most certainly did not denote the end of either the industrial revolution or the age of steam engines. Likewise, the collapse of NASDAQ stock index in no way implies that information society is now complete or that the potential for socio-economic development embedded in the information and communication technologies is somehow exhausted. Information technology sector that now yields highest productivity growth thus infiltrates into other sectors with information technology performing as an enabling tool, and triggers introduction of organisational (replacing hierarchical structures with networks, for instance) and financial innovations (various derivative instruments).

History of economics reveals that paradigms last for nearly half a century. First they evolve at an explosive rate in a narrow field of technology until the technology offers so many different possibilities of use and has become so cheap as to enable virtually all branches of industry to rapidly increase their productivity.

The first – installation – period of a paradigm is ruled by financial capital,²⁵ which is boosted by the more liberal economic environment (incl. capital markets!). History has demonstrated that after the speculative boom that always emerges in the middle of a paradigm as a result of excessive investment, and the following collapse, cash flows often shift towards second and third world countries that have different economic structure. Thus economic rise and fall eventually also reach them. Production capital takes over the lead position in the following development. As a result, attention in economic policy shifts more towards regulating supply and/or demand side of the economy. While focusing on these policies governments very often forget about reinforcing strict monetary policy and macroeconomic balance, which, in turn, may lead to collapses resulting from overproduction. These alternations in the lead role in economic development occupied first by financial and then by production capital, including the impact of paradigms on social and political trends, to a large extent also explain historic shifts from liberal trade policy to more protectionist periods and back — during the 20th century as well as earlier.²⁶

The internal logic behind the evolution of paradigms operates in a very similar fashion to the way new industrial branches emerge within paradigms (Figure 3):

- In phase one, it is inevitable that due to limited dissemination of knowledge only very few companies are able to make use of the considerably improved technologies, which have been created in the process of scientific research and may have taken several years or decades to materialise²⁷, and to generate applications for the new emerging markets. This creates extremely asymmetric markets where products are completely unique, all solutions are protected by patents and clients are forced to pay the price that is basically as high as whatever the seller fancies to ask for the product. This is an easy way to give rise to monopoly markets where “the winner takes all” and where there is consequently much to win but just as much to lose.

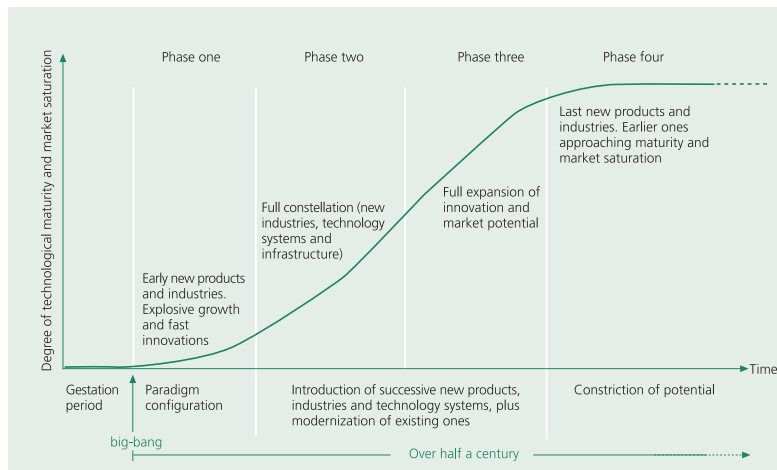
²⁵ Carlota Perez's techno-economic paradigm approach also offers a possibility to interpret the emergence and collapse of the Soviet Union in relation to the triumph and exhaustion of mass production paradigm that dominated the better part of the 20th century. During the *perestroika* period the Central Committee of the CPSU understood very well that „success in external economic activities is only possible through extensive exploitation of scientific and technical advances, relevant training for the cadre, overtaking of new markets and other similar activities” (see *NLKP Keskkomitee pleenumi materjalid, 27-28. jaanuaril 1987* („Proceedings of the plenum of CPSU Central Committee, 27-28 January 1987”), Tallinn, Eesti Raamat 1987, 62). But the Soviet model was based exclusively on the command-controlled economy and was lacking the complementary free financial capital, which would have allowed for investments separate from the existing economic structure to stimulate new paradigm based economic activities. As a fatal coincidence the new information and communication technologies driven paradigm also happened to contradict directly the profound ideological convictions of the Soviet block that had locked itself behind an „iron curtain”. (Seminars by Carlota Perez held on 24-25th April 2003 in Tallinn).

²⁶ For further insights into the role of financial capital and innovation see especially Leonardo Burlamaqui, “Schumpeterian Competition, Financial Innovation and Financial Fragility: An Exercise in Blending Evolutionary Economics with Minsky's Macrofinance”, 2000, <http://les1.man.ac.uk/cric/schumpeter/papers/6.pdf>; and Hyman Minsky, “Uncertainty and the Institutional Structure of Capitalist Economies”, Jerome Levy Institute, Working paper No. 155, 1996, 33.

²⁷ These are typically massive long-term investments into basic research made by public sector, international corporations or small knowledge-based companies.

- In the following phase, the quality of these innovative products becomes fit for mass consumption; emerging competition and decrease in prices lead to explosive growth of market, and massive amounts of new infrastructure is being constructed. This is also the time when the largest profits are extracted from this market. That type of explosive growth occurred in the mobile communications sector in the second half of the 1990s, which largely accounts for the phenomenal economic growth Finland experienced at that time. Finland “cashed in” full profits from the investments made into telecommunications related research and development, first mostly by the government and later increasingly by private companies.

Figure 3. Life cycle of a technological revolution.



Source: Carlota Perez, *Technological Revolutions and Financial Capital. The Dynamics of Bubbles and Golden Ages*, Cheltenham - Northampton, MA, Edward Elgar Publishers, 2002.

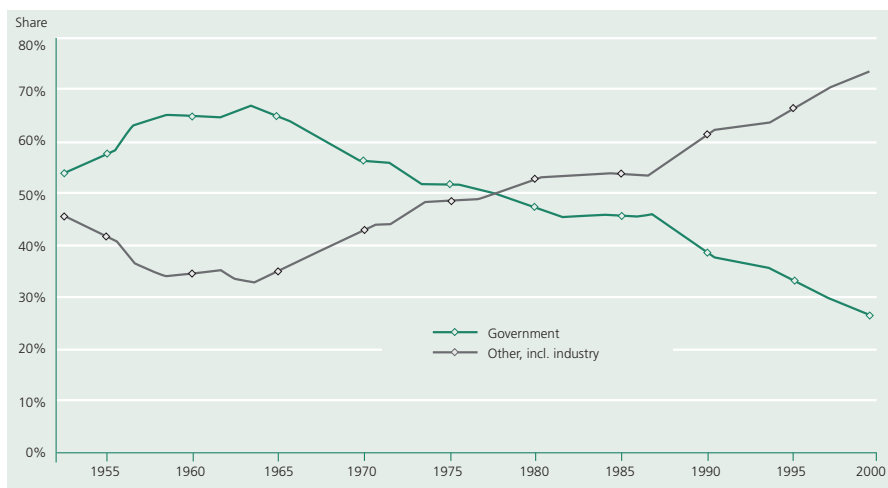
- Further development of the technology leads to the convergence of solutions offered by different manufacturers. Since all participants on the market can now offer identical solutions in regard to main functions, then the user does not really care anymore whether a particular mobile phone is created in the research and development laboratories of one or another company. In this period, at the latest, standards are established on the market that allow for combination or replacement of solutions developed by various producers. As the markets occupied first are becoming saturated, production as well as further development of existing products is simultaneously transferred to developing countries and/or other continents, i.e. closer to new markets and cheaper labour force.²⁸
- Eventually the potential of the innovative technology that once initiated the development becomes completely exhausted. Respective industries, that are now already of low technological level, get transferred to less developed countries. Innovative technologies and products once again start dominating the economic activities.

Economic competitiveness of a small country is thus evidently based on: a) the increasing share of medium and high technology companies in the generation of added value and particularly in export, and b) the actual nature and quality of the knowledge and technology base of these companies. In other words, are we in the right paradigm or are we just trying to use low-cost labour to succeed in the framework of an old paradigm, and thus implementing and developing technologies that generate no more of a major growth in productivity?

²⁸ The above approach to socio-economic development also helps to explain why over the past decades the share of service sector has significantly grown in the economies of advanced countries. Under the circumstances of globalisation and free movement of capital, goods and services, it is reasonable to organise production in such a manner that the largest possible share of strategic research and product development and knowledge-based services are kept as close as possible to company headquarters while the better part of routine assembly line and other similar functions get transferred into regions where the cost of labour is lower and that are, at the same time, located as close as possible to the destination markets.

It will probably come as no surprise to anyone, by now, that for the past 200 years USA has essentially been the most successful country in developing its economy right in line with the paradigm framework. Alexander Hamilton's *Report on Manufacturers*²⁹ and the increasing investments by the current US administration into future technologies share the common feature of focusing on constant renewal of economic structure and environment along the lines of technological development.³⁰ This situation is well illustrated on Figure 4, which shows that in the gestation and early stages of a new paradigm government investments into research and development constitute a much larger share than those of the non-governmental sectors. This share decreases remarkably by the point when technology has reached the level where private sector can already earn significant profits and continue to invest on its own.

Figure 4. Research and development funding in USA 1953-2000 (shares).



Source: National Patterns of R&D Resources: 2000, National Science Foundation.

At the same time, rapid dissemination of knowledge and technology (especially in the developed world) means that the productivity gained from a certain technology cannot continue to grow endlessly. Its slowdown occurs in inverse proportion to the dissemination of technology, since competition is growing fiercer and the potential of the relevant technology is becoming exhausted. In this situation a renewed growth in productivity is derived from a new technology and its corresponding paradigm. This new technology once again gives rise to asymmetric markets and division of knowledge. Therefore research, development and innovation policies must always adhere to the specific technology and its development stage.³¹

1.3. Innovation and cluster-based economic policy

As demonstrated above, the quality of economic activities or their knowledge and skills intensity changes over time. Maintaining and increasing a country's standard of living is thereby only possible via the renewal of existing competitive advantages and continuous movement towards new emerging or rapidly developing knowledge-based markets.

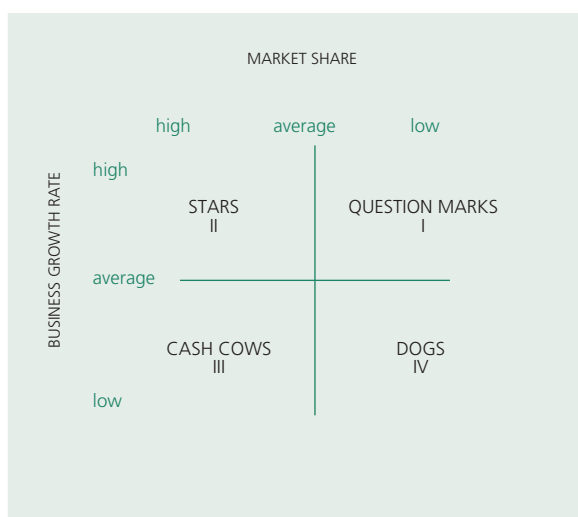
²⁹ Alexander Hamilton, *Report on Manufactures, Essential Documents in American History, Essential Documents*, 1492-Present, 1.

³⁰ We should also remember that in USA it is not only the federal government but also the state level that invest into future technologies and advancement of business.

³¹ Marek Tiits, Rainer Kattel, Tarmo Kalvet, *The Estonian Economy. Competitiveness and Future Outlooks*, Research and Development Council, Tallinn 2003.

The core strategy for the entire social and economic development is continuous investment in scientific research required for the conception and development of new, hopefully emerging industries (so-called “question marks”). The objective is to become a “star” by gaining a favourable competitive position (patents etc) and as large as possible market capacity by the time the new market reaches its growth phase. As time passes, growth of this new market will slow down. Knowledge intensity is no more the primary means of gaining market control, and market share of the company, size of this market share, power of trademark, chances of arranging production at as low costs as possible etc become significantly more important. These markets become “cash cows” where a favourable market position still allows for reaping fairly good profits, but such opportunities are generally about to get exhausted. (Figure 5)

Figure 5. Matrix of growth and market share.



Source: *Perspectives on Experience*, Boston Consulting Group, Boston, MA, 1974.

Depending on the specific field of science and technology, advanced countries mostly invest in research and development with a view to possible breakthrough in 3–10 years time, but investments with significantly longer time horizon are not unusual either. Such long-term contributions towards future entail considerable risks at all times. Since there is no way to predict future it can always happen that the breakthrough expected in a particular field will never be achieved.

Markets with slowing pace of growth, where a company has only attained a relatively weak position (so-called „dogs”), are better left behind early on since the chances for achieving either growth or profits on such markets are gradually declining. Government, at the same time, has to create opportunities for employing the released labour as well as capital in some new field.

The choice of which new markets the entrepreneurs will attempt to enter in a free market situation is not predictable with much certainty, but it is not completely arbitrary either. In a capitalist economy entrepreneurs are operating in free market conditions that are determined by direct market forces as much as they are by chance and decisive government policy (or lack of it).

Development of a country as a whole and increased welfare of its people thus requires striking a certain balance between market and government. Lack of decisive government policy is therefore just as bad as command economy type of „excessive regulation”, since both entail lost opportunities for development and pointless complications for private entrepreneurs.

Adam Smith, the founder of modern economic theory and policy introduces the concept „invisible hand” in *The Wealth of Nations*³², his main work on economic theory. Even today it is still the most widely used phrase for describing the mechanisms of free market. Adam Smith believed that self-regulation by the market is one of the components of the broader social system.³³ He describes how it is only **after** the necessary preconditions for economic development are established³⁴ that the resulting economic progress leads to the emergence of the „invisible hand” effect – economy seems to be developing and growing automatically, giving rise to increasing specialisation and facilitating the development of domestic economy, where this much regulation and other kind of state intervention is therefore not necessary anymore.³⁵

Business opportunities and profitability of investments for a specific entrepreneur are thereby directly dependent upon the earlier developments in that region. Progress in science and technology, in economic and social spheres, and in natural environment, all full of unexpected twists and turns, casts an endless line of new business opportunities into the hands of entrepreneurs. Ability of each individual entrepreneur to make the best of these opportunities will, however, largely depend on factors external to direct market competition. Existing human factor, availability of natural resources, market power of big corporations in monopoly position, and other aspects can either hinder or facilitate the exploitation of these opportunities.³⁶

Essentially the same idea is advocated by some of the more recent thinkers like John Williamson, author of the economic reforms’ package that became widely known as the „Washington Consensus”, and Francis Fukuyama, author of the famous book „The End of History”. Welfare of a country depends on its broader institutional and socio-economic environment that defines free market.³⁷

Then again, the knowledge of how to construe the emergence of new economic sectors and how to use decisive economic policy to establish a favourable economic environment to facilitate their evolution is, however, quite well known across the globe as well as easily accessible. In his *Principles of Economics* that he published in 1890 Alfred Marshall devoted a whole chapter to “industrial quarters”, which he defined as a geographically concentrated set of industries that have specialised in a specific field.³⁸ A century later, a neo-Marshallist approach surfaced again in the form of modern, cluster-based economic theory in the works of Harvard University Professor Michael Porter. It should not come as much of a surprise that Ireland was the first country to implement Porter’s theory in the 1990s.³⁹

Porter’s theory is now widely used for economic policy planning in North-American, Scandinavian and other advanced countries. His theory states that the evolution and competitiveness of economic clusters, i.e. certain groups of industry that are located in close geographic proximity, depend on four interacting factors of the so-called “Porter’s diamond”: a) firm strategy, structure and rivalry; b) quality of available human resources and infrastructure; c) factors influencing market demand; d) availability and development of related and supporting sectors.⁴⁰ (Figure 6)

³² Adam Smith, *The Wealth of Nations*, London, Campbell, [1776] 1991.

³³ See also Robert Heilbroner, *The Worldly Philosophers, The lives, times, and ideas of the great economic thinkers*, Touchstone Books, 7th ed, 1999.

³⁴ Smith interpreted the establishment of necessary preconditions for development in terms of the country’s broader socio-economic context that guides the evolution of free market. This context also included the mercantilistic protective mechanisms (especially customs) that England applied to defend its internal market and industry.

³⁵ Adam Smith, *The Wealth of Nations*, Volume 4, Chapter II, 399; see also Erik S. Reinert, “The Role of the State in Economic Growth”. *Journal of Economic Studies*, 1999, vol. 26, issue 4/5, 268-326. Friedrich List and his works from the 19th century have played an important role in the development of an industrial policy section in economic policy. He was the first one to articulate the need for infant industry protection, and said that it is only when the necessary skills and production volumes are established that the economy should shift towards the open market logic. In essence, List has also articulated how the whole catching-up logic made a significant contribution to Germany’s development in the second half of the 19th century. See, for instance, *Das natürliche System der politischen Ökonomie*, [1837]1927, 280-289.

³⁶ W. B. Arthur, ‘Self-reinforcing Mechanisms in Economics’, in P.W. Anderson, K. Arrow, D. Pines (eds.), *The Economy as Evolving Complex System*, Redwood City, California: Addison Wesley 1988, 9-31.

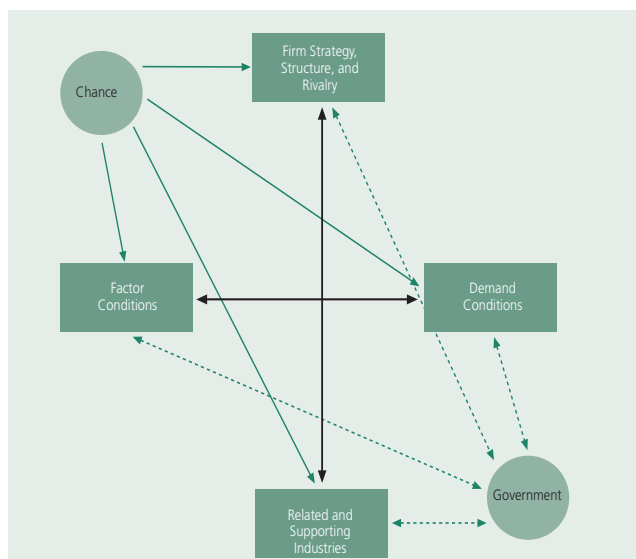
³⁷ Francis Fukuyama, *State Building: Governance and World Order in the Twenty-first Century*, Profile Books 2004; For a more detailed account of the role of government and external factors in economic development see, for example: Paul M. Romer, ‘Increasing Returns and Long-Run Growth’, *Journal of Political Economy*, 1986, 94, 5 (October 1986), 1002-1037; Ha-Joon Chang, *Globalisation, Economic Development and the Role of the State*, Zed Books 2003.

³⁸ Piirro Formica, *Industry and Knowledge clusters: Principles, Practices, Policy*, Tartu, Tartu University Press, 2003.

³⁹ Lars Mjøsset, *The Irish Economy in a Comparative Institutional Perspective*, Irish National Economic and Social Council, No. 93, 1992.

⁴⁰ Michael E. Porter, *The Competitive Advantage of Nations*, London, Macmillan, 1990.

Figure 6. „Porter’s diamond” depicting main factors influencing the evolution of economic clusters.



Source: Michael E. Porter, *The Competitive Advantage of Nations*, London, Macmillan, 1990.

Most important among these factors is the availability and generation of top quality human resources in respective sectors. Necessary preconditions can be provided only through a modern educational and research system. **Government demand for specific education and research is one of the main instruments besides classic economic policy methods that can and must be used to steer change in the structure of economy towards generating higher knowledge-intensity, i.e. higher level of value added. This is where government plays the central role, since it is only the government that has the capacity to do this.**

The core message of this approach does not diverge from that of the other theories of economic development that have become classics by now. Their uniform view is that the primary engine of socio-economic development resides in innovation and growth in the knowledge-intensity of economy.⁴¹

Timely investment in the creation of the necessary knowledge base for the future needs of an economic cluster opens up certain windows of opportunity for entering economic sectors that grow faster, rely on suitable level of technology and promise greater profits.⁴² Such a knowledge base thereby also creates prospects for the evolution of a high-technology export oriented industry in the respective sector. All other impacts resulting from economic environment play an equally important role in the development of companies that have already established themselves on the market as well as in the emergence and evolution of clusters.

One of the causes for the problems Estonian labour market is currently facing resides in the fact that the country has not prepared itself for the transformations in labour demand that inevitably accompany structural changes in economy. Then again, preparations for modernising economy must always be forward-looking in

⁴¹ According to Joseph A. Schumpeter (one of the most important theoreticians of all times in the field of innovation), technological change drives economic development. However, it is not the technology itself that develops economy, but the entrepreneurs who seek, find and exploit new solutions and opportunities (innovation). Joseph A. Schumpeter, „The economy as a whole. Seventh Chapter of the theory of economic development”, *Industry and Innovation*, 2002, 1/2, 93-145; On the role of knowledge in economy see, for example *Managing National Innovation Systems*, OECD, Paris 1999; R.A.Boschma, G.A.van der Knaap, „New high-tech industries and windows of locational opportunity: the role of labour markets and knowledge institutions during the industrial era”, *Geografiska Annaler*, 81b, 2, 1999, 73-89.

⁴² R.A.Boschma, G.A.van der Knaap, „New high-tech industries and windows of locational opportunity: the role of labour markets and knowledge institutions during the industrial era”, *Geografiska Annaler*, 81b, 2, 1999, 73-89.

their nature, and there is not much sense in adjusting Estonian educational and research system to the currently existing low technology based economy (although this seems to be what the market is calling for).

There is virtually no local clustering in either Estonian industry or research landscape. On the other hand, successful Estonian companies are getting increasingly integrated into Nordic clusters. The above-mentioned logic of economic development tells us that one of the primary tasks of public policy is to facilitate clustering. Actual situation in Estonia, however, implies that the chances for domestic clustering are essentially utopic in either short or medium term (5-15 years). What options does a country have in a situation like this?

1.4. Varying policy needs of countries in different stages of development

The top five technologically most advanced countries in the world, whose population comprises only 10% of the total population on the Earth, produced approximately 41% of the global gross national product in 1995. At the same time, 69% of world population live in countries that are not capable of any technological innovation, and the total gross national product of these countries accounts for 38% of the gross national product of the whole world. In one of his treatises Jeffrey Sachs has classified the world according to three groups – developers of new technologies, their appliers and the outsiders incapable of one or the other.⁴³ What would the latter benefit from having research and innovation policy, and should they be thinking about it in the first place?

Adam Smith has articulated what is today known as a classic insight: if economy is to develop and grow, different institutional mechanisms are to be implemented in different stages of economic development. Smith also outlines the gravest mistake a country can make in the development of its economy⁴⁴ – implementing policies that do not correspond to the country's level of development, for instance, excessively liberal economic policy in a country with low export capacity.⁴⁵

Countries with the world's highest standard of living are the leaders of economic development, and they have achieved this position because their domestic research and technological development are at the absolute top level of the world. All these countries have one or several industries that control a large share of the respective global market where they dictate the highest possible price.⁴⁶ The more freedom there is in the world for the movement of capital, goods and services, the more extensive economies of scale these industries and economies enjoy. Continuous new advances at the cutting edge of research and technology are indispensable for maintaining the living standard and economic – and frequently also (geo)political and military – position of these countries. Headquarters of the majority of international corporations are also located in these countries.

In the modern world, it is the big corporations, who surpass many countries in regard to their economic power, that partially, yet not by far completely, take over the long-term future oriented investment (research and development etc) functions associated with the „invisible hand”, while in a small catching-up country such functions can be performed only by the government. A catching-up country simply does not have any other mechanism to execute these functions, since its market comprises small companies planning their business in the maximum of 0.5-1 year timeframe thus lacking both sufficient knowledge and capital for such tasks.⁴⁷

In Sachs' classification the group of catching-up countries capable of absorbing modern technology comprises countries that have managed to create or maintain from earlier times a sufficiently favourable economic environment. They have enough social and human capital to be capable of applying relatively early on the new technologies created elsewhere. This group includes also Estonia whose economic success over the past

⁴³ Jeffrey Sachs, „A New Map of the World“, *The Economist*, 22.06.2000.

⁴⁴ This argument works in Estonian context as well – foreign trade deficit has not disappeared within the past ten years.

⁴⁵ Adam Smith, *The Wealth of Nations*, Volume 4, Chapter II, 399; see also Erik S. Reinert, „The Role of the State in Economic Growth. *Journal of Economic Studies*”, 1999, vol. 26, issue 4/5, 268-326.

⁴⁶ Michael E. Porter, *The Competitive Advantage of Nations*, London, Macmillan, 1990.

⁴⁷ This does not imply that people filling certain positions are somehow automatically smarter than others nor that the government could perform these functions alone independent from the market. – Neoclassic economic theory says that this is a classic market failure situation. Several other modern economic theories, on the other hand, are of the view (partially on the grounds of Serra's idealistic tradition of active government) that the very definition of government entails certain obligation to nurture the most favorable conditions possible for sustainable socio-economic development.

decade derives mostly from its capacity to attract foreign investments that have brought the capital needed for development, and have helped make the economy more effective. There is no realistic way for these countries to leap overnight into developing cutting-edge high technology based industries.

The main challenge facing Porter's investment-based economies of catching-up countries (incl. Estonia) lies in their capability to be innovative while learning to use and develop the latest imported technologies, simultaneously with establishing domestic industry that is competitive on international markets.⁴⁸ Degree studies and research are critical to countries in this phase of development for enhancing the quality of human resources and establishing the basis for future new high technology industries and economic sectors.⁴⁹ At the same time, these processes also require far-reaching support from economic policy.

If competitive advantages are not being continuously renewed there will not be enough of high quality productive resources, and the stimulus to domestic productive investments as well as to the influx of foreign investments will diminish or disappear. At some point potentially available domestic and international resources for investment will be exhausted, and further additions are not possible. A particularly dramatic representation of these developments is manifested, for instance, in a whole range of African countries, but also in Mongolia and elsewhere.

Nevertheless, it should also be kept in mind that the structure of an economy cannot be changed overnight. Path dependency is intrinsic and important to both successful catch-up and unsuccessful economic development. In the case of Estonia the desire to rapidly forget about where we come from is completely reasonable; yet understanding the meaning of the extensive alteration of the economic environment that took place in 1991-1992 is critical to today's and even more to future strategies of economic development. Majority of companies found themselves and emerged in the environment that surpassed them by several decades; there was clearly no way to simultaneously survive under these extremely liberal circumstances and make significant investments into knowledge etc. Same applies to consumption habits, labour market, financial services⁵⁰ etc. Not only has Estonia's economy and society dramatically changed over the ten years, but certain institutional frameworks have emerged and become established. The latter will be critical preconditions for development also in the coming 5-10 years. Estonian entrepreneurs will not engage overnight in knowledge and skills-intensive production (be it potato harvester or breast cancer medication).

Even a failed attempt at high technology development can make into a project that is extremely beneficial for a country like Estonia – but only if government stops acting as a bystander and engages vigorously in generating and supporting entrepreneurship also in sectors related to the specific high technology. For example, in the case of biotechnology, these related sectors can range from pharmaceutical and chemicals industries up to food and wood processing industries. In other words, the government would have to implement cluster-based economic policy. In such a case, even a failed high technology project generates new links between entrepreneurs, scientists and officials; developments and reforms take place, for instance, in the system of vocational education and in labour market policies etc. A new contender or **an entrepreneur** can take advantage of all this. The government has already borne part of the risks on his and his competitor's behalf. This is not to suggest that the government has to allocate some sort of subsistence allowances. Instead, the government should provide Estonian entrepreneurs as favourable conditions for business as developed countries do.

In summary, the logic of industry development goes as follows: high technology sectors are developed by decisive public policies – from research funding to patent subsidies and venture capital – that are, however, grounded in the needs and opportunities of that specific country and society, which are, in turn, determined by the existing industry structure and skills level. Industrial and innovation policies must always be twofold covering both high technology and existing industries. This is the only way that clusters and thereby virtuous circles can emerge, successively leading to increased standard of living.

⁴⁸ In his classic book *The Competitive Advantage of Nations* that was published in 1990 Michael Porter calls this phase of economic development investment-based, and speaks of innovation-based economic model in reference to developed countries. Yet modern (OECD and others) approach to the concept of innovation is much broader, encompassing also technology transfer, organisational transformation, financial innovation etc that constitute the basis for economic development in the investment-based economy.

⁴⁹ Moses Abramovitz, *Thinking About Growth*, Cambridge, Cambridge University Press, 1989; Michael E. Porter, *The Competitive Advantage of Nations*, London, Macmillan, 1990.

⁵⁰ On this point see Andres Juhkam, "Financial innovations in Estonia", PRAXIS Working Paper 6/2003.

1.5. Specifics of the catching-up strategy in small states

Recognition of certain resource restrictions that exist in socio-economic development and need to be taken into consideration while elaborating public policies is not at all new. The first one to cite the scarcity of (natural) resources as a limiting factor to economic growth was Malthus. In 1817, during the final phase of British industrial revolution, David Ricardo published *The Principles of Political Economy and Taxation* that explicated these mechanisms in greater detail, and concurrently put forward an original theory of economic development, which highlighted capital accumulation in modern industry as the engine of economic development.⁵¹

Since successful socio-economic development is grounded in investment into new high technology industries and in simultaneous modernisation of traditional sectors, small states nowadays, unfortunately, find themselves in a particularly complicated situation with their strategic choices strained by the two simultaneous developments. On the one hand, limited resources and growing complexity of developing basic technologies for high technology sectors impede small states from establishing a sufficiently strong infrastructure for research and development. Small (domestic) market does not permit entrepreneurs to make sizeable and ever increasing investments into research and development, especially under the conditions of shortening product life cycles and tightening competition.

On the other hand, global market for low and medium technology products is increasingly dominated by the scale and cost advantaged and rapidly industrialising South East Asian „tigers”, China, and India with Russia most likely to join them in the longer run.⁵² Consequently smaller scale of production together with relatively higher transaction costs make it generally rather difficult for small countries to compete on production costs also in traditional sectors. This forces otherwise equally advanced industries into seeking export opportunities and/or establishing foreign production bases earlier than it would happen in larger countries. This pressure on domestic companies to internationalise quickly should not be automatically viewed as a weakness of a national innovation system, but rather as a special feature that relates to small size.

Overcoming all these pressures requires that small countries make as optimal use of technology and market globalisation as they can by implementing appropriate policies to modernise local competencies and technological base. On the whole, to enhance their human resources and competitiveness through research and development European small countries have to choose between the following strategies:⁵³

I. Investing in the development and commercialisation of basic technologies

This strategy is common in large countries, but Sweden and Switzerland have also tried it, though unsuccessfully. Implementing it in a small country requires extreme mobilisation of resources, meaning essentially extensive reorganisation of the whole economy according to the strategic objectives set by technology and industrial policies.

II. Observing the policies of big corporations and subsidising their strategic choices

This strategy has been adopted by the Netherlands, though not always successfully implemented. This is *de facto* a national champion strategy, which presupposes that one or more big corporations have located their headquarters in that country. Focusing on the interests of big corporation(s) might turn out to have adverse impact on small and medium sized enterprises that are not able to keep pace with the speed of technological development. Production rationalisation decisions by big corporations can also lead to sudden changes in labour market.

⁵¹ Yujiro Hayami, *Development Economics. From Poverty to the Wealth of Nations*, Oxford, Clarendon Press 2000, 66-67.

⁵² Cees van Beers, *The role of foreign direct investment on small countries' competitive and technological position*, Government Institute of Economic Research, Helsinki 2003, <http://extranet.vatt.fi/knoggg/Reports/t100.pdf>; About China's massive industrialisation since 1950s see also: Angus Maddison, *The World Economy: Millennial Perspective*, OECD, Paris, 2001, 43.

⁵³ Cees van Beers, *The role of foreign direct investment on small countries' competitive and technological position*, Government Institute of Economic Research, Helsinki 2003, 8-9.

III. Focusing on rapid application of new knowledge and skills, and supporting investment in specific technology niches

This strategy proves successful only when the small country has a clear understanding of its strengths and weaknesses, and is able to respond to changes in the market competition in a timely manner. Broadly speaking, the longer the country waits, the less options it will have, and the more expensive the catching up with more developed countries becomes.

It was already explained above (see Ch 1.2) that basic research requires very long term investments forcing a small country into extreme resource mobilisation. In addition, there is no 1:1 linear causality between investments into basic research and successful spin-off into economy or emergence of high technology industry. It must be remembered that the choice of developing basic technologies involves long term and extremely large investments in actual numbers into the supposedly emerging „winner takes all” type of markets. Therefore, this strategy is not really an option for a country with a medium or low standard of living.

Although Estonia does not headquarter any multinational corporations, experiences of Ireland, Malaysia, Singapore and others have demonstrated that in certain circumstances the same role can be performed by „the right kind” of foreign direct investments. Implementing this strategy, however, requires exceptionally professional and determined public policy development; including enforcement of convergence between the policy of attracting high technology focused foreign direct investments and the existing structure of economy, and a proactive technology transfer policy to ensure that the know-how accompanying the foreign direct investments actually gets passed on to domestic enterprises.

Analysis of the evolution of Finnish telecommunications industry over the past half-century, on the other hand, reveals an excellent example of how focusing on a specific technological niche resulted in a successful breakthrough into the world market and establishment of a multinational corporation deeply rooted in Finnish domestic base. Even though nobody could foresee such developments several decades ago, Nokia's success in 1990s actually goes all the way back to the efforts of developing Finnish military radio communications systems in the 1960s.⁵⁴

Likewise, many of Estonian scientific achievements that have triggered vigorous commercialisation efforts in recent years have, in fact, resulted from investments made into higher education and research no less than 10-20 years ago. The volume of Estonia's annual investment in research and development is equivalent to some big corporation's weekly research and development expenditures; and Estonia's scientific workforce of approximately 3,000 researchers (in full-time equivalents) is comparable to some medium-sized lab in Europe or the US. Even if Estonia did manage to rapidly increase its investments to the level of 3-4 per cent of GDP, we would still remain but a very modest contestant on the international scale. Yet Estonia's existing research and innovation policy has undertaken to follow the assumption that Estonia is just as big a player as the US or the European Union are.⁵⁵

While large countries are undeniably the ones to determine the direction of scientific and technology development, the limited resources available to Estonia inevitably force the country into setting priorities and thereby taking on very substantial risks. This makes systematic forward thinking unavoidable for a small country (or a smaller region of a large country). In this regard it is of particular importance to develop human resources not in line with the existing structure of the economy and the limited domestic market, but according to the desired direction of foreign investments and evolution of global economy.⁵⁶

⁵⁴ Martin Fransman, *Knowledge and sectoral innovation systems: the mobile communications industry evolved largely by getting things wrong*, http://www.ie.ufrj.br/globelics/pdfs/GLOBELICS_0028_MartinFransman.PDF

⁵⁵ The above does not, however, mean that investment into basic research is either insignificant or unnecessary for a small country. Yet, it would be rather short-sighted of us to hope that every kroon or euro invested into research can be cashed out as profit earned in the same economy without carrying out any changes in its structure. Ensuring the quality of higher education, including degree studies etc is what should rather be expected as the primary output of such investments.

⁵⁶ See Alan Rugman, Joseph R D'Cruz, "The Double Diamond Model: Canada's Experience", *Management International Review*, 33, 1993; Leo van Grunsven, Chris van Egeraat, "Achievements of the Industrial 'High-road' and clustering Strategies in Singapore and Their Relevance to European Peripheral Economies", *European Planning Studies*, 7, 2, 1999.

2. Key areas of research and technology

2.1. Future visions for information, bio- and nanotechnology – 2015-2020

The US National Science Foundation, RAND Corporation, the US National Intelligence Council,⁵⁷ European Commission, various large corporations and many others involved in developing future scenarios all envisage a major information, bio- and nanotechnology and cognitive sciences based techno-economic revolution in the coming 10-20 years time. This revolution will radically change virtually all fields of our everyday life, and will simultaneously offer opportunities for faster economic development than any other area of research and technology would. In a way, information, bio- and nanotechnologies can be viewed as horizontal technologies that promise significant productivity growth in all fields of life and all branches of economy.⁵⁸

In the same vein, Estonian research and development strategy *Knowledge-based Estonia 2002-2006*⁵⁹ outlines the same areas of information technology and development of information society, biomedicine, and materials technologies as key areas of research, technology development and innovation that open up a whole range of new opportunities for economic development. This must not, however, mean that the country will narrow-mindedly focus on (high) technology or macroeconomic growth estimates alone, and forget all about the surrounding reality together with Estonia's current strengths and weaknesses. Quite the opposite – the objective of *Knowledge-based Estonia* strategy is that all fields of everyday life develop through the prioritised development of the aforementioned technologies and their extensive application. Alas, so far, no clear understanding has emerged in Estonia about what will be those areas where we expect rapid socio-economic development to take place, nurtured by global advances in research and technology, of which we might take advantage by smartly committing our limited resources.

The founder and Chairman Emeritus of Intel Corporation Gordon Moore noted already in 1965 that the number of transistors that fit on Intel microprocessor doubles in about every 18 months, and this pattern, nowadays called Moore's Law, predicts exponential growth in the number of transistors a microcircuit can hold.⁶⁰ This trend for the number of transistors to double every couple of years, which, in turn, allows for decreasing the size of electronic components and growing computation capacity, has continued for decades – while *Intel 8008* microprocessor, created in 1972, only held 2500 transistors, the contemporary *Itanium2* microprocessor already holds more than 400 million transistors. *NEC Corporation* recently announced that it has developed currently the world's smallest transistor with a gate length of about 5 nanometres, the size of which is only one-eighteenth of the previous transistors. This means that a microcircuit of one cubic centimetre can hold about 40 billion such new transistors. It is anticipated that these microcircuits should reach the market in around 2020. *Intel* itself also believes that this trend should generally persist for another 10-15 years when the existing methods for decreasing the size of transistors will hit their physical limits.⁶¹

Continuous rapid growth in computation and storage capacity, speed of data transmission etc will keep opening up opportunities for the emergence of new applications that were once thought inconceivable. This trend for persistent growth in computation capacity means that the performance of a computer equivalent to today's average personal computer will reach the level of information processing capacity of one human being already by the year 2010, and by the year 2020 it will be equal to the aggregate of the whole population of planet Earth.⁶² Although the social acceptability of these technologies is ethically questionable due to the blurring of boundaries between human and computer, technological developments are already unlocking the path to the use of various miniature implants injected straight into brain to enhance human capacities, for instance, by improving a person's information storage capacity, computation and language skills etc.⁶³

⁵⁷ See *National Science Foundation*, <http://www.nsf.gov/>; *Rand Corporation*, <http://www.rand.org/>; *U.S. National Intelligence Council*, <http://www.cia.gov/nic/>.

⁵⁸ See e.g. Philip S. Anton, Richard Silbergitt and James Schneider, *The Global Technology Revolution: Bio/nano/materials. Trends and Synergies with Information Technology by 2015*, RAND Corporation, <http://www.rand.org/publications/MR/MR1307/MR1307.pdf>, 2001.

⁵⁹ *Teadmistepõhine Eesti. Eesti teadus- ja arendustegevuse strateegia 2002-2006*, RTI 2001, 97, 606.

⁶⁰ Gordon E. Moore, "Cramming More Components Onto Integrated Circuits", *Electronics*, 19.04.1965, <http://download.intel.com/research/silicon/moorespaper.pdf>.

⁶¹ See e.g. *NEC Develops World's Smallest Transistor*, IDG News Service, 08.12.2003, http://www.infoworld.com/article/03/12/08/HNnectransistor_1.html; Victor V. Zhirnov, Ralph K. Cavin, James A. Hutchby and George I. Bourianoff, *Limits to Binary Logic Switch Scaling – A Gedanken Model*, Proceedings of IEEE, 91, 11.11.2003, <http://www.intel.com/research/documents/Bourianoff-Proc-IEEE-Limits.pdf>; "Intel prepares for next 20 years of chip making", *Computerworld*, 25.10.2004, <http://www.computerworld.com/printthis/2004/0,4814,96917,00.html>; Stephen Baker, "Nano and Chips: Uneasy Ties", *BusinessWeek*, 07.02.2005, http://www.businessweek.com/technology/content/feb2005/tc2005027_4712_tc119.htm.

⁶² See Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, New York: Penguin Books 2000.

⁶³ Michael C. Roco and William Sims Bainbridge (eds), *Converging Technologies for Improving Human Performance*, World Technology Evaluation Centre, http://www.wtec.org/ConvergingTechnologies/Report/NBIC_report.pdf, 2002.

Various research and development projects currently under way as well as the amendments being introduced into legislation in different locations across the world are solid proof of these developments not being a mere science fiction. Development of ID-card type of personal identification devices that can be implanted in human body has already been in progress for years, and now the US Food and Drug Administration (FDA) has officially confirmed their safety for use in various identification, security and financial applications. FDA has also granted permission for human clinical trials of brain implants that make it possible to use brainpower to give commands to computers. In Europe there are also several *cyborg* projects that have been in full swing for several years now.⁶⁴

Moreover, a technology chief from The Defence Advanced Research Projects Agency (DARPA) in the US believes that the Agency can build a thinking robot by 2030. Various field elements of the robot's artificial intelligence, such as reasoning and speech recognition, will most likely be completed much sooner.⁶⁵

Sensors that can be integrated into clothing, electronic ink, disposable paperboard computers produced in Sweden,⁶⁶ cubic millimetre sized wireless networks of minute computers (Smart Dust)⁶⁷ used in environmental monitoring and other areas as well as other devices are early examples of this kind of drastic shrinking in the size of computer technology, and of the continuing extraordinarily rapid evolution of information technology. Ray Kurzweil describes possible developments as follows: „*Computers are now largely invisible. People routinely use three-dimensional displays built into their glasses, or contact lenses. These “direct eye” displays create highly realistic, virtual visual environments overlaying the “real” environment. This display technology projects images directly onto the human retina, exceeds the resolution of human vision, and is widely used regardless of visual impairment. . . . Computers routinely include wireless technology to plug into the ever-present worldwide network, providing reliable, instantly available, very-high-bandwidth communication.*“⁶⁸

The prerequisite to continued evolution of information technology is, however, embedded in the sustained development of microelectronics and materials technologies (Figure 8). Just like the invention of transistors 55 years ago created the technological preconditions for the emergence of contemporary electronics industry and of the whole information technology paradigm, reports about the creation of certain early molecular transistors and memory devices⁶⁹ are a similar sign of possible dramatic changes in the structure of information technology systems that will hit their physical limits in some very distant future.⁷⁰ Yet the link between information, bio- and nanotechnologies works also in the opposite direction. Evolution of information technology is, in turn, a precondition for the development of novel bio- and nanotechnologies that perform sufficiently well and are suitable for application on a massive scale

For example, the equipment nowadays needed for DNA synthesis costs approximately 10,000 USD, but its price is decreasing rather rapidly due to technological advances, and thereby makes such „tools” more broadly accessible. This implies that the expected persistence in the growth of the capacity of computation technology described by Moore's Law will bring about fairly dramatic changes in the coming decade or so, both in biotechnology research and in the potential social and economic perception of biotechnology.

While the Human Genome Project took 13 years to complete the sequencing of human genome in 2000, growth in technological capacity described above implies that by the year 2010 every individual would be potentially able to sequence or synthesise 10^{10} pairs a day. And in ten years time the sequencing of an individual's DNA will take merely a few seconds. Comparison of these developments in biotechnology with the nowadays popular open-source software, such a *Linux* and others, would easily suggest that the world is moving towards „open-source” biological systems, i.e. they are available for modification by anyone.⁷¹ (Figure 7)

⁶⁴ See *U.S. Food and Drug Administration*, <http://www.fda.gov>; Kevin Warwick, 'Identity and Privacy Issues raised by Biomedical Implants'. *IPTS Report 67: 29-34*, European Commission Joint Research Centre 2002, <http://www.jrc.es/pages/iptsreport/vol67/english/IPTS676.html>.

⁶⁵ See Frank Tiboni, „DARPA tech chief envisions the future”, *Federal Computer Week*, 19.04.2004, <http://www.fcw.com/fcw/articles/2004/0419/feat-brachman-04-19-04.asp>.

⁶⁶ See David Gardner, „It had to happen: the disposable computer”, *TechWeb.com*, 04.03.2004, <http://www.techweb.com/wire/story/TWB20040304S0005> and <http://www.cypak.com>.

⁶⁷ Jim Butler, „Mobile Robots as Gateways into Wireless Sensor Networks”, *Deviceforge.com*, 02.05.2003, <http://deviceforge.com/articles/AT2705574735.html>.

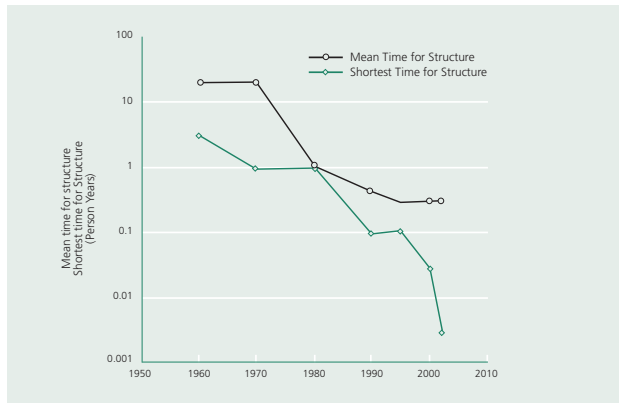
⁶⁸ Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, New York: Penguin Books 2000.

⁶⁹ E.g. a molecular memory device with the potential of holding 40 GB per square centimeter, for details see http://www.eurekalert.org/pub_releases/2004-04/uosc-spn042004.php.

⁷⁰ See e.g. Peter Weiss, „Shrinking toward the Ultimate Transistor”, *Science News*, 10. 08.2002.

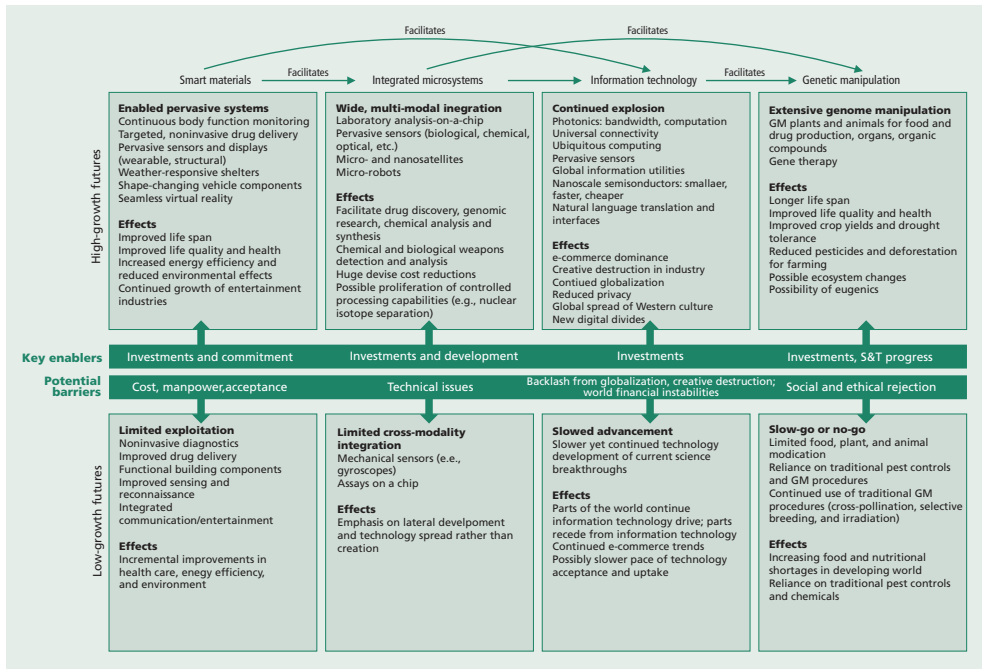
⁷¹ See Robert Carlson, „Open-source Biology and Its Impact on Industry”, *IEEE Spectrum*, 2004; Robert Carlson, „The Pace and Proliferation of Biological Technologies”, *Biosecurity and Bioterrorism: biodefense strategy, practice and science*, 1, 3, 2003.

Figure 7. Time for DNA sequencing and synthesis (person years).



Source: Robert Carlson, „The Pace and Proliferation of Biological Technologies”, *Biosecurity and Bioterrorism: biodefence strategy, practice and science*, 1, 3, 2003.

Figure 8. Potential interacting areas of materials technologies, microelectronics, information and gene technology by 2015.



Source: Philip S. Anton, Richard Silbergitt and James Schneider, *The Global Technology Revolution: Bio/nano/materials. Trends and Synergies with Information Technology by 2015*, RAND Corporation, <http://www.rand.org/publications/MR/MR1307/MR1307.pdf>, 2001, 37.

Broadly speaking, the objective in developing nano- and biotechnology is to have technology open up dramatically novel opportunities for people to shape the diversity of materials and living organisms. In the natural environment, diversity exists in places where it has emerged during the evolutionary process; the goal of bio- and nanotechnology is to create devices that enable people to generate and exploit the diversity of nature at a time and place they choose to.

50 years have passed since first successful organ transplant on a human being, and the scientific ambitions cultivated in the field of biotechnology have, by now, reached way beyond this level. There are various rather significant projects currently in progress all around the world that strive to produce “spare parts” for human beings by means of biotechnology. So for instance, scientists at the University of Manchester are actually developing an inkjet printer type of device that is able to “print out” tailor-made human cells to fit a patient’s exact dimensions.⁷² Scientists in *Johns Hopkins Medicine* believe they are close to being able to create biological pacemakers on the basis of genetically engineered heart cells developed from human embryonic stem cells, and thereby replace today’s rather inconvenient electronic pacemaker.

Kurzweil describes one possible image of future: “*Direct neural pathways have been perfected for high-bandwidth connection to the human brain. ... there is extensive use of communication using direct neural connections. This allows virtual, all-enveloping tactile communication to take place ...*”⁷³

One of the very trends in today’s technological thinking is to imitate the operating principles of nature in information technology (networks of nerves, genetic algorithms etc) as well as in all other spheres of everyday life. So for instance, *Nexia Biotechnologies* in Quebec, Canada produces „spider silk” from goat milk, and by imitating the structure of spider web they could create, for example, bullet-proof clothing that covers the whole body.⁷⁴ A counterbalance to this would be another well-known natural phenomenon found in the wings of certain butterflies that makes clothing invisible even to night vision equipment, for instance.

The most tangible indication of the development of these three key areas of technology having a dramatic and unavoidable impact on the world in the coming decades is the decision by the governments of USA, Japan and many others to rapidly increase the volume of research and development funding for bio- and nanotechnology. (see Ch 2.4 and 4.5).⁷⁵

Yet, on the whole, these changes are of the kind that no one remotely concerned about the future and personal privacy of him- or herself or their children should remain indifferent to. While changes in the natural environment result from evolution and struggle for existence determines the general direction, development of science and technology lacks such an external limiting factor like evolution. Therefore the human being must be its own regulator able to determine the proper path for technology and other means that it manipulates. Thus the future of technology is important in regard to economy just as much as it matters in social and ethical terms. Whereas information technology is already being extensively exploited, we still have no clue about the actual capacity of bio- and nanotechnology, about the true intentions of entrepreneurs, about possible consumer reactions etc. This all makes the tasks facing policy-makers, scientists and entrepreneurs unprecedentedly complex.⁷⁶

It is the more important then, for the future of Estonia, to cautiously estimate at least some trends in what and how the global development of research and technology (for the most part unaffected by Estonia) will influence, and what individual developments might mean or hold out for Estonia. Staying informed about these global trends is one of the major functions of Estonian research even if we are not able to make a fast profit in one or another field of research. The only two choices Estonia has are either to follow the global trends or degenerate.

⁷² About a possible biological pacemaker and biotechnology-based spare parts for human beings see also http://www.hopkinsmedicine.org/Press_releases/2004/12_20_04.html; “Skin and bones ‘made to measure’”, *BBC News*, 18.01.2005, http://news.bbc.co.uk/2/hi/uk_news/england/manchester/4184627.stm.

⁷³ Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*, New York: Penguin Books, 2000.

⁷⁴ See <http://nexiabioitech.com/>.

⁷⁵ See also Brad Wieners, „Eight Technologies That Will Change the World”, *Business 2.0*, June 2002, <http://www.business2.com/b2/web/articles/0,17863,514755,00.html>.

⁷⁶ On this point, it must be added that many of the information, bio- and nanotechnology related innovations and experiments have today also become particularly important in connection with the current war on terror.

2.2. Development of information technology and information society

Extensive spread of Internet and modern personal computers is, by far, not a sign of the end of information technology revolution – quite the opposite, in economic terms it is only getting started.⁷⁷ In the context of techno-economic paradigms (Figure 2 in Ch 1.2) the year 2005 means that the information technology related financial bubble has already burst (2001) and that we are currently entering the „golden age“ of information technology that is characterised by synergy and continuing of profound social and economic changes due to expanding application of information technology; this stage is estimated to last 20–30 years.⁷⁸ Various analysts claim that information technology is one the primary means of achieving economic development since it is supposed to account for approximately 50% of recent economic growth.⁷⁹

Up to the year 2020 key trends in the development of information and communication technologies will include not only the aforementioned convergence of materials technologies, microelectronics, information and biotechnology (see Ch 2.5), but also the realisation of the concept of Ambient Intelligence, which, in turn, leads to dramatic developments, for instance, in the public sector (e-government, e-democracy etc), services sector (e-services etc) as well as manufacturing sectors.

The concept of Ambient Intelligence (AmI),⁸⁰ which is based on the idea of ubiquitous computing, is at the very heart of all the various information technology sector related technology overviews and strategies developed by the European Commission for the year 2020 as well as other equivalent analyses. This concept was originally introduced by Marc Weiser, computer scientist in *Palo Alto Research Center* (Xerox PARC) already in 1988:

Since we started this work at Xerox Palo Alto Research Parc (PARC) in 1988 a few places have begun work on this possible next-generation computing environment in which each person is continually interacting with hundreds of nearby wirelessly interconnected computers. The goal is to achieve the most effective kind of technology, that which is essentially invisible to the user. To bring computers to this point while retaining their power will require radically new kinds of computers of all sizes and shapes to be available to each person. I call this future world „Ubiquitous Computing“.⁸¹

European Union's approach to AmI is, however, a further expansion of the Ubiquitous Computing concept comprising not only Ubiquitous Computing (1) and Ubiquitous Communication (2), but also the emergence of Intelligent User Friendly Interfaces (3).

The first one implies a change in paradigm where development moves from central mainframe computing towards personal computers, palm pilots and computers integrated into various objects. As a result, embedded information technology systems will be surrounding us everywhere. This will be complemented by object-to-object communication, including convergence and compatibility of infrastructure systems, broadband wireless connection, digital broadcasting, satellite connection etc. Interfaces (sensors, speech recognition, biometry etc) constitute the third pillar of AmI. Their most important characteristic is user-friendliness or, in other words, the environment created for the communication between humans and the virtual world must be such that it resembles in every way possible the reality of people's everyday life with no computer

⁷⁷ Due to diverging stages of economic development Estonia and Finland have different interpretations for the concept of *policy for information society*: in Estonia, information society related discussions focus on a more widespread application of Internet and mainly imported information technologies (*Tiger Leap* program of supplying schools with computers, e-government etc); in Finland, on the other hand, information society strategy has mostly emphasised the development of relevant domestic industry, broader socio-economic development and related innovations (economically sound application of new solutions).

⁷⁸ Carlota Perez, *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*, Cheltenham, UK: Edward Elgar, 2002.

⁷⁹ See e.g. OECD, *The OECD Information Technology Outlook 2004*, 2005, Paris: OECD; *Facing the Challenge, The Lisbon Strategy for Growth and Employment*, Report from the High Level Group chaired by Wim Kok, 03. 11.2004, http://europa.eu.int/comm/lisbon_strategy/pdf/2004-1866-EN-complet.pdf; PriceWaterhouseCoopers, *Rethinking the European ICT Agenda. Ten ICT-breakthroughs for Reaching Lisbon Goals*, 2004.

⁸⁰ See e.g. *Ambient Intelligence: from Vision to Reality*, ISTAG, September 2003, ftp://ftp.cordis.lu/pub/ist/docs/istag-ist2003_draft_consolidated_report.pdf; *Strategic Orientations and Priorities for IST in FP6*, IST Advisory Group, June 2002, ftp://ftp.cordis.lu/pub/ist/docs/istag_kk4402456encfull.pdf; *Software Technologies, Embedded Systems and Distributed Systems*, June 2002, IST Advisory Group ftp://ftp.cordis.lu/pub/ist/docs/istag_kk4402472encfull.pdf.

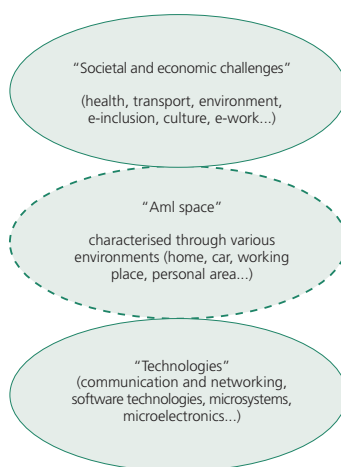
⁸¹ Marc Weiser, "Some Computer Science Issues in Ubiquitous Computing", *Communications of the ACM*, 1993, 36, 7, 75-84, 75.

mice, keyboards or display screens. Therefore it is a far-reaching vision about the future development of the Information Society where the emphasis is on greater user-friendliness, more efficient services support, user-empowerment, and support of human interactions.⁸²

Information Society Technologies Advisory Group (ISTAG) anticipates the realisation of this vision already by 2010: by that time people should be surrounded by intelligent intuitive interfaces that are embedded in all kinds of objects; AmI is capable of recognising and responding to the presence of different individuals, it operates in a seamless, unobtrusive and often invisible way.

In the context provided by Marc Weiser, ISTAG's AmI vision presents nothing radically new. Then again, in addition to techno-economic efficiency Europe has always paid more attention to the broader social context than America does.⁸³ Along these lines ISTAG has adopted a three-layered model where the societal and economic challenges are located in the upper layer, technologies in the lower layer, and the two are linked together by Ambient Intelligence. (Figure 9)

Figure 9. „Ambient Intelligence”, technologies and socio-economic challenges.



Source: IST Advisory Group, *Strategic Orientations and Priorities for IST in FP6*, 2002, ftp://ftp.cordis.lu/pub/ist/docs/istag_kk4402456encfull.pdf, 17.

Realisation of this vision entails AmI meeting the following technology requirements: very unobtrusive hardware; a seamless mobile/fixed communications infrastructure; dynamic and massively distributed device networks; natural feeling human interfaces (including the use and design of new software applications and materials); and dependability and security. Societal and economic challenges, in turn, influence the development of technologies and are currently very important for Europe, including issues like aging population, health care, cultural diversity, learning patterns, administrative matters and security etc.⁸⁴

⁸² For an illustrative example see *Scenarios for Ambient Intelligence in 2010*, Sevilla: IPTS, IST Society Technologies Advisory Group (ISTAG), 2001; see also *Valjavõte Infoühiskonna Tehnoloogiate Nõukogu (ISTAG) raportist "Näiteid ümbrisevast intellektist – visiooni aastaks 2010"* [An excerpt from the Information Society Technologies Advisory Group (ISTAG) report „Scenarios for Ambient Intelligence in 2010”], 2002, http://www.esis.ee/eVikings/foresight/Visioonid_final.pdf, translation into Estonian by SA Archimedes 2001.

⁸³ Compare also, for instance, the principles of scientific management developed by Frederick Winslow Taylor in the USA of the early decades of the 20th century, and the discourses on the philosophy of administration by such British philosophers as Oliver Sheldon, Josiah Charles Stamp and others; Rosamund Thomas, *The British Philosophy of Administration*, Cambridge: CBPSE, 1989.

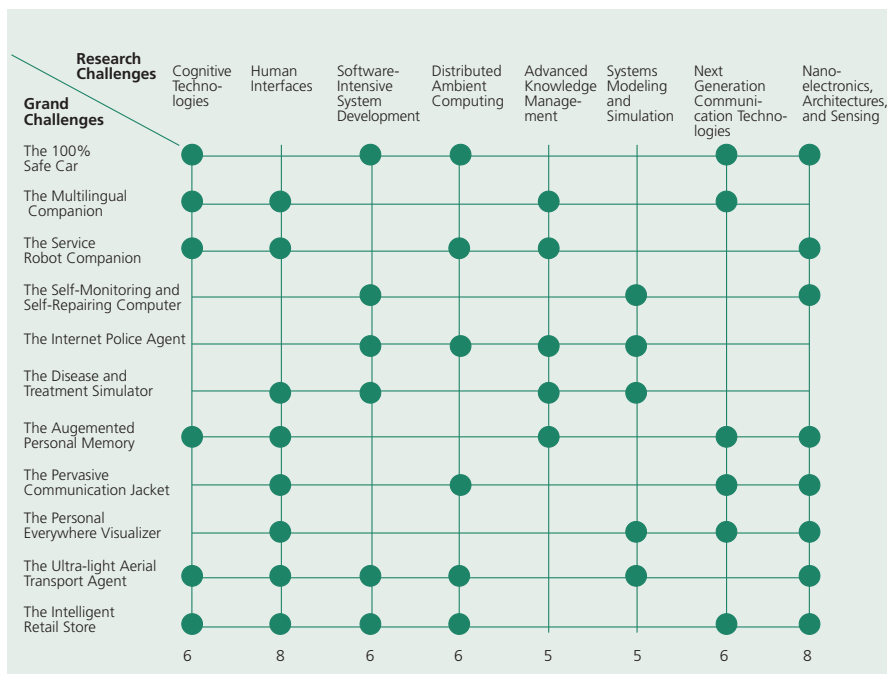
⁸⁴ For a detailed account of European Information Society scenarios see e.g. Rafael Popper, Ian Miles, Lawrence Green, Kieron Flanagan, *Information Society Technologies Futures Forum: Overview of Selected European IST Scenario Reports*, http://fistera.jrc.es/docs/Scenario_Pool_version_11.6.pdf, 2004.

A few of the applications developed in Estonia have already caught attention on the global scale (e.g. online banking, e-government), and vigorous advances in similar applications (e.g. applications operating through mobile communications infrastructure, e-health care) create further opportunities for realising Ambient Intelligence.

Yet, just like in any other situation there are threats that cannot be discarded. All these applications now being developed are linked to local services sector where the research intensity of innovations and thereby also the opportunity to protect these applications with patents, for instance, is much more limited in comparison to manufacturing sectors, and they are therefore more exposed to imitators (Ch 1.5). In addition, at this time the small size of domestic market significantly curbs the growth of companies as well as opportunities for launching knowledge intensive services.⁸⁵

Realisation of the AmI vision in the coming decade will require a great deal of further scientific research and technology development in various fields. (Figure 10)

Figure 10. Grand challenges and research trends.



Source: IST Advisory Group, *Grand Challenges in the Evolution of the Information Society*, 2004, <http://ftp.cordis.lu/pub/ist/docs/fet/7fp-pre-6.pdf>, 11.

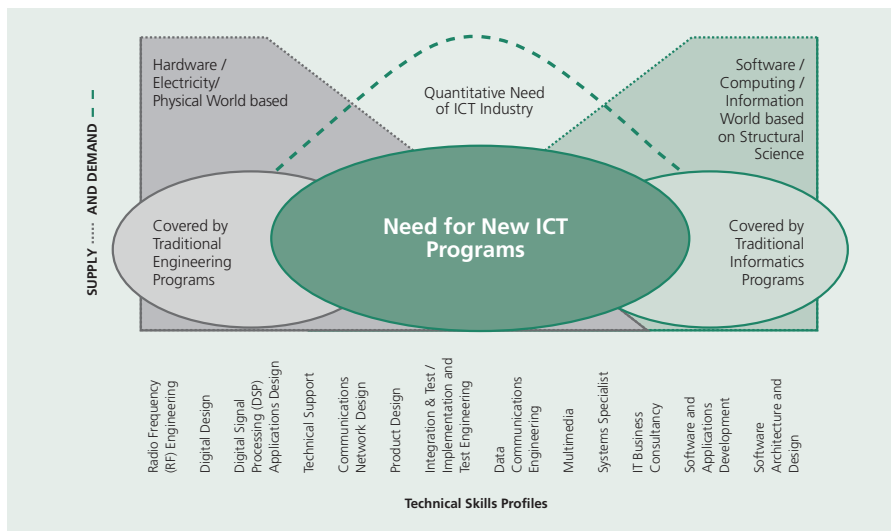
Approximately 100 information technology component or system trajectories up to the year 2020 have been forecasted within the framework of FISTERA (*Thematic Network on Foresight on Information Society Technologies in the European Research Area*) project. The forecasts are outlined in four layers: technology, its functionality, related services and the „ambient”.⁸⁶

⁸⁵ Rainer Kattel and Tarmo Kalvet, *Teadmistepõhine majandus ning infotehnoloogialane haridus: hetkeolukord ning väljakutsed haridussüsteemile aastani 2008* [Knowledge-Based Economy and Information Technology Education: Existing Conditions and Challenges Facing the Educational System up to the Year 2008], PRAXIS Center for Policy Studies, 2005.

⁸⁶ *Key European Technology Trajectories*, Telecom Italia Lab, 2003, <http://fistera.jrc.es/docs/D22&appendix.pdf>; the interactive tool is available on: <http://fistera.telecomitalialab.com/#>.

An additional, but a no less important trend is the ever more interdisciplinary character of research and education. Thus, a cross-European evaluation of ICT curricula in relation to generic skills profiles was undertaken within the framework of Career Space project⁸⁷. One of the more important problems outlined in this study was the fact that most information technology curricula have grown out of traditional study and research fields – physics and engineering sciences on the one hand, and mathematics and informatics on the other – while today’s industry needs a synthesis of both fields and more. Since contemporary information technology companies not only produce, install and maintain information technology applications and systems, but have to be well versed in business processes and capable of envisaging relevant applications in this context as well, then solid foundations in both engineering and informatics must be complemented by a broader systems perspective for embracing all other fields – therefore both traditional engineering and informatics oriented curricula are needed along with more interdisciplinary and combined curricula.⁸⁸ (Figure 11)

Figure 11. The profile of ICT industry needs depicting new curricula in comparison to the existing ones.



Source: *Curriculum Development Guidelines, New ICT Curricula for the 21st Century Designing Tomorrow's Education*, Career Space and International Co-operation Europe Ltd, 2001, <http://www.career-space.com/cdguide/serv2.htm>.

2.3. Biotechnology

Discussions about the possible impact of biotechnology commonly use the classification of biotechnology into the so-called green, red and white biotechnology. The first one denotes agricultural (e.g. plants that are more resistant to various weather conditions), the second one medical (e.g. more effective medications), and the third one industrial (e.g. enzymes for producing plastic) biotechnology.

⁸⁷ *Career Space* is a European Union partnership consortium with the world's leading information and communication technology companies – *BT, Cisco Systems, IBM Europe, Intel, Microsoft Europe, Nokia, Nortel Networks, Philips Semiconductors, Siemens AG, Telefonica S.A., Thales and the European Information, Communications and Consumer Electronics Technology Industry Association (EICTA)*. See <http://www.career-space.com/>.

⁸⁸ For a more detailed account see Rainer Kattel and Tarmo Kalvet, *Teadmistepõhine majandus ning infotehnoloogiaalane haridus: hetkeolukord ning väljakutsed haridussüsteemile aastani 2008* [Knowledge-Based Economy and Information Technology Education: Existing Conditions and Challenges Facing the Educational System up to the Year 2008], PRAXIS Center for Policy Studies, 2005.

2.3.1. Red biotechnology

The Last Human – this is precisely the title that Gregory Stock gave to the first chapter of his sensational book *Redesigning Humans* that was published in 2002.⁸⁹ Stock deems it inevitable that the opportunities offered by biotechnology to genetically change and „improve” a human (so-called germline engineering or changes that will also affect future generations) will be exploited sooner or later, and it is only the question of when and by whom. Today’s generations stand on the threshold of posthuman future.⁹⁰ The opportunities biotechnology offers are now barely conceivable (for instance, to cure cancer or reproduce organs) but so grand in their essence, and the need for them, let alone potential economic benefits, is so obvious that it is hard to see all the threats that come together with these developments. Daniel Callahan, one of the first bioethicists suggests that there is only one way to fight them: to rewind the evolution of technology.⁹¹

Given that the application of biotechnology concerns a much more intricate process than merely changing the genetic map of living organisms,⁹² then the more complex is also the whole red biotechnology related public policy, and should understandably play a major role in this regard – through decisions about development priorities, standards and the rest.⁹³

Biomedicine related biotechnology is certainly the most well-known one in Estonia, since this is precisely where Estonia’s main biotechnological competence lies in regard to both science and entrepreneurship. The general public has been introduced to this field via the Estonian Genome Foundation project. On the international scale red biotechnology has often been brought to the centre of attention by the persistently controversial debate over cloning, stem cells and the like. Red biotechnology is also widely represented in the economic activities of developed countries: for instance, red biotechnology occupies a significant share of biotechnology related economic activities in the US,⁹⁴ where biotechnology accounts for up to 46% of innovativeness in pharmaceuticals.⁹⁵

Whereas the red biotechnology that emerged in the 1970s mostly exploited the existing knowledge about the effects proteins can have, then today this potential has already been exhausted – now we first have to find the protein that is linked to one or another disease. An important role is played here by genomics, proteomics, transcriptomics, interactomics, pharmacogenomics and the like that are all based on cataloguing and systematising proteins etc.⁹⁶

Hence we can say that the biotechnology paradigm follows the changes in the treatment of diseases by moving towards personalised and preventive medicine, which is based on genetic studies and treatment with innovative medicines. This type of radical change is most supported by pharmacogenomics that uses the information about a person’s genome to find and construct a cure. Stem cells research and xenotransplantation offer opportunities for the reproduction of tissues and organs to treat the irreversible illnesses and injuries caused by strokes, Alzheimer’s and Parkinson’s disease, burns and spinal cord injuries.⁹⁷

Following from the above Figure 12 outlines the major trajectories in red biotechnology that the leading companies in this field mostly invest in.

⁸⁹ Gregory Stock, *Redesigning Humans. Our Inevitable Genetic Future*, Boston/New York: Houghton-Mifflin, 2002.

⁹⁰ See Francis Fukuyama, *Our Posthuman Future. Consequences of the Biotechnology Revolution*, New York: Farrar, Straus and Giroux, 2002.

⁹¹ Daniel Callahan, *False Hopes. Overcoming the Obstacles to a Sustainable, Affordable Medicine*, New Brunswick, NJ and London: Rutgers University Press, 1999.

⁹² The phrase „genetic modifications” is surrounded by numerous myths (about all that is possible), yet the biological reality is inevitably much more complex, and the causal role of genes in the development of organisms acutally limited. See for instance Evelyn Fox Keller, *The Century of the Gene*, Cambridge, MA and London: Harvard University Press, 2000, 133-148; then Michael Morange, *The Misunderstood Gene*, Cambridge, MA and London: Harvard University Press, 200; and Matt Ridley, *Nature via Nurture. Genes, Experience and What Makes Us Human*, London: Fourth Estate, 2003.

⁹³ More specifically about the ethical challenges in pharmacogenetics see Nuffield Council on Bioethics, *Pharmacogenetics. Ethical Issues*. London: Nuffield Council on Bioethics, 2003.

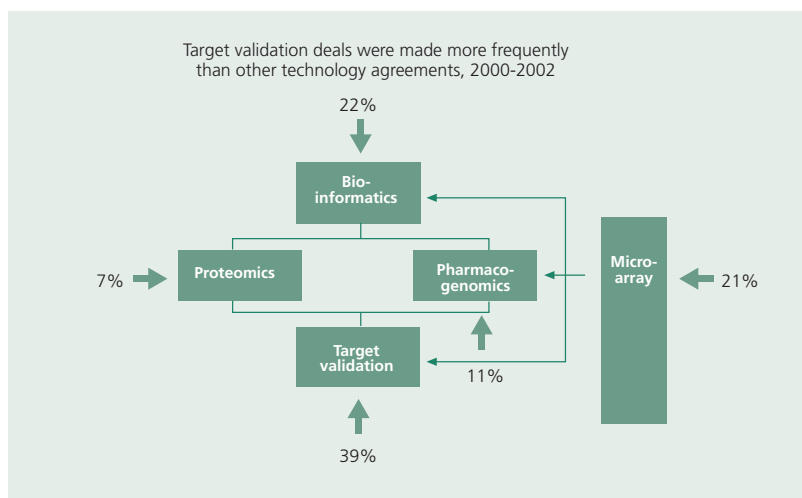
⁹⁴ *A Survey of the Use of Biotechnology in US Industry*, U.S. Department of Commerce, Technology Administration, Bureau of Industry and Security, 2003, http://www.technology.gov/reports/Biotechnology/CD120a_0310.pdf.

⁹⁵ European Commission, *Third European Report on Science and Technology Indicators*. Brussels: European Commission, 2003, 376.

⁹⁶ For a good and concise overview see *The Economist*, „Survey: Biotechnology”, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556.

⁹⁷ *Life sciences and biotechnology — A strategy for Europe*, Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, European Commission, 2002, 10-11.

Figure 12. Licensing strategies of top 20 pharmaceutical companies, 2000-2002.



Source: *Licensing Strategies. Benchmarking Analysis of the Top 20 Pharmaceutical Companies*, Datamonitor, 2003.

2.3.2. Green biotechnology

Green biotechnology is commonly taken to mean genetically modified (GM) agricultural products and foodstuffs.⁹⁸ While medical biotechnology is well represented primarily in the developed countries and especially their economic activities, then green biotechnology has retained a rather inconspicuous position in Estonia. Yet, public debate about green biotechnology has been no less heated in the developing countries as it is in the developed ones.

Whereas biomedicine has so far only consumed sizeable investments without giving much in return, which has, in turn, made investors rather anxious in recent years, the situation in agricultural biotechnology is dramatically different.

In 2002, the market volume of GM agricultural products totalled at \$4 billion, and GM agriculture took up 4% of the world's arable land.⁹⁹ While in 2001 GMO covered globally a total of 50 million ha of land, only 12,000 of it were in Europe.¹⁰⁰ USA clearly dominates GMO exports and actively urges developing countries to adopt extensive use of GM agricultural products with the promise of alleviating famine. Half the world's soybean crop is already genetically modified, and two-thirds of GM soybeans are grown in poor countries.¹⁰¹

⁹⁸ See Daniel Charles, *Lords of Harvest. Biotech, Big Money and the Future of Food*, Cambridge, MA: Perseus, 2001.

⁹⁹ For comparison see also the estimates by Princeton University, where the volume of GM agricultural product market in 2002 is suggested to amount to \$17 billion, *Genes, Trade and Regulation: The Seeds of Conflict in Food Biotechnology*, Princeton University Press, 2003, <http://www.pupress.princeton.edu/titles/7665.html>.

¹⁰⁰ *Life sciences and biotechnology — A strategy for Europe*, Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, European Commission, 2002, 11. About the plans to allow GMO commercialisation in the European Union and the United Kingdom see, respectively, „Seventeen GM varieties approved but coexistence decision postponed”, *EurActive.com*, 09.09.2004, <http://www.euractiv.com/Article?tcaturi=tcm:29-129877-16&type=News> and „Britain gives go-ahead for first GM crop”, *NewScientist.com news service*, 09.03.2004, <http://www.newscientist.com/news/news.jsp?id=ns99994754>.

¹⁰¹ “Survey: Biotechnology”, *The Economist*, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556.

There are two different sets of problems raised in debates about green biotechnology: technological (biotechnological) production of new living organisms or drastic modification of the existing ones, and industrial production of agricultural products. The first set is primarily concerned with the various technological solutions and their ethical acceptability or user-friendliness. The second set has to do with the problems of market competition and the dynamics of economic development: on the one hand, there is internationally varying regulation that creates barriers and excessive costs to GM products entering new markets,¹⁰² and, on the other hand, there is the question of whether and how to protect innovation in agricultural production. This last matter is acutely controversial in the context of developing countries and poverty with the rights to agricultural production owned by the rich Western countries while the users are mostly developing countries.

Innovation paradox in agricultural production arises when a farmer buys, for instance, a new variety of grain, which might be specifically adjusted to Estonian weather conditions, but he still has the discretion to sow it, store it for the following year or do whatever he likes. Yet reselling this product or anything similar would mean direct damage to the breeder of this hypothetical grain variety. At the same time, epidemics and the like compel today's agricultural sector to continuously renew their products.¹⁰³ *Union pour la Protection des Obtentions Végétales* (www.upov.int), which Estonia joined in 2000, was called into existence in 1961 for the purpose of protecting new agricultural products through an arrangement similar to international patent system. Since 1994 all members of WTO are obliged to implement UPOV type of legislation. Given that the development activities of this field are performed basically only in the major European and US corporations,¹⁰⁴ dissatisfaction and varying interpretations are inevitable.

Moreover, development of technology has complicated the problem even further by exploiting natural diversity and adding hybridisation – whereby the plants of a new generation consequently have new characteristics. Since relevant technology itself limits exploitation due to its advanced level of complexity, there is no real need for various agreements and all that. Biotechnology effectively enables the genetic modification of such plants that do not become subjected to hybridisation in the natural environment, and thereby creates opportunities for the introduction of the so-called genetic use restriction technology (GURT). In simple terms, GURT denotes the manipulation of a plant's genetic traits in a way that makes them render sterile seeds, i.e. it is impossible to re-use the harvested seeds.¹⁰⁵

Albeit GURTs are not in use as yet, their introduction is nevertheless highly probable seeing as it would essentially solve the paradox of the development activities in agricultural production. This will likely also lead to significant growth in the private sector agricultural development activities, which consequently implies an increase in prices and a decrease in public sector control. **Less developed and developing countries can obviously expect a major decline in the current level of agricultural research and development as they are not able to keep up with biotechnology.**¹⁰⁶

In conclusion, the agricultural potential of biotechnology is expected to be employed primarily for the purpose of making production processes more environmentally friendly and generating higher quality foodstuffs. In the near future, genetically modified plants may have a considerable role in the achievement of the former. An example of this is a transgenic soybean *Roundup Ready* that was created in the 1990s and allows for farming without chemicals or constant ploughing.¹⁰⁷ This basically gives the opportunity to

¹⁰² For a detailed account see Thomas Bernauer, *Genes, Trade, and Regulation: The Seeds of Conflict in Food Biotechnology*, Princeton, New Jersey, USA: Princeton University Press 2003; *World agriculture: towards 2015/2030: Summary Report*, Food and Agriculture Organization of the United Nations, 2002, <http://www.fao.org/docrep/004/y3557e/y3557e00.htm>.

¹⁰³ A concise overview of this whole range of issues is provided in Timothy M. Swanson (ed), *Biotechnology, Agriculture and the Developing World. The Distributional Implications of Technological Change*, Cheltenham, UK: Elgar, 2002.

¹⁰⁴ See Charles Spillane, "Agricultural biotechnology and developing countries: proprietary knowledge and diffusion of benefits", in Timothy M. Swanson (ed), *Biotechnology, Agriculture and the Developing World. The Distributional Implications of Technological Change*, Cheltenham, UK: Elgar, 2002, 67-134, 74-78.

¹⁰⁵ See Timothy Swanson, "Biotechnologies and developing world: how will the anticipated industrial changes in agriculture affect developing countries?" in Timothy M. Swanson (ed), *Biotechnology, Agriculture and the Developing World. The Distributional Implications of Technological Change*, Cheltenham, UK: Elgar, 2002, 3-21.

¹⁰⁶ See Timothy Swanson and Timo Goeschl, "The impact of CURTs: agricultural R&D and appropriation mechanisms", in Timothy M. Swanson (ed), *Biotechnology, Agriculture and the Developing World. The Distributional Implications of Technological Change*, Cheltenham, UK: Elgar, 2002, 44-66, 61.

¹⁰⁷ Jonathan Rauch, "Will Frankenfood Save the Planet?" *Atlantic Monthly*, October 2003, <http://www.theatlantic.com/issues/2003/10/rauch.htm>.

make arable land fertile (again), and thereby diminish deforestation and the like. In many less developed countries applying biotechnology to food production is even viewed as a matter of health care, since GM can offer more nutritious and healthy food to precisely the world's poorest countries. On the technology side, however, the main shortcoming of green biotechnology has stemmed from the fact that virtually all innovations have been producer, and not consumer oriented. It has been possible for several years now to produce vitamin-enhanced or healthier foodstuffs (e.g. vitamin-enhanced rice). Yet developed countries generally consume these foodstuffs in a processed form, and then it is remarkably cheaper to add the vitamins etc in the processing phase.¹⁰⁸

Intense debate on the issues of genetically modified foodstuffs will, no doubt, continue in Europe for quite a while. Yet it might be the so-called white, industrial biotechnology that actually brings about more dramatic changes in agriculture than green biotechnology – away from foodstuffs, and towards growing raw materials for industry instead.¹⁰⁹

Several companies are already in the business of „designing” animals and plants in order to turn them into therapeutic proteins production „factories”. For example, *GTC Biotherapeutics* (USA) uses transgenic goats to produce monoclonal antibodies;¹¹⁰ *Epicyte* (USA) produces the antibodies from maize.¹¹¹ Both technologies are a great deal cheaper than bioreactors, and their bulk production is very easy and inexpensive.¹¹²

2.3.3. White biotechnology

Biotechnology has been used for developing diverse applications for industry for many years now. In 1988 a Danish company Novozymes placed on the market the first transgenic enzyme for detergents. Novozymes proclaims on its website that “*Enzymes are the miracle workers of both nature and industry, changing the world into a better place to live.*”¹¹³ Today Novozymes is the world leader in enzymes production.¹¹⁴ Enzyme-catalysed processes have always been a much more effective method for generating molecules than traditional chemistry. It is only now, however, that the development of technology has reached the stage where it allows for the use of enzymes to create not only expensive products like drugs, but also consumer chemicals, and it is plastic and fuels that appear the most promising fields for the use of enzymes over the next decade.¹¹⁵

Above all, biopolymers are environmentally friendly since their production does not, in effect, have any consequence for global climate change. They are also biodegradable and facilitate productivity increase (see the examples below on textile enzymes and consumer chemicals).¹¹⁶

¹⁰⁸ “Survey: Biotechnology”, *The Economist*, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556.

¹⁰⁹ *Ibid.*

¹¹⁰ See <http://www.transgenics.com/>.

¹¹¹ See <http://www.epicyte.com/>.

¹¹² “Survey: Biotechnology”, *The Economist*, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556.

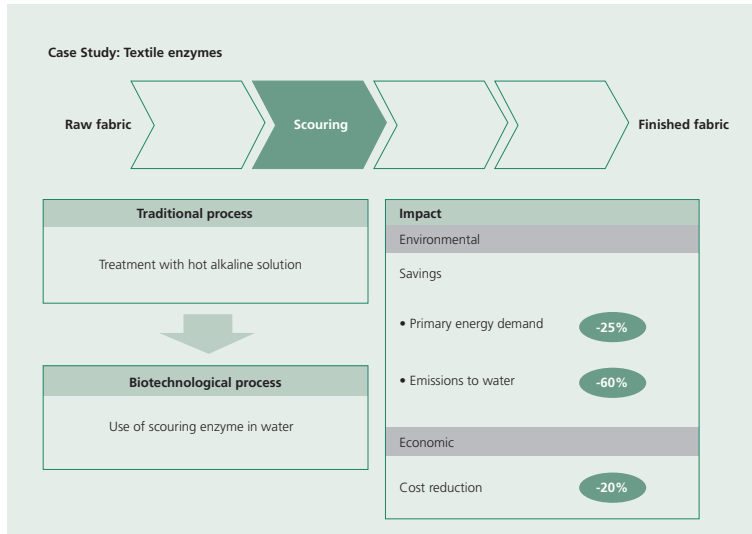
¹¹³ <http://www.novozymes.com/>; See also “Sea of Dreams”, *The Economist*, 29.04.2004, http://www.economist.com/science/displaystory.cfm?story_id=2628644.

¹¹⁴ “Survey: Biotechnology”, *The Economist*, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556.

¹¹⁵ See *White Biotechnology: Gateway to a More Sustainable Future*, EuropaBio, 2003, http://www.mckinsey.com/client-service/chemicals/pdf/BioVision_Booklet_final.pdf.

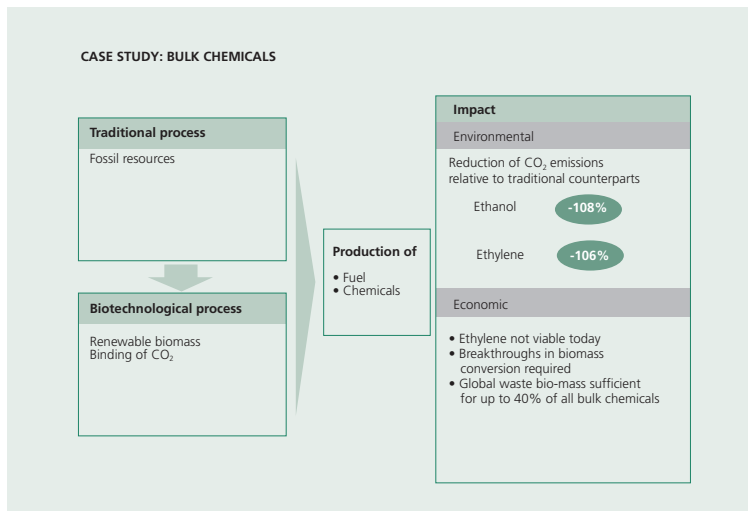
¹¹⁶ “Survey: Biotechnology”, *The Economist*, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556. See also National Research Council of Canada, *A Research Report of the Science and Technology Foresight Pilot Project: A Partnership of Federal S&T Organizations*, 2003.

Figure 13. Productivity of textile enzymes.



Source: *White Biotechnology: Gateway to a More Sustainable Future*, EuropaBio, 2003, http://www.mckinsey.com/client-service/chemicals/pdf/BioVision_Booklet_final.pdf.

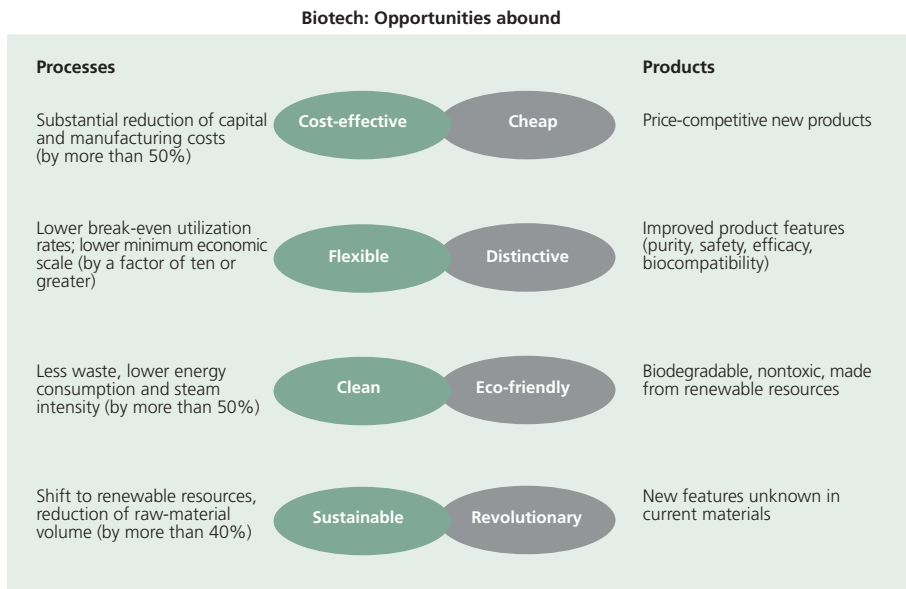
Figure 14. Productivity of consumer chemicals.



Source: *White Biotechnology: Gateway to a More Sustainable Future*, EuropaBio, 2003, http://www.mckinsey.com/client-service/chemicals/pdf/BioVision_Booklet_final.pdf.

Then again, the opportunities offered by biotechnology to cut costs and create clean production technologies and products may also lead to a revolution in renewable natural resources, which could reduce the usage of natural resources in industry by as much as 40% (see Figure 15).

Figure 15. **Biotechnology based opportunities for more effective and environmentally friendly production.**

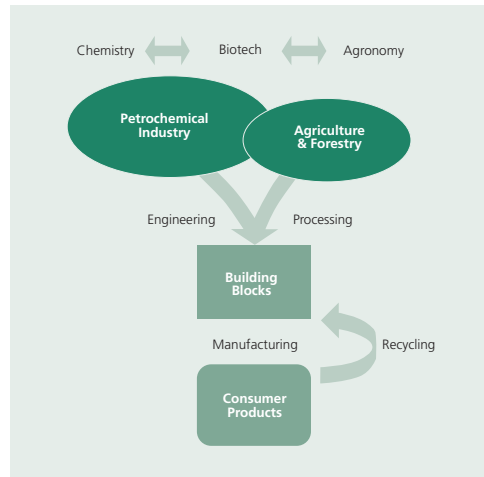


Source: Rolf Bachmann, Enrico Bastianelli, Jens Riese, and Wiebke Schlenzka, "Using plants as plants", *The McKinsey Quarterly*, 2000, 2, 92–99, <http://www.fractal.org/Life-Science-Technology/Publications/Using-plants-as-plants.htm>.

Since people have become more aware of what enzymes and micro-organisms can offer, industrial chemistry has gradually grown more influenced by biotechnology. Unlike contemporary chemistry, the future one will adopt new achievements immediately.¹¹⁷ Both from the perspective of technology development and economic exploitation it is important to keep in mind that a chemical industry based on renewable natural resources is only able to operate successfully if achievements in biotechnology are accompanied by progress in the traditional industries of agriculture and forestry. (Figure 16)

¹¹⁷ "Survey: Biotechnology", *The Economist*, 27.03.2003, http://www.economist.com/science/displayStory.cfm?story_id=1647556.

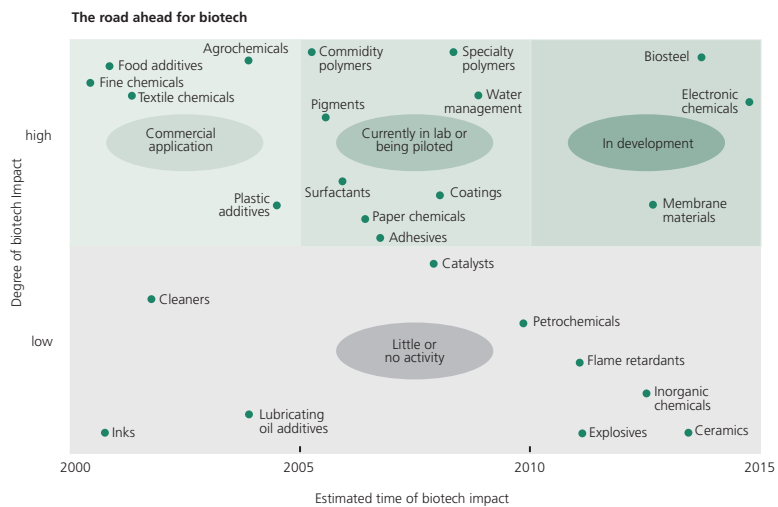
Figure 16. Link between biotechnology and traditional industries.



Source: *The Technology Roadmap for Plant/Crop-based Renewable Resources 2020*, Renewables Vision 2020, Executive Steering Group, 1999, http://www.oit.doe.gov/agriculture/pdfs/technology_roadmap.pdf.

Figure 17 provides a global overview of current applications, products being developed as well as potential future products and applications in the field of white biotechnology.¹¹⁸ The US chemical industry anticipates multiple biotechnology based innovations – new applications both in products and technologies – by the year 2020.

Figure 17. Status quo and future potential for the biotechnological development.



Source: Rolf Bachmann, Enrico Bastianelli, Jens Riese, and Wiebke Schlenzka, "Using plants as plants", *The McKinsey Quarterly*, 2000, 2, 92–99, <http://www.fractal.org/Life-Science-Technology/Publications/Using-plants-as-plants.htm>.

¹¹⁸ See also *The Application of Biotechnology to Industrial Sustainability. A Primer*, OECD, 2001.

Figure 18. Potential development paths in the US chemical industry up to 2020.



Source: *Vision 2020 Chemical Industry of the Future. Technology Roadmap for Materials*, Materials Technology Committee, 2000, http://www.oit.doe.gov/chemicals/pdfs/materials_tech_roadmap.pdf.¹¹⁹

In the 1980s several developments were under way in Estonia to generate enzymes for biotechnology, including efforts to employ immobilised enzymes.¹²⁰ Today there is no industrial production, hence no real output. At the same time it is a globally widespread industry (enzyme-based test kits, enzymes for biotechnological conversion, starch-modifying enzymes, enzymes for environmental technology, enzymes as medications – e.g. to help digestion etc). There are two main branches – pure enzymes-chemicals, and various mixtures for selective conversion. The latter are cheaper and production costs are lower (e.g. used in cleaning/separation processes, which are generally low on productivity). Expensive ones are suitable for pharmaceutical industry.

Fermentation technology is also used in Estonia, especially in the food industry: lactic fermentation processes (yoghurt, fermented milk and cream products – enzymic coagulation as an alternative to acidification-based coagulation, vegetable souring etc), and the general production processes of bread, beer, wine and spirit. Likewise in the production of animal feedingstuffs – ensilage, additives in food and feed etc. In addition, other processes are used worldwide – microbiological synthesis of raw materials in the probiotics production cycle and pharmaceuticals (antibiotics); specific proteins are used for the production of various intracellular components etc.

¹¹⁹ See also *Technology Vision 2020. The U.S. Chemical Industry*, American Chemical Society et al., 1996, <http://membership.acs.org/1/IEC/docs/chemvision2020.pdf>.

¹²⁰ Authors would like to extend their gratitude to Andres Jagomägi for the following information.

2.4. Nanotechnology

Nanotechnology¹²¹ as a name of a field of science and technology is rather new, but the earliest advances in nanotechnology (creating materials with desired features) were achieved by the mankind already in the 9th century when Caliphate potters created a technology for making multi-coloured lustre ceramics. This technology spread to Egypt, Persia and Andalusia already during medieval time, following the expansion of Islam Kingdoms, and then, in the 15th century, to Italy.¹²²

Today's science is already well-informed about the fact that carbon, gold and many other substances reveal novel characteristics when manipulated on a nanometric scale. Some substances begin to conduct light or electricity, others become harder than diamond, the third one turns into an important catalyst to chemical reactions. Even more remarkable is how a relatively small amount of nanoparticles can change the characteristics and behaviour of significantly bigger substances or organisms – ranging from molecule-sized electronic devices to hypereffective fuel elements and the like.

The (potentially) revolutionary importance of nanotechnology for science and economy derives chiefly from three aspects:

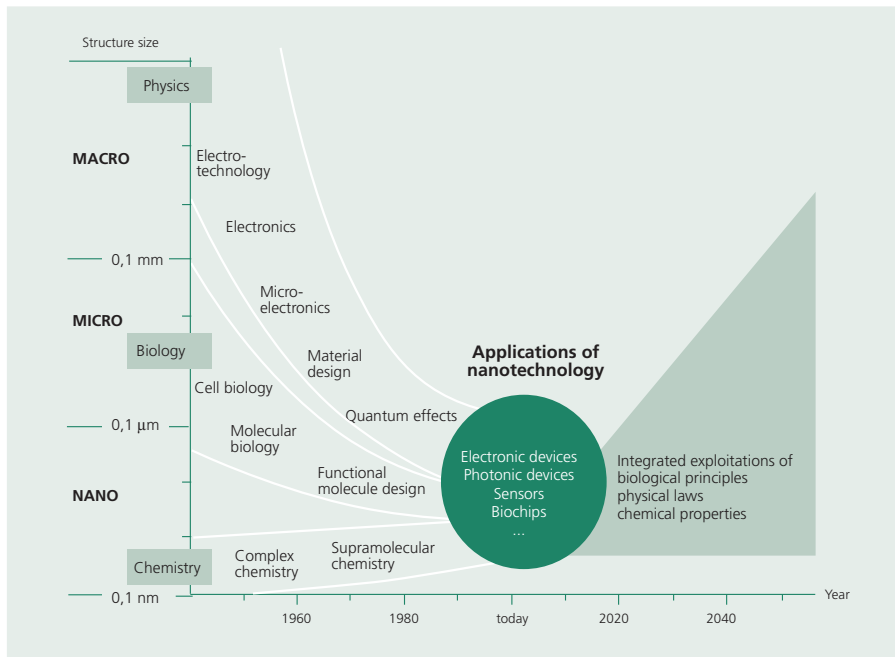
- 1) Nanotechnology's (anticipated) capacity and ability to handle both anorganic and organic substances and materials on the atom and molecule scale raises prospects for the emergence of completely new materials or materials with (qualitatively) novel characteristics. Nanotechnology can potentially transform the whole organic and anorganic world surrounding us.
- 2) Nanotechnology is multidisciplinary by its very nature: working on the nanoscale calls for merging physics, chemistry and biology as well as computer science. Therefore, developing nanotechnology and its various applications inevitably requires interdisciplinary science and learning.¹²³ This, again, implies a need for an enormous change in the whole contemporary system of research and education. On a broader scale it might also mean that the next technological revolution will start with precisely the convergence of different sciences and technologies. (Figure 8; for more see Ch 2.5)
- 3) In case nanotechnology turns out to be an economically profitable enterprise – and the above aspects point to plenty of reasons that speak for it – then it is likely that the development of nanotechnology itself will inevitably bring about colossal changes in economy, education and thereby also the social structure of our society.

¹²¹ Nanotechnology deals with structures on the scale of 0.1 (atom) to 100 nanometers (very big molecules). 1 nm = 10⁻⁹m or 0.000000001 meters. On the contemporary definition of nanotechnology see Wolfgang Luther (ed), *Industrial Application of Nanomaterials – Chances and Risks*, VDI, Technology Center, Future Technologies Division, 2004, <http://www.zukuenftigetechnologien.de/11.pdf>, 5-7. See also „Nanotechnology and the Developing World”, *PLoS Medicine*, 12.04.2005, <http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0020097>.

¹²² Caliphate was one of the largest and most developed countries during the Middle Ages. Its capital was first located in Medina, and since 762 in Baghdad. In 1258 Baghdad was conquered by Mongol forces and the Caliphate ceased to exist. For a more detailed account of this technology see Cipriano Piccolpasso, *Li tre libri dell'arte vasaio*, 1557; “The oldest known nanotechnology dates back to the 9th century!”, CNRS Institut des Sciences Chimiques Seine-Amont, 22.03.2004, <http://www.newmaterials.com/news/680.asp>.

¹²³ See e.g. M. C. Roco and W. S. Bainbridge, “Converging technologies for improving human performance: integrating from the nanoscale”, *Journal of Nanoparticle Research*, 4, 2002, 281-295, 282; and Greg Tegart, „Nanotechnology. The Technology for the 21st Century”, <http://www.nistep.go.jp/IC/ic030227/pdf/p2-3.pdf>; but also Joachim Schummer, „Multidisciplinarity and Interdisciplinarity in Nanoscale Research”, 2001, http://nanomr.dd6310.kasserver.com/downloads/s1/schummer_paper_final.pdf.

Figure 19. Physics, biology and chemistry meet in nanotechnology.



Source: VDI, Technology Center, Future Technologies Division, available as Greg Tegart, *Nanotechnology. The Technology for the 21st Century*, 2003, <http://www.nistep.go.jp/IC/ic030227/pdf/p2-3.pdf>.

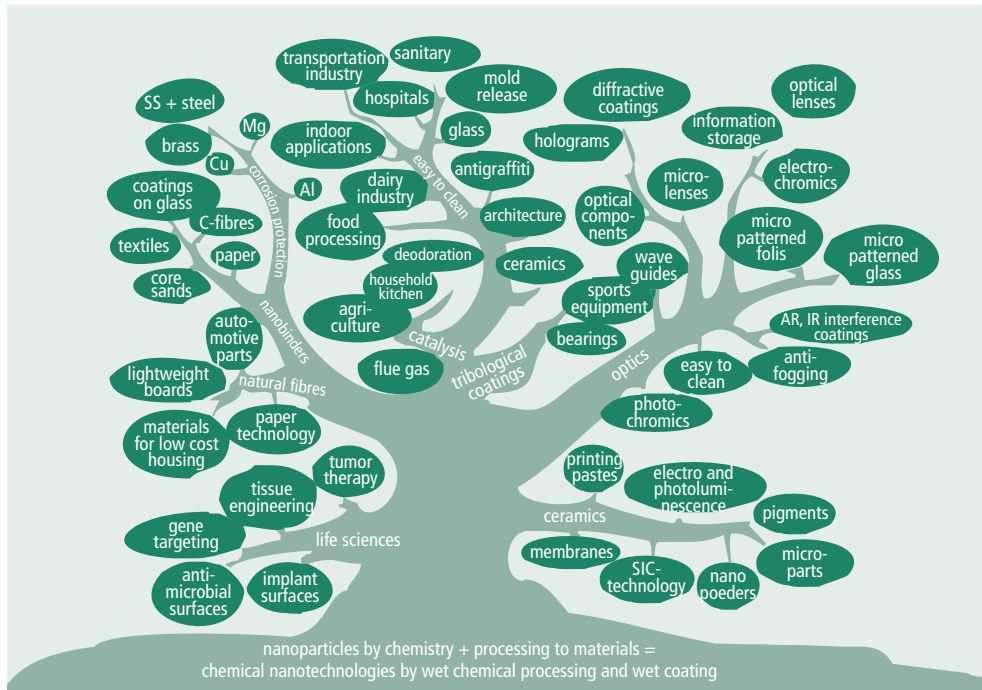
Its potential to generate materials with extremely durable, now still unimaginable qualities is but one significant economic motivation for the development of nanotechnology, albeit even here nanotechnology opens up massive prospects.¹²⁴ Figure 20 illustrates the potential impact of nanotechnology on various technologies and economic sectors.

Second, and today probably the most radical, therefore also the most far-fetched motivation is nanotechnology's potential to create nanorobots, universal molecular machines that are, among other things, capable of healing people, restoring cells and thereby making aging a reversible process; generating „personalised” chemical and biological weapons that attack only people with specific markers; or even creating new biological organisms.¹²⁵

¹²⁴ For details see Wolfgang Luther (ed), *Industrial Application of Nanomaterials – Chances and Risks*, VDI, Technology Center, Future Technologies Division, 2004, <http://www.zukuenfigetechnologien.de/11.pdf>, 7-10.

¹²⁵ This is so-called synthetic biology, see for instance Philip Ball, „Synthetic Biology for Nanotechnology”, *Nanotechnology*, 16, 2005, R1-R8; Jürgen Altmann, „Military Uses of Nanotechnology: Perspectives and Concerns”, *Security Dialogue*, 35, 2004, 61-79. Fantasies of such universal robots have belonged with the development of nanotechnology since its very inception, see for instance the debate between Drexler and Smalley http://www.kurzweilai.net/news/frame.html?main=news_single.html?id%3D2700; then also <http://www.thenewatlantis.com/archive/4/soa/nanotech.htm>. At the same time, there is today fairly little of peer reviewed nanoscience that focuses on this segment, see for instance Ralph C. Merkle, „Molecular building blocks and development strategies for molecular nanotechnology”, *Nanotechnology*, 11, 2000, 89–99.

Figure 20. Potential impact of nanotechnology on other sciences and technologies.



Source: *New Dimensions for Manufacturing. A UK Strategy for Nanotechnology*, DTI, 2002, 17, <http://www.dti.gov.uk/innovation/nanotechnologyreport.pdf>.

There are, in fact, two classic approaches to nanotechnology. The so-called top-down approach tries to minimise the structure of materials to nano scale: this essentially entails carving nanostructures out of larger objects. This approach is, above all, customary in nanoelectronics that is growing out of microelectronics, and in nanoengineering.¹²⁶ Bottom-up approach, on the other hand, involves manipulating individual atoms and molecules. This approach implies controlled or directed self-assembly of atoms and molecules, which is what enables the creation of nanorobots, molecular computers etc. The latter approach is actually much closer to the natural processes of chemistry and biology, where atoms and molecules come together to create structures such as crystals or cells. Hence it is just as well to say that the creation of a cell or a snowflake is nature's own nanotechnology at work.¹²⁷

The somewhat science fiction-like future prospects aside, nanotechnology is, in fact, already present in today's economy. The total global demand for nanoscale materials etc was estimated at \$7.6 billion in 2003, and is expected to grow 30% annually.¹²⁸

This means that the annual industrial production in the nanotechnology sectors should exceed \$1 trillion limit in 10-15 years from now, and the demand for nanotechnology workers should grow to about 2 million people by then.¹²⁹

¹²⁶ See for instance *New Dimensions for Manufacturing. A UK Strategy for Nanotechnology*, DTI, 2002, 16, <http://www.dti.gov.uk/innovation/nanotechnologyreport.pdf>; and also *Vision 2020: Nanoelectronics at the centre of change. A far-sighted strategy for Europe*, Report of the High Level Group, European Commission, 2004, http://europa.eu.int/comm/research/industrial_technologies/articles/article_1190_en.html.

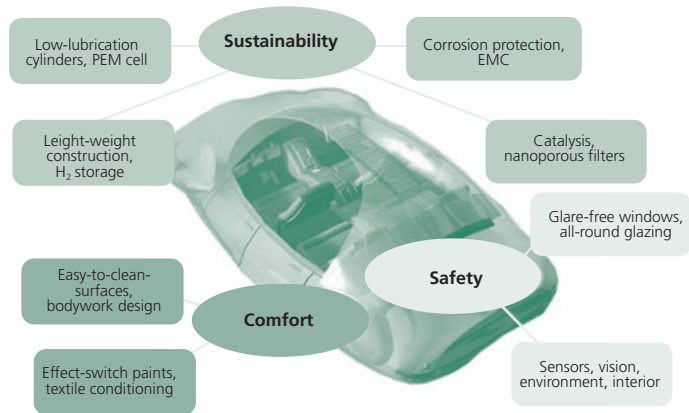
¹²⁷ *New Dimensions for Manufacturing. A UK Strategy for Nanotechnology*, DTI, 2002, 16, <http://www.dti.gov.uk/innovation/nanotechnologyreport.pdf>.

¹²⁸ *Nanotechnology: A Realistic Market Evaluation*, Business Communications Company, 2004, <http://www.bccresearch.com/advmat/GB290.html>.

¹²⁹ Mihail C. Roco, „Government Nanotechnology Funding: An international outlook“, *NSF Nanoscale Science and Engineering*, 2003, <http://www.nano.gov/html/res/IntlFundingRoco.htm>.

Evaluation of the application readiness of various nanotechnology solutions suggests that it is the existing industries that nanotechnology solutions will most likely reach first. Figure 21 demonstrates the potential role nanotechnology could play in reviving car industry: from new H₂ storage space that facilitates the utilization of hydrogen fuel and corrosion-resistant surfaces to coatings that change colour according to owners preferences etc.

Figure 21. **Nanotechnology reviving traditional industry, NanoMobil.**¹³⁰



Source: Volker Rieke and Gerd Bachmann, „German innovation initiative for nanotechnology“, *Journal of Nanoparticle Research*, 6, 2004, 435-446, 437.

Today's nanotechnology related activities can be roughly grouped into three areas: materials sciences; electronics and optoelectronics; and biomedicine.¹³¹ Table 1 provides an overview of solutions and products from all these nanotechnology areas that are expected to undergo rapid development within the coming years and enter the market before long – from better storage of solar energy, various electronic displays, and self-cleaning surfaces to the so-called „lab-on-a-chip” diagnostic technologies.¹³²

Table 1. **Today rapidly developing nanotechnology elements.**

Material sciences	Electronics and optoelectronics	Biomedicine
<ul style="list-style-type: none"> • New forms of carbon • Quantum dots and wires made by colloid chemistry • Nanostructured materials by self-assembly 	<ul style="list-style-type: none"> • Semiconductor optoelectronics • Photonics • Memory and data storage • New methods for data input and output • Plastic electronics • Molecular electronics • New concepts in computing 	<ul style="list-style-type: none"> • Drug delivery • Tissue engineering • The laboratory-on-a-chip

Source: Stephen Wood, Richard Jones, Alison Geldar, *The Social and Economic Challenges of Nanotechnology*, ESRC, 2003, 10-17.

¹³⁰ NanoMobil is a nanotechnology programme of German Federal Ministry of Education and Research, <http://www.bmbf.de/de/1846.php>.

¹³¹ See more about the visions for nanomedicine <http://www.nanomedicine.com>; Laura Mazzola, „Commercializing nanotechnology“, *Nature Biotechnology*, 21, 2003, 1137-1143; C. A. Haberzettl, „Nanomedicine: destination or journey?“, *Nanotechnology*, 13, 2002, R9-R13.

¹³² *New Dimensions for Manufacturing. A UK Strategy for Nanotechnology*, DTI, 2002, 23, <http://www.dti.gov.uk/innovation/nanotechnologyreport.pdf>.

Over the coming decade we will probably witness the introduction of such products and technologies as targeted drug delivery, polymer electronics, various biomedical sensors to monitor patients' health status, significantly stronger materials used in the production of tools, artificially generated organs and implants etc.¹³³ (Table 2) One cannot go without also mentioning new nanotechnology based medications, new cost-saving ways of producing medications, or even new methods of treatment (e.g. in surgery). Equally important are new opportunities for energy and natural resource (incl. hydrogen fuel) production.¹³⁴

Table 2. Estimated timing of the realisation of some technological opportunities in nanotechnology.

In 3 years	Selective bio nanosensors
	Specific drug delivery systems
	Nano-electronics based on miniaturized silicon devices
	Novel devices based on magnetic spin electronics
	Nanostructured materials as industrial catalysts
	Self-cleaning surfaces based on nanomaterials
In 10 years	Advanced medical diagnostics
	Targeted human cells for organ repair
	Single electron devices
	Optical computing
	Portable fuel cell and advanced battery
	Artificial photosynthesis

Source: Greg Tegart, „Nanotechnology. The Technology for the 21st Century“, 2003, <http://www.nistep.go.jp/IC/ic030227/pdf/p2-3.pdf>.

When we take a look at the positions various countries or regions hold in nanotechnology in regard to both public sector funding as well as patents and publications, we see mostly the US, Western Europe and Japan in the lead in all of these aspects.¹³⁵

¹³³ See also *Nanoscience and Nanotechnologies: opportunities and uncertainties*, Royal Academy of Engineering, Royal Society, 2004, <http://www.nanotec.org.uk/finalReport.htm>.

¹³⁴ See also the 10-15 year projections of potential developments presented by the National Research Council of Canada *A Research Report of the Science and Technology Foresight Pilot Project: A Partnership of Federal S&T Organizations*, National Research Council of Canada, 2003, 16.

¹³⁵ USA is also the leader in political support and regulation, see in particular <http://www.nano.gov/> and <http://www.nsf.gov/home/crssprgm/nano/>; a concise assessment of current activities is provided in Mihail C. Roco, „The US National Nanotechnology Initiative after 3 years (2001-2003)“, *Journal of Nanoparticle Research*, 6, 2004, 1-10.

Table 3. Worldwide government funding for nanotechnology R&D (million USD).¹³⁶

	1997	1998	1999	2000	2001	2002	2003	2004***
Western Europe	126	151	179	200	~225	~400	~650	~900
Japan	120	135	157	245	~465	~720	~800	~900
USA*	116	190	255	270	465**	697**	862**	960
Others	70	83	96	110	~380	~550	~800	~900
Total	432	599	687	825	1535	2367	3122	3660
% of 1997 level	100%	129%	159%	191%	355%	547%	722%	847%

Source: Mihhail C. Roco, „The US National Nanotechnology Initiative after 3 years (2001-2003)“, *Journal of Nanoparticle Research*, 6, 2004, 1-10, 2.

The world's leading industrial and technology countries have already launched extensive nanotechnology programmes that target basic research and applications as well as commercial exploitation. In all probability we will see nanotechnology having major impact on technology and economy only in another 15-20 years time, but this impact will presumably have revolutionary proportions and will span from agriculture and other traditional industries all the way up to high technology.

Yet the large-scale (with a budget of more than \$100 million) nanotechnology R&D programmes are today still very young even in the leading countries. The US National Nanotechnology Initiative was announced in 2000. In 2001 similar programmes followed in Japan and Korea, and in 2002 also in Germany and Taiwan.¹³⁷

According to publications and patents per inhabitant, several European countries appear to have rather promising positions in nanotechnology. Even the new member states of the European Union are among the top 50 most active countries in relation to their share of world's nanotechnology publications (1997-1999). And Estonia ranks 50th.¹³⁸ (Table 4)

¹³⁶ ‚Western Europe‘ includes all member states of the European Union as well as Switzerland; ‚others‘ includes Australia, Canada, China, Central and Eastern European countries as well as the countries of former Yugoslavia, Korea, Singapore, Taiwan etc * A financial year begins in USA on October 1 of the previous calendar year, six months before in most other countries. ** Denotes the actual budget recorded at the end of the respective fiscal year. Estimations use the nanotechnology definition as defined in the US National Nanotechnology Initiative – this definition does not include Micro-Electro-Mechanical Systems, and includes the publicly reported government spending. *** Denotes initial data. See also Mihhail C. Roco, „Government Nanotechnology Funding: An international outlook“, *NSF Nanoscale Science and Engineering*, 2003, <http://www.nano.gov/html/res/IntlFundingRoco.htm>; and *Towards a European strategy for nanotechnology*, European Commission, COM(2004) 338 final, 12.5.2004.

¹³⁷ M. C. Roco, „Broader societal issues of nanotechnology“, *Journal of Nanoparticles Research*, 5, 2003, 181-189, 183. About German initiatives see Volker Rieke and Gerd Bachmann, „German innovation initiative for nanotechnology“, *Journal of Nanoparticle Research*, 6, 2004, 435-446; Taiwan, though a relatively smaller country as compare to the ones mentioned above, has also developed very comprehensive schemes for developing and financing nanotechnology, see C. K. Lee et al., „A catalyst to change everything: MEMS/NEMS – a paradigm of Taiwan's nanotechnology program“, *Journal of Nanoparticle Research*, 4, 2002, 377-386.

¹³⁸ *Third European Report on Science and Technology Indicators*. Brussels: European Commission, 2003, 394.

Table 4. Nanotechnology publications and patents per inhabitant.¹³⁹

Normalized publications (1997-99) per million inhabitants		Normalized patents EPO&PCT (1991-99) per million inhabitants	
150.2	Switzerland	12.2	Switzerland
91.4	Israel	4.4	Germany
73.5	Sweden	3.9	Israel
61.5	Germany	3.8	Belgium
56.9	Denmark	3.6	France
56.8	Singapore	3.5	USA
52.6	Austria	2.4	Netherlands
50.0	France	2.4	Sweden
48.3	Finland	2.3	Japan
47.7	Netherlands	1.8	UK
46.4	Japan	1.5	Canada
43.6	Belgium	1.3	Australia
42.7	UK	1.0	Austria
39.2	USA	0.5	Italy
43.6	Slovenia	0.3	Spain

Source: Ramón Compañó and Angela Hullmann, „Forecasting the development of nanotechnology with the help of science and technology indicators“, *Nanotechnology*, 13, 2002, 243-247, 246.

The fields with the biggest share in nanotechnology patents are chemistry, biomedicine and semiconductors. Nanotechnology is already today very closely tied to all these fields in practical applications. (Table 5)

¹³⁹ Publications represent the data from Science Citation Index, patents from the European Patent Office and Patent Cooperation Treaty. For a comparison see also European Commission, *Third European Report on Science & Technology Indicators 2003*, http://www.cordis.lu/indicators/third_report.htm, and Dora Marinova and Michael McAleer, „Nanotechnology strength indicators: international rankings based on US patents“, *Nanotechnology*, 14, 2003, R1-R7, and for information about nanotechnology patents registered in the US Patent and Trademark Office see Huang et al., „International nanotechnology development in 2003: Country, institution, and technology field analysis based on USPTO patent database“, *Journal of Nanoparticle Research*, 6, 2004, 325-354, 331.

Table 5. Leading technology fields relative to the number of patents filed in the US Patent and Trademark Office, 1976-2002.

Rank	Technology field	Number of Patents	Average Patent Age
1	435 Chemistry, molecular biology and microbiology	7837	7.28
2	514 Drug, bio-affecting and body treating compositions	6364	7.84
3	424 Drug, bio-affecting and body treating compositions	4760	7.05
4	428 Stock material or miscellaneous articles	3847	8.23
5	250 Radiant energy	3783	10.14
6	530 Chemistry: natural resins or derivatives, peptides or proteins, lignins or reaction	3772	7.80
7	536 Organic compounds - part of the class 532-570 series	3701	5.90
8	438 Semiconductor device manufacturing process	3584	6.31
9	257 Active solid-state devices (e.g. transistors, solid-state diodes)	3480	7.93
10	427 Coating processes	3179	9.10
11	436 Chemistry: analytical and immunological testing	2941	9.87
12	430 Radiation imagery chemistry process, composition, or product thereof	2883	9.66
13	359 Optics: systems (including communication) and elements	2743	8.77
14	356 Optics: measuring and testing	2556	10.20
15	422 Chemical apparatus and process disinfecting, deodorizing, preserving, or sterilizing	1665	9.05
16	204 Chemistry: electrical and wave energy	1660	9.65
17	252 Compositions	1647	10.48
18	524 Synthetic resins or natural rubbers - part of the class 520 series	1515	9.01
19	546 Organic compounds - part of the class 532-570 series	1503	8.62
20	210 Liquid purification or separation	1451	9.48
	Average	3243.55	8.62

Source: Huang *et al.*, „International nanotechnology development in 2003: Country, institution, and technology field analysis based on UPTSO patent database“, *Journal of Nanoparticle Research*, 6, 2004, 325-354, 340.

Then again, the very fact that the development of nanotechnology is so entwined with many vitally important fields such as medicine, environment, security, as well as with economically critical fields such as semiconductors and chemistry, makes it imperative to exercise great caution in introducing nanotechnology solutions. This is precisely why already today the analysis of ethical, legal and social aspects has emerged as a fairly significant facet of nanotechnology. Research in social impact assessment of both bio- and nanotechnology will most likely gain considerable importance in an attempt to avoid the setbacks experienced in biotechnology during the placement on the market of genetically modified organisms.¹⁴⁰

¹⁴⁰ For an overview see Anisa Mnyusiwalla *et al.*, „Mind the gap: science and ethics in nanotechnology“, *Nanotechnology*, 14, 2003, R9-R13.

2.5. Convergence of information, bio- and nanotechnologies

Current techno-economic paradigm is mostly based on information and communication technology, which means that information technology sector shows highest growth rates in productivity, and this trend will spread into other sectors along with information technology. Bio- and nanotechnology, on the other hand, are only at the beginning of their paradigm – if and when they actually become engines of a paradigm is not at all established, because we do not know **yet** what are going to be these very specific technological solutions (like *Intel* microprocessor many years ago) that will make these technologies (either independently or by way of integration) penetrate virtually every other economic sector. The prerequisite to a paradigm change is that the new technological solution or the group of solutions is cheap, that it can be produced fast and in large quantities, and that it is widely applicable.¹⁴¹

Besides, we cannot expect the bio- or nanotechnology “microprocessor” to just come out of blue sky at a random place and in a random field – just like over the past 200 and plus years it was never the technology that directed the development of economy, but the economy and entrepreneurs, above all, that picked new technologies¹⁴² (see also Ch 1.3). Thus, it is the technological bottlenecks of today’s technologically advanced companies that most of the investments are targeted at. This relates to not only bio- and nanotechnology companies, but all the sectors more or less closely related to these two as well.

However, since it is not established yet when and what exactly is to be expected of the radical technological innovations in the fields of bio- and nanotechnology, then there are extremely high risks involved,¹⁴³ which is why appropriate supporting strategies and policies are so badly needed. This is precisely how the US has been most successful in developing its economy in line with the paradigm framework with most of the government investments into research and development made at the gestation and early stages of a new paradigm, and significantly decreased by the time the paradigm has evolved to the point where private sector is already able to earn very big profits and carry on the investment.¹⁴⁴ (For more details see Ch. 1.2, incl. Figure 4) For example, in the 1970s the US federal government was in effect the only major client of the emerging computer industry, whereas today government role in the total turnover of this industry is negligible.¹⁴⁵

¹⁴¹ Carlota Perez, “Structural Change and the Assimilation of New Technologies in the Economic and Social System”, *Futures*, 15, 357-375, 1983.

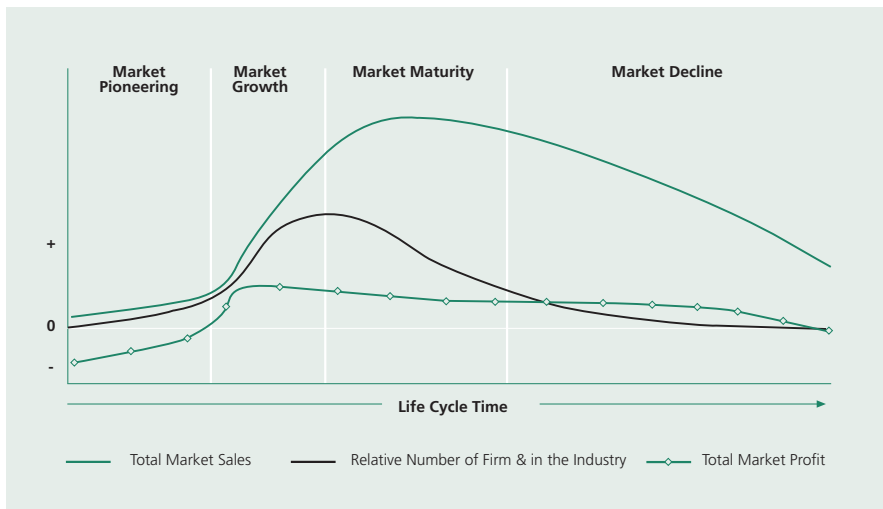
¹⁴² See also: Wiebe Bijker (ed), *The Social Construction of Technological Systems*, Cambridge, MA, MIT Press, 1994.

¹⁴³ There are no “full guarantees”, for sure. Nuclear energy was considered an “almighty” technology with a great potential to change the whole world in quite the same way after the World War II. Admiral Lewis Strauss, chairman of the US Atomic Energy Commission believed in the 1950s that nuclear energy will become altogether “too cheap to meter”. Yet for multiple reasons, incl. relatively poor safety systems and lack of social acceptability of this technology, these predictions were never fulfilled.

¹⁴⁴ About the cost-effectiveness of public sector investments into research and development see e.g. Ammon J. Salter and Ben R. Martin, „The economic benefits of publicly funded next term basic research: a critical review”, *Research Policy*, 2001, 30, 3, 509-532.

¹⁴⁵ About close competition between the US and Japan on the computer industry market in the 1950-1960s and about the governments’ active role in nurturing their domestic information technology industries see also Hideaki Miyajima *et al*, *Policies for competitiveness, Comparing business-government relationships in the ‘Golden Age of Capitalism’*, Oxford University Press, 1999.

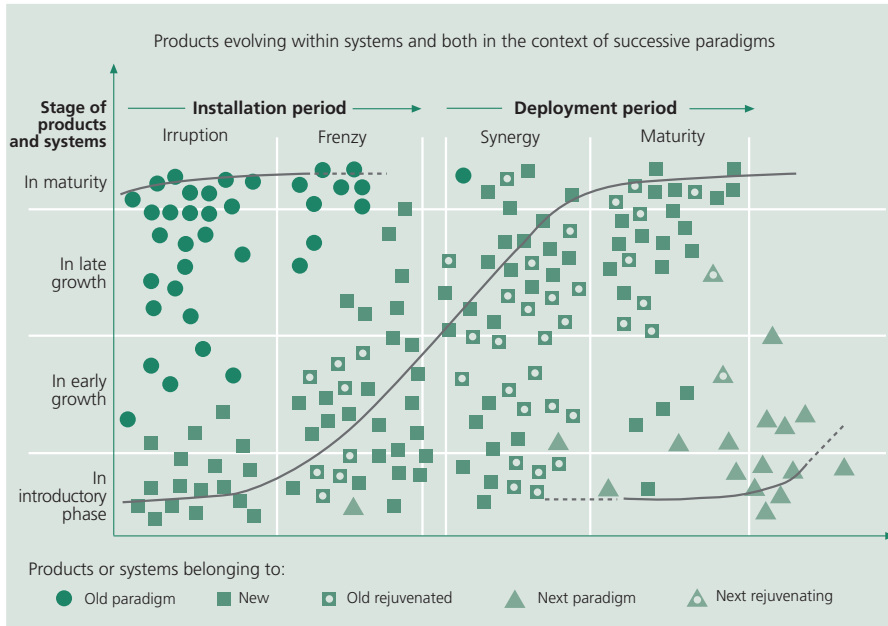
Figure 22. Product life-cycle: sales, relative number of firms and profitability.



Source: Cundiff *et al.* *Fundamentals of Modern Marketing*. Englewood Cliffs, Nueva Jersey, Prentice-Hall, 1973. Referenced in Carlota Perez.

History of economy and technology has taught us that in the coming decade life will most likely continue along the lines of information technology canon. Then again, rapid dissemination of knowledge and technology (especially in the developed world) means that the productivity gained from a certain technology cannot grow endlessly. Its slowdown occurs in inverse proportion to the dissemination of technology, since competition is growing fiercer and the potential of the relevant technology is becoming exhausted. In this situation a renewed growth in productivity is derived from a new technology and its corresponding paradigm. It is already apparent how new bio- and nanotechnologies are more and more vigorously infiltrating the sphere of information technology, and the other way round. This will lead to a change of techno-economic paradigm as a result of either the convergence of information technologies and/or independent dramatic developments in bio- and nanotechnology (see also Ch. 1.2). (Figure 23)

Figure 23. Evolution of techno-economic paradigms.



Source: Carlotta Perez, from the seminar in Tallinn on 24-25.4.2003.

The trends described above imply that technology policy must be based on a sound analysis of global markets. It is now high time to aggressively grow a solid competence base in bio- and nanotechnology. Yet when you ask people in the companies currently operating in Estonia about priorities or “needs of the economy”, they clearly place the priorities elsewhere due to current structure of the economy (and relevant political power positions) etc. Analysing developments in other countries makes it pretty clear that free market is not capable of making the right decisions here.

In Europe as well as other places most of the private sector research and development expenditure still flows into relatively few economic sectors, and the four largest among them – automobiles and parts, pharmaceuticals and biotechnology, IT hardware, and electronic and electrical equipment account for 67% of global investment into research and development. (Table 6)

Table 6. European Union and Non-European Union R&D investments by sector, data from 2003.¹⁴⁶

	European Union		Non-European Union	
	% of all sectors	R&D / sales	% of all sectors	R&D / sales
Automobiles and parts	23.8	4.6	15.7	4.1
Pharmaceuticals and biotechnology	17.0	15.2	18.5	15.1
IT hardware	12.4	15.6	22.9	8.6
Electronic & electrical equipment	10.3	6.5	10.9	5.7
Chemicals	7.2	4.2	4.2	3.8
Aerospace & defence	6.8	8.0	2.1	2.7
Engineering & machinery	4.6	2.5	2.5	2.8
Telecommunication services	2.8	1.0	2.0	2.5
Software & computer services	2.6	12.8	7.8	10.0
Oil & gas	1.9	0.3	1.2	0.5
Remaining 21 sectors	10.6	1.5	12.2	2.1
Total (31 sectors)	100	3.2	100	4.5

Source: *Monitoring Industrial Research: The 2004 EU Industrial R&D Scoreboard*, vol. 1, European Commission, 2004, 6.

All the “pictures” presented above are very technology deterministic and describe only some of the possibilities made available by the development of science and technology. Technological feasibility does not, however, mean that the reality will actually follow these exact paths or that people will buy into everything that is made possible by technology. Described trends in the development of research and technology should, by no means, be viewed as conclusive and unrivalled. They reflect the expected developments in the demand dynamics of global economy, and visions that today’s technology leaders have suggested for the future of research and development and that people work really hard to realise. From the point of view of Estonian economy and society, these are pretty much exogenous developments that occur autonomously from whatever we do anyways. The critical questions are whether and how do we prepare ourselves for these developments.

Yet these developments do not constitute a mandatory list that definitely has to be executed to the full. Instead, a small country should view them as a background or a description of what is possible and likely to happen in the world of science and technology, against which to draw up its own strategies. They do, however, also give us much needed pointers that can be used in further analysis while seeking solutions for the socio-economic challenges Estonia will face in the future. Yet in reality it is still the people and their today’s strategic preferences that are at the centre of attention, and those are influenced by specific surroundings as well as social, economic and other aspects of various technologies among other things. Therefore, it is important to take into account the following risks that a bio- and nanotechnology focus raises:

- 1. timing of the investments and unrealistic expectations** – radical technological breakthroughs (miracles) usually take much more time to materialise than initially anticipated. Compare, for instance, how only a few years ago all those ardent expectations about gene technology and personalised medicine still seemed so feasible. Unstable financial markets, possible anxiety among the public, difficulties in launching mass production can all cause several years of delay in the expected breakthroughs in medical and energy technology as well as other fields.

¹⁴⁶ Table 6 presents data on the top 500 R&D-investing companies in the European Union and another 500 outside the European Union. The sector classification presented in the table follows that of *Financial Times Stock Exchange index*; “R&D / Sales ratio” denotes the ratio of company’s R&D investment to its net sales.

- 2. possible (suspected) environmental hazards / social acceptability issues etc associated with new bio-nanotechnologies and materials** – our surrounding environment, including air and water, are filled with natural molecules and nanoparticles. If any of the new particles that humans have created with the help of bio- or nanotechnology should turn out to be hazardous to the surrounding environment, this whole field might encounter setbacks comparable to what genetically modified foodstuffs and nuclear energy have had to face earlier.

In case Estonia has faith in the above-mentioned visions of the developments in bio- and nanotechnology, then we have to be able to direct our resources today into the rapid “production” (importing) of specialists for those specific fields. In case we believe in something else, we should invest accordingly. Whatever choices we make, it will mean that at least in that area Estonian scientific competence will have to be raised above the average level of the broader field and to the very cutting edge. This is the only way to secure top quality higher education and degree studies. It is also the only way to create a basis for the influx of first-rate foreign investments into the respective areas etc.

Yet, this also touches upon much broader issues – from vocational education to the financing of enterprise support schemes. Those who prefer it that way could actually say that it is “the invisible hand” that invests like crazy in information technology industry in one decade only to do the same with biotechnology the next decade.

In the end, what matters is the principle that: **only government is capable of bearing the risks critical to economic development (for instance, by investing today into biotechnology), and doing this in a prudent and consistent manner (for instance, by modernising the existing chemical industry with the help of biotechnology etc). The most important lesson is that the risks can never be divided between the high technology and the so-called traditional sectors, but must be borne together.**

3. Socio-economic challenges facing Estonia

3.1. External balance

Over the past years economies of the Baltic states have grown remarkably fast in comparison with the economic stagnation that occurred in Western Europe and North America, and have exceeded both GDP and productivity growth indicators of developed countries by several percentage points every year. Estonia's most important macroeconomic indicators are generally viewed as showing good results. For instance, Estonia registered the highest government surplus of 3.1% (in 2003) and the lowest ratio of government debt to GDP (4.9% of GDP in 2004) among the European Union member states.¹⁴⁷ At the same time, in recent years, analysts of various organisations (incl. Bank of Estonia, IMF, Swedbank, ETLA etc) have highlighted the high current account deficit,¹⁴⁸ which is not sustainable in medium or long term according to IMF estimates,¹⁴⁹ as one of the main threats to Estonian economy. European Central Bank recommends that Estonia maintain its current budgetary discipline while simultaneously curbing growth in wages and loans. The Bank of Estonia (central bank of the Republic of Estonia), on the other hand, proposes that we curb the loans provided for domestic consumption and focus more on facilitating exports.¹⁵⁰

Some imbalance in external trade (and current account) is often considered natural for developing countries due to sizeable investments needed for modernising their economies, and the expected increase in exports growth in the long run. Yet Estonia's external trade has shown no signs of balancing over the past 10 years. A simple comparison of industrial production, import and export indicators demonstrates that in 2000 the volume of Estonian produce exceeded domestic consumption only in fishery products, various wood processing products (incl. furniture and newspapers), lime and cement. In all other commodity groups domestic consumption surpassed Estonian production. In other words, Estonia's domestic demand exceeds the value added by local production, which is reflected in the steady and rising current account deficit. (Table 7)

Table 7. Estonia's GDP and balance of payments 1993-2004 (in million EEK).¹⁵¹

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
GDP	22820.3	31349.4	43060.6	55895.4	68576.1	78027.6	81775.9	92937.7	104459.0	116915.3	127333.8	141493.4	164918.4
Change, constant prices %		-1.6	4.5	4.4	11.1	4.4	0.3	7.9	6.5	7.2	6.7	7.8	9.8
Trade balance	-1925.0	-4615.9	-7615.5	-12288.2	-15652.8	-15725.5	-12096.9	-13143.6	-13783.9	-17995.6	-21483.0	-24803.2	-23057.7
Exports	10762.7	15828.5	19428.2	21833.4	31846.5	37786.3	36995.2	56345.9	58667.1	58333.6	63599.8	75061.0	98715.3
Imports	-12687.7	-20444.4	-27043.7	-34121.6	-47499.3	-53511.8	-49092.1	-69489.5	-72451.0	-76329.2	-85082.8	-99864.2	-121775.9
Services	997.1	1362.7	4330.3	6245.0	8232.7	8049.3	8341.5	9574.6	10160.2	9677.4	11782.6	13738.5	12552.7
Exports	4434.3	6657.0	10022.9	13352.8	18366.7	20804.0	21951.9	25485.8	28866.5	28279.7	30819.9	35591.3	39697.2
Imports	-3437.2	-5294.3	-5692.6	-7107.8	-10134.0	-12754.7	-13610.4	-15911.2	-18706.3	-18602.3	-19037.3	-21852.8	-27114.5
Goods and services	-927.9	-3253.2	-3285.2	-6043.2	-7420.1	-7676.2	-3755.4	-3569.0	-3623.7	-8318.2	-9700.4	-11064.7	-10504.9
Current account	279.0	-2145.6	-1810.6	-4806.9	-7810.2	-6760.2	-3607.7	-5093.4	-5889.5	-11882.9	-15401.9	-17963.0	-17285.8
% of GDP	1.2%	-6.8%	-4.2%	-8.6%	-11.4%	-8.6%	-4.4%	-5.5%	-5.6%	-10.2%	-12.1%	-12.7%	-10.5%

NB! The GDP data for 2005 is based on preliminary calculations of the Statistical Office of Estonia. Source: Eesti Pank, <http://www.eestipank.info>, Statistical Office of Estonia, <http://www.stat.ee>, March 2006; calculations by the authors.

¹⁴⁷ *Euro-indicators News Release 117/2004*, Eurostat, 23.09.2004, http://epp.eurostat.cec.eu.int/cache/ITY_PUBLIC/2-23092004-AP/EN/2-23092004-AP-EN.PDF, and *Euro-Indicators News Release 39/2005* Eurostat, 18.03.2005, http://epp.eurostat.cec.eu.int/pls/portal/docs/PAGE/PGP_PRD_CAT_PREREL/PGE_CAT_PREREL_YEAR_2005/PGE_CAT_PREREL_YEAR_2005_MONTH_03/2-18032005-EN-AP.PDF

¹⁴⁸ In the 2nd quarter of 2004 Estonia's current account deficit was 20.4% of GDP, in Latvia 16.7%, in Lithuania 10.6%. Even though circumstances are not at all the same, many other Central and Eastern European Countries are also experiencing significant current account deficit. See <http://www.economagic.com>. The record high deficits in the first half of 2004 may have been inflated by the pre-accession import boom, but a current account deficit exceeding even 5% of GDP is generally considered dangerous for economic sustainability. See e.g. Jason Furman and Joseph E. Stiglitz, „Economic Crises: Evidence and Insights from East Asia”, in William C. Brainard and George L. Perry (eds), *Brookings Papers on Economic Activity, 1998:2*, Brookings Institution Press, 1999, 1-114, <http://brookings.nap.edu/books/0815711956/html/>.

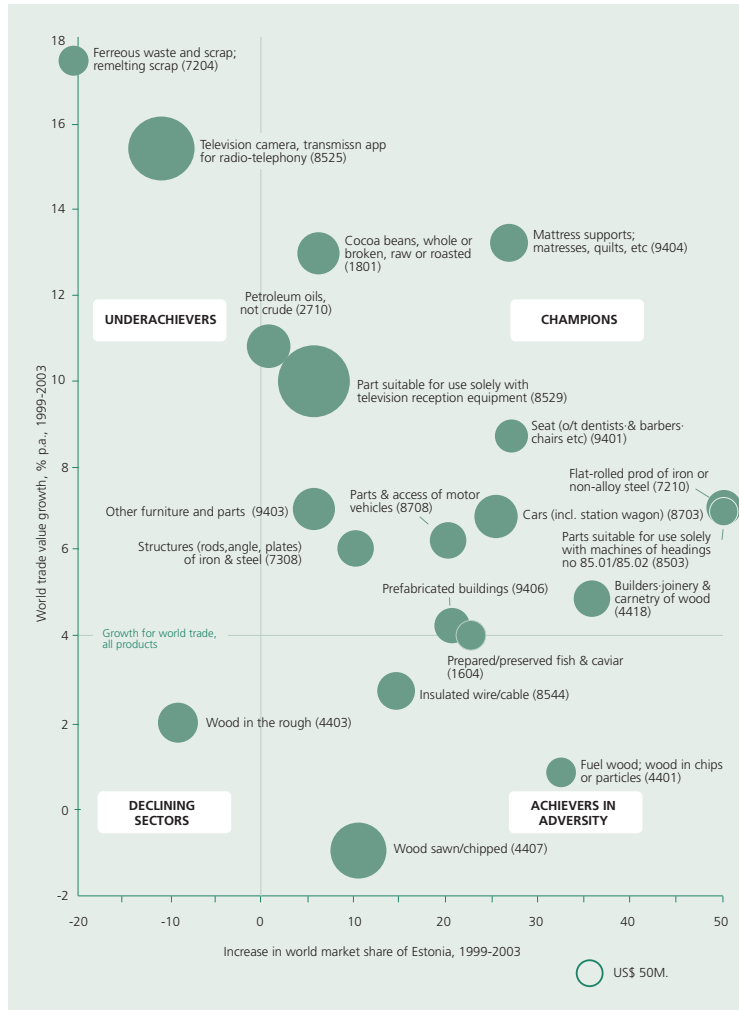
¹⁴⁹ Robert Burgess, Stefania Fabrizio and Yuan Xiao, *Competitiveness in the Baltics in the Run-Up to EU Accession, IMF Country Report No 3/114*, April 2003, 5, <http://www.imf.org/external/pubs/ft/scr/2003/cr03114.pdf>.

¹⁵⁰ *Convergence Report 2004*, European Central Bank, Frankfurt, 2004, 44; Vahur Kraft's presentation in Riigikogu, 12th October 2004.

¹⁵¹ In addition to exceptionally high foreign trade deficit, in 2003 income deficit also amounted to a record 7.9 million EEK, i.e. 46% higher than the year before. Inflow of revenues increased only by 1% that year. 75% of the revenue deficit derived from reinvested earnings. See Eesti maksebilansi aastaraamat 2003 [Balance of Payments Yearbook 2003], Eesti Pank 2004, 20, http://www.bankofestonia.info/pub/et/dokumendid/publikatsioonid/seeriad/mbaasta/_2003/.

Estonia's imports are mostly dominated by various machinery and equipment (incl. notably information and telecommunication equipment), means of transportation, chemical and food products. In addition to the transit of liquid fuel, which plays a significant role in both imports and exports,¹⁵² most important Estonian exports include telecommunications equipment, raw wood, sawn timber and furniture as well as foodstuffs. It is noteworthy that the global market has seen a rapid increase in both fuels and electronics markets over the past years, whereas growth of Estonian market share has been considerably modest. (Figure 24)

Figure 24. Estonian export portfolio 1999-2003.



Source: *Perspectives on Experience*, Boston Consulting Group, Boston, MA, 1974; *Estonia: Country Profile*, UNCTAD/WTO International Trade Centre, <http://www.intracen.org>, February 2005; adjustments by authors.

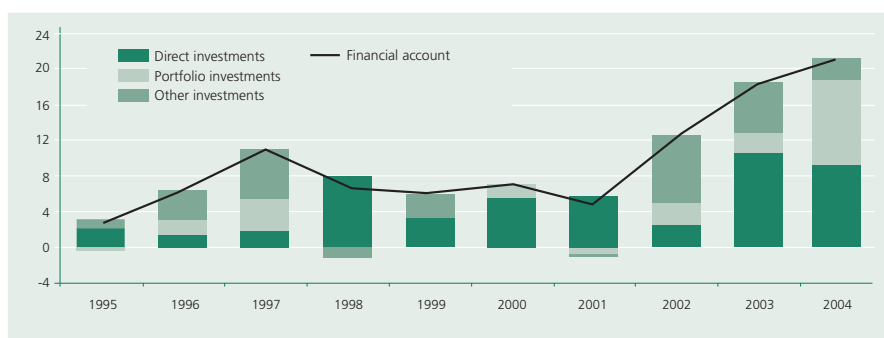
¹⁵² The size of Estonian transit cluster is estimated at 10% of the country's GDP, which is a result of the increases during recent years. At the same time, no rapid growth in this share is to be expected. See *Competitiveness of the Estonian Transit Corridor*, Center for Strategic Initiatives, Tallinn, 2003/2004.

Successful socio-economic development requires the production of “star products and services” or at least some operation with “question marks” that have high growth potential; “cash cows” still allow for some profits to be earned, but competition is rapidly tightening in this segment. Most of Estonian produce, however, belongs to the “cash cow” category, while achievements in new promising areas are rather modest. (See also Ch 1.3.)

Even though the services side of Estonia’s balance of payments has shown an annually increasing surplus, it is not sufficient to cover both trade balance deficit and also the recently more and more escalating income deficit. In 2004, income deficit amounted to 8.9 billion EEK or 6.3% of GDP.¹⁵³

Whereas in earlier years current account deficit was mostly balanced out by the inflow of foreign direct investments, then, even with the record amount of direct investments received in 2003 and 2004, which the authors consider an exception, it is still the short-term and portfolio investments that have demonstrated the fastest growth in recent years.¹⁵⁴ (Figure 25)

Figure 25. Changes in the structure of foreign investment capital flows, billion EEK.



Source: *Eesti maksebilansi aastaraamat 2004* [Estonia’s Balance of Payments Yearbook 2004], Eesti Pank, Tallinn 2005.

On the whole, Estonia’s gross external debt, excluding foreign direct investments, amounted to 80% of GDP in 2004 and more than 80% in 2004. (Figure 26)

Loan stock to private individuals has increased lately by an almost identical volume with Estonia’s gross external debt, exceeding the 29 billion EEK limit by the end of 2004. At the same time, loan portfolio of Estonian commercial banks totalled at more than 90 billion EEK.¹⁵⁵ These results leave Estonia in the worst position among new EU member states, old member states as well as the rest of developed countries – in this group there are only two countries in the world that exceed Estonia (Iceland and New Zealand) – and this is certainly a potential source of concern.¹⁵⁶

¹⁵³ *Estonian balance of payments*, Eesti Pank, <http://www.eestipank.info>, November 2004.

¹⁵⁴ In contrast to the earlier predictions total inflow of foreign direct investments into Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Slovenia and Hungary decreased from 23 billion USD in 2002 to 22 billion USD in 2003. Source: *World Investment Report 2004*, UNCTAD, New York and Geneva, 2004, 72, www.unctad.org; see also *Economic Survey of Europe*, 2004 issue 1, New York, United Nations Publications, 2004, 76 ja 83-89.

¹⁵⁵ *Loans granted to customers by groups of customers*, Eesti Pank, <http://www.eestipank.info>, January 2005.

¹⁵⁶ *IMF Country Report No 04/357*, IMF, <http://www.imf.org/external/pubs/ft/sctr/2004/cr04357.pdf>.

Figure 26. Estonia's external debt.



Source: Eesti Pank, <http://www.eestipank.info>, March 2006; calculations by authors.

3.2. Productivity growth and economic development

Upsetting the external balance of an economy in a fixed exchange rate system is generally expected to automatically cause a slowdown in the inflow of financial resources, which will lead to a decrease in investments and domestic consumption. This, in turn, is expected to reduce the current account deficit. Yet, such type of reduction in the size of economy results in a decline of employment and higher social costs without facilitating any increase in the country's standard of living.¹⁵⁷

Main factors to determine and facilitate an increase in the standard of living are employment and the value added per inhabitant. The more added value gets created in the country, i.e. the higher the productivity of the economy, the higher is the purchasing power of that country.¹⁵⁸ According to Eurostat, Estonia's GDP per capita in Purchasing Power Standards (PPS) was 49% of the EU average in 2003.¹⁵⁹ Then again, in 2002 Estonia's labour productivity per person employed was 4-5 times and hourly wages 6-7 times lower than the average of the EU15. (Table 8) Nonetheless, in more recent years, the pace of pay increase has surpassed the growth of productivity in Estonia.¹⁶⁰

¹⁵⁷ While analysing the sources of the 1997 Asian economic crisis Joseph Stiglitz, winner of the Nobel Prize in economics, discovered that automatic stabilisers might not always work on financial markets. Outflow of „hot money” and inability to refinance external debt (irregardless of whether it is a public or private sector debt) can easily lead to an economic crisis. This is why it is important for the developing countries that provide foreign-currency loans to raise their liquid foreign currency reserves, and implement the regulatory barriers outlined in the IMF Statutes against the devastating outflow of „hot money”, if needed. See, for instance Joseph E. Stiglitz, „Capital Market Liberalisation, Economic Growth, and Instability”, *World Development*, 28, 6, 2000, 1075-1086; Ilene Grabel, „International Private Capital Flows and Developing Countries”, in Ha-Joon Chang (ed), *Rethinking Development Economics*, UK: Anthem Press, 2003, 325-345.

¹⁵⁸ Relationships between the domestic and international equilibrium of an economy as well as their meaning in economic policy development are very well described by the internationally best known Estonian economist Ragnar Nurkse, who not many people actually know of in Estonia. See Ragnar Nurkse, „Domestic and International Equilibrium”, in Seymour Edwin Harris (ed), *The New Economics: Keynes' Influence on Theory and Public Policy*, New York: A. A. Knopf 1947, 264-292.

¹⁵⁹ *GDP per capita in Purchasing Power Standards (PPS)*, Eurostat, 12 February 2005, <http://europa.eu.int/comm/eurostat/>.

¹⁶⁰ Robert Burgess, Stefania Fabrizio and Yuan Xiao, *Competitiveness in the Baltics in the Run-Up to EU Accession*, IMF Country Report No 3/114, April 2003, 5, <http://www.imf.org/external/pubs/ft/sct/2003/cr03114.pdf>; see also Marek Tiits, Rainer Kattel, Tarmo Kalvet, Rein Kaarli, *The Estonian Economy, Competitiveness and Future Outlooks*, Tallinn: Research and Development Council, 2003, 17.

Table 8. Hourly wage and labour productivity in Europe.¹⁶¹

	Hourly labour costs ¹⁶² euros, 2000	Labour productivity per person employed**, 000 euros, 2002	Weekly working hours (full-time work), 2002
Czech Republic	3.90	16.9	42.4
Estonia	3.03	12.0	40.8
Cyprus	10.74	n/a	40.9
Latvia	2.42	12.0	43.6
Lithuania	2.71	10.7	39.4
Hungary	3.83	17.0	41.2
Poland	4.48	16.9	42.7
Slovenia	8.98	25.4	41.3
Slovakia	3.06	13.3	42.1
EU25	19.09	51.9	39.2
EU15	22.21	57.6	38.7

Source: *The New EU of 25 Compared to EU15, News Release 36/2004*, Eurostat, 11 April 2004, <http://europa.eu.int/comm/eurostat/>.

The main source of economic gap between Germany and Estonia, just like all other Central and Eastern European countries, resides in the low level of productivity in the manufacturing industry of this region. In 2000, 28% of Estonia's productivity gap resulted from the low productivity levels of manufacturing industry.¹⁶³ Yet despite the lag manufacturing industry has still been the major source of productivity growth in a number of new member states of the European Union over the period of 1993-2000. While manufacturing industry occupied the first position everywhere, the other more important sources of productivity growth in Estonia were transport, storage and communication, and modernisation of health and social work. During the period mentioned above more than 40% of the productivity growth of the Estonian economy was derived from these three sectors.¹⁶⁴ (Table 9)

This simple calculation demonstrates, among other things, that transport sector, which has traditionally enjoyed a more prominent status in Estonian economic policy than manufacturing sector, has actually contributed significantly less to the productivity growth of the Estonian economy than manufacturing industry.

¹⁶¹ These indicators cover industry and services.

¹⁶² Hourly labour costs mean annual labour costs divided by the number of hours worked. The EU25 indicator excludes here Belgium and Malta.

¹⁶³ Johannes Stephan, *Evolving Structural Patterns in the Enlarging European Division of Labour: Sectoral and Branch Specialisation and the Potentials for Closing the Productivity Gap*, Halle: Institut für Wirtschaftsforschung Halle – IWH, 5/2003, 19, http://www.iwh-halle.de/projects/productivity-gap/publications/Report_WP1.pdf.

¹⁶⁴ Statistically, productivity growth rates are an aggregate effect of productivity changes in individual sectors (manufacturing, services, agriculture etc) and employment shifts between sectors. Even though Estonian economy has gone through major structural changes over the past ten years, productivity in various sectors has remained fairly similar, and thus only 16% of the productivity growth of the Estonian economy in the period of 1991-2000 has actually been derived from the structural changes. *Ibid*, 27-29.

Table 9. Ranking of most influential branches as a source of manufacturing productivity growth, between 1993/1994 and 1999/2000.¹⁶⁵

Estonia			Poland		
D	Manufacturing	21.0%	D	Manufacturing	20.3%
I	Transport, storage and communication	11.3%	A	Agriculture, hunting and forestry	15.4%
N	Health and social work	9.7%	G	Wholesale and resale trade	14.0%
Total sum of the above 3 sectors		42.0%	Total sum of the above 3 sectors		49.7%
Czech Republic			Slovakia		
D	Manufacturing	30.6%	D	Manufacturing	27.7%
G	Wholesale and resale trade	12.4%	A+B	Agriculture, forestry and fishing	9.6%
F	Construction	7.8%	I	Transport, storage and communication	9.4%
Total sum of the above 3 sectors		50.8%	Total sum of the above 3 sectors		46.7%
Hungary			Slovenia		
D	Manufacturing	28.8%	D	Manufacturing	34.4%
G	Wholesale and resale trade	12.4%	G	Wholesale and resale trade	12.6%
I	Transport, storage, communication	9.8%	F	Construction	7.2%
Total sum of the above 3 sectors		51.0%	Total sum of the above 3 sectors		54.2%

Source: Johannes Stephan, *Evolving Structural Patterns in the Enlarging European Division of Labour: Sectoral and Branch Specialisation and the Potentials for Closing the Productivity Gap*, Halle: Institut für Wirtschaftsforschung Halle – IWH, 5/2003, 31, http://www.iwh-halle.de/projects/productivity-gap/publications/Report_WP1.pdf.

Economic growth, or productivity growth of the economy, do not, by themselves, necessarily ensure the ability of companies to successfully maintain their position on the increasingly competitive global market. A more detailed analysis shows also that in both the Slovak Republic and Estonia above-average annual rates of national productivity in comparison to the EU15 during the period of 1993/1994–1999/2000 resulted largely from falling employment and structural shifts in employment at the sectoral level. Therefore, there are reasons to believe that the technological content of productivity growth has been lower in the development of these countries than predicted by productivity growth rates. At the same time, technological development has been the main source of manufacturing productivity growth in the other countries presented in Table 9.¹⁶⁶

Then again, the above is a clear signal to those who develop economic policy in Estonia that there is, indeed, a need for additional initiatives that aim to increase the competitiveness of our companies. Since trade balance deficit accounts for the largest share of Estonia's current account deficit – in comparison with the “old Europe” Estonia's manufacturing productivity ranks one of the lowest among the six countries studied by Stephan *et al*, yet manufacturing productivity growth still yields potentially the highest contribution to the development of the economy – then further analyses (and reflections of a possible future Estonian development strategy) have best to focus on the development of manufacturing as well as transport, storage and communication sectors.¹⁶⁷

¹⁶⁵ Contribution to the productivity growth of the economy is calculated as a fraction of the sum of all weighted sectoral productivity growth rates, weighted by employment shares.

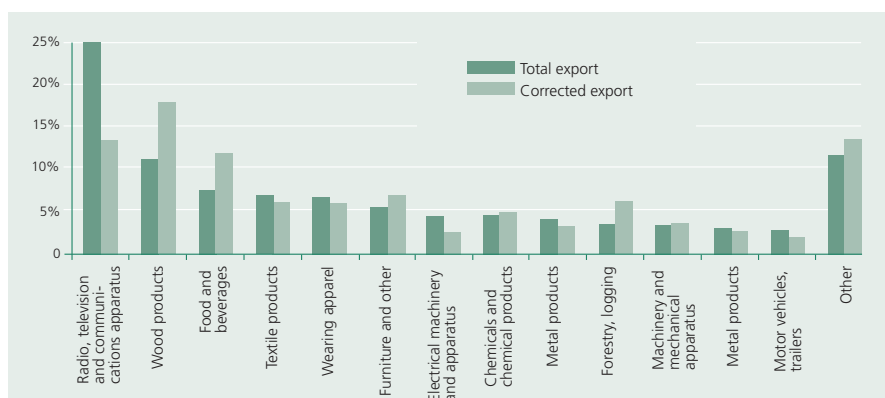
¹⁶⁶ *Ibid*, 33. In Estonia high intensity of structural change in manufacturing industry has had a significant impact on productivity growth with the structure of its manufacturing industry resembling that of Germany by the turn of the century. Namely, more than one fifth of the manufacturing productivity growth can be traced back to employment shifts at the expense of branches which achieved lower levels of efficiency in the use of resources. Had it not been for this particular reallocation of employment between branches of manufacturing, Estonia's productivity growth in this sector would have turned out to be much lower at an average 4.8% per annum for the period of 1993–2000. See Johannes Stephan, *Evolving Structural Patterns in the Enlarging European Division of Labour: Sectoral and Branch Specialisation and the Potentials for Closing the Productivity Gap*, Halle: Institut für Wirtschaftsforschung Halle – IWH, 5/2003, 50–51, http://www.iwh-halle.de/projects/productivity-gap/publications/Report_WP1.pdf.

¹⁶⁷ *Ibid*, 33.

European Competitiveness Report, published by the European Commission in 2003, repeats again the same conclusion many analysts have arrived at earlier – that the economies of several Central and Eastern European countries (incl. Bulgaria, Latvia, Lithuania, Poland and Romania) reveal external trade and manufacturing specialisation structures that have become ‘locked in’ the traditionally rather labour-intensive, low-skill sectors. Specialisation structures of Hungary, Czech Republic, Slovakia as well as Estonia, on the other hand, have shown a fairly rapid increase in the share of more technology-driven sectors. Along these lines, it is also observed that specialisations of different countries are largely determined by foreign direct investments plus education and labour supply structures.¹⁶⁸

High technology sectors like information and telecommunication technologies and electronics do make up a significant share in the specialisation and export structures of Estonia, Hungary and other Central and Eastern European countries. Yet their contribution to the added value of exports still turns out to be considerably smaller than that of several more traditional resource-intensive sectors. (Figure 27) These developments might first appear surprising, but they are really explained by the ever-expanding globalisation and vertical intra-industry trade where price competition has driven less competitive functions of this sector into the cheaper Central and Eastern European countries, whereas control over all activities and profit generation remains in the developed countries.¹⁶⁹

Figure 27. **Export structure in 2001, adjusted to gross and added value.**



Source: Ülo Kaasik, *Eesti eksporditoodete lisandväärtus* [Added value of Estonian exports], Working Papers of Eesti Pank, 3, 2003, 11.

A more detailed analysis of specialisation patterns within different industries reveals that during the period of 1995-2000 low technology industries of the Baltic countries have shifted towards more medium and high technology functions at the same time as high technology industries are increasingly specialising in low and medium technology segments.¹⁷⁰

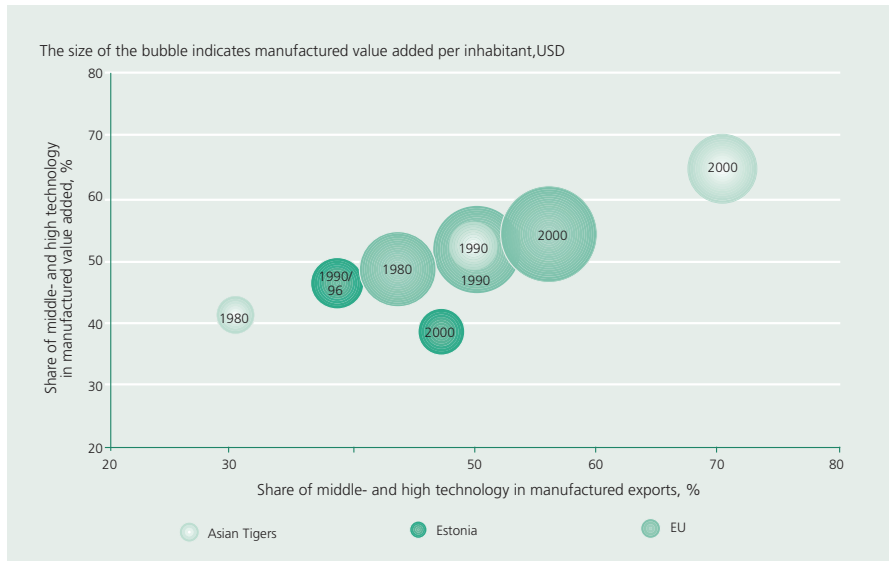
¹⁶⁸ *European Competitiveness Report 2003*, European Commission, 2004, 229, http://europa.eu.int/comm/enterprise/enterprise_policy/competitiveness/doc/compreg_2003_en.pdf.

¹⁶⁹ In Estonian context, the role of international corporations is evident already in the one example of the the import-export status of *Elcoteq Tallinn LLC* that has emerged as one of the biggest employers in Estonia. It is not the fact whether international statistics views Estonia as a high technology country due to the contribution of *Elcoteq Tallinn LLC* to our export indicators that is important. Rather, it is the understanding that we need to achieve the integration of local companies into international production – i.e. added value creation chain, and continued upward movement on the value chain, that actually matters. See also Dieter Ernst and Linsu Kim, „Global Production Networks, Knowledge Diffusion, and Local Capability Formation”, *Research Policy*, 31, 8-9, 2002, 1417-1429; Hubert Gabrisch and Maria Luigia Segnana, *Vertical and Horizontal Patterns of Intra-industry Trade Between EU and Candidate Countries*, Halle, 2003, 32, <http://www.iwh-halle.de/projects/productivity-gap/>.

¹⁷⁰ Uwe Dulleck, Neil Foster, Robert Stehrer and Julia Wörz, *Dimensions of Quality Upgrading in CEECs*, WIIW Working Papers 29, 2004, 11-12, <http://www.wiwi.ac.at/pdf/wp29.pdf>.

Technology transfer that accompanies foreign direct investments has, on the one hand, had a crucially stimulating role in Estonian development, which is common for the countries in investment-based phase of development. In the 1990s, on the other hand, we also witnessed stagnation in the structure of Estonian industry with specialisation on low technology and resource-intensive activities that do not allow for further income growth today. (Figure 28)

Figure 28. Development of industry in Estonia, Western Europe and South East Asia, 1980-2000.¹⁷¹



Source: *Industrial Development Report 2004. Industrialization, Environment and the Millennium Development Goals in Sub-Saharan Africa*, UNIDO, UNIDO: Vienna, <http://www.unido.org/>, 2004; calculations by authors.

Such a situation is a result of both the dissolution of the market of the Soviet Union, and the harsh economic logic according to which it is always the relatively more advanced industry of the comparatively less advantaged country that gets wiped out first in the process of opening up markets.¹⁷²

If Estonia was to survive in the established price competition, it would take as low as possible unit costs of products or as cheap labour as possible, and a rapidly growing volume of production.¹⁷³ Estonian medium and low technology enterprises operate today under the conditions of diseconomies of scale, i.e. increasing volume leads to a decrease in the amount of added value per unit. This distinctly points to the inadequacy of the technological solutions they use and to the presence of considerable price competition. On the one hand, it indicates vigorous modernisation, but on the other hand, it also implies intensive concentration and diminishing specialisation in the economy.¹⁷⁴

¹⁷¹ Figure 28 depicts data from the following countries. EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, United Kingdom. Asian tigers: Korea, Malaysia, Singapore, Thailand. Calculations of the average are presented in all cases.

¹⁷² Vanek-Reinert effect, Erik S. Reinert, *International Trade and the Economic Mechanisms of Underdevelopment*, Ph D. Thesis, Cornell University, Ann Arbor, Michigan, 1980; Erik S. Reinert (ed), *Globalization, Economic Development and Inequality: An Alternative Perspective*, Cheltenham: Elgar, 2004; see also Erik S. Reinert and Rainer Kattel, *The Qualitative Shift in European Integration: Towards Permanent Wage Pressures and a 'Latin-Americanization' of Europe?*, Tallinn: PRAXIS Working Paper no 17/2004, 2004 http://www.praxis.ee/data/WP_17_20042.pdf.

¹⁷³ See e.g. Marek Tiits, Rainer Kattel, Tarmo Kalvet, Rein Kaarli, *The Estonian Economy. Competitiveness and Future Outlooks*, Tallinn: Research and Development Council, 2003.

¹⁷⁴ Rainer Kattel and Riivo Anton, „The Estonian Genome Project and Economic Development”, *TRAMES*, 1/2, 8, 2004.

Backwardness in Estonian manufacturing sector derives mostly from the low productivity levels of food, textiles and wood processing industries. Since Estonian manufacturing sector is almost completely specialised on areas that relate to wood processing, it is reasonable to focus Estonia's economic catch-up with Western Europe, at least in the immediately upcoming years, primarily on increasing the productivity in the wood processing industry (incl. manufacture of furniture and paper) that currently dominates the specialisation structure. (Table 10)

Table 10. **Ranking of most influential branches as a source of manufacturing productivity growth, between 1993/1994 and 1999/2000.**

Estonia			Poland		
DN	Furniture and other manufacturing	18.8%	DA	Manufacture of food products, beverages and tobacco	16.6%
DD	Manufacture of wood and wood products	15.6%	DK	Manufacture of other machinery and equipment	9.1%
DL	Manufacture of electrical and optical equipment	10.5%	DI	Manufacture of other non-metallic mineral products	8.3%
Sum of the 3 branches		44.9%	Sum of the 3 branches		34.0%
Czech Republic			Slovakia		
DM	Manufacture of transport equipment	15.9%	DM	Manufacture of transport equipment	22.8%
DK	Manufacture of other machinery and equipment	15.5%	DK	Manufacture of other machinery and equipment	14.6%
DJ	Manufacture of basic metals and fabricated metal products	13.7%	DL	Manufacture of electrical and optical equipment	12.7%
Sum of the 3 branches		45.1%	Sum of the 3 branches		50.1%
Hungary			Slovenia		
DL	Manufacture of electrical and optical equipment	22.6%	DJ	Manufacture of basic metals and fabricated metal products	17.1%
DA	Manufacture of food products, beverages and tobacco	14.1%	DK	Manufacture of other machinery and equipment	13.1%
DM	Manufacture of transport equipment	16.6%	DB	Manufacture of textiles and textile products	12.4%
Sum of the 3 branches		53.3%	Sum of the 3 branches		42.6%

Source: Johannes Stephan, *Evolving Structural Patterns in the Enlarging European Division of Labour: Sectoral and Branch Specialisation and the Potentials for Closing the Productivity Gap*, Halle: Institut für Wirtschaftsforschung Halle – IWH, 5/2003, 51, http://www.iwh-halle.de/projects/productivity-gap/publications/Report_WP1.pdf.

3.3. *Acquis communautaire* and innovation

Adoption of the *acquis communautaire* of the European Union has been another major factor besides foreign direct investments to influence the socio-economic development in Central and Eastern European countries. Transposition of the European Union regulation has actually had a much greater impact on technological and thereby also socio-economic development of Estonia than the official innovation policy that focuses mostly on the commercialisation of local research accomplishments. This resulted partially from the general political priorities and partially from the youth and crudeness of Estonian innovation policy.¹⁷⁵

¹⁷⁵ See also Rainer Kattel, "Innovatsioonipoliitika valitsemine: Eesti näide" [Governance in innovation policy: case of Estonia], in Vello Pettai and Eveli Illing (eds), *Valitsemine ja hea valitsemine*. [Governance and Good Governance] Tallinn: PRAXIS Center for Policy Studies, 2004.

Transposition of the *acquis* at a pace suitable for Estonia, and the investments made to comply with its requirements and introduction of common standards clearly cause long term spillovers in the form of growth in productivity and improved competitiveness of the industry. Albeit *acquis* does not influence all industries in quite the same way, all industries are, in the end, still forced to make significant investments into the modernisation or innovation of their products, working environment, production processes as well as waste management and the like in order to meet the terms imposed by the European Union regulation.¹⁷⁶

Estonian energy sector is a typical example of how the need to comply with the European Union common regulation forces one sector of the economy into radical renewal. More than 90% of all Estonian electricity is produced by Narva power plants, whose level of efficiency in the production of electricity is less than 30%. Pursuant to the European Union environmental protection requirements all of the old energy blocks currently operating in Narva must be closed down no later than in the year 2015. This year the transfer to new technology should be completed in two blocks in Narva, which will cost a total of 3.9 billion EEK. These two blocks, with their total capacity of 430 MW, are able to cover but about a quarter of the total electric power currently needed in Estonia. Hence, in order to satisfy the domestic energy demand and to observe the environmental protection requirements, Estonian energy production system will have to make significant investments either into the renovation of old power plants or into building new ones.¹⁷⁷

However, the externally imposed need to quickly implement Western standards may also result, in the short run, in a loss of competitiveness in several sectors of industry in Central and Eastern European countries, which can consequently bring about sudden structural changes in the economy and society. Obligation to fully implement common European regulations can cause serious problems for several new member states, and especially for small enterprises (in a situation where no transition period is granted). Food, chemicals, metal and machinery manufacturing as well as energy sector are deemed to be in the worst position.¹⁷⁸

Situation in North Eastern part of Estonia in particular, where employment in manufacturing is higher than elsewhere, gives grounds for much concern. On the one hand, this region is one of the richest in Estonia in regard to natural resources, and this is where most of the manufacturing is located with mining, chemical and textile industries playing the main role. Then again, the heavy industries in this area were mostly oriented towards the Soviet Union market, and were no more competitive after the collapse of the Union, and are not really so even now. Restructuring the manufacturing industry is therefore one of the major challenges facing North Eastern Estonia. It has already led to a significant loss of jobs and will most likely continue to do so. Estonian wood processing sector and its development prospects, on the other hand, receive a positive assessment.¹⁷⁹

It follows from the above that the best opportunities Estonian innovation policy has for facilitating economic development derive from the various fields that relate to modernisation of wood processing industry, and from movement towards higher value-added activities in the value chain. Finnish economic development in the 1970-1980s and the policies implemented to catch up with Sweden offer, in this respect, plenty of valuable and inspiring examples.¹⁸⁰

¹⁷⁶ Community market standards have greatest impact on food and chemical industries where the regulations of the *acquis* apply to as many as 2/3 of all products. Manufacture of machinery, transport and electrical equipment are also significantly affected by the community market regulation. Occupational health and safety regulation concerns mostly wood processing and chemical industries, whereas competition restrictions apply mostly to metal-working industry. Then again, largest investment duties are levied by the European Union environmental protection requirements that influence most of all coal and metals as well as pulp and paper industries. See Peter Havlik, Michael Landesmann, Roman Römisch, Robert Stehrer and Björn Gillsäter, *Competitiveness of Industry in CEE Candidate Countries: Composite Paper*, Vienna: Vienna Institute for International Economic Studies, 2001.

¹⁷⁷ *Estonian National Development Plan for the Implementation of the EU Structural Funds – Single Programming Document 2004-2006*, 2004, 60-65, http://www.struktuurifondid.ee/failid/ESTONIAN_SPD_2004_2006.pdf; *Long Term Public Fuel and Energy Sector Development Plan*, <http://www.mkm.ee/index.php?id=9289>.

¹⁷⁸ Peter Havlik, Michael Landesmann, Roman Römisch, Robert Stehrer and Björn Gillsäter, *Competitiveness of Industry in CEE Candidate Countries: Composite Paper*, Vienna: Vienna Institute for International Economic Studies, 2001, 120-144.

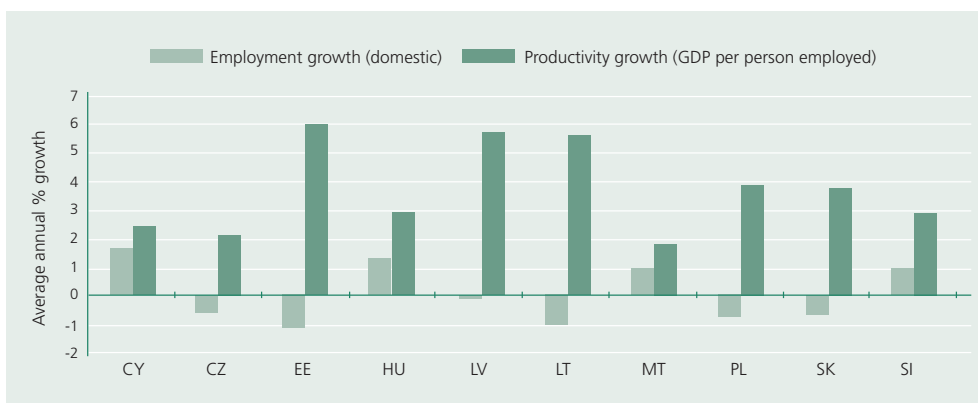
¹⁷⁹ *Ibid.*, 149-150.

¹⁸⁰ See Tarmo Lemola, „Transformation of the Finnish Science and Technology Policy”, *Science Studies*, 1/2003, 52-67.

3.4. Human resources, employment and social sustainability¹⁸¹

The process of restructuring and modernising Estonian economy and industry has been featured by technological and organisational innovations that established a good basis for productivity growth, but also led to a decline in employment. These developments can be partially attributed to the reduction of the kind of overmanning typical in socialist economies as well as to the introduction of new labour-saving technologies and to the closure of inefficient enterprises. Unfortunately, the more productive enterprises have not been able to create new jobs at the same pace.¹⁸² (Figure 29)

Figure 29. Average GDP growth in new member states of the European Union during the years 1997-2002.



Source: *Jobs, jobs, jobs: Creating more employment in Europe, Report of the Employment Task Force chaired by Wim Kok*, Office for Official Publications of the European Communities, 2004, 91.

While total employment has decreased in Estonia by 16% over the past 15 years, employment in manufacturing has dropped as much as 60% and in agriculture even more than 67% during the period of 1989-2003. Whereas in 1989 the share of manufacturing in total employment was 26%, then by 2003 it had fallen to 23%; in agriculture from 18% to below 6%, respectively. Comparatively the highest increase in employment has occurred in wholesale and retail trade whose share in total employment has grown from 7% to 14%. Employment has doubled in financial intermediation. In the light of the lending boom we are also witnessing some expansion in real estate employment. (Table 11)

Notwithstanding the general fall in employment in Estonia, the number of workers in elementary occupations has essentially remained constant, whilst the number of skilled and craft workers has become twice as low (even three times as low in agriculture and fishery). The number of officials has decreased by a third, the number of professionals and associate professionals by a fourth.¹⁸³

¹⁸¹ For a detailed overview see *Human Development Report 2003*, United Nations Development Programme, UK: Oxford University Press, 2003; *Estonian Human Development Report 2003*, Tallinna Pedagogical University, Tallinn, 2003.

¹⁸² Jaan Masso, Raul Eamets and Kaia Philips, *Creative Destruction and Transition: The Effects of Firm Entry and Exit on Productivity Growth in Estonia*, Institute for the Study of Labor (IZA), Discussion Paper 1243, 2004.

¹⁸³ *Employed persons aged 15-69 by sex and major groups of occupation (1989-2003)*, Statistical Office of Estonia, November 2004.

Table 11. **Employment: Employed persons aged 15-69 by economic activity (thousands).**

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Agriculture, hunting and forestry	150.8	140.2	132.2	117.5	96.2	82.8	58.7	55.3	49.7	48.6	43.6	38	36.8	38	33.9	30.8
Fishing	26.5	24.3	23.1	20.2	15.6	12.8	5.8	4.9	6.8	4.8	3.1	2.9	2.7	1.9	2.3	3.6
Mining and quarrying	12.3	12.3	12.1	12.5	11.4	11.1	9.2	8.8	7.1	7.5	7.9	7.2	5.8	5.7	5.6	7.9
Manufacturing	214.9	212.1	202.3	183.1	151.1	140.5	157.7	148.4	136	131.3	122.4	128.9	133.5	127.3	133.5	139.6
Electricity, gas and water supply	18.6	19	18.7	18.3	18.3	19.2	15.4	15.7	16.6	17.2	16.4	14.7	11.4	10.5	10.2	12.0
Construction	64.9	66.1	65.7	60.2	51.6	48.6	34.5	35.5	44.8	44.1	38.9	39.7	39.3	38.9	42.9	46.8
Wholesale and retail trade	61.6	63.2	65.6	71.9	80	85.9	80.1	82.5	86	85.4	81.5	79	83.4	85.7	80.1	79.7
Hotels and restaurants	18.8	18.2	19.1	18	17	18.2	17.2	17	14	13.7	13	19.9	17.3	17.9	17.3	16.2
Trade, storage and communication	65.6	68.3	68.2	62.3	59.1	57.4	63.7	61.9	56.3	54.9	59	56.7	53.6	53.7	56	51.4
Financial intermediation	3.9	4.2	4.8	5.8	6.5	7.7	6.9	6.3	7	8.1	8.6	7.7	7.1	7.9	7.6	7.9
Real estate, renting and business activities	33.6	34	31.8	29	28.3	30	31.2	31	33.5	36.7	36.5	39.2	36.9	43.3	42.8	37.6
Public administration and defence	32.8	32	31.5	32.4	34.5	35.3	34.5	33.7	32.3	34.7	34.6	33.9	34.2	33.1	34.3	36.7
Education	51	48.7	47.6	48.3	48.7	46.9	53.8	54.1	55.6	53.2	49.8	44.2	50.5	54.8	55.7	53.0
Health and social work	50.5	49.5	50.4	48.2	46.9	46.1	35.7	35	35.1	33.4	30.8	28.1	30.4	31	35.7	37.1
Other economic activities	32	33.6	33.5	33.7	33.7	32.8	29	29.2	32.1	28.8	29.3	28.2	29.4	29.6	30.2	28.3
Economic activities total	837.9	825.8	806.6	761.4	698.9	675.4	633.4	619.3	613	602.5	575.3	568.3	572.2	579.3	588.1	588.6
Employment rate (%)	76.4	75.0	73.2	69.5	65.5	64.6	61.7	61.2	61.3	60.6	58.2	57.6	58.1	58.8	59.7	59.7

Source: Statistical Office of Estonia, March 2006.

In recent years, employment has declined in the medium and high technology branches of Estonian manufacturing industry remaining at 3.4% in 2003 (4.9% in 2001), which is only about half of the EU15 and EU25 average indicator. The same applies to employment in medium and high technology branches of services industry¹⁸⁴ – Estonia's employment in the respective sector (2.3% in 2003) constitutes 66% of the equivalent indicator for EU15 and 73% of the EU25.¹⁸⁵

Since structural changes in the economy have led to specialisation in less knowledge and skills intensive activities and a large part of industry is experiencing diseconomies of scale (see Ch. 3.2), it is not surprising that in Estonia a 1% increase in labour costs results in a 0.26% decrease in employment.¹⁸⁶ This generates strong pressure to reduce taxes and differentiate (read: reduce) minimum wage levels, because otherwise current cost-based competitive advantages do not render companies competitive anymore. Even if cost-cutting would, in the short run, help the less successful companies save jobs, it really only delays the process of finding proper solutions to the structural problems facing Estonian economy.

¹⁸⁴ It is important to remember that knowledge-intensive services are characterised by a certain employment minimum regardless of the size of the country they are located in. Hence, in a smaller country this means a relatively larger portion of total employment. Secondly, exportable services constitute only a rather small part in the standard list of knowledge-intensive services. This is why, after all, they only make a limited contribution to fostering economic development and competitiveness, as defined by the authors of this book.

¹⁸⁵ *European Innovation Scoreboard 2004. Comparative Analysis of Innovation Performance*, European Commission, 2004, http://trendchart.cordis.lu/scoreboards/scoreboard2004/pdf/eis_2004.pdf; *European Innovation Scoreboard 2004. Annex 2. Country Pages EU25 + Candidate countries*, European Commission, 2004, http://trendchart.cordis.lu/scoreboards/scoreboard2004/pdf/eis_2004_annex2.pdf.

¹⁸⁶ Janno Järve, *Tööjõukulude mõju töajõu nõudlusele Eesti tööstusettevõtetes* [Impact of labour costs on labour demand in Estonian manufacturing enterprises], Policy Analysis 1/2002, Tallinn: PRAXIS Center for Policy Studies; Marit Hinnosaar, Tairi Rõõm, *The Impact of Minimum Wage on the Labor Market in Estonia: an Empirical Analysis*, Working papers of Eesti Pank, 8, 2003.

Despite the high (and often long term) unemployment in Estonia, entrepreneurs are unable to find suitably qualified labour. An even more important problem is actually the modest number of well-qualified science and engineering graduates.¹⁸⁷ (See also Table 12)

Table 12. Share of science and engineering¹⁸⁸ graduates among the 20-29 years age class, 1993-2002.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Ireland	19.10	21.00	21.40	21.90	21.80	22.40		23.20	21.70	20.50
Finland	13.20	13.00	13.00	13.10	15.80	15.90	17.80	16.00	17.20	
Lithuania					7.30	9.30	11.70	13.50	14.80	14.60
Sweden	6.20	6.30	7.30	7.40	7.80	7.90	9.70	11.60	12.40	13.30
Japan			12.70	12.50		12.36	12.76	12.97	13.04	
EL-15					10.30	10.70	11.12	11.43	12.38	12.47
Bulgaria					6.00	5.50	6.50	6.60	7.90	11.70
EL-25					9.28	9.67	10.12	10.45	11.30	11.49
US	10.30	10.90	11.20	11.50		9.60	9.70	10.20		
Slovenia					6.30	8.00	8.40	8.90	8.20	9.50
Latvia					6.90	5.90	6.30	7.50	7.60	8.10
Estonia					4.20			7.00	7.30	6.60
Netherlands	5.50	5.40	5.60	6.60		6.00	5.80	5.80	6.10	6.60
Hungary					5.00	5.00	5.10	4.50	3.70	4.80

Source: *European Innovation Scoreboard 2004, Comparative Analysis of Innovation Performance*, European Commission, 2004; *European Innovation Scoreboard 2004. Annex 2. Country Pages EU25 + Candidate countries*, European Commission, 2004, <http://trendchart.cordis.lu/scoreboards/scoreboard2004/>.

People who used to be economically active earlier, but lost their jobs and are in need of retraining, find that their existing skills are only good enough for minimum wage jobs or no good for any work at all. Yet it is not only the productivity, but also the size of labour force that are critical to maintaining or increasing the general standard of living.¹⁸⁹ Today's high unemployment levels among the 15-24 year age group, which amount to 17% for men and even 26% for women, is a cause for particular concern in this context.¹⁹⁰ (Figure 30)

¹⁸⁷ About information and communication technology sector see Rainer Kattel and Tarmo Kalvet, *Teadmistepõhine majandus ning infotehnoloogialane haridus: hetkeolukord ning väljakutsed haridussüsteemile aastani 2008* [Knowledge-Based Economy and Information Technology Education: Existing Conditions and Challenges Facing the Educational System up to the Year 2008], PRAXIS Center for Policy Studies, 2005.

¹⁸⁸ Science and engineering (S&E) graduates are defined as all post-secondary education graduates (educational groups 5a and above) in life sciences (ISC42), physical sciences (ISC44), mathematics and statistics (ISC46), computing (ISC48), engineering and engineering trades (ISC52), manufacturing and processing (ISC54) and architecture and building (ISC58).

¹⁸⁹ Although it was, indeed, also implemented in the Soviet Union, full employment policy as one of the core elements of the European Union Lisbon strategy is not at all tied to any socialist approach. After the „great depression” of the 1930s most developed industrialised countries shared the view that securing full employment is one of government's main tasks. Demand and productivity growth were supposed to be key sources for covering sizeable labour costs. Likewise, 19th century policies of Napoleon III attributed much importance to securing employment for the poor during economic recession in order to prevent hunger and uprising. Thus, even if technology-driven reduction in the number of jobs is a part of the toll that reorientation to high technology takes, it is still vital to adopt preventive measures to try and sustain employment levels. This is the very reason why a transition to high technology sectors and extensive structural changes must, nonetheless, begin with the modernisation of the existing labour-intensive traditional industry where available resources facilitate and volumes allow for real expansion.

¹⁹⁰ See also *Labour Market and Social Policies in the Baltic Countries*, OECD, 2003, <http://213.253.134.29/oecd/pdfs/browseit/1403021E.PDF>.

Figure 30. Unemployment levels in Estonia 1993-2004.



Source: Statistics database, Statistical Office of Estonia, April 2004.

Albeit Estonia's 60% employment rate in 2004 compares well to the European Union average, it gets nowhere close to the 70% level in the United States. Shorter working time, lower employment rates and productivity are also among the main reasons why Europe is economically lagging behind the United States. Even though it is the very goal of the Lisbon strategy to achieve the 70% employment level in Europe by 2010, the actual realisation of this objective does not look very feasible. This does not mean, however, that achieving these goals would somehow have become less critical to the European competitiveness *vis-à-vis* USA, China and South East Asia.¹⁹¹

While EU15 countries are investing an average 1% of their GDP into active labour market policies, new member states contribute only 0.2% of GDP. Although Estonia's active labour market policies have proven effective, and every kroon invested into employment training has brought 3 kroons in return for the society, spending on active labour market policies in Estonia still accounted for a mere 0.08% of GDP in 2002.¹⁹²

Rise in the number of inactive people is, again, inevitably linked to growing wealth stratification. Hence, most of the Central and Eastern European transition countries have been experiencing a dramatic increase in financial inequality over the past 15 years.¹⁹³ Both the insecurity of the transition period, and the fact that 30% of the families with two children and 45% of the families with three children live below the poverty line in Estonia (at risk of poverty even as many as 60% of the latter),¹⁹⁴ in turn, clearly affect general demographic trends. An overview of income distribution in various new member states of the European Union demonstrates that the distribution is most uneven precisely in Estonia. (Figure 31)

¹⁹¹ Achieving the 70% employment goal in Estonia by 2010 would require additional 60-70 thousand people to be employed over the following five years. See also *Facing the Challenge: The Lisbon Strategy for Growth and Employment, Report from the High Level Group Chaired by Wim Kok*, European Commission, November 2004, 11-12, http://europa.eu.int/comm/lisbon_strategy/pdf/2004-1866-EN-complet.pdf; *Employment in Europe 2004: Recent Trends and Prospects*, European Commission, 2004; *The EU Economy: 2004 Review*, European Commission, Brussels, 2004, 4.

¹⁹² Reelika Leetmaa, Andres Võrk, Raul Eamets, Kaja Sõstra, *Aktiivse rööpoliitika tulemuslikkuse analüüs Eestis* [Analysis of the effectiveness of proactive employment policy in Estonia], Tallinn: PRAXIS Center for Policy Studies, 2003; *Key Structural Challenges in the Acceding Countries: The Integration of the Acceding Countries into the Community's Economic Policy Co-ordination Processes*, European Economy, Occasional papers no. 4, European Commission, July 2003.

¹⁹³ *Transition: First Ten Years*, World Bank, Washington D.C. 2002, 9.

¹⁹⁴ *Leibkonna sissetulekute ja kulutuste uuring* [Survey of household income and expenditure], Statistical Office of Estonia, 2000.

Figure 31. Income level and distribution in various new member states of the European Union.



Source: Tobias Hüsing, *The Impact of ICT on Social Cohesion: Beyond the Digital Divide*, Paper presented at the 14th Economic Forum, September 9-11, 2004, Krynica Zdrój, Poland, 2004, 8, <http://fiste.jrc.es/download/impact%20of%20ict%20on%20social%20cohesion%20-%20husing%20-%20final%20draft%20.pdf>.

While in Europe employment is already rapidly declining as a result of aging population, in Estonia labour supply should remain pretty much at the same level without migration until 2015, then starting to fall rapidly due to low birth rates experienced throughout the past ten years.

The most tangible indication of these upcoming trends is the fact that the number of 16-18 year olds is going to start its plunge in Estonia already in 2007, and by 2015 its level will be half of that in 2003.¹⁹⁵ This, in turn, means that the need for student places in higher and vocational education system that follows the basic and secondary education will halve. Yet in order to adhere to the *Lisbon strategy* we should be increasing the number of the 24-65 year olds participating in further training by 2.4 times by the year 2010.¹⁹⁶

In addition, by the year 2020 the age group of 15-24 years will comprise half as many people as in 2000 due to the impact of low birth rates in Estonia. (Figure 32) Whereas today there are four working-age people per one retired person, according to the estimates of the UN this number will drop to three by the year 2025 and to less than two by the year 2050.¹⁹⁷ This rapid aging of population that is taking over the whole Europe will inevitably lead to an intense competition for immigrants: most particularly among the highly qualified specialists.¹⁹⁸

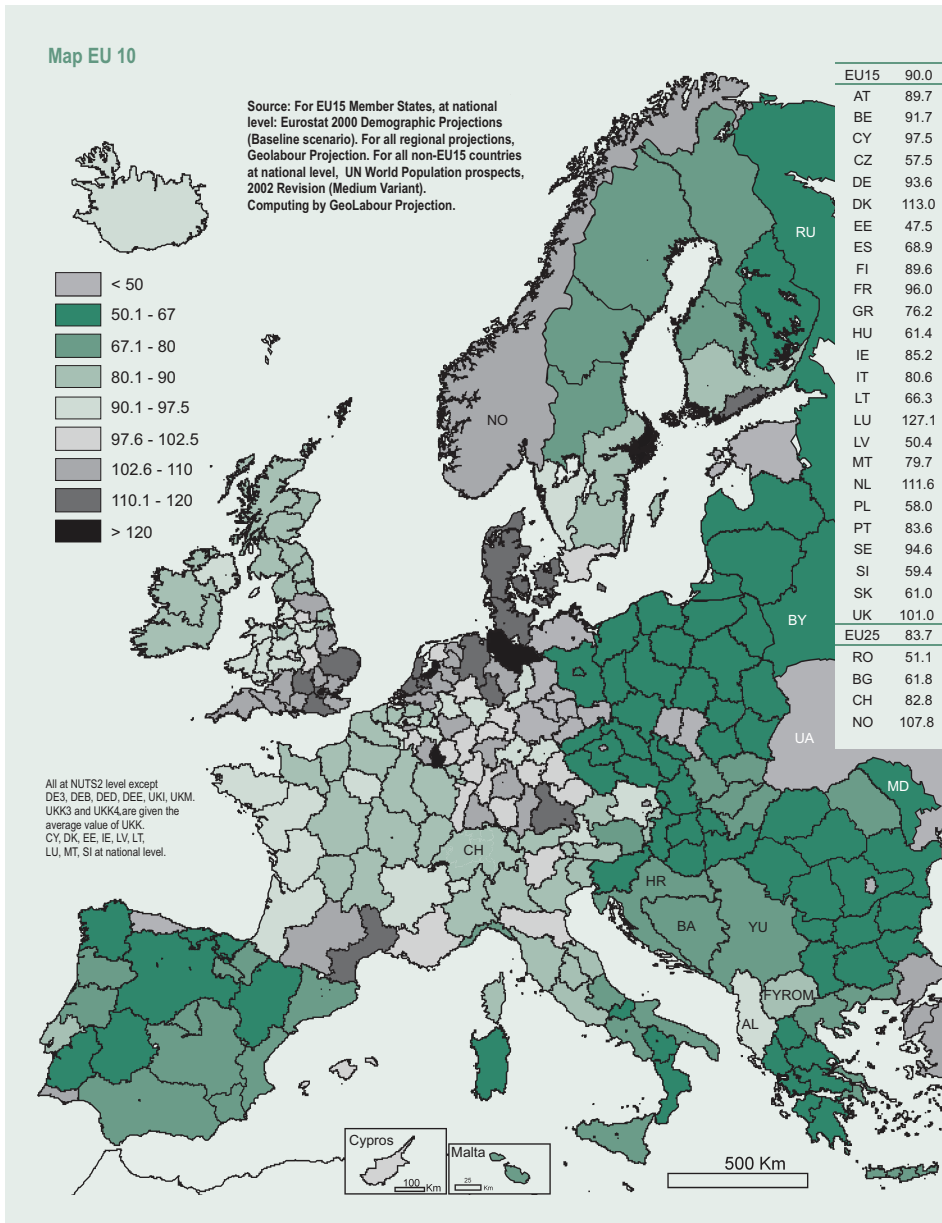
¹⁹⁵ Reelika Leetmaa, *Eesti tööturg ja Lissaboni strateegia eesmärgid* [Estonian labour market and the objectives of Lisbon strategy], presentation, Tartu, 5th November 2004.

¹⁹⁶ Tiina Annus, Jussi S. Jauhiainen, Katrin Jõgi, Jaak Kliimask, Liis Kraut, Mihkel Laan, Rivo Noorkõiv, Garri Raagmaa, Aloysius Ferdinand Maria (Lock) Nieuwenhuis, *Kutseõppeasutuste võrgu korraldamine läbivalv regionaalset spetsialiseerumist* [Organisation of vocational school network in accordance with regional specialisation], Tallinn: PRAXIS Center for Policy Studies, 2003, <http://www.praxis.ee/data/Koolivqrk0.pdf>.

¹⁹⁷ *World Population Prospects: The 2002 Revision Population Database*, United Nations, <http://esa.un.org/unpp>, December 2003.

¹⁹⁸ See e.g. *Best Before 01012015, Future Makers – Finland 2015*, Sitra, 2003, http://194.100.30.11/suomi2015/suomi2015_7/english/Best_%20before_01012015.pdf.

Figure 32. Number of people in the age group of 15-24 years in 2020 (2000 = 100%).



Source: Géry Coomans, *Atlas of Prospective Labour Supply*, Geolabour, Dublin 2004, <http://www.geolabour.com>.

Estonia is also facing some major challenges in health care. Besides the needs, for instance, to reform Estonian hospital network and secure the development of health care system, Estonia is also approaching critical conditions in regard to HIV/AIDS. It is estimated that in about ten years time at the latest every third premature death in Estonia will be caused by HIV/AIDS.¹⁹⁹ Along the same lines, the US Central Intelligence Agency (CIA) has warned that the epidemic spread of HIV/AIDS in Russia is likely to aggravate its social, economic, health care and military problems. United Nations Development Program estimates that the HIV epidemic in Russia will cause a 10-12% decrease in GDP.²⁰⁰ Estonia's situation is even more complicated. In the region of the former Soviet Union the virus is spreading fastest precisely in Estonia; the number of HIV-infected people per inhabitant is second highest in Russia, followed by Ukraine, Latvia and Byelorussia. Plus the level of AIDS illness is about twice as high in the population of Estonia as it is in Byelorussia.²⁰¹

According to OECD assessment, high unemployment levels, modest incomes, and a much more uneven income distribution than in many European countries do not really leave Estonian government many choices. Estonian labour market policy must adopt the establishment of such an institutional framework that facilitates innovation and new job creation as its main goal.²⁰²

¹⁹⁹ Presentation by former Minister of Social Affairs Marko Pomerants at a cabinet meeting, 18th November, 2004.

²⁰⁰ *The Next Wave of HIV/AIDS: Nigeria, Ethiopia, Russia, India, and China*, Central Intelligence Agency, 2002, 28, http://www.cia.gov/nic/PDF_GIF_otherprod/HIVAIDS/ICA_HIVAIDS20092302.pdf

²⁰¹ See also Olusoji Adeyi, Enis Baris, Sarbani Chakraborty, Thomas Novotny, Ross Pavis, *Averting AIDS Crises in Eastern Europe and Central Asia - A Regional Support Strategy*, World Bank, September 2003; Ruta Kruuda, Maris Jesse, Kadi Viik, *HIV/AIDSi ennetustegevuse hindamine Eestis 2004* [Evaluation of HIV/AIDS prevention program in Estonia 2004], PRAXIS Working Paper 16/2004, http://www.praxis.ee/data/toimetised_16_2004_templatis0.pdf.

²⁰² *Labour Market and Social Policies in the Baltic Countries*, OECD, Paris 2003.

4. Estonia's competitive position in Europe

4.1. About the economic opportunities of our children

While campaigning in 1928 Herbert Hoover still believed in the America of the “Progressive Era” and was not shy about spelling it out: “We in America today are nearer to the final triumph over poverty than ever before in the history of any land.” This message appealed to voters. Hoover, who became the US president a year later, was a champion of individualism, market efficiency, international gold standard and balanced budget policy. Focusing on increasing government efficiency, cutting taxes, public-private cooperation instead of regulation and the rapidly developing American industrial economy will take care of the rest were prevalent slogans of the era.²⁰³ Even the *Ladies' Home Journal* declared: in fact, everyone should be rich, because you only have to invest a tiny bit every week to make a fortune in 20 year time.

In October 1929 the US stock market crashed. The following economic collapse and the Great Depression that devastated the whole Western world put Hoover's previously solid-sounding faith in free enterprise into a naïve and even tragic light. John Maynard Keynes, who brought the world out of the Great Depression in the 1930s, did not consider planned economy feasible, but he did devote a whole essay on describing the development prospects of the capitalist economy for the coming hundred years (*sic!*).²⁰⁴ This experience shows that viewing government and enterprise as adversaries is indeed destructive, and in no way supports the progress of society.

It is in the nature of human beings to expect that in their quest for stability and well-being, future will be a progressively favourable continuation of current positive developments. Alas, the history is full of examples of both government and market failures. No one is safe from ill fortune or incompetence, especially in a small open economy, which is largely at the mercy of global trends. Consequently, today's increases in oil prices, growth in political tensions and ongoing warfare generate multiple trends in the global economy that render the future rather insecure. A reasonable balance between government regulation and free market logic is, thus, essentially the safest path towards future.

Whereas in 1997 the inability to refinance their loans and the exhaustion of foreign reserves caused by the outflow of “hot money” led first Thailand and then a number of other South East Asian countries to abandon dollar-pegged exchange rates and to an acute economic crisis, then by now the situation appears reversed with some similarities evident in the economic difficulties the US was going through at the end of the 1980s. USA is experiencing major trade deficit and rapid growth in external debt,²⁰⁵ which have caused the dollar exchange rate to decline to the level of early 1990s. In recent years it is the rapidly growing Asian countries that have become the main creditors to the US government. (Figure 33) The more dollar exchange rate declines, the less attractive American bonds become as potential investment targets for Asian central banks. Since yuan is pegged to the dollar, this decline in dollar exchange rate also cannot alleviate the American trade deficit, which is largely generated by Chinese imports. On the other hand, it would be as hard for the Asian countries to de-peg their currencies, because, for instance, a potential 20% rise of yuan against dollar would mean for China alone a 100 billion dollar hole (ca 8% of China's GDP) in foreign reserves, plus a significant setback in exports to the US.²⁰⁶

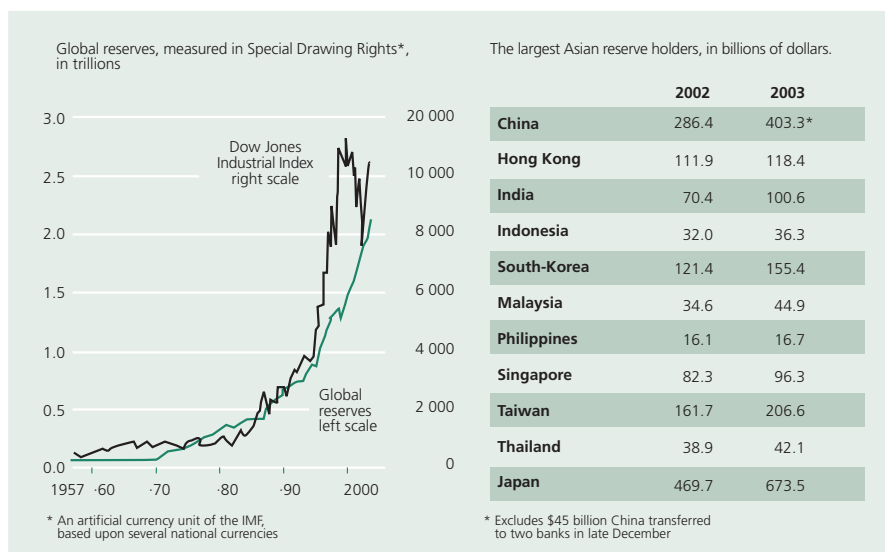
²⁰³ Ronald Edsforth, *The New Deal: America's Response to the Great Depression (Problems in the American History)*, Blackwell Publishers, 2000, 11-13.

²⁰⁴ John Maynard Keynes, “Economic Possibilities for Our Grandchildren”, published as John Maynard Keynes, *Essays in Persuasion*, New York: W.W.Norton & Co., 1963 [1932], 358-373.

²⁰⁵ See also W Joseph Stroupe, “Crisis towers over the dollar”, *Asia Times*, 25.11.2004, http://www.atimes.com/atimes/Global_Economy/FK25Dj03.html; Brett Arends, “On State Street”, *Boston Herald*, 23.11.2004, <http://business.bostonherald.com/businessNews/view.bg?articleid=55356>.

²⁰⁶ See e.g. Robin Shepherd, “New Europe's economic challenges”, *United International Press*, 10.12. 2004; Brian Bremner and Pete Engardio, “The Makings of a Meltdown”, *The Economist*, 13.12. 2004; Michael R. Sesit “Currency Reserves, and Concerns, Build Up”, *Wall Street Journal Europe*, 11.02. 2004; Richard Duncan, *The Dollar Crisis: Causes, Consequences, Cures*, John Wiley & Sons, 2003.

Figure 33. Growing financial bubble?



Source: Michael R. Sesit, „Liquidity pool Amassed By Asian Central Banks Sparks Inflation Worries”, *Wall Street Journal Europe*, 02.02. 2004.

While Asian Tigers and China are enjoying the fruits of their consistent economic policies of the past 50 years, Russia's exports to the European Union – one of its main markets of destination – are dominated by growing specialisation on natural resources and/or cheap labour intensive economic activities. Recent increase in oil prices has, indeed, improved Russia's economic situation, but this alone is still not enough to sustain a long-term income growth for its population. IMF and World Bank estimate that continued developments in this direction can easily result in Russia falling into a “Dutch disease” type of classic economic crisis as soon as oil prices drop.²⁰⁷

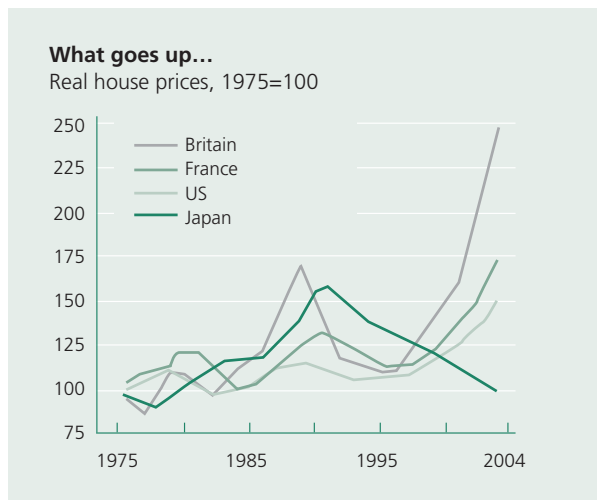
In the light of relative economic stagnation of the Western countries, recent years have witnessed a massive flow of portfolio investments and cheap debt financing into the comparatively faster growing economies of the developing markets, causing rapid increase in local stock exchange indices.²⁰⁸ Even if at first sight this looks like a fairly positive development for the several new member states of the European Union, their high current account deficit and heavy external debt burden still imply possible threat of instability. Having to fight speculative attacks against forint three times in 2003 and the decision by the Hungarian central bank to raise the base rate of forint to 10% level in order to refinance public sector external debt indicate that their situation is one of the most complicated in the whole region.²⁰⁹

²⁰⁷ Karoly Attila Soos *et al.*, “Russian manufacturing industry in the mirror of its exports to the European Union”, *Russian Economic Trends*, 11, 2002, 31–43; “IMF tells Russia to focus on inflation, not growth”, *Agence France Press*, 17.11. 2004, <http://uk.biz.yahoo.com/041116/323/f6qqr.html>.

²⁰⁸ In 2004 Bratislava stock exchange index climbed 77%, Budapest and Tallinn stock exchange indices each 53%. Prague stock exchange has enjoyed a 49% rise. See “Eastern European bourses enjoy boom”, *Agence France Press*, 13.12.2004.

²⁰⁹ See e.g. *Economic Survey of Europe, 2004 issue 1*, New York: United Nations Publications, 2004, 51–52.

Figure 34. Real house prices, 1975 = 100.



Source: „The global housing market: Flimsy foundations”, *The Economist*, 09.12.2004.

Although there have been other real estate booms in history, the hyper-low base rate of leading currencies has this time triggered a truly global real estate boom. Rapid growth in debt burden has nurtured the escalation of the real prices of real estate in Britain by 2.5 times from the 1997 level; the increase has been slightly lesser in France and USA. (Figure 34) Real estate prices have also gone through a significant expansion in Australia, Ireland and Spain, several Central and Eastern European countries and elsewhere. Yet economy is cyclical in nature, so every upsurge is quite certainly followed by a period of decline.

Seeing as growth in real estate prices has been a global phenomenon, IMF projects that the setbacks in the economy to be brought about by rising interest rates and decline in prices will also occur globally.²¹⁰

Even economic theorists are no more as convinced of the economic laws that were still deemed bullet-proof just a couple of years ago. Paul Samuelson, one of the founding fathers of modern economic theory, for instance, whose textbooks most contemporary macroeconomic experts have once studied from, is one of those who refers to the works of David Ricardo and John Stuart Mill and calls it “the popular polemical untruth” to assume that the (US) economy always profits from globalisation and free trade.²¹¹

Along the same lines, in South America the current “Washington Consensus” based reform policy is increasingly viewed as a failure. In order to gain more clout in global policy arena 12 countries have come to an agreement to launch already by the year 2019 a *South American Community* modelled following the example of the European Union and including a regional parliament, common market, common currency etc.²¹²

We do not know what kind of solutions the above-mentioned trends in the world economy, policy and research will lead to,²¹³ but all of these as well as many other socio-economic, technological, environmental and other global trends will most certainly have a significant impact on the future of Estonia too. Although

²¹⁰ *World Economic Outlook*, IMF, September 2004, 71-89; About the connection between economic cycles and real estate price fluctuations see Ronald Kaiser, “The Long Cycle in Real Estate”, *Journal of Real Estate Research*, vol. 14, 3, 1997, 233-257.

²¹¹ Paul A. Samuelson, “Where Ricardo and Mill Rebut and Confirm Arguments of Mainstream Economists Supporting Globalisation”, *Journal of Economic Perspectives*, 18, 3, 2004, 135-146.

²¹² *Declaración del Cusco sobre la Comunidad Sudamericana de Naciones III Cumbre Presidencial Sudamericana*, 8. December 2004, http://www.comunidadandina.org/documentos/dec_int/cusco_sudamerica.htm; John Williamson, *From Reform Agenda to Damaged Brand Name: A short history of Washington Consensus and suggestions for what to do next*, Finance & Development, IMF, September 2003, <http://www.imf.org/external/pubs/ft/fandd/2003/09/pdf/williams.pdf>.

we are not able to control the external environment, relying on good luck alone for future progress is still one of the riskiest strategies to pick. Analysing various future developments helps to better prepare long-term strategies, increase readiness to act in various circumstances and hopefully also to guard, at least somewhat, against unpleasant surprises.

After World War II, guided by this very same insight, *RAND Corporation* started keenly mapping potential future threats, and elaborating respective development scenarios for the purpose of enhancing American military planning. In the 1970s Japan adopted several of the foresight methodologies used in the US, and applied them extremely successfully at the service of technological and socio-economic development. Inspired by Japan's post-war economic miracle majority of developed countries, including China and others have made more or less sound attempts at using various foresight methodologies. Even though it is not the goal of foresight to predict the future, a professionally managed process that includes a broad range of experts does help bringing closer the understandings of various groups of society about their desired future, and thereby incorporates an element of self-fulfilling prophecy.²¹⁴

4.2. European Union and shifts in international division of labour

Economic theories have basically always followed the principle of a positive relation between welfare and market size. This principle became famous through the works of Adam Smith.²¹⁵ Accordingly, enlargement of the European Union opens up many new opportunities. Larger markets and lower production costs offer tremendous prospects for growing trade flows, investments and economic development all across Europe. Then again, the European Union brings together economies with dramatically diverse levels of income and development,²¹⁶ which raises fundamental questions about the whole possibility of establishing policies that fit all member states simultaneously, and about interdependencies between various states.

Enlargement of the European Union lets Western European companies relocate their production units that struggle with price competition, and offers greater economies of scale. At the same time, these developments offer new member states the much needed access to larger market, capital and technology.²¹⁷

Prima facie, largest ever enlargement of the European Union that added ten more countries is therefore also very good news for Estonian entrepreneurs and the economy as a whole. Taking advantage of the opportunities offered by the enlargement is, however, altogether not that easy. Low income levels of their population make new member states still a less attractive destination market for investors as compared to Western Europe. In addition, markets of the new member states are not very large on their own, except for maybe Poland. Although the income levels in Central and Eastern European countries have generally followed the productivity growth trends, and the latter have been significant ever since 1991, the persistently modest productivity levels do not allow for rapid increase in incomes.

Starting with David Ricardo, the concept of *comparative advantage* that results from differences in labour productivity has been the classic approach to explaining international trade. Ricardo believed that differing productivity levels between various countries arise from the countries' economic environment or "climate" that favours one or another activity. Since every economic environment always favours some activities more

²¹³ An example of a very current issue would be the continuously growing oil prices and projections about the remaining fossil fuel reserves. Just like during the oil crisis of the 1970s, development of alternative technologies for energy production has once again established its presence on global agenda. Whilst in the 1970s it was thought that technology-wise we are only 20 years away from hydrogen solutions, virtually the same projection still applies today, since there have been no major investments into this sector during the intervening years. For a more detailed account of the developments in this field see „Hydrogen not a solution for the short term, says UK economist”, *EurActive.com*, 13.10.2004, http://www.euractiv.com/Article?tcaturi=tcm:29-130838-16&type=News&_lang=EN.

²¹⁴ See e.g. Denis Loveridge, *Foresight: A Guide for Sponsors, Organisers and Practitioners*, PREST, University of Manchester, 1999; James Gavigan *et al*, *A Practical Guide to Regional Foresight*, FOREN network, 2001.

²¹⁵ About the specifics of economic policy in small states see e.g. E.A.G. Robinson (ed), *Economic Consequences of the Size of Nations*, London: Macmillan, 1963.

²¹⁶ Julie Pellegrin, *The Political Economy of Competitiveness In an Enlarged Europe: Who Is In Charge?*, <http://www.ciaonet.org/isa/pej01/>; see also Julie Pellegrin, *Political Economy of Competitiveness in Enlarged Europe*, Palgrave Macmillan 2001.

²¹⁷ Julie Pellegrin, *The Political Economy of Competitiveness In an Enlarged Europe: Who Is In Charge?*, http://www.ciaonet.org/isa/pej01/europa.eu.int/comm/enterprise/enterprise_policy/industry/doc/sec_234_200n.d

than others, it is, of course, more profitable for the entrepreneurs to rather invest in activities that offer better revenue opportunities. Investment decisions made by entrepreneurs are thus dependent upon government actions in developing the economic environment.²¹⁸ This logic is the very basis of the understanding that the European Union, just like any other free trade area, is beneficial for the associated countries under the conditions of competent/successful specialisation.

Analyses of the impact of the European Union enlargement upon future international specialisation primarily highlight two groups of industries. In the sectors where trade between Western Europe and Central and Eastern Europe was more or less in balance prior to enlargement, larger economies of scale are expected to bring about additional economic growth for both regions. On the other hand, Baldwin, Francois, Portes et al believe that in those sectors where Western Europe has so far had significant surpluses in trading with Central and Eastern Europe (e.g. chemical, rubber and plastic products, means of transportation, and various capital goods etc) the latter will drop out of competition as soon as markets are fully opened up. Biggest winners in this whole situation are countries that are involved in the export of these goods to Central and Eastern Europe.²¹⁹

European agreements extended the common market of the European Union to virtually all manufacturing products of new member states already on January 1st 1995. Estonia, in turn, abandoned all trade barriers. Hence it is exactly the above described trend that we have been witnessing during the second half of the 1990s, even if it has been somewhat alleviated by the growth rates in services sector.²²⁰ Future impact of the European Union membership is therefore mostly limited to the full application of the *acquis* etc (see also Ch. 3.3 and 4.3), and does not really generate much change in trade discipline anymore.

Although a larger market does allow for more specialisation, both the above and historic experiences have clearly demonstrated that free movement of capital, goods, services and labour itself does not ensure automatic convergence in the standards of living. By the same token, membership of the European Union has not led to convergence in the standards of living of most of the low technology specialised “cohesion countries” in the Union’s periphery with those of the core countries regardless of massive investments into regional policies.²²¹

Development of the former Eastern Germany emerges as one of the most drastic examples of the latter situation. It should be one of the most positive examples of integration since it received massive investment flows from Western Germany, and not only did both parts of Germany fully open their markets to each other, but their labour, social and other policies were also harmonised in the process of adopting the institutional structure of Western Germany. Yet the rejoining of the two Germanys, which cost 1,250 billion euros, has basically led to catastrophic outcomes. One of the most conspicuous trends is the emergence of rapidly developing economic oases in random cities surrounded by rapid stagnation and massive unemployment.²²²

²¹⁸ The theory of comparative advantage assumes that the economic environment of different countries varies in regard to the availability of factors of production, i.e. land, labour force, natural resources, and capital. Contemporary versions of this theory often focus on only one factor of production – labour productivity in various countries. Unfortunately, these approaches completely discard such important factors for economic development as technological change and economies of scale. In addition, the theory of comparative advantage completely overlooks several cross-border effects that are extremely important for a small country, e.g. intra-industry trade and foreign investments. For a more detailed account see Dornbusch 1977; Michael E. Porter, *The Competitive Advantage of Nations*, London, Macmillan, 1990, 11-21.

²¹⁹ Frank Barry, Aoife Hannan, *Will Enlargement Threaten Ireland’s FDI Inflows?*, Quarterly Economic Commentary, Economic and Social Research Institute, Dublin, December 2001, 55-67, 55; Richard Baldwin, Joseph F. Francois and Richard Portes, “The Costs and Benefits of Eastern Enlargement: The Impact on the EU and Central Europe”, *Economic Policy*, 12.04.1997, 125-176.

²²⁰ Some exceptions were made towards steel, coal and textile products where free trade was implemented to the full extent only somewhat later. See *Impact of Enlargement on Industry*, SEC(2003) 234, European Commission, 2003, 5.

²²¹ While the rich Western European countries were actively specialising and concentrating their labour into high productivity sectors, Eastern Europe and Baltic states were gradually becoming the suppliers of raw materials and agricultural produce already in the 16th-17th centuries. See e.g. Angus Maddison, *The World Economy: Millennial Perspective*, OECD, Paris, 2001, 75-80; Daniel Chirot (ed), *The Origins of Backwardness in Eastern Europe. Economics and Politics from the Middle Ages Until the Early Twentieth Century*, University of California Press, 1991.

²²² See *Der Spiegel*, <http://www.spiegel.de/politik/deutschland/0,1518,294097,00.html>.

This kind of uneven domestic development is characteristic of not only Germany or Europe. *New York Times* and *Business Week* observe a swift decline in the wage levels of American middle class, which indicates the emergence of peripheries in other very highly developed countries as well, and essentially confirms the fact that industry clustering is no more chiefly linked to geographic location.²²³ While a quarter of the US labour force is trapped in low-wage jobs with no real prospects for advancement, there is a massive outflow of jobs into Asian countries that have relatively low standards of living. (About technological development and relocation of economic activities see also Ch. 1.4). It is not only the cheaper functions, but also the relatively technology-intensive activities that are being relocated. *Boston Consulting Group*, *RAND Corporation* and other well-known analysts point to the share of more complex manufacturing processes rapidly moving to China, because there the production allows for less automation and more use of cheap skilled labour force, instead.²²⁴

If other countries, including Estonia, were to try and uphold their current, mostly price-based competitive advantage by competing with China, for instance, on the same grounds, then the only further competitive advantages could obviously be even cheaper labour, lower taxes, weaker educational and social system etc. Altogether this strategy is called “race to the bottom”.²²⁵

Adam Smith was prompted into writing about the wealth of nations by the stratification and poverty he witnessed in England, the country that he scornfully called ‘a merchant state’. Contrary to mercantilists who were convinced that the majority will need to remain poor and ignorant for the sake of the happiness of the society as a whole, in *The Wealth of Nations* Smith described the welfare of all members of a society as an essential starting point for the evolution of capitalist market economy.²²⁶ History offers plenty of examples about an unjustly large social inequality sooner or later leading to the overthrowing of existing rulers or, even worse, to a desire for a strict order, and to the disappearance of a free and democratic society.²²⁷

The United States President Abraham Lincoln’s Civil War policy of uniting the northern and southern states with the intention of facilitating social mobility and technological development, and putting the countries interests above those of small groups has proven a much more effective approach to increasing general social well-being. This is the very reason why the United States is still known as a land of opportunity where every paper-boy can become a millionaire.²²⁸

The policy of doing nothing or ignoring the structural problems of the economy and social disparity does not facilitate the emergence of any attractive development prospects for the future of Estonia. The model of the *Lisbon strategy* stresses that in addition to increasing the international competitiveness of companies, public policy developers must pay much more attention to the well-being of the society as a whole – Estonia is competing in the European Union not only with its products and services, but also with its capacity to offer an attractive social environment where people would actually like to live. At the end of the day, it is precisely the latter that enables a country to attract more foreign investments, which, in turn, lead to more favourable conditions for generating additional high-wage jobs; simplify access to international markets, high technology, capital etc.

²²³ See e.g. “The Wal-martization of America”, *New York Times editorial*, 15.11.2003; Aaron Bernstein, “Waking up from the American Dream”, *BusinessWeek*, 01.12.2003; Elicien Appelbaum et al, *Low-wage America: How employers are reshaping opportunity in the workplace*, Russell Sage Foundation, 2003.

²²⁴ *Made in China. Why Industrial Goods are going next*, The Boston Consulting Group, 2003.

²²⁵ China is witnessing massive urbanisation, and economic development is progressively spreading from the coastal areas towards the inland. Even the relatively high social imbalance is now more easily tolerable since the incomes of even the poorest segment of population are increasing. People are more optimistic about the future of their children than they used to be.

²²⁶ Adam Smith, *The Wealth of Nations*, London, Campbell, [1776] 1991, Book I, VIII.

²²⁷ Although Aristotle believed that one kind of people was born to rule and the other kind to obey, he warned already in 350 BC in his *Politica* (see book V, IX) against excessive disproportions in any society, which he considered dangerous for both rulers and the social order. See also Robert Heilbroner, *The worldly philosophers. The lives, times, and ideas of the great economic thinkers*, Touchstone Books, 7th edition, 1999, 40-74; Fareed Zakaria, *The Future of Freedom: Illiberal Democracy and Home and Abroad*, W.W. Norton Company, New York & London, 2003.

²²⁸ Robert Hormats, “Abraham Lincoln and the Global Economy”, *Harvard Business Review*, August 2003, 58-68; Aaron Bernstein, “Waking up from the American Dream”, *BusinessWeek*, 01.12.2003.

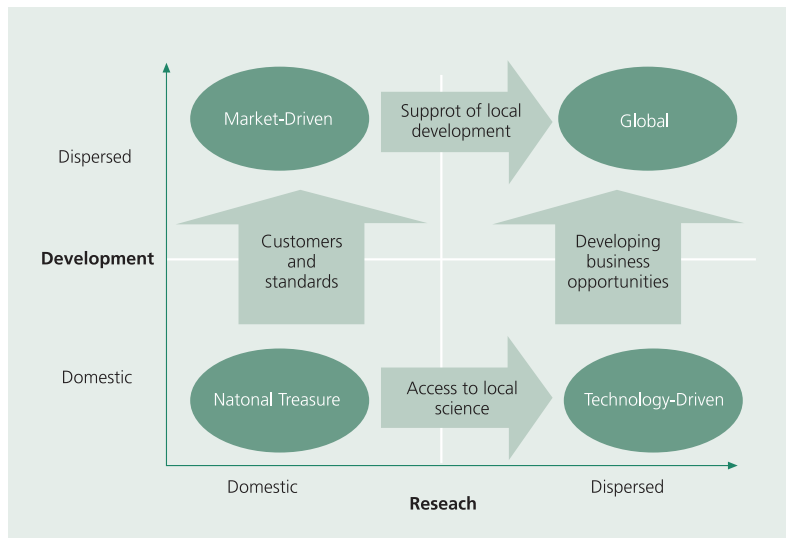
The following scenarios thus assume that Estonia will be experiencing further development with no excessive social disproportions. The focus is on the type of economic specialisation that is needed for job creation and higher income generation, or, in other words, on restructuring the economy towards more research and technology-intensive activities. These possible developments described in the scenarios below are not at all mutually exclusive. We also make no attempt at assessing the likelihood of their attainability, which largely depends on Estonia's own decisions or lack of decisions in the upcoming years.

Prior to setting off to resolve the structural problems of Estonian economy and labour market it is important to have a rather clear vision about the type of economic structure and the role we actually want Estonia to have in Europe (the world) in the coming 10-20 years, and what pattern of specialisation this requires from education, research and other sectors. Although there is now way to actually predict the future, Estonia still needs a good long-term vision of how to confront the impending demographic and socio-economic challenges.

4.3. Scenario I: Scandinavian periphery

Internationalisation of research and development is mostly driven by the desire of companies to get better access to foreign technologies or to adapt their own produce to the specific requirements of foreign markets, to their standards etc. (Figure 35) Special attention should be paid to the activities of large countries and multinational corporations, since they are the ones dominating the high technology market and investments into research and development. About 30-40% of contemporary global trade is really intra-firm trade, i.e. it takes place within the production and sales networks of international companies.

Figure 35. Major trends and factors in the internationalisation of research and development.



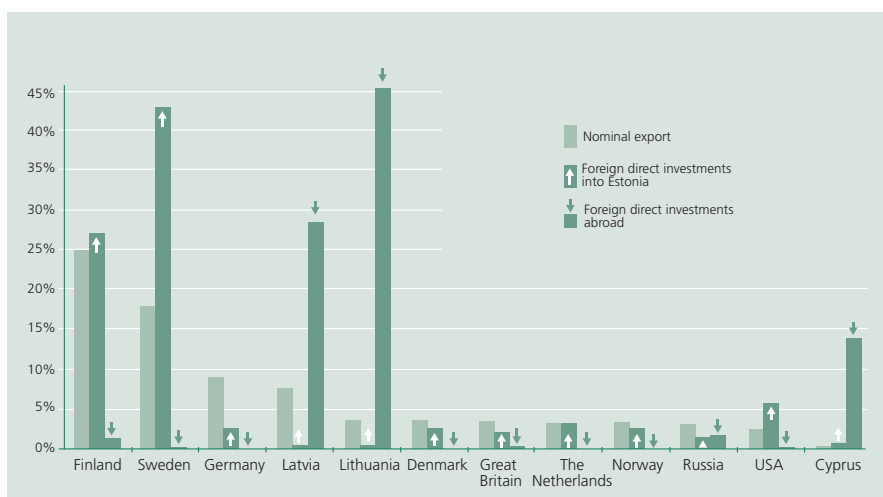
Source: Maximilian von Zedtwitz and Oliver Gassmann, "Market versus technology drive in R&D internationalization: four different patterns of managing research and development", *Research Policy*, 31, 2002, 569-588, 581.

A professionally devised foreign investment strategy allows a country to achieve quite drastic changes in the structure of industry and the whole economy in a rather short time span. Good timing, availability of modern infrastructure (incl. education and research) and suitably qualified labour force as well as a fair amount of good luck are all critical to success. Favourable tax policies and government's financial subsidies alone do not really play that great a role in the pursuit of more research and technology intensive investments. Multinational corporations treat them as additional benefits rather than primary decision criteria.²²⁹

Irish experiences after joining the European Union are also a good evidence of how the geographic and sectoral distributions of post-accession foreign investment flows might not resemble that of the pre-accession investment flows. The Irish were quite fortunate to have the post-accession investments flow into notably different sectors from what used to be their economic specialisation. Although Ireland did not have any competitive advantages in the chemical and metal manufacturing sectors prior to joining the European Union, it was precisely these sectors that developed fastest after the accession due to massive foreign investments they received.²³⁰

Within the 1990s Estonia has really grown into a coherent part of Nordic international economic clusters. 70% of the foreign direct investments that came to Estonia as of the end of 2003 originated from Finland and Sweden. In 2003 the most important countries of destination for Estonia's basic exports were also Sweden and Finland. Estonia's own foreign direct investments were mostly targeting Latvia and Lithuania. Financial sector was responsible for 2/3 of the foreign direct investments originating from Estonia. (Figure 36)

Figure 36. Most important countries of destination for Estonia's basic exports, and the structure of Estonia's foreign direct investments by countries, 2003.



Source: Statistical Office of Estonia, Bank of Estonia, June 2004, calculations by authors.

Compared to other Central and Eastern European countries in 1999, companies with 10% or more foreign capital were clearly most dominant in Estonian industries. Even though only less than a third of all companies included foreign capital, the latter were responsible for more than 90% of Estonia's total sales

²²⁹ Cees van Beers, *The role of foreign direct investment on small countries' competitive and technological position*, Government Institute of Economic Research, Helsinki, 2003.

²³⁰ Frank Barry, Aoife Hannan, Will Enlargement Threaten Ireland's FDI Inflows?, *Quarterly Economic Commentary*, Economic and Social Research Institute, Dublin, December 2001, 55-67, 55; Frank Barry, Aoife Hannan, *FDI and the Predictive Powers of Revealed Comparative Advantage Indicators, 2001, manuscript*, <http://www.ucd.ie/~economic/staff/barry/fdi.html>.

and investments into research and development. The relatively higher share of local capital based enterprises in manufacturing employment implies significantly higher productivity levels in companies that include foreign capital.²³¹ (Table 13)

It is thus possible to examine Estonia's prior and potential future developments using the "flying geese" model that has been very popular in analysing the rapid development of South East Asian countries. According to this model, rapid economic development in a developed country and the gradual relocation of its economic activities in the neighbouring countries facilitates economic development in the latter too. As the standard of living increases and the relative cost advantages fade away the catching-up country will start abandoning the less knowledge and technology intensive economic activities.²³²

Table 13. **Foreign investment based vs local industrial enterprises, 1999.**²³³

	Bulgaria	Czech Republic	Estonia	Hungary	Lithuania	Latvia	Poland	Romania	Slovakia	Slovenia	Average
Total number of companies	1334	1168	373	360	171	194	1540	1711	151	1093	801
incl. FDI based:	95	191	108	84	6	36	198	289	9	118	113
% of total number of companies	7.1	16.4	29.0	23.3	3.5	18.6	12.9	16.9	6.0	10.8	14.4
% of sales	26.6	62.3	92.1	96.4	9.1	51.7	53.3	30.9	8.5	38.0	46.9
% of employment	15.2	30.0	56.0	48.9	3.4	31.6	18.8	19.4	6.2	17.3	24.7
% of R&D Investments	33.7	34.8	90.1	36.9	18.0	19.0	56.5	32.1	32.7	14.5	36.8
Ratio of income level to that of local companies	1.73	1.34	1.41	1.31	1.00	1.00	0.74	1.21	1.25	1.16	1.22

Source: Jože P. Damijan *et al.*, *Technology transfer through FDI in TOP-10 transition countries: How important are direct effects, horizontal and vertical spillovers?*, Institute of Economic Research, Working Paper 17, Ljubljana, February 2003.

Because of the significant role of the foreign capital it is useful to explain the prior structural changes and the possible future trends in Estonian economy via the description of the development and expansion of Nordic economic clusters. Development of Finnish economic clusters basically reflects the structural changes in Estonian economy.²³⁴

- The share of **timber and forestry cluster**, incl. furniture production, publishing and printing as well as the currently still moderately successful paper production, more than doubled in Estonia within the period of 1992-2002, now amounting to 27% of Estonia's manufacturing produce. International trade indicators suggest that alongside with the fuel transit and textile industry this cluster is really one of Estonia's primary comparative advantages.²³⁵

²³¹ See also Helena Hannula and Katrin Tamm, "Restructuring and Efficiency in Estonian Manufacturing Industry: The Role of Foreign Ownership", University of Tartu, *Faculty of Economics and Business Administration Working Paper Series* 15/2002.

²³² Kaname Akamatsu, "Waga kuni yomo kogyohin no susei" [Trend of Japanese Trade in Woolen Goods], *Shogyo Keizai Ronso*, 13, 1935, 129-212; Kiyoshi Kojima, "The „flying geese” model of Asian economic development: origin, theoretical foundations, and regional policy implications", *Journal of Asian Economics*, 11, 2000, 375-401; Jože P. Damijan and Matija Rojec, *Foreign Direct Investment and the Catching-up Process in New EU Member States: Is There a Flying Geese Pattern?*, *WIIW Research Reports* 310, October 2004.

²³³ These numbers represent the data from manufacturing companies with 100 and more employees (As an exception, the data about Slovenia include companies with 10 and more employees). The data about Estonia are from the year 1998.

²³⁴ See also K. Alho, C. Hazley, Hannu Hernesniemi, M. Widgrén, *The Effects of the Eastern Enlargement of the EU on Production Structure in Finland*. ETLA Discussion Paper No 752 (in Finnish), ETLA 2001.

²³⁵ See also Urnas Varblane and Kadri Ukrainski (eds), *Eesti puidusektori konkurentsivõime* [Competitiveness of Estonian wood industry], Tartu University Press, Tartu 2004; Doris Hanzl, Waltraut Urban, *Competitiveness of Industry in CEE Candidate Countries: Forest-based Industries*, Vienna Institute for International Economic Studies, Vienna, 2000.

As a positive trend, processing of raw material in Estonia is increasingly replacing exports of raw timber. Estonian forestry sector is tightly integrated into the broader Scandinavian forestry cluster via ownership and trade relations.²³⁶ Nordic companies are primarily interested in the Baltic countries as suppliers of raw material, and also as a suitable location for labour-intensive production in close proximity to the export markets of continental Europe. At the same time we find the higher value adding activities like production and design of wood and timber processing machinery and of high quality paper to be dominant in Finland and Sweden.

Environmental protection requirements of the *acquis* have a considerable impact on Estonian and Latvian wood processing industries, yet the readiness of their companies to actually comply with these requirements is relatively low. It is therefore likely that the companies not able to update their technologies fast enough will either end up in foreign ownership or will have to terminate their activities.²³⁷

- **Food industry** is one of the most important sectors both in regard to volume of production and employment in Estonia as well as in most of the other new member states of the European Union with its total share amounting to nearly 25% of manufacturing produce in Poland and the Baltic countries. In Estonia, this indicator has plunged from 32% in 1992 to only 17% in 2002. In spite of that, it is still a fairly important sector for Estonian economy accounting for 20% of total manufacturing employment.

Although the Baltic countries with their cheaper raw materials and lower labour costs are direct competitors to Finland, Finish entrepreneurs also see good investment opportunities in launching their own production in this area that will carry their brand names. Indeed, foreign capital already has about 25% share in Estonian food industry. Since complying with the requirements of the European Union is very costly in food industry and readiness for this very low in the Baltic countries, it is to be expected that also in this industry several of the companies currently owned by domestic capital will likely be transferred into foreign ownership.²³⁸

- The share of **textile and garment industry** in Estonian manufacturing produce has also halved within the past 10 years, yet still accounting for 10% of manufacturing produce and 18% of manufacturing employment in 2002. Textile industry is not expected to have significant problems in complying with the requirements of the *acquis*, but instead, it is struggling with growing labour costs of sewing work, and small volumes that do not support the use of subcontractors from India or elsewhere.

Due to increasing labour costs and elimination of international trade barriers the only real prospects remaining for this industry are close collaboration and clustering with other industries (e.g. furniture production), focusing on specific high technology and knowledge intensive produce (e.g. production of fabrics with special qualities, garments with embedded information technology and the like).²³⁹

- **Manufacture of metals and metal products** constitutes 7% of manufacturing produce. Since this is generally an extremely capital-intensive field, it would be difficult for Estonian companies alone to compete on a global scale. Foreign capital is present in 21% of the companies of this sector. On the other hand, it is rather likely for a certain section of the activities that are losing their cost advantages in Scandinavia (e.g. production of specific parts of various machinery and equipment) to be gradually relocated into the Baltic countries.

²³⁶ The share of foreign capital in Estonian wood processing industry is no less than 57%, and is 13% in furniture industry. See Evis Sinani, Klaus Mayer, *Identifying Spillovers of Technology Transfer from FDI: The case of Estonia*, Copenhagen Business School, April 2001, 26.

²³⁷ Peter Havlik, *Competitiveness of Industry in CEE Candidate Countries*, European Commission, DG ENTR, February 2002, http://www.wiiw.ac.at/pdf/competitiveness_composite.pdf.

²³⁸ *Ibid*; Statistical Database, Statistical Office of Estonia, 2004, <http://www.stat.ee>.

²³⁹ Large part of Mexican textile industry is also moving into China, where workers only make 0.68 USD an hour instead of the 2.45 USD in Mexico. About the impact that the removal of international trade barriers has had on textile industry see also: *A New World Map in Textiles and Clothing: Adjusting to Change*, OECD, Paris 2004; "The textile industry: The looming revolution", *The Economist*, 11.11.2004; Paul Magnusson, „Who'll Survive The Textile Trade Shakeout?", *BusinessWeek*, 20.12.2004.

²⁴⁰ Tarmo Kalvet, *The Estonian ICT Manufacturing and Software Industry: Current State and Future Outlook*, Institute for Prospective Technological Studies - Directorate General Joint Research Centre, European Commission: Sevilla, 2004, <http://www.jrc.es/home/publications/publication.cfm?pub=1200>.

- **Information and communication technology**, incl. manufacture of electrical equipment, optical and precision instruments, constitutes approximately 6% of Estonia's manufacturing produce, notwithstanding its enormous share in exports. Thereby Estonia is of interest to Sweden and Finland both as a new emerging market and increasingly also as a fairly convenient host country for labour-intensive assembly processes of electronics industry. The *Elcoteq* plant in Tallinn is no more alone with a whole range of smaller electronics producers now relocating their production to Pärnu, Elva and elsewhere in Estonia.²⁴⁰
- The share of **chemical industry** in manufacturing produce has also halved from the 1992 level, now accounting for a modest 4%. Foreign capital is present in 20% of enterprises engaged in oil and chemicals production, and 57% of the enterprises engaged in rubber and plastic production. Chemical industry is struggling to comply with the requirements of the *acquis* in the sections of common market and environmental regulation.
- **Construction and manufacture of construction materials** in Estonia is both a promising new market and a source of relatively cheap labour for Nordic companies. Due to logistic reasons it is precisely the countries close by that are more attractive to Finish and Swedish investors. Even though real estate and construction sector has experienced rapid progress over the past years, exhaustion of the global real estate boom can lead to serious setbacks in this sector, which can cause increased unemployment and other negative developments.
- **Transport**, but most particularly the east-west transit (e.g. oil transit from Russia to Western Europe) industry competition with neighbouring countries is mostly related to the efficiency of logistic systems, i.e. low costs. Bearing in mind the vigorous expansion of the ports of St. Petersburg, one of the key options for enhancing the competitiveness of the transit corridor or increasing the added value generated in Estonia is clearly the development of local manufacturing or the industry of processing raw materials and products in transit.

Since several Estonian low and medium technology industries have problems with fulfilling the requirements of the *acquis*, and it is generally typical of these fields to experience gradual concentration of economic activities, then we can expect Scandinavian investors to show heightened interest to take over Estonian companies that operate in those fields. This has already occurred in the financial sector, and is now also happening in timber and food industries and in the production of metals and metal products.

In consideration of Estonia's future, however, there is really no reason to focus on the economic integration with Finland and Sweden alone.²⁴¹

In the global economy Finland and Sweden are certainly competitors. Their specialisation profiles are pretty similar in regard to both transport and telecommunication systems sector. Even if Finland does have a better innovation and business environment, Sweden is simply larger and therefore has a much broader competence base needed for structural changes. While Helsinki has closer ties with Estonia due to geographic proximity, Stockholm strives to strengthen its role as a geographic centre of the Baltic Sea region. Geographic advantages render the endorsement of cooperation between Finland and Sweden just as likely.²⁴²

²⁴¹ Comparison of the added value of Estonian exports across countries shows that Estonian export to Sweden and Finland is significantly less profitable in comparison with other countries of destination. In addition, contribution of exports to Estonia's economic growth has declined over the period of 1994-2001. In 2001 the average contribution of one unit of exports to Estonia's GDP is down 19% from the 1994 level in case of the exports to the European Union; the relevant indicator is 28% for the exports to Finland, and 12% for the exports to Sweden. See Ülo Kaasik, *Eesti eksporditoodete lisandväärtus* [Added value of Estonian exports], Working Papers of Eesti Pank, no 3, Tallinn 2003, 9.

²⁴² Kai Böhme, Åge Mariussen, Lars Olof Persson, „Strategies for competition and co-operation between metropolises in the Baltic Sea region”, Regional Studies Association, Gdansk, Poland, 15-18. September 2001.

Figure 37. Economic specialisation in the Baltic Sea region.



Source: Nordisk cluster mapping, Oxford Research, January 2002; UNCTAD/WTO International Trade Centre, February 2005, <http://www.intracen.org>; adjustments by the authors.

Seeing as Berlin and St. Petersburg are historically the most important cities in Northern Europe, both Stockholm and Helsinki are very much interested in cooperation with the North West part of Russia, which is rich in human as well as natural resources.²⁴³ Today St. Petersburg is an emerging centre for international trade and tourism. It is quite likely, then, that in the long run St. Petersburg and Berlin will restore most of their former prominence and will become the principal trade centers between east and west.²⁴⁴

A prerequisite to this development is the emergence of an innovation system that integrates the research and technology environment of St. Petersburg with Western technologies, industries and global markets. It is quite possible that in future St. Petersburg will play a significant role in information and communication technology sector, thus becoming a strong competitor to Finland and Sweden.²⁴⁵

The integrated region of Øresund is making also Denmark an increasingly important player in the Baltic Sea transport sector. Moreover, the Øresund region has a great potential for developing a knowledge-based economy in information technology, biotechnology, new media as well as medical sectors.²⁴⁶ Hamburg, Warsaw, Berlin, but also the Øresund region, devote rather limited attention to the Baltic Sea region in view of their own development. These metropolises have focused their development efforts more on the relations with continental Europe. Since most of them are also metropolises on the European scale, they become rather important for Estonia as centres that drag along the whole Baltic Sea region with the latter possibly functioning as their support base.²⁴⁷

In the short and medium term, concentrating on the creation of favourable conditions for receiving foreign investments and technology transfer is probably the most effective way that Estonian economic policy can help secure sustained generation of new jobs and growth in labour productivity.²⁴⁸

This implies that in order to be successful in competing with the neighbouring countries Estonia's educational, vocational and retraining systems as well as applied research and development activities need to go through structural adjustments that are consistent with the developments in respective cross-border economic clusters and with the relocation of economic activities within the Baltic Sea region.

Nonetheless, it is important to understand that the influx of foreign investments might not always truly support local entrepreneurship and the socio-economic development of a country as a whole. Various studies conducted in the Central and Eastern European countries suggest that so far the primary interest of foreign investors has been to exploit rather than develop the local resources of host countries. Likewise, current investments from Nordic countries into the Baltic countries have been chiefly driven by the desire to expand domestic markets, i.e. they are mostly focused on the acquisition of market share and resource. There is no reason to criticise the foreign investors for this, though. It is crucial to comprehend, instead, that Estonia's present strategy of providing the foreign companies with a cost-effective environment is, indeed, relatively effective for generating jobs and maintaining a good standard of living, but does not usually offer much opportunity for accelerated development.²⁴⁹

²⁴³ About developments in St. Petersburg and North-West Russia see Grigory Dudarev, Sergey Boltramovich, Pavel Filippov and Hannu Hernesniemi, *Advantage North West Russia, The New Growth Centre of Europe?* SITRA, Helsinki, 2004, 291, <http://www.sitra.fi/Julkaisut/raportti33.pdf>.

²⁴⁴ Kai Böhme, Åge Mariussen, Lars Olof Persson, „Strategies for competition and co-operation between metropolises in the Baltic Sea region”, Regional Studies Association, Gdansk, Poland, 15-18. September 2001.

²⁴⁵ About the competitiveness and development potential of St. Petersburg region see also Grigori Dudarev, Hannu Hernesniemi, Pavel Filippov, *Emerging Clusters of the Northern Dimension – Competitive Analysis of Northern Russia – A Preliminary Study*, ETLA, Helsinki 2002; Sergey Boltaramovich, Pavel Filippov, Hannu Hernesniemi, *The Innovation System and Business Environment of North-West Russia*, ETLA Discussion Paper no 953, December 2004.

²⁴⁶ Kai Böhme, Åge Mariussen, Lars Olof Persson, „Strategies for competition and co-operation between metropolises in the Baltic Sea region”, Regional Studies Association, Gdansk, Poland, 15-18. September 2001.

²⁴⁷ *Ibid.*

²⁴⁸ John Zysman and Andrew Schwartz (eds), *Enlarging Europe: The Industrial Foundations of a New Political Reality*, University of California International and Area Studies Digital Collection, Research Series #99, 1998, <http://repositories.cdlib.org/uciaspubs/research/99/>; Johannes Stephan, *Evolving Structural Patterns in the Enlarging European Division of Labour: Sectoral and Branch Specialisation and the Potentials for Closing the Productivity Gap*, 2003, 23, <http://econwpa.wustl.edu:8089/eps/dev/papers/0403/0403003.pdf>

²⁴⁹ *Ibid.*; see e.g. Harley Johansen, „Nordic Investments in the Former Soviet Baltic Frontier: A Survey of Firms and Selected Case Studies”, *Geografiska Annaler*, Series B Human Geography, 82, 4, 2000, 207-219; Frank Barry, Aoife Hannan, *Will Enlargement Threaten Ireland's FDI Inflows?*, Quarterly Economic Commentary, Economic and Social Research Institute, Dublin, December 2001, 55-67, 56-57; Katrin Männik, „The Role of Foreign Direct Investments in Technology Transfer to Estonia”, in Urmas Varblane (ed), *Foreign Direct Investments in Estonian Economy*, Tartu University Press, Tartu 2001, 216.

Unfortunately, most of the economic sectors seeking opportunities for relocation in the Baltic Sea region are increasingly resource and capital intensive fields with only a few well-known brands dominating the global market as suppliers of technology and innovative solutions. Because of the limitations on both scale and recognition of local brands, it would be rather difficult for the Estonian industry to achieve international breakthrough in fields like that. In addition, Estonia's low and medium technology based manufacturing sectors must confront the tightening low-price competition. Local companies will not be able to build the competence base needed for achieving economic independence if they specialise only in the assembly of components mostly produced abroad or in some individual isolated segments of the value chain. The fortunes of the *maquila-industries* in Mexico as well as in Hungary, Scotland (the so-called "dual economies" where the strong foreign investment based companies dominate the market, while domestic companies lag far behind them in regard to productivity as well as capacity to earn profits) over the past decade are all instructive examples of how the foreign investments that target standardised labour-intensive activities prove to be rather mobile as soon as prices increase in the host country in case it does not have any other advantages. These investments will then quickly move on into countries with even lower standards of living like Russia, Ukraine and other regions of the former Soviet Union, but also China.²⁵⁰

For the sake of Estonia's future prospects, we should thus be interested in more than tax competition that only focuses on maintaining cost-advantages, and in more than the needs of neighbouring countries with higher standards of living to offshore the less knowledge-intensive functions of their economies into low-cost regions. In order to successfully compete in the global economy it is important to appreciate the strategic trends in the lead countries and their continued efforts to persistently generate new technology-based competitive advantages. The weakness of our independent innovation policy can only lead to the continuation of the south-finlandisation trend described in the future scenarios of *Eesti 2010*, meaning that "Estonia would be leading a life of a servant to Europe".²⁵¹

4.4. Scenario II: Vigorous modernisation of traditional sectors

OECD analyses suggest that about half of the productivity growth in the economies of developed industrial countries results from large-scale application of information technology in industry as well as services sector.²⁵²

Success of Nokia in the 1990s was largely based on the several decades of intense efforts by the government of Finland to establish domestic industry base. As a matter of fact, Nokia that alone invests about 1% of Finland's annual GDP into research and development,²⁵³ together with the network of its business partners are actually the whole Finnish information and communication technology cluster. Although the scale is not quite the same, the Finnish model of relying on one major corporation has turned out somewhat similar to the Japanese *keiratsu* or Korean *chaebol*-based development model, while the well-being and development of the whole country is fundamentally dependent on the prosperity of one individual large industrial conglomerate.²⁵⁴

Yet the coming decade will most certainly not see an uninterrupted continuation of Nokia's current outrageous success. GSM systems are being replaced by the 3rd generation mobile telephony systems – a new field where the division of intellectual property, technology standardisation and growth potential of markets differ radically from the patterns that dominated the world 10-20 years ago. The new mobile communication systems are increasingly complex, plus the intellectual property that is vital to the evolution of the industry is now split between a much larger number of companies than it used to be. (Table 14)

²⁵⁰ See also *Impact of Enlargement on Industry*, SEC(2003) 234, European Commission, 2003, 15.

²⁵¹ See *Üleriigiline planeering "Eesti 2010"* [Nationwide plan "Estonia 2010"], <http://www.sisemin.gov.ee/atp/failid/tais2010.pdf>.

²⁵² *The Sources of Economic Growth in OECD Countries*, OECD, Paris 2003, <http://www1.oecd.org/publications/e-book/1103011E.PDF>.

²⁵³ See also *Research and Development in Finland 2004*, Statistics Finland, 2004.

²⁵⁴ Yoon Heo, "Development strategy in Korea reexamined: an interventionist perspective", *The Social Science Journal*, 38, 2001, 217-231; Michael E. Porter, *The Competitive Advantage of Nations*, London, Macmillan, 1990.

This means that due to simultaneous global dissemination of knowledge and technology, growing complexity of information technology systems, and significant expansion in the role of brand names in marketing, an increasing share of research and development activities is moving out of North America and Western Europe into Asia (China, India) and Latin America.²⁵⁵ Japan and South East Asian newly industrialised countries have already taken or are about to take over the lead from Scandinavia in several technology sectors.²⁵⁶ The acquisition of *Siemens'* mobile phone unit by BenQ and *Ericsson's* collaboration with Sony are but a few examples. This trend affects not only mobile connection systems, but also an array of other sectors like displays, data carriers and others that once used to be dominated by the USA or Western Europe.²⁵⁷ Explosive development is also taking place in China and India that both have enormous population as well as technological and market potential.

Table 14. Ownership distribution of patents vital to the development of GSM and 3rd generation mobile communications.

	Number of essential patents	Number of firms holding essential patents	Key players' shares of the essential patents							
			Nokia	Ericsson	Philips	Motorola	Alcatel	Siemens	Qualcomm	Others
GSM	2024	24	41%	360	171	194	1540	1711	151	1093
UMTS	3499	30	27%	84	6	36	198	289	9	118

Source: Petri Rouvinen, Pekka Ylä-Anttila, Little Finland's Transformation to a Wireless Giant, 94, Chapter 5 in S. Dutta, B. Lanvin & F. Paua (eds), *The Global Information Technology Report 2003-2004*, New York: Oxford University Press 2003, 87-108.

Likewise, the St. Petersburg region that is located right next to Estonia has good prospects for combining relatively low costs with rapid development of knowledge-based economy. (Table 15) Research activities in North West Russia are becoming increasingly integrated into western industries and global markets. Several large corporations like *Sun Microsystems*, *Intel*, *Motorola*, *LG Electronics*, *Siemens*, *Togethersoft* (*Borland*) and many others have already bought or established their own research and development centers in Russia. Steve Chase, head of the Russian Intel branch speaks highly of the new distribution of labour: "Give the urgent projects to the Americans, big projects to the Indians, and the impossible ones to the Russians. The Russians can do anything."²⁵⁸

²⁵⁵ According to the estimates of both *Forrester Research* and the European Union, the movement of information technology jobs into regions that offer cheaper (but no less qualified) labour force might lead to a loss of up to 1.2 million jobs in Europe over the next 10 years. These trends will have greatest impact in the United Kingdom, France, Italy and the Netherlands. United Kingdom alone will lose close to 3% of its jobs by the year 2015 as a result of these trends. Expenditure on off-shore services will rise in Europe from the 2004 level of 1.1 billion euros to 3.6 billion euros by 2007. See also David Metcalfe and Sonoko Takahashi, *Two-speed Europe: Why 1 Million Jobs will Move Offshore*, Forrester Research, 18.08.2004; European Foundation for the Improvement of Living and Working Conditions, *Outsourcing of ICT and related services in the EU: A status report*, European Commission, Luxembourg 2004.

²⁵⁶ Timo Hämmäläinen, „Catching-up and forging ahead: Explaining the postwar growth experience in Finland”, June 2000, manuscript for publication in the collection *National Competitiveness and Economic Growth: The Changing determinants of Economic Performance in the World Economy*; Dan Steinbock, *Finland's Wireless Valley: Domestic Policies, Globalising Industry*, Tekes, November 2002, http://www.tekes.fi/eng/publications/Finlands_Wireless_Valley.pdf.

²⁵⁷ Yet there is also evidence of the opposite movement as several Asian investors are trying to obtain technological know-how through the purchase of struggling low and medium technology-based companies as well as research and development labs in Europe and USA. Another reason for this trend is the need of South East Asian companies to ensure a smooth entrance to these markets through a local production base (for instance, Czech Republic has received fairly numerous Asian investments based on this logic, and is now becoming practically „overcrowded”).

²⁵⁸ Sergey Boltaramovich, Pavel Filippov, Hannu Hernesniemi, *The Innovation System and Business Environment of North-West Russia*, ETLA Discussion Paper no 953, December 2004, 40.

Table 15. Computer programmer's average annual income in US dollars.

Poland and Hungary	4800 .. 8000
India	5880 .. 11000
Philippines	6564
Malaysia	7200
Russia	5000 .. 7500
China	8952
Canada	28174
Ireland	23000 .. 34000
Israel	15000 .. 38000
USA	60000 .. 80000

Source: Merrill Lynch, „Smart Access Survey”, *CIO Magazine*, November 2002.

Even though information technology and electronics produce did constitute approximately 25% of Estonia's basic exports in the beginning of 2004, Estonia's domestic information technology industry is still highly unlikely to become a global player any time soon. Then again, the remarkable share that Elcoteq and other Nordic electronics producers have in Estonian exports also indicates an untapped potential. Since the increasingly competitive global electronics production industry is facing decreasing margins, several contract manufacturing companies across the world are now seeking opportunities to move up on the value chain, incl. efforts to launch their own research and product development units. Mobile phone development and production is currently entering the process that is somewhat similar to the way IBM opened up its personal computer platform to other producers many years ago. Whether Estonian companies and research institutions will succeed in finding their own niche within these activities and get the industry to really take root in Estonia will be directly dependent upon their capability to supply the global manufacturing giants with suitable and highly qualified researchers and engineers.

Development of Taiwan's information technology industry is an excellent model of how a country can build up its own industry by supporting the clustering of domestic small and medium-sized enterprises and then linking them up with global production networks where they start out by executing simpler production functions and then move on to providing their own designs to products being marketed under the label of some large company that has significant market power only to try and enter the market one day with their own products carrying their very own labels.²⁵⁹

Development of technological competitive advantages is, on the one hand, very much related to earlier investments in education, research and development. Then again, as odd as it initially sounds, it is important that Estonia also learn from the experiences of Taiwan how the currently rather modest investments in industry and technology can be carefully displayed as a strategic advantage. Namely, companies operating in mature industry sectors have an entirely reasonable tendency to protect their prior massive investments in technology and production. This makes them ignore certain new technologies that interrupt existing development paths, albeit these also hold the potential to radically change the rules of the game and business models for the entire economic sector. Although large companies will not give up their positions easily, this still presents a significant opportunity for smartly operating smaller players.²⁶⁰

²⁵⁹ Dieter Ernst, "Catching-up, crisis and truncated industrial upgrading. Evolutionary Aspects of Technological Learning in East Asia's Electronics Industry", UNU INTECH Lisboa Conference, September 1998.

²⁶⁰ Compare the impact P2P file sharing software had on music and movie industry; or the expected impact of Internet-telephony systems on traditional telephone connection business models.

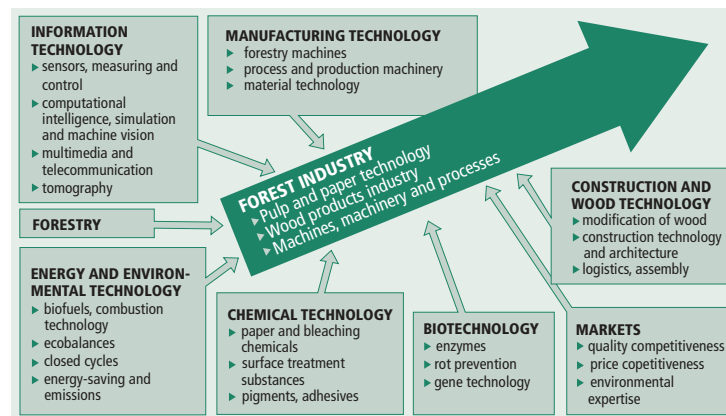
Since Estonian information technology companies generally do not hold prior massive long-term investments, it should give them a certain level of opportunistic freedom to innovate their products, services and organisation in such a way as to help them move into specific new knowledge and technology intensive niches. Systems integrators could thus invest into the creation of certain universal products or services that allow for economies of scale. Microelectronics and electronics industry in general should, on the other hand, analyse carefully various developments in the industry and the technology, and seek out different opportunities, working, for instance, on specific technological breakthroughs in areas like optoelectronics or bio-nanoelectronics etc. (See Ch. 2.4 above)

At the same time it is important to recognise that Finland and Ireland are virtually the only countries in Europe where information technology industry plays an extremely important role in economic development. In the rest of Europe information technology contributes to productivity growth predominantly through broad application of new solutions throughout economy, accompanied by relevant organisational rearrangements.

Although empirical studies confirm that in view of increasing the standard of living it is most useful to try and specialise on the low value-adding end of possibly higher technology based economic activities, development of high technology industry itself entails very high risks for a small country (see Ch. 1.5 above).²⁶¹ Taking into account the competitive advantages that Estonian economy possesses today it is particularly important to effectively apply information as well as other new (key) technologies to further augment the existing strengths of forest cluster, food and textile industries, energy etc.²⁶² (see also Figure 38)

Unfortunately, most of Estonia's traditional sectors currently more or less lack even the basic technological competence needed to advance on the basis of imported high technology. Only government is in the position to take initiative here using public procurement and commissioning to generate initial networks, collaborative formations and products.

Figure 38. Role of new technology in the evolution of forest industry cluster.²⁶³



Source: Alfred Watkins and Natalia Agapitova, *Creating 21st Century National Innovation System for a 21st Century Latvian Economy*, Policy Research Working Paper 2357, World Bank, 2004, 25.

²⁶¹ R. Stehrer, J. Wörz, *Industrial Diversity, Trade Patterns and Productivity Convergence*, WIIW Working Papers No. 23, November 2002.

²⁶² If we still want to have a chemical industry, machinery and other today's medium technology sectors in Estonia in 20 years time, it is critical to foster the capability of Estonian industry and research sector to apply and further renew future bio- and nanotechnology solutions.

²⁶³ About the potential of biotechnology in forestry see also Staffan Laestadius, "Biotechnology and the Potential for a Radical Shift of Technology in Forest Industry", *Technology Analysis & Strategic Management*, 12, 2, 2000.

In the same way, it was the massive investments made in the 1960-70s into technology transfer as well as research and development needed for the development of forest cluster that have made Finland the country with the world's most modern production systems in this field. Production of high quality paper, forestry technology, and relevant consulting services etc today constitute a significant share of Finland's exports. Specific technology programs targeting the exploitation of key technologies to further leverage the sector's competitive advantages has continued to be one of the central elements of Finnish technology policy.²⁶⁴

At the same time it would be wrong to limit the thinking of Estonia's future specialisation opportunities to local competitive advantages or those of the neighbouring regions. Development of Swedish steel industry and machinery sector, Nordic mobile telephony as well as Japanese robotics industry are all good examples of how a globally successful manufacturing sector can get started from the investments made into research and technology development to overcome the weaknesses in some specific field. Fast decline in the population size means that it is crucial for Estonia to find more ways to apply new technologies in public administration, educational system, social sphere and other areas.

One such area that has caught more public attention in Estonia is medicine, which is struggling not only with financing and other similar structural problems but (maybe because of the latter) also with massive departure of doctors to other countries. Then again, in virtually every country health care system is one of the most knowledge intensive sectors that can significantly boost the socio-economic development of the whole nation. One and possibly the most direct example of the benefits generated by the expansion of the European Union is the potential opportunity for providing cross-border health care services to the citizens of neighbouring countries.

The broader areas of natural sciences and health care have traditionally been among the strongest advantages in Europe, but are not so anymore. Europe is still the world leader in the manufacture of pharmaceuticals, but innovative leadership of pharmaceutical industry has gradually shifted into the USA. While in 1990-2002 the relevant research and development expenditure grew 5 times in the USA, the same type of expenditure increased by a mere 2.5 times in Europe.²⁶⁵

General conditions of the pharmaceutical industry are further aggravated by the onslaught of cheap generic medications from China, Taiwan and Mexico as well as by the growing market share of illegal counterfeit drugs. While the manufacture of generic drugs is shifting into Asia, traditional research and development intensive pharmaceutical industry is moving into Central and Eastern Europe. Scandinavia, on the other hand, is becoming a hot spot for investments due to its special biotechnology intensive pharmaceutical industry. Estonia's advantages in being a potential host country for investments into pharmaceutical industry are not very remarkable at the moment. Estonia could currently offer relatively favourable conditions only for the manufacture of generic drugs.²⁶⁶

Then again, bearing in mind the existing research competences, taking advantage of the Scandinavian biomedical cluster is today maybe the only option that Estonia has for developing within the coming 10-15 years a domestic biotechnology sector, which would truly contribute to local economic development (i.e. actually raise real productivity and wage levels). (Figure 39)

A mere ten years ago bringing a part of pharmaceutical industry into Estonia would have meant an investment in the volume of our whole GDP, which is clearly absurd – all the inhabitants of Estonia taken together would not satisfy the requirements of a third phase clinical test. Yet today there is nothing impossible about this, since the section of pharmaceutical industry does not have to be large at all, and some functions are already moving away from the traditional pharmaceutical industry looking for cheaper and high quality

²⁶⁴ See e.g. Tarmo Lemola, "Transformation of Finnish Science and Technology Policy", *Science Studies*, 16, 1, 2003, 52-67; *The future is knowledge and competence, Technology Strategy – review of choices*, Tekes, 2002.

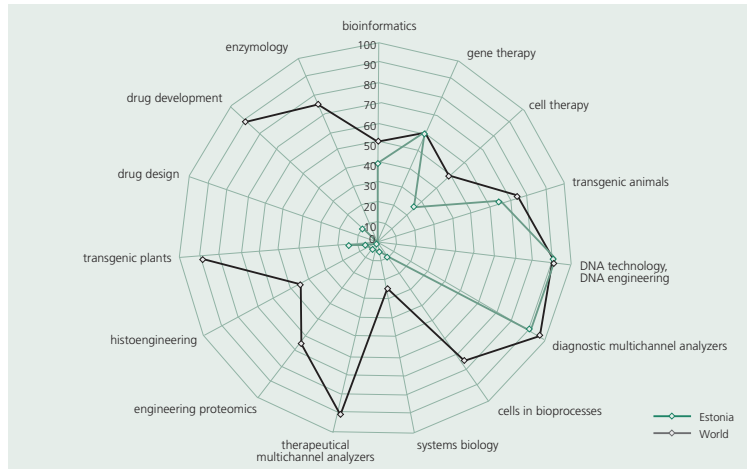
²⁶⁵ I. Brodie *et al*, *EU Life Sciences – Driving Change in the European Life Sciences Industry*, Gap Gemini Ernst & Young, Utrecht 2004, 10; see also Rainer Nitsche, Tom Wilsdon, *Innovation in the pharmaceutical sector*, Charles River Associates, 8th November 2004.

²⁶⁶ I. Brodie *et al*, *EU Enlargement – Driving Change in the European Life Sciences Industry*, Gap Gemini Ernst & Young, Utrecht 2004, 54-62, http://www.de.capgemini.com/servlet/PB/show/1303401/EU_Life_Sciences.pdf;

About biotechnology related developments in Finland and Sweden see also Gabriela von Blankenfeld-Enkvist *et al*, *OECD Case Study on Innovation: The Finnish Biotechnology Innovation System*, Innomarket, Turku, January 2004; Anna Nilsson *et al*, *Knowledge Production and Knowledge Flows in the Swedish Biotechnology Innovation System*, Centre for Medical Innovations, Karolinska Institutet, <http://www.ki.se/cmi/publications/KnowledgeProductionandKnowledgeFlows.pdf>.

labour in the biotechnology sector. The greatest challenge for Estonian policy makers is to make sure that the development of biomedicine does not occur in separation from the trends in the existing industry and knowledge base.

Figure 39. **Biotechnologies' readiness for commercial application; Estonia's strengths and weaknesses.**²⁶⁷



Source: the authors.

Even though majority of the biotechnology related discussions often focus on biomedicine and the development of pharmaceutical industry, which both also happen to be the strongest areas of specialisation in Estonia's neighbouring countries, it would be a serious mistake to tie all our future prospects with this area alone.

4.5. Scenario III: Venturing into new high technology economic sectors

Diffusion of knowledge and technology, and rapid technological development of Asian countries force USA as well as Western Europe to invest into radically new technology areas in order to sustain their relatively higher standards of living. Along the lines of what was described in Chapter 2, these technologies will most likely be bio- and nanotechnology.

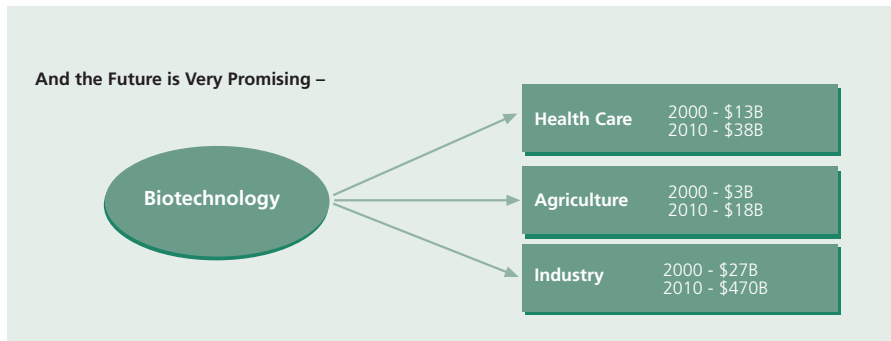
On the one hand, technological development and increasing specialisation help to enhance the effectiveness of current economic activities, but on the other hand, these developments also generate completely new capital goods and markets. Just like the information technology paradigm brought along personal computers, internet and many other previously unimaginable novel products and services and the infrastructure needed to operate them, similar developments can be expected in connection with bio- and nanotechnologies. Unfortunately

²⁶⁷ This figure is constructed using the information about Estonian biotechnology sector competence base as it was outlined in the study conducted by Fraunhofer ISI in the autumn of 2002. While compiling this book we collaborated with various biotechnology-focused interest groups trying to assess the position of these competences on the technology development curve, and comparing Estonian competences to those in the rest of the world. This figure therefore reflects primarily the opinions of biotechnology experts themselves about the existing competences and relative position in global competition. See also Fraunhofer ISI, *Research on the Estonian Biotechnology Sector Innovation System*, Tallinn: Enterprise Estonia, 2003, <http://www.isi.fhg.de/publ/downloads/isi03b59/estonian-biotechnology.pdf>.

we simply do not know yet what those radically new products will look like, what kind of knowledge or skills exactly is needed to generate them or what kind of competitive advantages and specialisation they will engender for Estonia in the longer term and in regard to global scale.

The market share of biotechnology alone is expected to exceed the 100 billion euro threshold by the year 2005. By the end of the decade, the global market share of biotechnology and its related sectors will most likely reach beyond 2000 billion euros.²⁶⁸

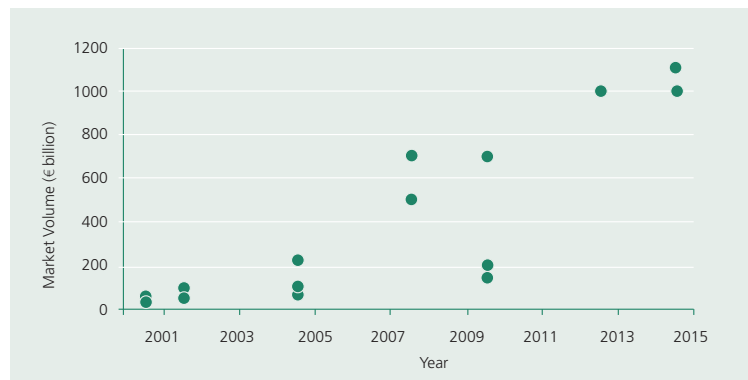
Figure 40. Assessments of growth in biotechnology market volume.



Source: McKinsey & Company and Piper Jaffray Ventures

Likewise, the European Commission stands by the estimates of the US National Science Foundation (NSF), *US Nanobusiness Alliance* and many other analysts in believing that the global market for nanotechnology and nanotechnology-based products will grow into the volume of more than a trillion euros by the year 2015.²⁶⁹ (Figure 41)

Figure 41. Expected growth of nanotechnology market.



Source: *Towards a European strategy for nanotechnology*, European Commission, COM(2004) 338 final, 12.5.2004.

²⁶⁸ *Life sciences and biotechnology — A strategy for Europe*, Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions, European Commission, 2002, 12. See also *Emerging Biotechnology Players. From Innovation to Realization*, Datamonitor, 2002.

²⁶⁹ It is important to note that a comparison of the projections various institutions present for nanotechnology market shows that the projections originating from the US tend to be considerably more optimistic than those coming from Europe or Japan. This is well in line with the remarkable gap between the per capita nanotechnology investments in USA and other countries. (Table 3, Ch. 2.4).

Explosive growth in research and development investments in the areas of bio- and nanotechnology will ensure that the following 10-20 years are going to witness the formation of new dominant technology platforms, emergence of new “winner takes all” markets, and extremely tough technological competition. This kind of investment into new base technologies is somewhat similar to a casino where participating governments and large corporations are forced to make billions of euros, dollars or yens worth of bets, while the rules and other participants of the game will become known only much later when the game is already in full swing.²⁷⁰

One option for the smaller countries is to invest in the areas that have been neglected by the large countries for one or another reason. The government of the city-state of Singapore has therefore established a 600 million dollar biotechnology investment fund that focuses primarily on stem cells related research and other state-of-the-art areas in biotechnology. And Singapore is not at all alone in trying to benefit from the standpoint of the US federal government that has banned stem cells related biotechnology research. In addition to Australia, China, India, Japan, Korea and other countries, Arnold Schwarzenegger in the US state of California has personally decided to invest billions of dollars over the coming decade into stem cells research related biotechnology.²⁷¹

Comparable long term and massive investments into basic research, which might potentially generate successful spin-offs that lay the foundations for the emergence of a high technology industry, are virtually impracticable in Estonian circumstances. The actual volume of investments needed and the related risks are simply too large. Yet the Irish experience in the 1980-1990s shows Estonia that an active and well-focused policy of attracting appropriate foreign investments can help us partake in this.²⁷² Ireland has managed to successfully exploit its membership of the European Union to attract high technology investments from USA. In the light of good logistics, labour supply, cultural proximity and other favourable conditions, the goal of American industrialists in making massive investments in Ireland was really nothing less and nothing more than to establish a production base for entering the European market. Since the US investments helped Ireland enter the new emerging industry sectors significantly earlier and more forcefully than most of the other European Union member states did, it accelerated considerably the development of the whole economy and society as the economy went through fairly drastic structural changes.²⁷³

Today's Finland is a good example of a country where one of the primary motivations for the incoming foreign direct investments is the presence of specific competences and the strong economic clusters surrounding them. Availability of prior world-class research and development is of vital importance when trying to attract such investments.²⁷⁴

Developing countries like Estonia are better off attracting investments that are looking to occupy new markets just like it happened in Ireland. At the same time, the countries should make sure that these transactions bring along not only production, but also some research and development related activities. Even if Estonia does not have as many logistic, cultural and other advantages as Ireland does for obtaining investments from the US, it should still explore very seriously various opportunities for encouraging bio- and nanotechnology related investments from USA, South East Asia and other regions. The Irish experience has demonstrated that a deep understanding of the emergence and formation processes of new industry sectors in USA, Asia and elsewhere is a critical precondition to the success of this policy, as is a proactive attitude in approaching

²⁷⁰ See Brian W. Arthur, “Increasing Returns and the New World of Business”, *Harvard Business Review*, July-August 1996, 100-109.

²⁷¹ Bruce Einhorn, Jennifer Veale, Manjeet Kripalani, “Asia is stem cell central”, *BusinessWeek*, 15.01.2005; “Schwarzenegger in stem cell research”, *BBC News*, 19.10.2004.

²⁷² About the analysis of the choice of location for foreign investments and investment decisions see John H. Dunning, „The eclectic paradigm as an envelope for economic and business theories of MNE activity”, *International Business Review*, 9, 2000, 163-190.

²⁷³ As a reminder, before Ireland joined the European Union, most of its incoming investments were of the market-seeking type as well, especially since they mostly came from the United Kingdom and Continental Europe rather than the US. See Frank Barry, Aoife Hannan, *Will Enlargement Threaten Ireland's FDI Inflows?*, Quarterly Economic Commentary, Economic and Social Research Institute, Dublin, December 2001, 55-67, 60; „Investment in Finland reaches a market of 80 million people”, *EnterpriseFinland*, 31.3.2004.

²⁷⁴ On this point see also Cees van Beers, *The Role of Foreign Direct Investments on Small Countries' Competitive and Technological Position*, Government Institute for Economic Research, Helsinki, 2003, 116, <http://extranet.vatt.fi/knogg/Reports/t100.pdf>.

specific companies and offering them favourable conditions to launch production in Europe.

There are, of course, no ready-made criteria for predicting the growth of emerging industries, but a comparison of some general indicators like total volume of investment into research and development as well as risk financing figures, publication and patenting data etc can serve as a fairly good guide to sectoral advances.²⁷⁵ Table 16 lists, for instance, leading institutions in nanotechnology patenting. Once again we see mostly US companies and research institutions in the lead. USA and IBM as a country and as a company, respectively, also outrank everyone else in the comparison of patent citations, i.e. both US and IBM patents are cited most often in the world.²⁷⁶

Table 16. Top 20 institutions that have registered the highest number of nanotechnology related patents in the US Patent Office during the years 1976-2002.

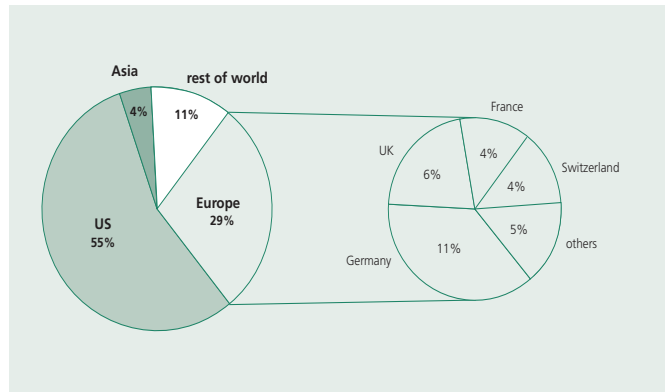
Rank	Assignee Name	Number of Patents	Average Patent Age
1	International Business Machines Corporation	1302	6.74
2	Xerox Corporation	957	7.55
3	Minnesota Mining and Manufacturing Company	807	7.69
4	Eastman Kodak Company	708	10.38
5	Motorola, Inc.	508	7.16
6	The Regents of the University of California	491	4.13
7	NEC Corporation	483	4.42
8	Micron Technology, Inc.	457	2.53
9	Canon KaDushiki Kaisha	408	5.52
10	E. I. Du Pont de Nemours and Company	367	11.45
11	General Electric Company	367	11.54
12	Texas Instruments Incorporated	366	7.77
13	Hitachi, Ltd.	335	6.43
14	The United States of America as represented by the Secretary of the Navy	330	8.63
15	The Dew Chemical Company	327	11.04
16	Kabushiki Kaisha Toshiba	317	5.47
17	Abbott Laboratories	297	6.62
18	Advanced Micro Devices, Inc	295	2.61
19	Massachusetts Institute of Technology	271	8.28
20	Merck & Co., Inc.	251	8.63
	Average	482.2	7.23

Source: Huang et al., „International nanotechnology development in 2003: Country, institution, and technology field analysis based on UPTSO patent database“, *Journal of Nanoparticle Research*, 6, 2004, 325-354, 336.

²⁷⁵ Patent statistics and the like are not really all-powerful. It should be kept in mind when analysing different technology areas that competitive positions as well as diverse strategies companies use for market entry in different sectors vary significantly between the areas. Statistics itself is characterised by certain innate inertia and resistance to changing classifications etc, which usually results in the emerging industries being ignored until they are so big and important that they simply cannot be ignored anymore. This is what inspired the famous quote by Robert Solow in the 1980s: „computers are everywhere but productivity statistics“.

²⁷⁶ Huang et al., „International nanotechnology development in 2003: Country, institution, and technology field analysis based on UPTSO patent database“, *Journal of Nanoparticle Research*, 6, 2004, 325-354, 345-346.

Figure 42. New nanotechnology companies established in 1997-2002.



Source: CEA, Bureau d'Etude Marketing.

Estonia's competence base in new key technologies is actually in a pretty good shape, and that is due to historic reasons.²⁷⁷ On the one hand, Estonia does lag significantly behind Scandinavia in bio- and nanotechnology, neurosciences and immunology in regard to the number of scientific publications per inhabitant, but then again, Estonian numbers compare rather well with those of Ireland. (Table 17)

Table 17. Scientific publications and citations per million inhabitants.

	Bio-informatics		Genetics		Nano-technology		Neurosciences		Immunology	
	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.	Publ.	Cit.
Estonia	17.0	67.4	129.9	341.5	44.7	104.4	217.2	592.1	186.0	472.8
Latvia	3.0	0.4	17.5	28.1	23.8	15.3	35.8	53.2	49.0	120.5
Lithuania	3.1	11.4	22.0	113.3	28.1	24.2	34.8	67.4	33.1	60.4
Finland	80.1	279.7	1153.2	5651.2	148.3	295.7	1417.3	3963.2	1745.2	5506.3
Sweden	115.8	440.4	965.3	4240.8	296.3	720.7	1611.6	4565.8	2148.4	7398.1
Denmark	94.7	406.2	868.6	3482.7	191.7	726.2	1083.5	2825.2	1507.7	5093.1
Iceland	117.5	110.4	1421.0	8799.9	60.5	138.9	609.0	1299.9	901.0	2706.6
Ireland	27.5	87.4	270.4	1103.4	94.3	246.9	462.0	1188.3	539.0	1713.0
Poland	5.6	7.6	49.9	85.2	33.1	23.2	105.2	105.7	92.7	131.2

Source: Mapping excellence in Science and Technology across Europe, <http://www.cwts.nl/ec-coe>, December 2003.

Up until very recently, however, Ireland also paid relatively little attention to independent research and development policy. In order to rectify this situation and alleviate the shortage of top specialists, Ireland has recently embarked on proactive policies to attract the researchers and engineers from all over the world to

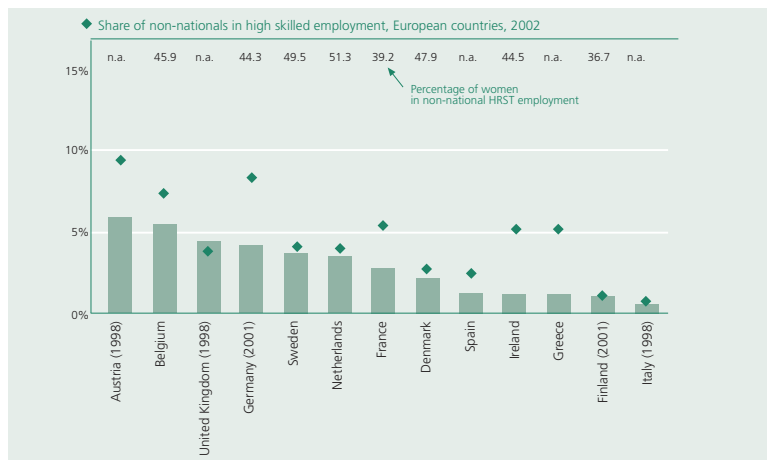
²⁷⁷ While Estonian competence base in biotechnology has been well mapped in the Fraunhofer study, in the case of nanotechnology, on the other hand, it is not even clear what the competence base in Estonia looks like, and how much are the companies that today dominate Estonian economy able to utilise nanotechnology. In all probability, this capacity is very moderate.

²⁷⁸ See e.g. Science Foundation Ireland, <http://www.sfi.ie>.

come to Ireland where they are badly needed in the fields of information and biotechnology.²⁷⁸

Likewise, Estonia needs to considerably expand its bio- and nanotechnology competence base so as to keep pace with other countries. Whereas Ireland has a much better demographic profile (Figure 32 in Ch. 3.4), Estonian society might be much more willing than Western Europe or even the Nordic countries to accept students from Asia, and thereby create an important long-term competitive advantage. Being a small country in Europe, this kind of internationalisation seems pretty much inevitable. (Figure 43)

Figure 43. Share of foreign workers in highly skilled European workforce, 2002.



Source: *OECD Science and Innovation Policy: Key Challenges and Opportunities*, 2004, 37, <http://www.oecd.org/dataoecd/18/17/23706075.pdf>.

Creating a cutting edge competence base in bio- and nanotechnology requires not only significant diversification in the supply of education,²⁷⁹ but also a considerably more active and clear-cut government support specifically to bio- and nanotechnology related basic research and technology development. This all is useful when there is a very sound system of intellectual property protection in place, which, in turn, also ensures a more effective protection of the research results published in academic journals etc.

Since in Europe private sector investments into research and development are strongly clustered both sector-wise and within specific industries, local research and development activities can occur only with the involvement of the foreign owners of companies. It is therefore crucial for Estonia to look for opportunities to more actively engage in the research and development programmes of the Nordic countries and Europe as well as in the more fitting European technology platforms now being launched.²⁸⁰

At the same time, developing countries like Estonia should be careful about the investment-based development path, because successful development in one specific sector (bio- or nanotechnology, for instance) might not automatically translate into a considerable positive impact on the well-being of Estonian population. The latter may happen when, for example, the new high technology sector will emerge as a small part of a larger international production network that does not have much business with traditional economy, and where all the added value generated will move out of Estonia. This means that simultaneously with strengthening the competence base in bio- and nanotechnology, Estonia must also modernise its existing industry, especially the sectors that yield more employment and export volumes in Estonia like forest, food, textile and chemical industry etc.

²⁷⁹ Since nanotechnology raises questions about the adequacy of the whole current division between different research fields, various opportunities should be explored in Estonia for changing the way science and engineering classes are taught, starting with high school level education.

²⁸⁰ In most of the European countries 20-30 largest companies basically account for the majority of industrial research and development investments. See *Monitoring industrial research: the 2004 EU industrial R&D scoreboard, volume I*, European Commission, 2004, <http://eu-IRIscoreboard.jrc.es/>; For details about European technology platforms see <http://www.cordis.lu/technology-platforms/>.

5. Policy recommendations

By no means does the analysis presented above claim to provide the absolute prophesy about the upcoming developments in the next decade. Moreover, it is highly unlikely that any of the described scenarios would materialise automatically in the exact way depicted above; it would sooner be some combination of them. Predicting the future is not the actual goal in the process of envisaging potential long-term development trends. The value of this work lies rather in outlining the premises, relevant risks and windows of opportunity that these strategies entail.

Even if chance does play a fair share in this all, the investment opportunities for entrepreneurs as well as further development of Estonia as a whole will mostly depend on the activities that the public sector decides to embark on (or not to embark on) in shaping Estonian economic environment. Without a clear long-term vision, however, these activities have no chance of success.²⁸¹

Although the *Lisbon strategy* of the European Union and *Knowledge-based Estonia* have both been instrumental strategic documents in raising the issue of economic competitiveness into the focus of political agenda, Estonia today still lacks the mechanisms to ensure that Estonian economy is actually moving towards higher knowledge intensity. Since regular assessment of policies and their impact is not yet common practice in many areas essential to the competitiveness of Estonian economy, then public policy is also visibly uneven having no obvious goal and incapable of solving the structural problems facing our socio-economic development.²⁸²

So for instance, Estonian innovation policy does not currently provide any effective mechanisms to influence the factors that hinder productivity growth in wood processing or electronics industries, which have greatest impact on our economic growth and exports. Neither are there any schemes that would specifically support the emergence of new high technology economic sectors. The needs of the companies in those two industries are, however, radically different.

Since the mechanisms for public policy development and coordination are generally extremely weak, then education, research and development, employment, innovation and other policies also have a mere marginal impact within the current framework.

5.1. Cluster-based economic policy

One of the primary tasks for Estonian public sector is basically to answer the following question: how to ensure a systematic consideration of private sector problems in public policy development and assessment. In order to do that the government needs a system that provides it with constant feedback on the actual trends in private sector as well as potential long-term developments, labour needs etc. Establishing such a system is one of the major prerequisites for the creation of any kind of comprehensive long-term development strategy in Estonia. This system for policy development and coordination should prioritise the goals of social and environmental sectors along with the 5-6 most important economic clusters in regard to technological and socio-economic development (for example, wood and forestry cluster or information technology and electronics cluster etc), the value chains of which together basically account for the whole Estonian economy.

Establishing this system in practice entails the formation of permanent task forces comprising representatives from private and public sectors. These groups then generate regular overviews of potential future developments, current problems and possible solutions in their sector. Reports presented by these task forces must then become an integral part in the process of education, research and development policy formulation, coordination and evaluation.

²⁸¹ Carlota Pérez, „Technological change and opportunities for development as a moving target”, *CEPAL Review* 75, December 2001, 109-130.

²⁸² See *Riigi tegevus raba suunamisel ettevõtluse toetamiseks* [Government activities in providing funding for entrepreneurship development], Audit Report No 2-5/03/95, State Audit Office of Estonia, 2003; *Outcome of the product development projects supported by the Enterprise Estonia Foundation*, Audit Report No 2-5/04/109, State Audit Office of Estonia, 2004.

The primary output of the above task forces should be formulation of technology programmes needed for the development of the respective clusters, their later assessment and constant updating. The issues presented in these programmes must reach the whole policy spectrum from new curricula formation to the schemes for attracting foreign investments and export subsidies. They would then a) actually create new sectors where Estonia emerges with strong research and development, which is well competitive on the European scale; which are also b) closely related to real economic activities; c) interdisciplinary and d) grounded in the collaborative efforts of local as well as foreign (if needed) competence centres.

5.2. More effective policy coordination in the Baltic Sea region

In the ever tightening global economic competition, Estonia is clearly an integral part of the economic area of the Baltic Sea region and of the surrounding cross-border economic clusters. Any long-term development strategy Estonia adopts therefore needs to take into account the development plans of our neighbouring countries and include mechanisms for the coordinate our long-term policies (incl. education, research etc).

Nordic countries have long understood that small states are not necessarily competitors in the global competition. Instead, they can fairly successfully complement each others' competitive advantages. Having become a part of the economic clusters of the Baltic Sea region rather organically and effortlessly, it will be a major challenge for Estonia to significantly improve the coordination of its education, research, innovation and other policies with those of the Nordic countries as well as Latvia and Lithuania.

Initiating international foresight and cluster programmes the prospective goals or which is to support advanced specialisations in higher education, and open up national research and development programmes to each other is undoubtedly one of the softer forms of policy coordination.

5.3. Developing infrastructure for knowledge and technology

Although governments around the globe often have the tendency to think of infrastructure development in a static form of roads and sewage treatment facilities, nearly every single one of such projects also entails an opportunity for technology development. Investment in power plants or public transportation and the like can be used to offer domestic companies a good occasion for learning and enhancing their competitive advantages. Public procurement system must support the exploitation of such opportunities.

In addition to better policy coordination and initiation of cluster-based technology programmes Estonian public policy should continuously pursue the following three key targets:

1. Attracting talented people to come and work in Estonia, and providing them with a favourable working and living environment;
2. Facilitating knowledge and technology transfer from foreign investment based enterprises into domestic industries and service sectors;
3. Increasing the capability of local enterprises to apply the knowledge created abroad, including continued education and in-service training; investing in basic research to keep abreast of global research and technology trends and to sustain the high quality of our educational system.

6. Appendices

Table 18. Supply and demand of industrial produce in Estonia (in current prices).

Industry (ISIC 4-digit code)	Apparent consumption ²⁸³		Ratio of output to apparent consumption		Imports as % of apparent consumption		Exports as % of output	
	Total (US\$ '000)	Per-capita (US\$)	1997	2000	1997	2000	1997	2000
	2000	2000						
Processing/preserving of meat (1511)	110897	80	0.72	0.80	65.10	46.60	51.50	33.00
Processing/preserving of fish (1512)	42580	31	1.37	2.10	34.50	52.40	52.10	77.30
Processing/preserving of fruit & vegetables (1513)	35311	25	0.54	0.31	66.00	86.30	37.50	55.90
Dairy products (1520)	122276	88	1.18	1.23	40.10	23.80	49.10	38.00
Grain mill products (1531)	16253	12	0.30	0.19	96.20	85.80	87.30	24.60
Starches and starch products (1532)	...	...	-	...	99.00	...	87.60	...
Prepared animal feeds (1533)	25383	18	0.70	0.56	31.90	45.50	2.90	2.30
Bakery products (1541)	66071	47	0.85	0.90	21.20	11.70	6.80	1.90
Cocoa, chocolate and sugar confectionery (1543)	36281	26	...	0.56	...	89.60	...	81.30
Other food products n.e.c. (1549)	...	...	0.44	...	87.10	...	71.00	...
Distilling, rectifying & blending of spirits (1551)	39655	28	0.76	0.73	29.30	41.70	6.60	20.60
Wines (1552)	26226	19	0.11	0.29	90.10	73.20	12.90	6.10
Malt liquors and malt (1553)	53338	38	0.85	0.93	22.30	20.00	8.50	13.70
Soft drinks; mineral waters (1554)	25492	18	1.01	1.00	33.00	31.20	33.60	31.30
Textile fibre preparation; textile weaving (1711)	134301	96	0.77	0.74	87.10	88.20	83.10	84.10
Carpets and rugs (1722)	16947	12	0.76	1.08	39.50	25.50	20.00	30.90
Tanning and dressing of leather (1911)	16072	12	0.39	0.19	93.40	90.10	82.90	49.00
Luggage, handbags, etc.; saddlery & harness (1912)	6705	5	...	0.68	...	91.60	...	87.60
Sawmilling and planing of wood (2010)	60945	44	...	3.47	...	38.10	...	82.20
Builders' carpentry and joinery (2022)	68854	49	1.03	1.28	14.30	13.10	16.90	32.20
Other wood products; articles of cork/straw (2029)	8591	6	3.23	2.04	36.70	31.30	80.40	66.40
Corrugated paper and paperboard (2102)	27513	20	0.53	0.60	64.40	60.60	33.20	34.50
Other articles of paper and paperboard (2109)	56829	41	...	0.34	...	89.70	...	70.00
Publishing of books and other publications (2211)	30441	22	0.60	0.60	48.10	44.80	13.40	8.10

Publishing of newspapers, journals, etc. (2212)	47448	34	0.97	1.02	4.70	3.60	1.70	5.70
Other publishing (2219)	7787	6	0.61	0.89	40.90	19.40	3.40	9.80
Printing (2221)	56002	40	0.89	0.94	25.10	22.40	16.00	17.30
Service activities related to printing (2222)	3986	3	0.78	0.96	25.80	14.10	5.40	10.60
Processing of nuclear fuel (2330)	...	...	0.00	...	100.00	...	...	...
Other chemical products n.e.c. (2429)	74814	54	0.63	0.48	47.40	65.80	17.10	29.20
Plastic products (2520)	155999	112	0.46	0.48	75.00	80.50	45.90	59.80
Glass and glass products (2610)	43361	31	0.96	0.90	79.50	68.00	78.50	64.50
Refractory ceramic products (2692)	...	...	0.67	...	33.90	...	1.60	...
Struct.non-refractory clay; ceramic products (2693)	18776	13	0.26	0.65	84.20	46.40	40.30	17.80
Cement, lime and plaster (2694)	11878	9	2.04	1.72	16.70	18.00	59.30	52.40
Articles of concrete, cement and plaster (2695)	49877	36	0.91	0.97	27.00	20.00	20.20	17.70
Cutting, shaping & finishing of stone (2696)	7005	5	0.83	0.87	23.70	18.70	7.90	7.10
Other non-metallic mineral products n.e.c. (2699)	19424	14	...	0.36	...	87.70	...	65.70
Tanks, reservoirs and containers of metal (2812)	...	...	0.37	...	95.30	...	87.40	...
Cutlery, hand tools and general hardware (2893)	26440	19	0.36	0.43	88.40	84.10	68.20	62.60
Other fabricated metal products n.e.c. (2899)	104098	75	0.43	0.43	82.00	85.60	57.80	66.70
Ovens, furnaces and furnace burners (2914)	...	...	0.65	...	82.60	...	73.20	...
Other general purpose machinery (2919)	73498	53	...	0.41	...	77.90	...	46.30
Agricultural and forestry machinery (2921)	31344	23	0.32	0.50	89.70	73.70	68.00	47.70
Food/beverage/tobacco processing machinery (2925)	16080	12	...	0.39	...	69.60	...	22.50
Electricity distribution & control apparatus (3120)	...	...	0.54	...	62.70	...	31.00	...
Electronic valves, tubes, etc. (3210)	485763	349	0.12	-	92.30	97.30	37.50	55.20
Industrial process control equipment (3313)	48423	35	0.78	0.96	50.60	5.40	36.50	1.40
Building and repairing of ships (3511)	53587	38	0.92	0.88	20.60	18.50	13.40	7.80
Building/repairing of pleasure/sport. boats (3512)	...	...	0.77	...	85.30	...	80.90	...
Furniture (3610)	97973	70	1.32	1.78	35.30	42.10	51.00	67.50
Jewellery and related articles (3691)	5083	4	0.83	0.80	69.80	76.20	63.60	70.30
Musical instruments (3692)	...	...	1.10	...	83.70	...	85.10	...
Other manufacturing n.e.c. (3699)	29489	21	0.43	0.56	81.60	77.70	56.80	60.00

Source: United Nations Industrial Development Organisation, June, 2004, <http://www.unido.org/>.

CURRICULUM VITAE

Marek Tiits

1. Personal data

Date and place of birth: 20 July 1971, Pärnu
Citizenship: Republic of Estonia

2. Contact information

Address: Institute of Baltic Studies
Lai 30
Tartu 51005
Estonia
Phone: +372 6999484
E-mail: marek@ibs.ee

3. Education

2002 – 2004 University of Tartu, Faculty of Social
Sciences, *Master of Arts in Public
Administration and Social Policy*

1989 – 1996 University of Tartu, Faculty of
Mathematics, *Bachelor of Science in
informatics*

4. Language skills

Estonian native language
English good
Russian limited

5. Special courses

Summer 2005 Globelics Academy Ph.D.-School on
National Systems of Innovation and
Economic Development,
May-June 2005

Summer 2005 Cambridge Advanced Programme on
Rethinking Development Economics,
University of Cambridge, July 2005

6. Professional employment

1996 –	Institute of Baltic Studies, Chairman of the board
2007 – 2008	Estonian Development Fund, Economic expert
2004 – 2006	Archimedes Foundation, Senior innovation policy analyst
2001 – 2003	State Chancellery of the Republic of Estonia, Head of the Secretariat of the Research and Development Council

7. Recent research projects

2009 – 2011	Impact of Networks, Globalisation, and their Interaction with EU Strategies (EU FP7 SSH large-scale integrating project)
2005 – 2008	Estonian Regional Innovation Strategy (EU FP6)
2005 – 2007	Industrial restructuring in the NIS: experience and lessons from the EU new member states (EU FP6)

8. Defended theses

Thesis: “Anonymous payment system and its applications in modern information technology environment” (*Bachelor of Science*)

Thesis: “The Role of Innovation Policy in an Industrial Catching-up Strategy for Estonia” (*Master of Arts in Public Administration and Social Policy*)

9. Main areas of scientific work

Science, technology and innovation policy, (national) systems of innovation, clusters, foresight, information and communication technologies

10. Publications

- Marek Tiits & Kristjan Rebane. 2009. Eesti infotehnoloogia tulevikuvaated [Estonian ICT outlooks], Tallinn Estonian Development Fund.
- Marek Tiits. 2008. "Estonia's Economic Integration into Cross-border Production Networks of the Baltic Sea Region." In: Ruslan Grinberg, Peter Havlik, Oleh Havrylyshyn (eds.) *Economic Restructuring and Integration in Eastern Europe: Experiences and Policy Implications*. Germany: Nomos Verlagsgesellschaft, 281-296.
- Marek Tiits et al. 2008. "Catching up, forging ahead or falling behind? Central and Eastern European development in 1990-2005." *Innovation – The European Journal of Social Science Research*, 21, 1, 65-85.
- Marek Tiits, "Technology-intensive FDI and economic development in a small country – the case of Estonia". *TRAMES Journal of Humanities and Social Sciences*, 11 (61/56), 3, 324-342.
- Marek Tiits (ed). 2007. *Kaupmeeste riik [The Nation of Merchants]*. Tallinn: Estonian Academy of Sciences.
- Marek Tiits. 2006. "Industrial and trade dynamics in the Baltic Sea Region since 1990s." In: Tarmo Kalvet & Rainer Kattel (eds.) *Creative destruction management: Meeting the challenges of the techno-economic paradigm shift*, Tallinn: Praxis Center for Policy Studies: Tallinn.
- Marek Tiits et al. 2006. "Globalisation of R&D and economic development: policy lessons from Estonia." In: *Globalisation of R&D and Developing Countries*, Geneva: UNCTAD.
- Marek Tiits et al. 2005. *Made in Estonia*, Tartu: Institute of Baltic Studies.
- Marek Tiits et al. 2003. *Competitiveness and Future Outlooks of the Estonian Economy*, Tallinn: State Chancellery of the Republic of Estonia.
- Marek Tiits. 2003. "Towards modern STI policy-making in Estonia." *TRAMES Journal of Humanities and Social Sciences*, 7 (57/52), 1, 53-62.

ELULOOKIRJELDUS

Marek Tiits

1. Isikuandmed

Sünniaeg ja -koht: 20. juuli 1971, Pärnu
Kodakondsus: Eesti Vabariik

2. Kontaktandmed

Aadress: Balti Uuringute Instituut
Lai 30
Tartu 51005
Eesti
Telefon: 6999484
E-mail: marek@ibs.ee

3. Hariduskäik

2002 – 2004 Tartu Ülikool, Sotsiaalteaduskond,
magister artium avaliku halduse ja
sotsiaalpoliitika erialal

1989 – 1996 Tartu Ülikool, Matemaatika-
teaduskond, *baccalaureus scientiarum*
informaatika erialal

4. Keelteoskus

eesti keel emakeel
inglise keel hea
vene keel vähene

5. Muu hariduskäik

suvi 2005 Doktorikool teemal “Rahvuslikud
innovatsioonisüsteemid ja
majandusareng”, *Globelics Academy*,
mai-juuni 2005

suvi 2005 Arenguökonomika suvekool
edasijõudnutele, Cambridge'i Ülikool,
juuli 2005

6. Teenistuskäik

1996 –	Balti Uuringute Instituut, juhatuse esimees
2007 – 2008	Eesti Arengufond, majandusekspert
2004 – 2006	Sihtasutus Archimedes, innovatsioonipoliitika vanemanalüütik
2001 – 2003	Eesti Vabariigi Riigikantselei, Teadus- ja Arendusnõukogu sekretariaadi juhataja

7. Valik viimastest teadusprojektidest

2009 – 2011	Impact of Networks, Globalisation, and their Interaction with EU Strategies (EU FP7 SSH large-scale integrating project)
2005 – 2008	Estonian Regional Innovation Strategy (EU FP6)
2005 – 2007	Industrial restructuring in the NIS: experience and lessons from the EU new member states (EU FP6)

8. Kaitstud lõputööd

Thesis: “Anonüümne maksesüsteem ja selle kasutusvõimalused
kaasaegses infotehnoloogia keskkonnas” (*Baccalaureus scientiarum*
informaatika erialal)

Thesis: “Innovatsioonipoliitika roll Eesti majandusarengu strateegias”
(*magister artium* avaliku halduse ja sotsiaalpoliitika erialal)

9. Teadustöö põhisuunad

Teadus-, tehnoloogia ja innovatsioonipoliitika; (rahvuslikud) innovatsiooni-
süsteemid; klastrid, arenguseire, informatsiooni- ja kommunikatsiooni-
tehnoloogiad

10. Publikatsioonid

- Marek Tiits & Kristjan Rebane. 2009. Eesti infotehnoloogia tulevikuvaated. Tallinn: Eesti Arengufond.
- Marek Tiits. 2008. "Estonia's Economic Integration into Cross-border Production Networks of the Baltic Sea Region." In: Ruslan Grinberg, Peter Havlik, Oleh Havrylyshyn (eds.) *Economic Restructuring and Integration in Eastern Europe: Experiences and Policy Implications*. Germany: Nomos Verlagsgesellschaft, 281-296.
- Marek Tiits et al. 2008. "Catching up, forging ahead or falling behind? Central and Eastern European development in 1990-2005." *Innovation – The European Journal of Social Science Research*, 21, 1, 65-85.
- Marek Tiits, "Technology-intensive FDI and economic development in a small country – the case of Estonia". *TRAMES Journal of Humanities and Social Sciences*, 11 (61/56), 3, 324-342.
- Marek Tiits (ed). 2007. *Kaupmeeste riik*. Tallinn: Eesti Teaduste Akadeemia.
- Marek Tiits. 2006. "Industrial and trade dynamics in the Baltic Sea Region since 1990s." In: Tarmo Kalvet & Rainer Kattel (eds.) *Creative destruction management: Meeting the challenges of the techno-economic paradigm shift*, Tallinn: Praxis Center for Policy Studies: Tallinn.
- Marek Tiits et al. 2006. "Globalisation of R&D and economic development: policy lessons from Estonia." In: *Globalisation of R&D and Developing Countries*, Geneva: UNCTAD.
- Marek Tiits et al. 2005. *Made in Estonia*, Tartu: Balti Uuringute Instituut.
- Marek Tiits et al. 2003. *Competitiveness and Future Outlooks of the Estonian Economy*, Tallinn: State Chancellery of the Republic of Estonia.
- Marek Tiits. 2003. "Towards modern STI policy-making in Estonia." *TRAMES Journal of Humanities and Social Sciences*, 7 (57/52), 1, 53-62.

TALLINN UNIVERSITY OF TECHNOLOGY
DOCTORAL THESES
SERIES I: SOCIAL SCIENCES

6. **Ülle Madise.** Elections, Political Parties, and Legislative Performance in Estonia: Institutional Choices from the Return to Independence to the Rise of E-Democracy. 2007.
7. **Tarvo Kungla.** Patterns of Multi-Level Governance in Europe: The Challenge of the EU's Enlargement. 2007.
8. **Mikk Lõhmus.** Avaliku halduse detsentraliseerimine Eestis. 2008.
9. **Tarmo Kalvet.** Innovation Policy and Development in the ICT Paradigm: Regional and Theoretical Perspectives. 2009.
10. **Thomas Duve.** Die Verschuldung deutscher Gemeinden: Präventionsansätze im Spannungsverhältnis von kommunaler Selbstverwaltung und staatlicher Gesamtverantwortung. 2009.
11. **Veiko Lember.** Contracting-Out Public Services and Public Procurement for Innovation: Revisiting Contracting Limits in Estonia and Beyond. 2009.
12. **Raivo Linnas.** An Integrated Model of Audit, Control and Supervision of the Local Government Sector: The Case of Estonia. 2010.
13. **Simon Lang.** Transformations in European R&D and Regional Policies within the Multi-Level Governance Framework: The Changing Nature of the European Union Ten Years after the Launch of the Lisbon Strategy. 2010.
14. **Erkki Karo.** Governance of Innovation Policy in Catching-up Context: Theoretical Considerations and Case Studies of Central and Eastern European Economies. 2011.
15. **Margit Suurna.** Innovation and High-Technology Policy, Policy-Making and Implementation in Central and Eastern European Countries: The Case of Estonia. 2011.
16. **Marek Tiits,** Technology Foresight and the Catching-up Strategy in Small Countries: The Case of Estonia. 2011.

