Productivity in Europe and the United States

Technology Trends and Policy Measures

EPTA

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Introduction: A Second Machine Age

According to MIT economists Erik Brynjolfsson and Andrew McAfee, we are standing on the threshold of a «second machine age». 3D-printing, autonomous cars, speech recognition and cheap, flexible robots all herald a new era where the norm is abundance rather than scarcity. As they succinctly put it: «Computers and other digital advances are doing for mental power … what the steam engine and its descendants did for muscle power».[1]

The picture is, however, not entirely rosy; there is a worry that this development might eventually lead to fewer jobs, and a widened income gap. Carl Benedikt Frey and Michael A. Osborne have analysed how susceptible different kinds of jobs are to be taken over by new technology.[2] They conclude that low-skill, low-income jobs are most exposed, and estimate that as much as 47% of US employment is at risk of being eradicated.

On this basis, a crucial issue for all economies will be how to take advantage of technological development, without at the same time raising the unemployment rate. The risk for jobless growth is therefore a paradox to be taken seriously.

Productivity after the financial crisis

The financial crisis in 2008 and the following economic recession have put productivity on the agenda as the central driving force of growth in the world's economies. During the following years, few countries have been able to fully regain lost momentum, but there are signs of new technological and organisational innovations. There is also a renewed interest in industrial policy and policy measures for advanced manufacturing. Some of these new policy initiatives are described in this report; from the German Industry 4.0, via catapult centres promoting innovation in the UK, to the Danish productivity commission and Dutch work on Robots, employment and social justice.

We hope that the contributions in this report will make it possible for different nations and regions to exchange knowledge and experiences on all these pressing affairs. Because of the increasingly globalised world we now live in and the rapid diffusion of technology, few challenges are contained within one region or country. By describing challenges and policies, in different countries and regions, we hope policy makers will be aided in their efforts to develop effective strategies for the future.

[1] Brynjolfsson, E. and McAfee, A. 2013. *The Second Machine Age – Work. Progress, and Prosperity in a Time of brilliant Technologies*.
[2] Frey, C.B. & Osborne, M.A. 2013, "The Future of Employment: How Susceptible are Jobs to Computerisation?" http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

How this report was made

This report is the result of a collaboration in which the members, and associate members of the European Parliamentary Technology Assessment network (EPTA), have contributed with reports from their respective country or region.

Each member institution is reporting on the following topics:

- The national situation at a glance, which describes the current status on productivity and other financial and technological matters.
- Productivity challenges, in which the main obstacles hindering productivity growth are outlined.
- Technology trends and policy initiatives.

The Norwegian Board of Technology, holding the presidency of EPTA for 2014, has developed the template and edited this joint report. I commend Project Manager Jon Fixdal and Project Assistant Alexander Myklebust on their work of coordinating and editing the contributions.

Finally, I would like to thank all the participating institutions for their contributions to these important issues.

Tore Tennøe, Director

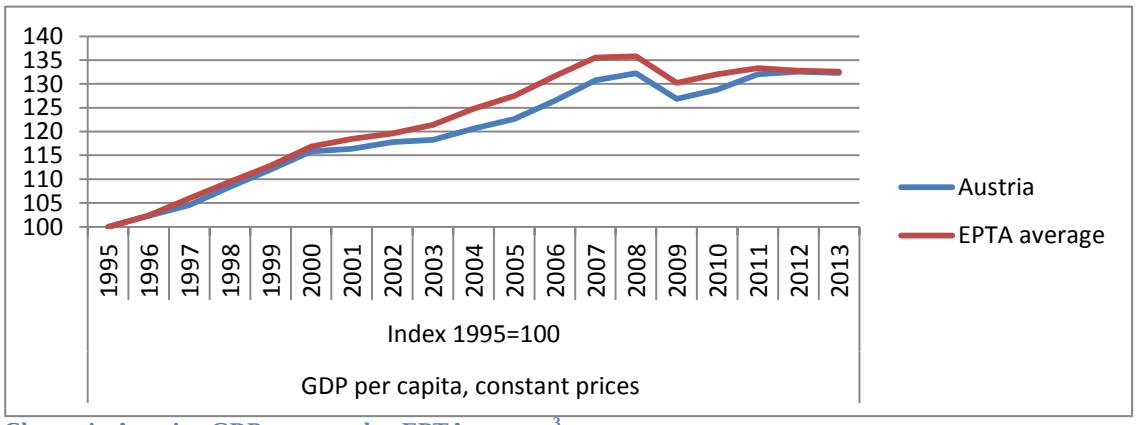
Oslo, 22 October 2014

Austria

Austrian productivity at a glance

In spite of the difficult global framework conditions and the economic crises, the Austrian overall economic development could perform very positively in recent years as compared to other countries: since 2000, the GDP is growing steadily (with an exception in 2009) and also above the European average; the per-capita income is amongst the highest five in Europe. A closer look at how the income is distributed shows that income inequality measured by the Gini coefficient has risen from 0.349 (1970) to 0.452 (2010). The gender pay gap remains one of the highest in Europe with about 37% considering all employees. On the positive side, Austria´s unemployment rates are the lowest in the whole European Union with a current rate of 4.7% and an average of 4.4% in the period 2000-2013. Satisfaction with working conditions is generally high.

Any growth in productivity takes place if the output in a production process increases per unit of input. Therefore, productivity gains can be derived by more efficient production processes, by general technical progress, increased governmental framework conditions or increased organisational structures. The total factor productivity has risen during the last ten years with only one year (2009) with a negative growth rate. The labor productivity index has increased on average from 100% in 2005 to 116% in 2013, but varies strongly in different sectors: for instance, the labor productivity index in the energy sector has risen to 170% (2013), whereas in the building sector it remained stable in the same period. Regarding environmental indicators, resource productivity has slightly increased in recent years, but greenhouse gas emissions and energy intensity remain on a high level.



Change in Austrian GDP compared to EPTA average[3]

[3] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Productivity challenges

Changing labor force

Population forecasts predict a growth of the Austrian population in the next decades whereas the amount of people in employable age will decline, especially from 2020 onwards. The underlying reason for this change in the labor force is the structure of the Austrian population with an increasing proportion of elderly people. This development will also be reflected in the labor force: the share of elderly will rise while the share of new entrants in the labor market and of younger people in general will decline.

Another development is that people in the labor force are better educated than in the previous decades with more people with secondary and tertiary education and less without any graduation. As people with better education are more likely to join the labor market and as reforms in the pension system lead to longer working periods an overall decline in the labor supply is not expected. The main challenges in this field include keeping the elderly in the labor force (also in cooperation with enterprises) for longer time than now, fighting unemployment of the elderly and setting measures for age-based working places. Although no generalization between the relationship of years in employment and productivity can be made productivity will certainly be affected by a changing labor force and will vary substantially between different economic sectors.

Deficits in the education system

Schooling and education are, on the one hand, the basis for innovation and efficiency on both the national and global level and, on the other hand, the basis for social promotion and integration as well as for increasing social differences. The Austrian educational system hardly addresses adequately these challenges as children from financially poorer families are still likely to get a worse education than children from more prosperous families. This corresponds to the early segregation in two school types at the age of ten years. Solutions are still and already for a long time under discussion.

A country’s economy can benefit from the apparent direct productivity gains of higher education. In the tertiary education system, a favorable development concerns the number and gender (a trend to more female graduates) of graduates in mathematics, informatics, natural sciences, and technical sciences. Today, the gap to current innovation leaders in this respect has been reduced. However, the tertiary education system in Austria substantially lacks funding. Although the public funding rate increased by 8% yearly in the period 2000-2010 the aim of a rate of expenditure of 2% of GDP (currently: 1.52%) for higher education is still missed by 400 million Euro.

Funding of research and innovation

Research institutions both inside and outside universities substantially lack adequate governmental funding. To meet the scientific and economic interests of Austria modernizing and extending the necessary research infrastructure is urgently needed otherwise an even wider gap to the innovation leaders amongst OECD countries is predicted. Another hindering

factor is that the competitive funding of Austrian research has decreased in 2014, to the level of 2007, without any compensation in other areas.

The ongoing tendency of decreasing public spending on research also leads to a growing proportion of graduate students not realizing their potential. For instance, female academics are employed in non-academic occupations at a rate of 35.7%. Overall female occupation in research institutions also constitutes no improvement of gender equality and a wide gap to the innovation leaders because of existing structural and cultural barriers. To succeed in the competition and with respect to the quality of location it would also be necessary to activate the innovation potentials generated in business companies.

The main challenges of the current policy regarding innovation efforts in enterprises concern the cooperation of science and business companies, the foundation and funding of innovative enterprises, and the lack of venture capital. The critical phase especially for young, small and innovative start-ups begins when public subsidies for seed capital finish and new investments are needed. One solution currently debated is improved framework conditions for private investments including the coupling of public subsidies with private investments.

Technology trends and policy initiatives

Governmental RTI strategy

The current research, technology and innovation (RTI) strategy of the Austrian Federal Government (2011) has the overall aim of turning Austria's position as an innovation follower to an innovation leader within the EU. To strengthen Austria's innovative capacity the following measures and developments are envisaged: reforming the Austrian education system in combination with the innovation system; strengthening basic research and applied research in combination with its institutions and infrastructure; strengthening the innovation capacity of business companies; optimizing the funding system; and strengthening Austria's international position.

In order to optimize the implementation of the governmental RTI strategy an inter-ministerial task force has the following main duties: accompaniment, concretization and coordination of the implementation of the strategy; strategic and system-oriented adjustment and coordination of the activities of the ministries involved; and dealing with the recommendations of the RTD Council (see below). A project on behalf of the Council monitored and analyzed the RTI governance since the implementation of the strategy. The results shed light on the weaknesses of Austrian RTI governance such as the fragmentation of policy structures. The new Federal Government restructured the competences of the ministries involved in RTI governance in late 2013; the consequences for RTI governance remain to be seen.

Austrian Council for Research and Technology Development recommendations

The main task of the RTD Council consists of consulting systematically, independently and thoroughly the Austrian Federal Government in all issues of RTI policy. The main goal of its work is essentially to contribute to a future-oriented RTI policy. In doing so, the Council sees itself as a central node in the network of the broad technology and research landscape, as a coordinator and amplifier of the diversified activities, as a bridge between actors, as a filter, and most of all as a prioritizer.

The Council also formulated two strategies (in 2005 for 2010 and in 2009 for 2020) with recommendations for the future development of the Austrian RTI system, and one strategy (in 2007) for the advancement of excellence. One central recommendation is the intensification of research and innovation activities to increase productivity.

Environmental technologies

The Austrian environmental technology industry has shown a continuous and also an above-average growth compared to the manufacturing sector over the last twenty years. Remarkably, this industry sector could rise by 8% in the period 2007–2011 while the manufacturing sector only grew by 2.4%. This development is also reflected in the employment rate: employment in this industry has risen by 6.5% per year while in the manufacturing factor it has gone down by 1.2%. Annual growth rates of productivity in the environmental technology industry are around 5% for the period 2009–2011.

Considerable structural changes took place in shifting from the production of technologies for environmental activities to a rising significance of clean energy technologies. The reason is seen in a change of priorities of environmental policy. Due to increasing environmental problems a high growth potential for this industry is expected. The positive growth prospects go hand in hand with an increasing internationalization and trade activities, but also with a rising competitive pressure.

The Austrian environmental technology industry is highly research and innovation intensive. In a questionnaire, 79% of the enterprises indicated that their innovation was a novelty for the Austrian market and 66% that this was also the case on an international scale. Due to this innovation success, even the competitiveness on global markets could be improved. To keep and to improve this market position, continuous investments in research and development for new technologies will be required. The Austrian environmental technology industry is seen as an extremely dynamic development of research-intensive, innovative and internationally oriented activities with high potentials for the future.

Information and communication technologies (ICT)

The use of ICT is one of the most important fields to increase the competitiveness of Austria´s economy and to contribute to the further development of an information society. In comparison to other OECD countries it can be positively observed that Austria shows an above-average ICT-development. The Networked Readiness Index states that Austria is constantly amongst the best 20 worldwide since 2004. The growth of the ICT-branch is above

GDP-growth and also the investment quote has risen above average and is predicted to do so in the future which means in turn enhanced employment possibilities. The Austrian Federal Government formulated four overriding goals in its ICT strategy (see above): increasing the quantity and quality of R&D of ICT; reaching a leading position in competition; reaching a leading position as research site; and enhancing the attractiveness for leading researchers and developers. It will be a future challenge not only to foster the use of ICT but also to further develop ICT itself in Austria, especially with regard to the emergence of Industry 4.0.

Industry 4.0

This new emerging field combines ICT and its applications with industrial production and manufacturing technologies. As Austria is considered as a high-tech, export-oriented industrial site it is of high importance to support the development of Industry 4.0 from its beginning. The Federal Ministry for Transport, Innovation and Technology provides 250 million Euros in the next two years for enterprises and research institutions to further develop this field. One important project is the foundation of a pilot plant together with the Technical University Vienna where a laboratory is installed with real industrial machines and logistic systems in a close to reality factory. First results are expected for 2015. For the future, a high potential is seen for the enhanced foundation of start-ups in this area.

Catalonia

Catalan productivity at a glance

The Catalan economy, like the economy of the Spanish State, has traditionally had low and even negative rates of apparent labour productivity growth: from 2000 to 2008, rates were between -2.2% and 1.4%. However, this situation changed after the start of the economic crisis in 2008 as employment fell much more sharply than GDP, leading to increases of over 2% in labour productivity in Catalonia since 2009 (in 2012 it passed the threshold of 3% to reach 3.5%). Job losses caused by the intense economic crisis have brought the unemployment rate in Catalonia to above 20% (in 2007, before the start of the crisis, it was at its lowest level, around 6%).

The increase in labour productivity combined with wage restraint has enabled a reduction in unit labour costs and consequently improved competitiveness, which has benefited the foreign sector of the Catalan economy through a significant boost of its exports. This fact, together with the contraction of imports due to falling domestic demand, has led to an improvement in the trade balance, which has traditionally been negative.

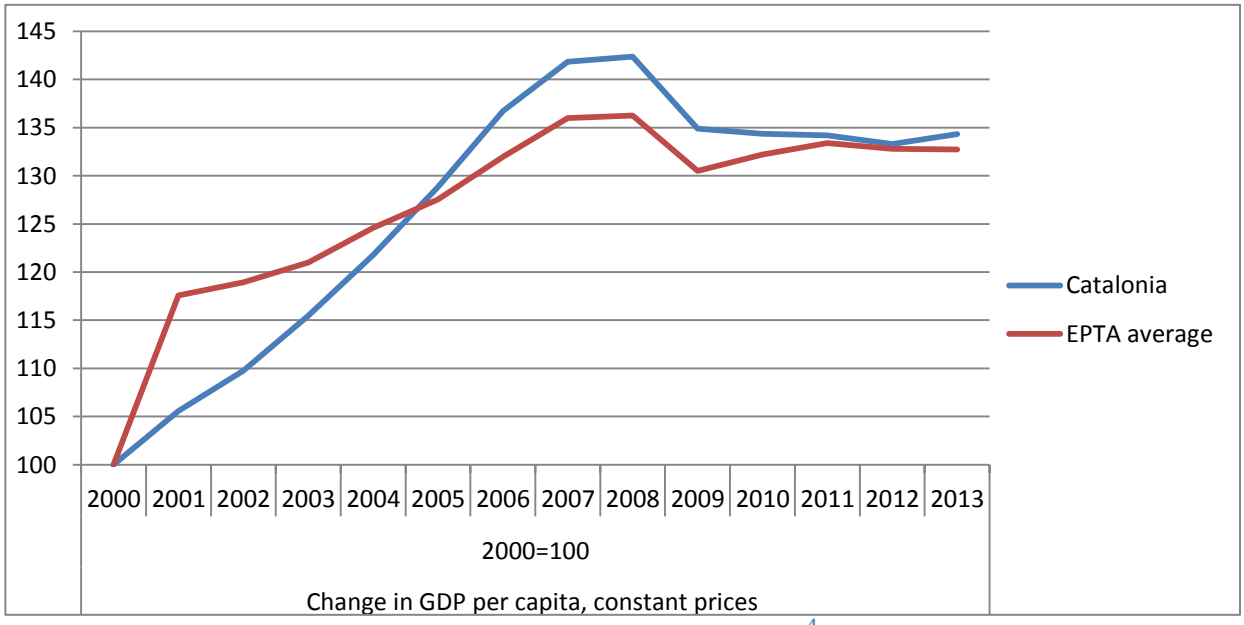


Figure 1: Change in Catalan GDP per capita compared to the EPTA average.[4]

[4] Source: OECD (http://stats.oecd.org/index.aspx?queryid=559); and IDESCAT (Statistical Institute of Catalonia) for the figure of Catalonia. http://www.idescat.cat/economia/inec?tc=3&id=8151&lang=en).

Total factor productivity (TFP) by components. Variation in volume (%).
Catalonia

	TFP	GDP	Labour factor	Capital factor	Labour contribution	Capital contribution	Capital-labour ratio	Labour productivity	Capital productivity
2013	1.4	-0.5	-3.3	-0.4	-1.8	-0.2	2.9	2.7	-0.2
2012	1.4	-1.3	-4.7	-0.1	-2.6	0	4.7	3.5	-1.2
2011	1.1	-0.2	-2.6	0.3	-1.4	0.1	2.9	2.4	-0.5
2010	1.3	0.2	-2.8	1	-1.5	0.5	3.8	3	-0.8
2009	-2	-4.5	-7.2	3.2	-4	1.4	10.4	2.7	-7.7
2008	-1.8	-0.2	0.1	3.5	0.1	1.6	3.4	-0.3	-3.7
2007	-1	2.7	3.1	4.4	1.7	2	1.2	-0.4	-1.7
2006	0.2	3.7	3.1	4	1.7	1.8	0.9	0.6	-0.3
2005	0.4	3.8	3.2	3.6	1.7	1.6	0.4	0.6	0.2
2004	0.1	3.1	2.2	3.8	1.2	1.7	1.5	0.8	-0.7
2003	0.7	3.7	2.3	4	1.2	1.8	1.7	1.4	-0.3
2002	0	2.5	1.3	4	0.7	1.8	2.7	1.2	-1.5
2001	0.1	3.1	2.1	4.1	1.1	1.8	2	1	-1
2000	-1.6	3.3	5.5	4.2	3	1.9	-1.4	-2.2	-0.8

[5]

Productivity challenges

1) A low value-added economic structure

The Catalan economy has traditionally been an industrial economy, but in the last few decades industry has lost ground to the service sector as a result of economic development and, among other factors, the expansion of the tourism sector around Barcelona. It has also lost ground to the construction sector as a result of the housing bubble that started in the mid-1990s. Although the excessive size of the construction sector has been adjusted by its contraction during the economic crisis that began in 2008, low value-added sectors still form a large part of the Catalan economy.

An economy with a large proportion of sectors specialized in low value-added activities is an economy in which labour productivity is low. The sectors with higher value-added should form a greater proportion of the Catalan economy. They are areas in which the productivity of labour can increase most because of their capital-labour ratio, the incorporation of technological innovation and the use of more skilled human capital.

[5] Source: Statistical Institute of Catalonia (Idescat) and Catalan Ministry of Economy and Knowledge.
(*) The indexes refer to the evolution of the contribution of each factor to GDP; variations show the contribution of each factor in percentage points of variation in GDP.

www.idescat.cat/economia/inec?tc=5&id=5124

In low value-added sectors that use less advanced technology or that use technology less intensively and have a more standardized production, competition is based on price and they are therefore the sectors most vulnerable to international competition. Productivity gains are essential to gain international competitiveness and market share.

2) **Company size**

Company size is a factor that can have an impact on labour productivity. Small companies tend to have fewer opportunities to incorporate physical capital than large companies and the use of more technology favours labour productivity gains. The Catalan economy, like that of the whole Spanish State, is characterized by a high proportion of small businesses.

According to the figures for 2014, as many as 99.2% of Catalan companies have fewer than 50 employees or no employees (95.4% have fewer than 10 employees or no employees) and such a small scale makes labour productivity growth more difficult.

R&D, innovation and human capital

Levels of research and development of the Catalan economy (the latest figures available, for 2012, place R&D at 1.51% of GDP) are low compared with the European average of over 2%. Greater investment in R&D by both the public and the private sector, the adoption of an innovation, process and product culture, improvements in staff training to suit the needs of businesses and reorganization of working time are factors that contribute to labour productivity growth, which is an important element for the Catalan economy to increase per capita income.

Technology trends and policy initiatives

In 2014, the Government of Catalonia has started to focus on strategic areas of specialization and has developed for the first time a sectorial approach to the Catalan industrial strategy. This approach involves cross-sectorial initiatives to increase competitiveness in seven areas (food, chemicals, energy and resources, industrial systems, design-related industries, sustainable mobility-related industries, health industries and experience-based industries). These initiatives are based on the following general principles of action:

- Alignment with EU industrial policy (the Catalonia 2020 strategy), and especially with the Research and Innovation Strategy for Smart Specialization (RIS3).
- Public promotion-private leadership: companies should be taking the initiative. The Government's task is to support them in adapting to the change of industrial model and to facilitate their activities.

- Selectivity: public promotion should concentrate on projects selected for their ability to drive the whole economy.
- Efficiency: resources must be properly aligned and correctly prioritized for the strategic objectives to be achieved.

The main objectives of three of the instrumental support programmes to improve competitiveness are the following:

1) **Catalan Clusters Programme:** The aim is to boost the competitiveness of the Catalan economy, to systematize the actions of the Government of Catalonia in the area of cluster policy and to help to rationalize the map of clusters in Catalonia.
2) **Business Innovation Programme:** This programme includes actions aimed at increasing innovation rates in Catalonia, promoting innovative companies in Catalonia and their commitment to R&D investment (especially among SMEs) and increasing the instruments of technology transfer of the Catalan innovation ecosystem. It also aims to streamline technology centres and reorient them towards a model with greater critical mass to achieve higher levels of efficiency and better serve Catalan businesses.
3) **Internationalization and Investments Programme:** Year after year, Catalonia is positioned as a magnet for companies around the world that choose the region to set up their production facilities or as a base for operations in the markets of North Africa, Europe and Latin America. This dual nature has so far shown good results that should be maintained and consolidated in order to position Catalonia and Catalan companies on the world stage. Work is being done to strengthen companies and to foster the internationalization of the Catalan economy, while ensuring an economic return by fostering the growth of Catalan companies through internationalization: foreign trade, investment and technology and attracting and increasing productive investments by international companies in Catalonia.

Three Catalan trending topics on productivity

The business fabric of Catalonia is characterized by its strong diversification, with no branch of activity in industry (except food) exceeding 15% of industrial GVA. Given this diversity, we list three of the seven strategic areas in Catalonia that make up the sectors of RIS3CAT and the Industrial Strategy for Catalonia. Each of these areas or industries will have a specific plan of actions aimed at implementing long-term projects through agreement with the private sector.

a) Chemicals, energy and resources: Activities with higher value-added and innovative content, such as energy efficiency, cogeneration, home automation and renewable energy.

The businesses involved are becoming increasingly aware of responsible energy consumption and the green economy and have generated a significant network of innovative companies.

Companies in the waste sector are world leaders and others have experience in managing water resources in times of scarcity and seasonality.

Waste treatment emphasizes prevention, recovery, recycling, valorisation and minimizing different types of waste. Catalonia has the potential to become a hub for knowledge on smart solutions and is preparing to adapt new technologies to these markets. Some negative external factors (growth of the property market, the constantly changing legal framework of energy, and falling infrastructure investments) can be converted into future opportunities for local industry and on international markets.

b) Food: This includes the whole value chain, from the primary sector and primary processing to distribution, retailing and catering, and including the traditional food industry. The food industry has shown a positive trend in recent years as a result of creating more direct links with consumers. It has also improved operational efficiency and cost optimization by integrating backward production and improving production efficiency, logistics, product differentiation, and expansion in international markets.

c) Sustainable mobility: Businesses are increasingly determined by the regulations of the environment, by schemes to deter the use of private vehicles, by promotion of public transport (the train is becoming very important), and by the complex growth of urban logistics, mainly due to the expansion of e-commerce and capillary distribution. People are adopting the concept of sharing rather than ownership. Mobile technology is creating new business models. Catalonia has a territory and cities with a prominent position in the concept of smart mobility and a great opportunity to position its industry at the forefront of smart, efficient and sustainable mobility.

Denmark

Danish productivity

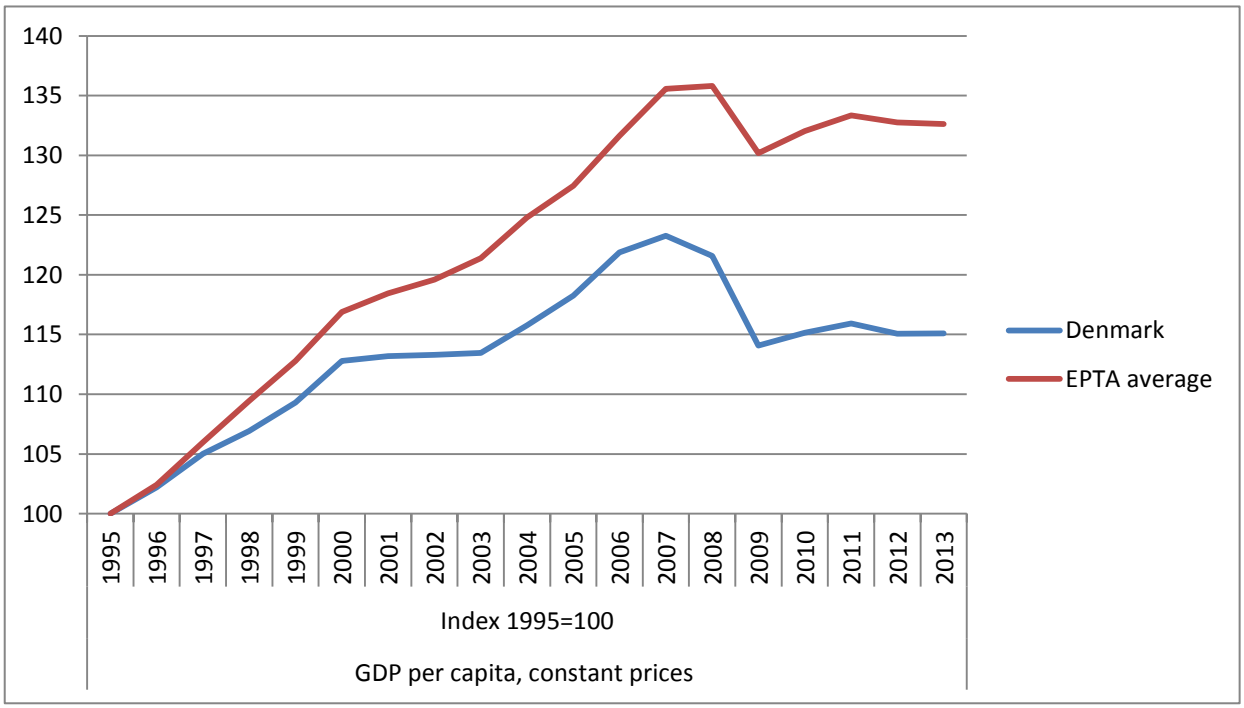
Productivity in Denmark (measured as growth in productivity/hour) was stagnating in 1990 and has been decreasing since then. Growth in GDP stagnated with the financial crisis and has had a very little increase thereafter. It has therefore during the last decade been seen as a main problem for future Danish welfare that the growth in productivity is low.

However, The Danish Economic Council has just released its status on the Danish economy, which signals the different viewpoint that hourly productivity and value-production per hour needs to be seen as a whole, and in that light Danish productivity does not seem problematic. The background is that Denmark produces high-value products and those parts of the production that delivered the lowest hour-productivity have been eradicated during the crisis. Danish companies in average produce a value of 60 USD/hour, which is among the highest levels in the world. OECD in 2013 gave Danish reform policies good grades with regard to their probable positive effect on future productivity.

Nevertheless, it has been and is still an issue in Danish politics to increase the Danish productivity.

According to the financial report 2014 from the Danish Ministry of Finance the productivity per hour has grown with 1%/year since 1995, which is regarded as low. It is especially in business areas, which do not meet international competition that low productivity increase is seen. This puts burden upon other production areas because of unnecessarily high domestic prices and drainage of the labor force.

Danish productivity can potentially be increased in all sectors. But especially the service sector is interesting because of its high proportion of the national product and because of its relative detachment from international competition. An increase of 1% productivity in the service sector will turn out as a 0.5% increase in Danish GDP, as compared to a 0.1% GDP increase a similar productivity expansion in the industry sector.



Change in Danish GDP per Capita, compared to the EPTA average.

Productivity challenges

Competition and effective regulation

Because of the potential in areas, which are detached from international competition, it is necessary to increase the domestic competition and ensure smooth regulation in order to avoid excess bureaucracy. These are issues that have been extensively treated by the Danish Productivity Commission (more on this below).

Increase in education and competence

In general, Denmark has a main global competitive advantage in a well-educated work force. However, shortening the time used for education, increasing the quality of educations, and targeting educations more towards the need of Danish enterprises will ensure or expand this competitive advantage in the future.

Investments in new technology, machinery and research/innovation

Very good examples of significant increase in productivity have been seen in connection to automation in Danish industry in recent years, and the potential in this area seems large because of a highly specialized and technically advanced Danish industry. The investment situation, however, hinders this development because of cautiousness in investments since the financial crisis – by the industries themselves and by investors. 75% of all industrial research investments are made by 10 companies – so there is a great potential in increasing the research and innovation activities in the large group of small and medium sized companies, which produces 60% of the value in the industrial sector.

A more effective public sector
Before the financial crisis a main problem in Denmark was lack of skilled labor. Some therefore see a main challenge in shrinking the use of labor in the public sector, thereby making more labor available for the private sector. To this comes that a decrease of spending in the public sector will make it easier for Denmark to ensure financial stability in the future and increased productivity is seen as a means for achieving that goal.

Policy initiatives

The Productivity Commission
The Danish Government established in 2012 a Productivity Commission, which was to scrutinize Danish productivity development and make recommendations to strengthen the productivity in Danish business and the public sector. The Commission had 9 members of which 8 were economists and one a political scientist. It ended its work in March 2014. The Commission has made a long list of recommendations, which largely focus on economic frame conditions (e.g. tax, public-private-partnership), increased competition, reduced bureaucracy, and the education system.

The outcomes of the work of the Commission have been received with lukewarm enthusiasm by policy-makers. One reason may have been the Commission's obvious reliance on neo-liberalist thinking, which is increasingly subject to criticism in Denmark. Another reason may be that there are very few recommendations for business actors to make use of, since most recommendations are focused on actions at the ministries of finance and economy and their influence on other ministerial areas. Finally, the Commission early on made certain policy recommendations, which were not well received, such as suggesting building large shopping malls close to Danish cities, and which may have reduced the Commission's general impact.

"Reform amok"
An impressive number of reforms have been made by the Government since the beginning of its mandate in autumn 2011 making the Prime Minister state the Government had run "reform amok". The main focus of all reforms has been the future availability of enough skilled labor coupled to reduction of the costs for different forms of social security.

- A tax reform has decreased taxes for high incomes in order to make careers more attractive and increase investments.
- State-supported employment of workers with low productivity has been reduced.
- Access to early pension for handicapped and ill persons has been reduced and an evaluation system been set up to avoid having people fit for a job being on pension.
- The period for social support during illness has been shortened and a closer follow-up scheme on ill persons in employment has been implemented.
- A 'growth package' has been issued, including lower taxes on some commodities and lower taxes for business.

- Education grants have been reduced and have sharper time limits in order to get candidates to the labor market earlier and avoid drop-outs.
- Primary education has received increased education hours/week and teachers have increased work time. Mandatory home-work help will be installed later.
- Social insurance for young people without education has been reduced in order to incentivize towards education.

To this comes a set of initiatives by the former Government, including increase of the pension-age, reduction of support at early retirement, reduced state support for unemployed and lower taxes for business and high incomes.

These reforms have been heavily criticized for being socially skewed and for pressing the work force beyond the limit. Denmark already has a sad record in stress, strokes and suicide among people in employment. However, the reforms have enjoyed strong support from industry, parts of the labor unions, and the OECD.

The role of technology

Innovation or technology

It is interesting that the role of technology as a means to increase Danish productivity has received relatively little attention in the Danish policy debate. The Productivity Commission only touched upon it in rather general terms and none of the many reforms have had a clear focus on the use of technology in the public, service, agricultural or industry sectors. The key word that comes closest to technology is ‘innovation’, mostly used in the sense of producing new marketable inventions. Technology as a key production and optimization means is rarely debated.

The focus on innovation instead of technology is interesting because Denmark has a majority of its exporting companies in agriculture, B-2-B production and in research intensive larger companies (pharmaceuticals, energy-efficient equipment, wind turbines...), which are areas with already well-structured research-innovation chains or with little influence on innovation of the final product. However, in all of these areas increased effectiveness through automation and technological optimization may have a very significant role to play for productivity.

Automation

Denmark in general has a technologically highly advanced industry. However, recent cases have shown that there are options for very high productivity increase connected to even further automation in combination with re-education of the workers. The outcome of this combination has shown to be strong because workers can be converted to highly skilled automat managers taking care of raw material logistics, maintenance and product development implementation. This gives room for faster production and a wider range of product varieties, opening for increased competitiveness and new niches.

Business magazines and newspaper business sections are the main carriers of these cases and examples but they have not yet led to new policies on, for example, investment opportunities. A clear policy on increasing the technological competitiveness in the different production sectors is still to be seen.

Digitization

One area in which technology is clearly seen as a means for productivity increase is digitalization of the public sector. This began already at the end of the 1990's and in 2011 the Agency for Digitization was established with a main agenda of pushing the public sector into close-to-fully digital communication internally and with the citizens. The Digitization Strategy sets up targets for the government, regions and municipalities with regard to services to be fully converted to e-services, secure communication strategy, centralized ICT center for all state institutions, and many more initiatives.

This has placed Denmark as one of the frontrunners in public sector digitization. The business-case of this development is difficult to assess, since it is coupled to a forced reduction of public spending, which makes it difficult to evaluate if the reduced spending comes from increased productivity (digitization; other organizational means) or from reduced quality of public services.

The down-side of this development is that it already has proven to leave a 'B-team' of elderly, low-resource and lowly educated people behind. But also, surprisingly for many, a relatively large proportion of young people give up on digital public services. The up-side, which many people enjoy, is that most contact to the public sector now can be done at any time of the day and without the need for personal contacts with bureaucracy. In average there is little doubt that on the citizens' side there has been an increase in productivity because of digitization.

European Union

EU productivity at a glance

Labour productivity per hour worked is one indicator of the EU economy's competitiveness and ability to ensure prosperity for its citizens over time. Among the factors contributing to labour productivity growth are: technological innovation, improvements in workers' skills and the organisation of work. If GDP grows and the number of hours worked remains stable, the indicator will also rise, indicating the annual increase in the output produced by one hour of work. GDP at constant prices is expressed in PPS, in relation to the European Union average, which ensures the comparability of labour productivity between Member States. Data are collected from reliable sources applying high methodological standards. Restrictions in comparability over time are related to the construction of the indicator as such rather than to shortcomings of data production.

Methods are well documented and explained. Inter-temporal comparability is restricted especially by the use of Purchasing Power Parities (PPP). While PPPs ensure geographical comparability, this may be restricted by the fact that the indicator's labour component (total hours worked) is not yet fully harmonised across countries.

EU productivity challenges and STOA study

2.1 The initial Lisbon Agenda (2000)

The initial Lisbon Strategy was based on the European Council resolution of March 2000, in Lisbon, to turn the EU into the most competitive knowledge-based economy by 2010. The purpose of the Lisbon agenda was to deliver stronger, lasting growth and create more and better jobs in order to unlock the resources needed to meet Europe's wider economic, social and environmental ambitions, thus making Europe a more attractive place to invest and work.

The Lisbon strategy was designed to help Europe address the challenges of an ageing population, as well as the need to increase productivity and the competitive pressures of a globalised economy.

Economic modernisation was at the heart of the strategy for growth and jobs, as a key to maintaining Europe's unique social model in the face of increasingly global markets, technological change, environmental concerns and demographic pressures.

Real labour productivity per hour worked
Euro per hour worked

GEO/TIME	2005	2006	2007	2008	2009	2010	2011	2012	2013
European Union (28 countries)	30,2	30,9	31,3	31,2	30,7	31,4	31,8	31,9	32,1
Euro area (18 countries)	34,8	35,5	36,0	35,9	35,5	36,3	36,7	37,0	37,3
Belgium	45,4	45,8	46,2	46,0	45,3	45,9	45,8	45,7	45,9
Bulgaria	4,0	4,1	4,3	4,3	4,3	4,5	4,7	4,8	4,9
Czech Republic	11,7	12,4	13,0	13,0	12,8	13,0	13,3	13,2	13,1
Denmark	51,4	51,9	52,2	51,1	49,8	52,4	52,5	52,6	53,4
Germany	39,9	41,3	42,0	42,0	40,9	41,7	42,4	42,6	42,8
Estonia	9,2	9,7	10,3	10,0	10,3	10,9	10,8	11,2	11,4
Ireland	44,1	44,6	45,1	45,0	46,5	48,2	50,1	50,4	48,8
Greece	19,8	20,8	21,5	22,2	21,1	20,4	19,9	20,2	20,2
Spain	27,9	28,1	28,5	28,7	29,4	30,0	30,4	31,5	32,1
France	43,6	44,9	44,9	44,4	44,2	44,7	45,3	45,4	45,6
Italy	32,4	32,5	32,6	32,4	31,7	32,5	32,5	32,2	32,2
Cyprus	20,1	20,4	20,8	21,2	21,0	21,3	21,2	21,5	21,6
Latvia	5,9	6,3	7,9	7,3	7,2	7,6	7,9	8,2	8,4
Lithuania	7,7	8,2	8,7	8,8	8,3	9,4	10,1	10,3	10,6
Luxembourg	63,1	63,9	64,9	60,8	59,4	60,0	59,5	58,2	-
Hungary	10,7	11,1	11,1	11,3	10,9	11,0	11,0	11,3	11,5
Malta	15,3	15,5	15,4	15,4	14,6	15,2	14,2	14,5	-
Netherlands	44,7	45,5	46,2	46,2	45,1	46,0	46,1	45,6	45,8
Austria	36,1	37,3	38,1	38,3	38,2	38,9	39,1	39,5	39,9
Poland	8,4	8,6	8,8	9,0	9,1	9,8	10,2	10,4	10,6
Portugal	15,6	15,8	16,1	16,1	16,1	16,7	16,9	17,0	17,1
Romania	4,6	4,9	5,2	5,6	5,4	5,3	5,4	5,4	5,6
Slovenia	18,2	19,3	20,1	20,1	20,1	20,6	21,4	21,3	21,4
Slovakia	10,4	11,0	11,8	12,1	11,8	12,3	12,6	12,8	13,2
Finland	38,4	39,5	40,8	40,3	38,2	39,4	40,0	39,5	39,7
Sweden	42,7	44,0	44,1	43,3	42,3	44,0	44,4	44,9	45,5
United Kingdom	38,9	39,7	40,8	40,3	39,3	39,8	40,0	39,3	39,2

Table 1: Real labour productivity per hour worked (euro per hour worked)[6]

To unlock existing resources in Europe, an initial action plan was agreed by all EU Member States. It comprised investing more in young people, education, research and innovation to generate wealth and provide security for every citizen; opening up markets; cutting red tape; investing in modern infrastructure to help enterprises grow, innovate and create jobs; developing a skilled entrepreneurial workforce; ensuring a society with high levels of employment, social protection and a healthy environment.

2.2 The renewed Lisbon Agenda (2005)

The mid-term look at the Lisbon strategy in 2005 showed the outcomes to be somewhat disappointing, particularly with regard to employment, so the Council modified it to focus primarily on creating growth and jobs. In order to give the strategy some fresh momentum the European Commission set up in 2005 a simplified coordination procedure and a focus on the National Action Plans (NAP). The emphasis was no longer on long-term targets (of which the

[6] Source: Eurostat:
-http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/nama_esms.htm
-http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/tsdec310_esmsip.htm

only one to be retained was the figure of 3% of GDP to be devoted to research and development by 2010), but shifted in favour of the urgent action needed in the Member States.

2.3 The Europe 2020 strategy (2010)

In the past 2000-2010 decade the Lisbon Strategy has proved to be the European Union's most relevant strategic action and development plan. Although its ambitious goals are far from being fully achieved in its ten-year life cycle, its contribution to progress in different areas of EU economic development and social cohesion was considered to be relevant and there is no doubt that Lisbon type reforms need to be continued in the 2010-2020 decade. The importance of constructing a new economic model for the EU has become evident following the economic crisis, which pointed towards numerous structural weaknesses in the member state economies. Therefore the new "Europe 2020" project, launched in March 2010, focused particularly on finding an adequate response to the on-going challenges by assigning greater value to themes such as knowledge and innovation, low carbon economies, higher growth, employment and social cohesion.

Europe 2020 is about more than just overcoming the crisis from which our economies are now gradually recovering. It is also about addressing the shortcomings of our growth model and creating the conditions for a smart, sustainable and inclusive growth.

Five headline targets have been set for the EU to achieve by the end of 2020. These cover employment; research and development; climate/energy; education; social inclusion and poverty reduction.

The objectives of the strategy are also supported by seven 'flagship initiatives' providing a framework through which the EU and national authorities mutually reinforce their efforts in areas supporting the Europe 2020 priorities:

Smart growth initiatives

- Digital agenda for Europe
- Innovation Union
- Youth on the move

Sustainable growth initiatives

- Resource efficient Europe
- An industrial policy for the globalization era

Inclusive growth initiatives

- An agenda for new skills and jobs
- European platform against poverty

In March 2014, the Commission published a Communication taking stock of the Europe 2020 strategy, four years after its launch. In May 2014, a public consultation feeding into the midterm review of the Europe 2020 strategy is launched until 31 October 2014.

2.4 Country specific recommendations for the period 2014-2015

In March 2014, the European Commission released country-specific recommendations for 2014-215 to meet the Europe 2020 objectives. They have been made to 26 countries (excluding Greece and Cyprus, which are implementing economic adjustment programs) and are based on the progress achieved since 2013. The main conclusions are:

1) Growth has returned, including in most of the countries affected by the crisis. Only Cyprus and Croatia are expected to see their economies shrink this year and, by 2015, all EU economies are expected to be growing again.

2) Public finances continue to improve. In 2014, the aggregate budget deficit of EU countries is expected to fall below the 3% of GDP limit for the first time since the crisis hit. The Commission recommends that Austria, Belgium, the Czech Republic, Denmark, Slovakia and The Netherlands exit the Excessive Deficit Procedure, which will bring the number of countries still in the Excessive Deficit Procedure down to 11 (from 24 in 2011).

3) Reforms in the most vulnerable countries are paying off. Ireland exited its financial assistance programme in December 2013, Spain in January 2014 and Portugal in May 2014. Greece is forecast to return to growth in 2014, while the situation in Cyprus has stabilised. Thanks to its determined pursuit of economic reforms, Latvia was able to join the euro in January.

4) Rebalancing is taking place, with current account positions improving in a number of countries. In March 2014, for the first time since the Macroeconomic Imbalances Procedure was introduced, the Commission concluded that two countries (Denmark and Malta) are no longer experiencing imbalances, and that Spain was no longer in a situation of excessive imbalance.

5) The outlook is for a modest rise in employment from this year onwards and a decline in unemployment to 10.4% by 2015, as labour market developments typically lag behind GDP by half a year or more. Major reforms to improve the resilience of the labour market have been introduced in several Member States, including Spain, Portugal, Italy and France.

6) The recovery is still unevenly spread and fragile and structural reforms of our economies need to continue, specifically:

- To tackle high unemployment, inequality and poverty
- To shift to jobs-friendlier taxation
- To boost private investment
- To make our economies more competitive
- To bring down debt.

2.5 EC Advanced Manufacturing Task force

The mission of the Advanced Manufacturing Task Force of the European Commission is to coordinate Union efforts to increase the competitiveness of Europe's manufacturing industry. It aims to do so by fostering the development, and speeding up the market uptake of European advanced manufacturing technologies by industry. Advanced manufacturing includes all production solutions that can improve the productivity (production speed, operating precision, and energy and materials consumption) and/or to improve waste and pollution of manufacturing production both in traditional sectors and emerging industries. The task force published its recommendations on 19/03/2014. It presents an overview of measures taken recently to foster the adoption of advanced manufacturing by European industry in order to increase its competitiveness.

In order to foster the development and adoption of Advanced Manufacturing for Clean Production technologies by European industry, the Task Force has focused so far on three main lines of action:

1. Accelerating the commercialisation of advanced manufacturing technologies.

- Promoting public private partnerships to enable faster commercialisation
- Bridging the gap between research and the market in advanced manufacturing

2. Removing obstacles to demand for advanced manufacturing technologies.

- Strengthening the cooperation with the European Investment Bank
- Integrating advanced manufacturing in regional strategies when appropriate
- Promoting process innovation and clean production technologies
- Strengthening industry' involvement in the implementation of the Energy Efficiency
- Innovative incentive schemes in advanced manufacturing in line with EU State Aid
- Enhancing cooperation with European standardisation organisations on advanced manufacturing
- Implementing State aid modernization

3. Reducing skills shortages and competence deficits.

- Addressing skills shortages in advanced manufacturing
- Strengthening links between industry, education and training institutions
- Promoting the diffusion of workplace innovation in advanced manufacturing

The line of action on advanced manufacturing has been explicitly welcomed by the European Parliament.[7]

2.6 STOA Technology Assessment Project (launch: October 2014)
Impact and potential of collaborative Internet and additive manufacturing technologies
Will crowdsourcing, open data and 3D printing revolutionise the industrial society?

The Internet is allowing virtual communities to easily co-create digital assets and intellectual content at a very low "cooperation cost". The ideology behind the open-source software development methodology has actually spread to new domains such as open data, open design and open innovation. A new set of Internet tools and services is now available to leverage the "wealth and the wisdom of the crowd". Complex projects can be crowd-sourced and crowd-funded by small and medium-sized companies to reduce their cost of doing business. The "crowd" itself uses and modifies "open data" to "co-create" new open designs for the purpose of participating in "crowdsourced" projects.

On the other hand, additive manufacturing technologies are breaking through. Thanks to the rapid advances in 3D printing, 3D scanning, robotic and contour crafting technologies, it starts to be possible to build, from digital data, cheaper objects (large or small) using much less material than if manufactured traditionally using subtractive manufacturing industrial technologies. New object designs are possible that possess innovating physical properties impossible to obtain otherwise. If 3D printing technology continues to develop, it will be possible to 3D print some objects "just in time" and "locally" using "digital designs' co-created by many users, and downloaded (legally or illegally) from the Internet. Labour, transport and storage costs might be dramatically reduced, hence further contributing to the potential emergence of a "new industrial" era.

On the payment side, the development of the use of crypto-money such as BitCoin might disinter mediate banks, credit-card companies and other central players in the payment business, making financial traceability and identity tracking harder to achieve for law enforcement and fiscal purposes.

The long term combination of all these technologies may revolutionise the industry and the global economy given the potential productivity gains that may result from it. The objective of this foresight study is to analyse what could be the combined and long-term effect (10 years) of these technologies on the global economy and on the manufacturing and services industry in particular, and to propose policy options to address the challenges identified and

[7] See the Resolution of 15 January 2014 on reindustrialising Europe to promote competitiveness and sustainability: http://www.europarl.europa.eu/sides/getDoc.do?type=TA&reference=P7-TA-2014-0032&format=XML&language=EN

leverage the corresponding opportunities. A workshop will take place on 27 January 2015 and the final report will be published in June 2015.

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EU policy initiatives and studies

- The Lisbon Strategy 2000 – 2010: An analysis and evaluation of the methods used and results achieved, EP Policy Department A, 2010.
- PREDICT 2013 REPORT: An Analysis of ICT R&D in the EU and Beyond, IPTS, JRC/EC
- Output, Input and Productivity Measures at the Industry Level: The EU KLEMS Database
- The Macroeconomic Effects of the Single Market Programme after 10 Years, EC
- A vision for the internal market for industrial products COM(2014) 25 final, EC, see for instance section 2 for the impacts of EU law on industrial growth
- Competitiveness report 2013: no growth and jobs without industry, EC
- COM(2014) 339 final: Research and innovation as sources of renewed growth
- Mission Growth: Europe at the Lead of the New Industrial Revolution, *Communication For a European industrial renaissance*, (with SWD/2014/014 final) and the EU Industrial Structure, Report 2013, EC.
- European Parliament: Resolution Renaissance of Industry for a Sustainable Europe (RISE) Strategy (15 Jan 2014).
- Mapping the Cost of Non-Europe, 2014 -19, EPRS, 2014
- How can European industry contribute to growth and foster European competitiveness? Study, EP Policy Department A, 2014
- Policy paper 39: Output and Productivity in the Education Sector, INDICSER project,
- December 2012, see also other policy briefs (healthcare, employment, etc.)
- SERVICEGAP Discussion Paper 50 *Productivity and its drivers in service industries: Synthesis*
- SERVICEGAP Discussion Paper 45 *Growth and Productivity in EU Services Sectors*
- SERVICEGAP Discussion Paper43 Innovation and Productivity in Services: The Role of Organisational Capital and IT.
- Closing the US-EU productivity gap: Knowledge assets, absorptive capacity, and institutional reforms, VOX, 25 April 2014
- European economy 2014, Energy Costs and Competitiveness, EC
- The Cost of Non-Europe in the Single Market for Energy, EPRS, 2013. See all the related EP cost of non-Europe studies here.
- The knowns and unknowns of productivity: What explains the long-standing productivity gap between the UK economy and the other big OECD economies and what policies might be effective in helping to close it? Centre for Economic Performance (CEP), 2014.
- The UK Productivity and Jobs Puzzle: Does the Answer Lie in Wage Flexibility? - published in the Economic Journal, 2013, 124, 433-452

- What determines productivity performance of telecommunications services industry? A cross-country analysis, Eric C. Y. Nig, Applied Economics, 2012, 44, 2359–2372
- Productivity and economic growth in Europe: a comparative industry perspective, Marcel P.
- Timmer and Robert Inklaar, University of Groningen , International Productivity Monitor, 2011.
- Capturing the ICT Dividend: look at the use of technology to drive productivity and growth, Oxford Economics, 2011.
- Unlocking the ICT growth potential in Europe: Enabling people and businesses, EC study, 2012.
- Raising European Productivity Growth through ICT, ITIF, 2014.
- ICT services and small businesses' productivity gains: An analysis of the adoption of
- broadband Internet technology, Massimo G. Colombo, et al, Information Economics and Policy 25 (2013).

Finland

Finnish productivity at a glance

Strong growth, innovation and structural reforms in the decade preceding the 2008 global economic and financial crisis transformed Finland into one of the world's most competitive economies, ensuring a high level of well-being for its citizens. More recently, however, competitiveness has deteriorated and output has fallen. The big productivity challenge of the Finnish economy is that since 2007 Finland has lost its leading global positions in the electronics and in the forest sector.

Finland had outperformed most comparable countries on GDP growth since 2000, but was hit particularly hard by the 2008 economic and financial crisis. It went through a double dip and output is still about 7% below its late 2007 peak (see Figure 1). More recently, GDP has expanded weakly since 2012 and during the last months the crisis in Ukraine, as well as Russian sanctions, have hit the Finnish agricultural sector and food production especially hard. Foreign demand remains subdued and the economy is undergoing deep restructuring as the electronics and forest sectors collapsed. Weak household income growth and confidence weigh on private consumption and residential investment, while low capacity utilisation and uncertainty holds back business investment. The gradual improvement in the world economy and especially in the European economy will support the recovery, but strong growth will require innovation and gains in competitiveness to revive exports and investment.

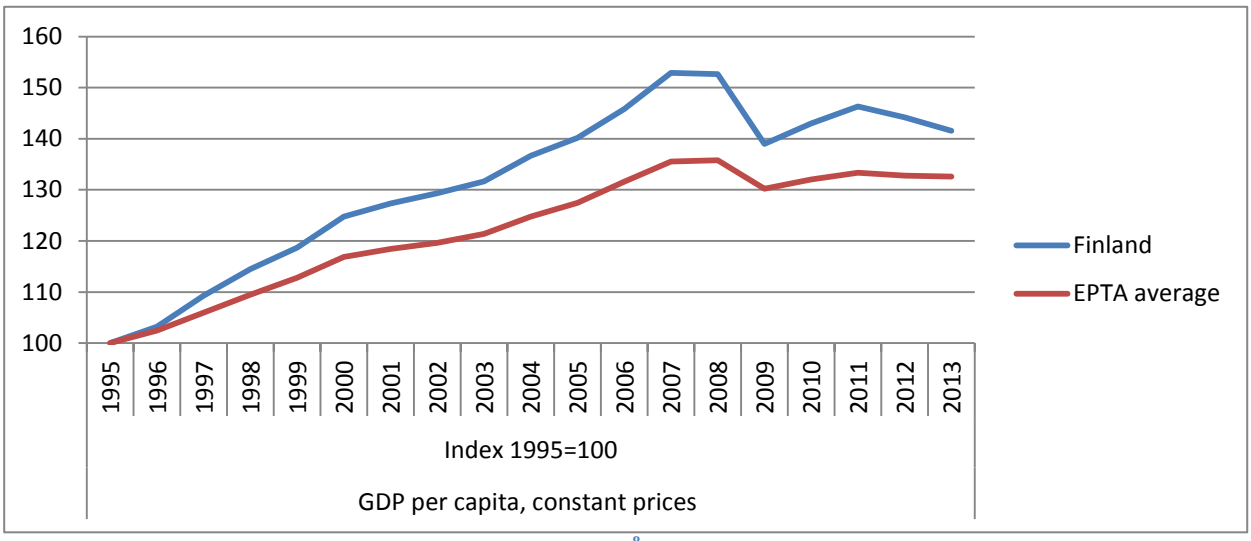


Figure 1: Change in Finnish GDP compared to EPTA average[8]

[8] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

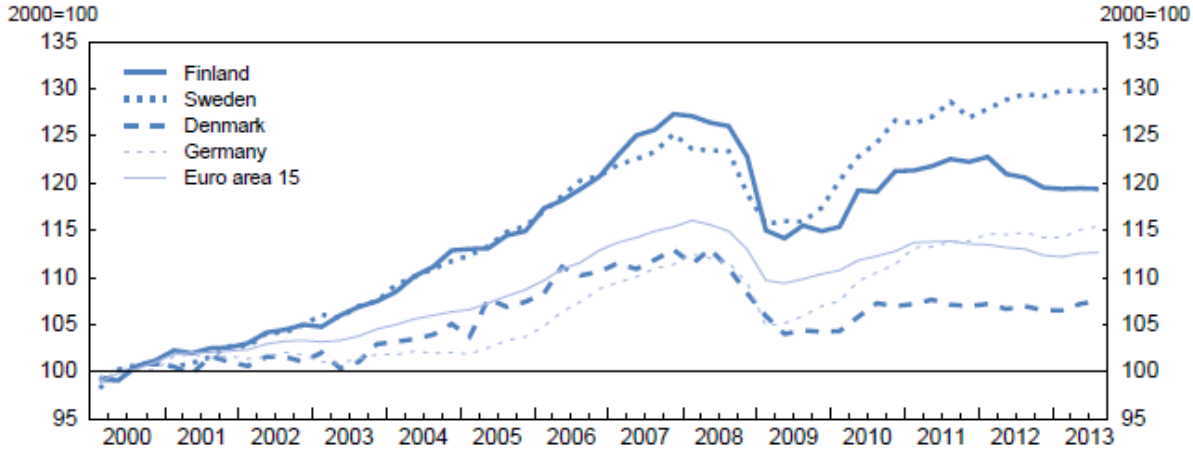


Figure 2: Development of the real GDP in Finland and in some other countries[9].

The positive economic development before 2007 and rapidly decreased productivity in the main export sectors implies that Finland has lost ability to compete in all main components of the cost competitiveness since 2000. Cost competitiveness improves when 1) productivity growth is fast, 2) the growth of labor compensation is slow and 3) the price of value added grows fast (Maliranta 2014). Since 2007, the Finnish development has been bad in all these indicators and the state of the cost competitiveness is now exceptionally bad in the Finnish business sector and in its main industries. Declining tendencies started already before 2008 crisis. Roughly one half of the decline can be attributed to the relatively slow productivity growth and another half to the relatively rapid increases in labor compensation.

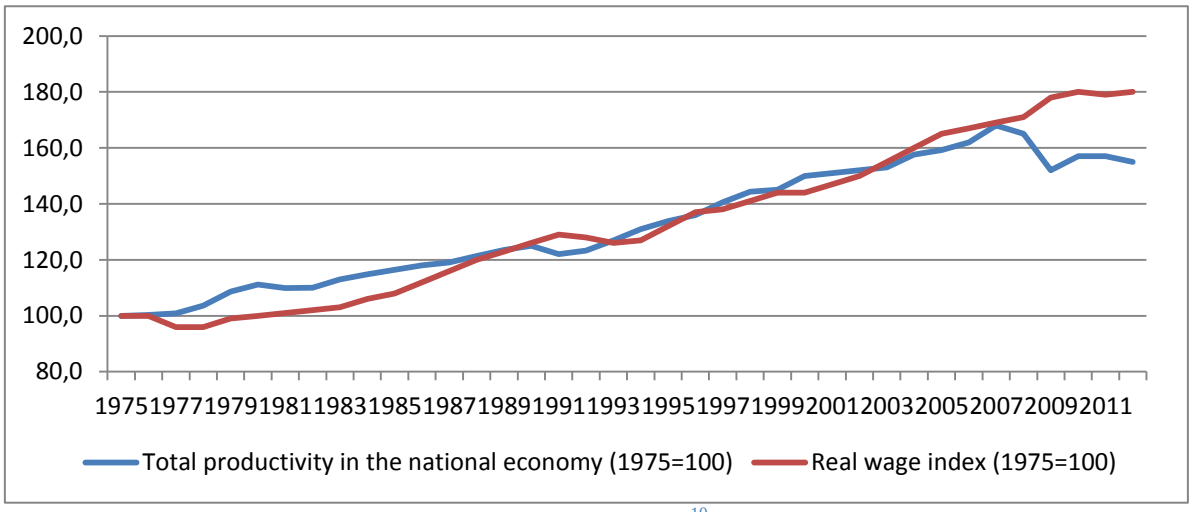


Figure 3: The development of the productivity and wages in Finland[10]

[9] source: OECD Economic Review 2014
[10] source: the Statistics of Finland

Productivity challenges

Important interconnected productivity challenges for Finland are the following:

- Cost/benefit ratio of the Finnish R&D investments has not been good;
- Instead of big companies the focus should be on small and medium size innovative companies

R&D

Since 1990s Finland has invested heavily in innovation. Still in 2013 Finland spent about 3½ per cent of GDP on R&D, which is amongst the highest levels in the OECD. More than two-thirds is funded by the private sector, even though there has been a recent decline in the electronics sector's R&D spending.

After Nokia

Since the year 2000 the cost/ benefit ratio of the Finnish R&D investments has not been good. An explanation is that the traditional production culture of Finland does not function as good as it functioned still in the 1990s. Traditionally the Finnish export has been based on a few big companies.

These firms were in the 1950s and 1960s mostly forest industry firms or firms that produced chemicals or machinery for forest industry firms. They used Finnish subcontractors. Those subcontractors did not have their own foreign customers. Since the 1980s Nokia continued this tradition of large dominating companies. The share of Nokia of the Finnish R&D investments illustrates its past leading role in the Finnish high-tech sector. In the 1990s Nokia invested more in R&D than all Finnish universities.

Just during the five years since 2007 the Finnish electronics sector collapsed with Nokia, falling from 6% of total value added in 2007 to little more than 1% recently. The erosion of the other big company sector - the wood and paper production and the related activities - has been more gradual, but of almost similar magnitude (Figure 3).

A special feature of the Finnish economic situation is that big Finnish companies, especially forest companies, but also some other companies - e.g. the Kone company that is the second largest supplier of lifts to the Chinese market - have been very successful in the international market, but this success has not benefitted the Finnish economy much because the companies have a reduced work force in Finland and do not use as many Finnish subcontractors as before.

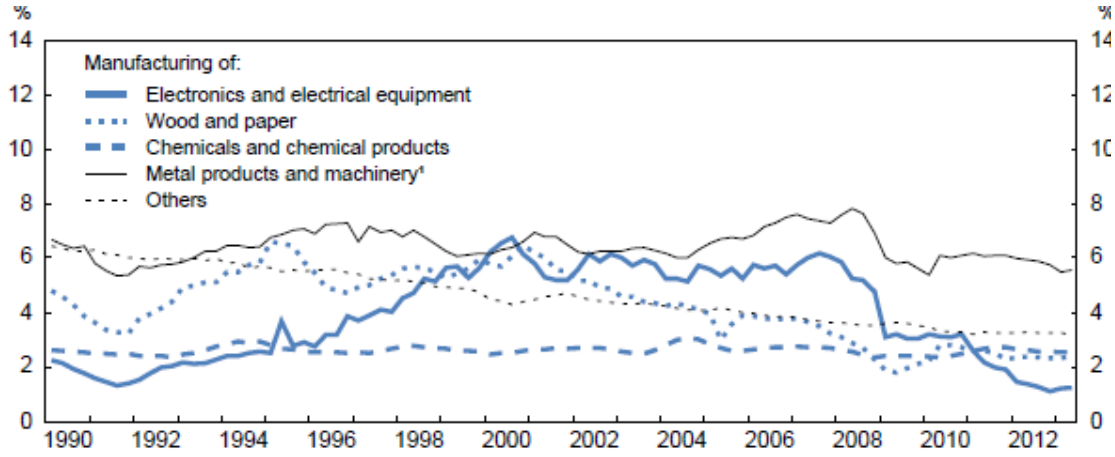


Figure 4: The share of electronics and forest products in output[11]

Small and medium-sized firms

To better productivity, Finland needs first of all innovative small and medium sized firms that can be successful in the global market without large Finnish company partners. This is now generally realized in Finland and it is an explanation for rather broad interest concerning the Radical Technology Inquirer developed in the Committee for the Future.

Policy trends and policy initiatives

Green energy

Based on its large renewable energy and material resources and related skills, Finland has especially good opportunities in the green technologies. Finland, like other Nordic countries, has set climate change mitigation and green growth as strong priorities. The government is using a variety of demand and supply-side instruments to promote energy efficiency, which supplement EU legislation. In particular, energy taxes are based on energy content, CO2 and particle emissions, following international best practice. They have been increased progressively and are high by OECD standards. Feed-in tariffs for electricity produced from renewable energy were introduced in 2011. The share of renewable energy in overall energy production is about a third, one of the highest in the OECD, and Finland is likely to meet its ambitious target of a share of 38% for renewable energy by 2020.

A Policy Initiative: Radical Technology Inquirer

The Radical Technology Inquirer was developed in the Committee for the Future during the years 2012 and 2013. It is a tool that might help small and medium size companies to develop strengths in the global market. Especially it helps the companies to identify updated and in the long term working solutions to the choices between different technological options. In that way it might be an important tool to develop the productivity in Finland. It is not suitable just for Finland. Other countries or even the whole EU might benefit from it. The main content of

[11] source: OECD Economic Review 2014

the Finnish version of the Inquirer is presented in the draft translation and updating of the Inquirer mentioned in the literature.[12]

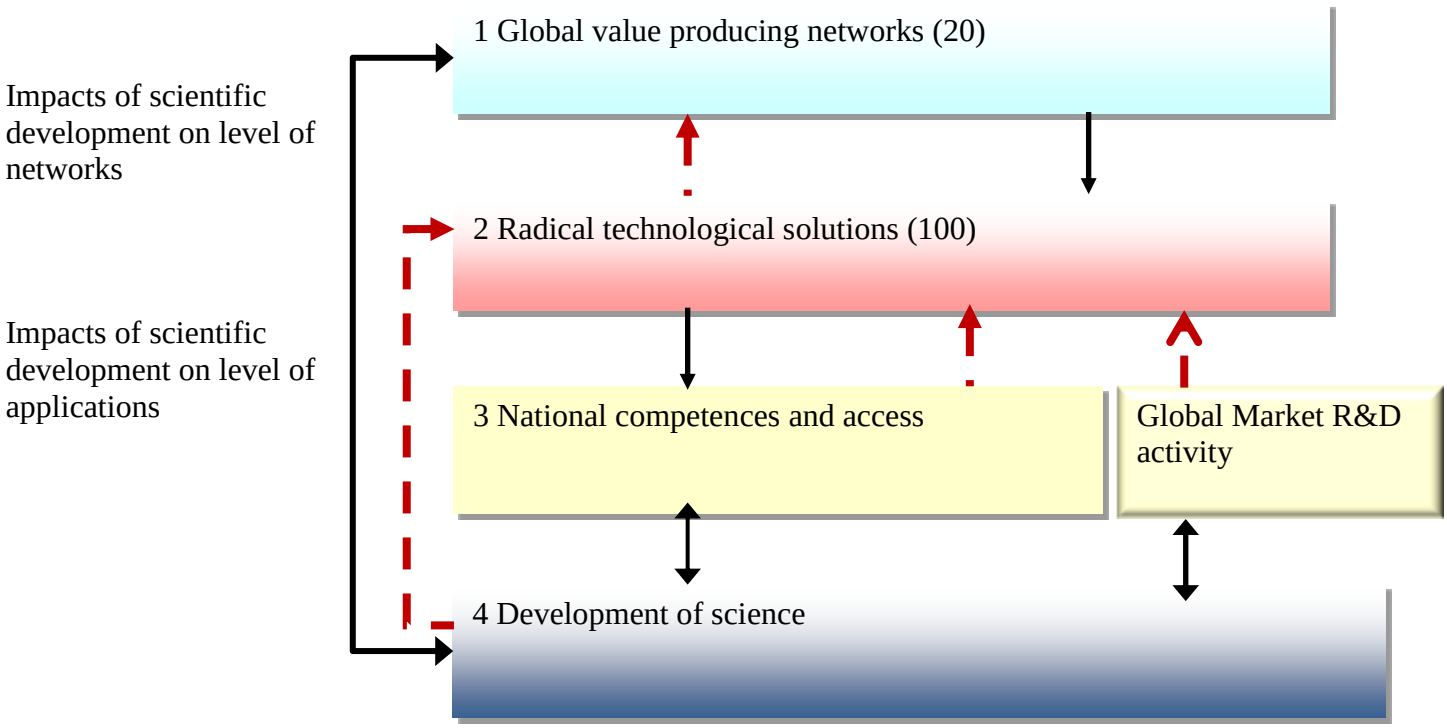
The Inquirer is based on systematic study of open data sources of the Internet, evaluations of experts and crowdsourcing. The first list of 100 promising technological solutions was found based on facilitated Facebook discussion. About 600 persons have registered to the discussion pages. About 100 activists have suggested promising Internet sources of technological breakthroughs. Like extensive technology Delphi studies of NISTEP in Japan[13] or BMBF Foresight 2007-2009 in Germany in 1990s[14] the Inquirer provides an expert based whole picture of future possible promising technological developments. The method is, however, more flexible than those methods in the use of expert information and expert judgments are complemented with rich information of Internet sources. On the other hand, the tool is more systematic in the selection and evaluation of promising technological options than e.g. the Top Ten lists of the MIT Technology Review[15].

Main elements of the method/tool are illustrated below. Its key elements are global value producing networks (20) and promising radical technological solutions or breakthroughs (100). The idea is to evaluate any emerging technological breakthrough based on the anticipated values of 25 indicators: anticipated impacts on the 20 global value producing networks (possible impact values 20,10,5,3,1) ; the anticipated maturity of the breakthrough 2020-2030 (values 1-4); the scientific promise of breakthrough technologies (0-2); breakthrough focused global market R&D activity (0-1) ; (Finnish) national competence in the breakthrough (0-1); and national access to relevant application areas of the breakthrough (0-1). Red arrows in the picture 1 illustrate these ways to evaluate radical technological solutions. Potentially important connections that the model does not take into account explicitly are illustrated with black arrows.

Based on 25 indicators, a list of the 100 most promising technological breakthroughs is built. The most promising 25 get ****, the next 25 ***, the next 25 ** and the rest *. A bit simplified, the star status is based on the sum of the impacts on the 20 global value producing networks that is multiplied with the sum of the values of the other indicators. The pilot evaluations and the implied level list of solutions were made by the authors of the pilot project and the scientific adviser of the Committee for the Future, Olli Hietanen. The impacts on the 20 global value producing networks were ad hoc judgments of four evaluators. The evaluations of the scientific promises of the technological breakthroughs are based on the Science Maps of the Japanese NISTEP institute[16]. The evaluations of global market R&D activity are based e.g. on the recent patenting. The excel-table of the appendix illustrates the evaluation method showing how 28 radical technological are evaluated to the four * groups.

[12] For further information concerning the Inquirer, please contact osmo.kuusi@utu.fi.
[13] http://www.nistep.go.jp/en/
[14] http://www.isi.fraunhofer.de/isi-wAssets/docs/v/de/publikationen/07_Dritter_Bericht_Teil-II_englisch.pdf
[15] http://www.technologyreview.com/
[16] www.nistep.go.jp/HP_E/researchworks/...sciencemap/index.html

The key idea of the tool is that the list of the 100 most promising technological solutions are continuously challenged based on the most recent developments. The challenging can happen from the generic perspective or for example from the point of view of the technology portfolio of some company. There will be a comparative stable generic "basic list" and from various perspectives made special lists. In the generic evaluation of the pilot study, the perspective is global in anticipated impacts on the 20 global value producing networks, in the maturity of the breakthrough 2020-2030, in the scientific promise and in R&D activity. The competence and access indicators are actor dependent even in the generic evaluation. Because the first application of the method was built for the use of the Finnish national technology and science policy, evaluations are made based on Finnish national competences and Finnish national access.



France

French productivity at a glance

A long-term decline of productivity
This decline has been recently analysed by the French Council of economic analysis in a note of September 2014.

This note points out that France has legitimate concerns regarding its long-term growth prospects.

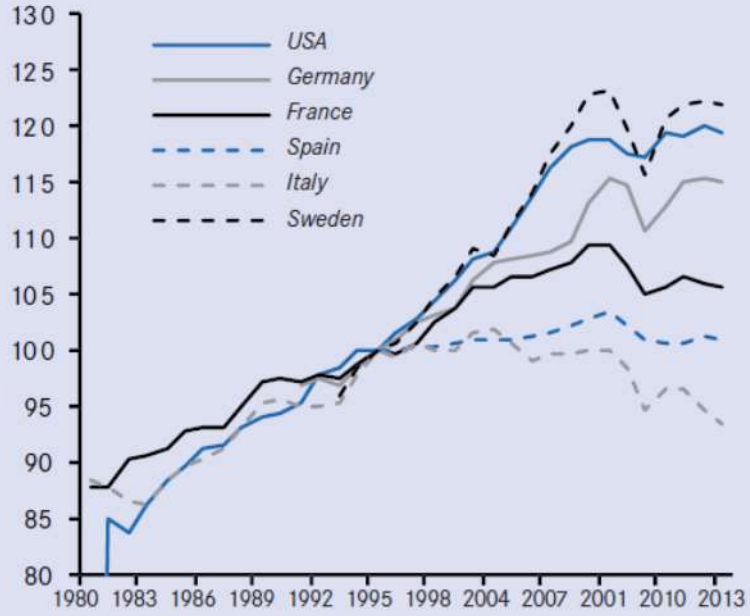
This is due to the decline in productivity gains across sectors, the relative decline in the weight of the manufacturing sector within the economy, the small share of new-technology producing sectors within our economy.

1. Average rate of growth for productivity per capita

	USA	Germany	France	Italy	Sweden	Spain
1971-1979						
• prod. per capita	1.22	2.91	3.28	3.20	1.06	4.06
• hourly prod.	1.68	4.11	4.30	4.34	1.68	4.70
1980-1989						
• prod. per capita	1.37	1.04	1.92	1.98	1.53	2.33
• hourly prod.	1.39	2.07	2.85	1.88	1.20	3.40
1990-1999						
• prod. per capita	2.02	1.67	1.28	1.33	2.56	1.04
• hourly prod.	1.73	2.23	1.84	1.34	2.02	1.08
2000-2013						
• prod. per capita	1.38	0.66	0.67	- 0.27	1.46	0.89
• hourly prod.	1.83	1.18	1.06	0.21	1.71	1.17

This evolution affects labor productivity, defined as production per person or also as production per hour worked. More recently, it has affected total factor productivity.

2. Total factor productivity, base 100 in 1995



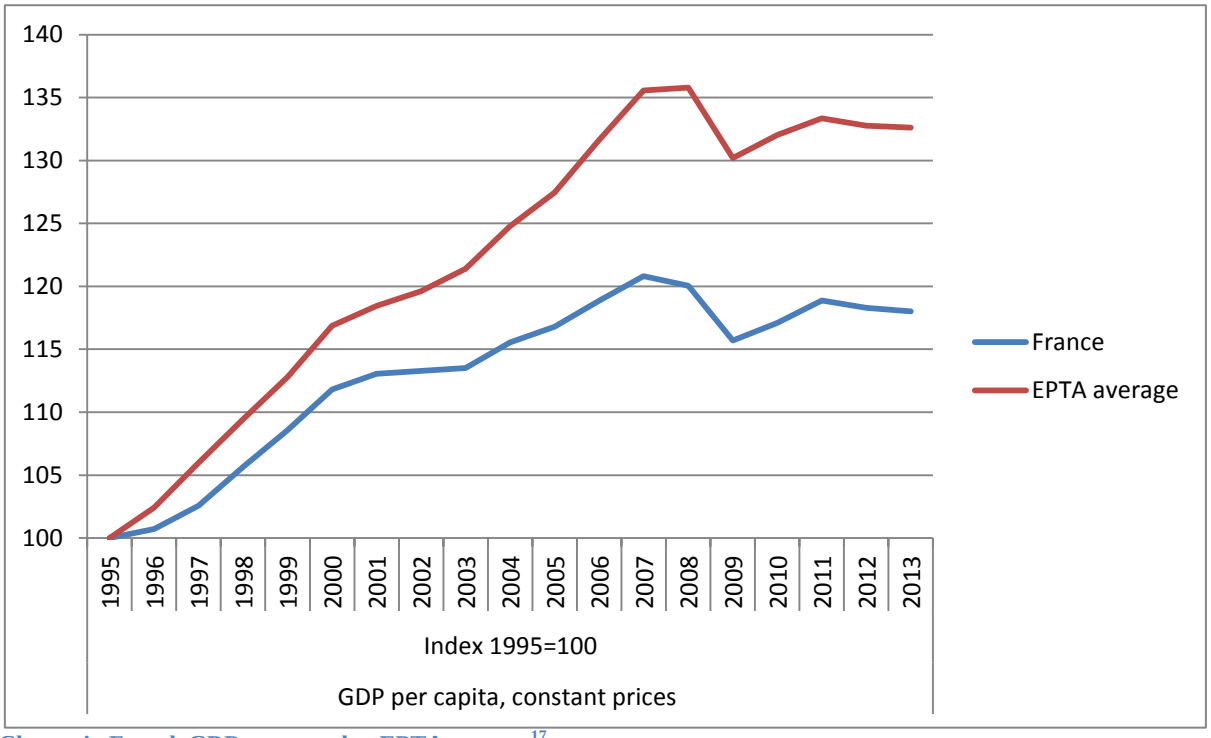
Interpretation: Total factor productivity (TFP) calculated based on a Cobb-Douglas production function with a coefficient of 0.36 on capital (0.64 on labour), *cf.* Lequiller F. and A. Sylvain (2006): *Partage de la valeur ajoutée : éléments descriptifs et comparaison internationale*, 11th Symposium of the 'Association de comptabilité nationale', Paris, 18-20 Jan.

Source: Authors' calculation.

For the French Council of economic analysis, this evolution is mainly linked to the insufficient skills of both young people and adults. It is a matter of concern, as insufficient training is lessening the productivity of employed individuals and of a high number of unemployed young and older people – a phenomenon that continues to be specific to France as opposed to most developed countries. This lack of skilled individuals within the workforce is also an obstacle to heavily investing in the field of sophisticated technologies.

But productivity is only one indicator, the main question being how to promote growth and a sustainable growth.

It appears that productivity, growth and employment in the future will be influenced by long-term tendencies.



Change in French GDP compared to EPTA average[17]

Productivity challenges

These tendencies apply to most developed countries. According to a recent colloquium organized by OPECST on an innovation principle, the main problems to be faced in the future will be: growth of world population, ageing of population in developed countries, climate change, growing urbanization, growing tensions on drinking water, food, energy and raw materials.

Some of these tendencies will have an impact on the capacity to take risks, and then on innovation. Others on the need to find new sources of financing of new activities (linked to the digital economy or to the energy transition). Emerging countries will save less, invest more and will allocate their resources in function of their internal needs, whereas they have in the past contributed to the financing of investments in developed countries.

Schumpeter's analysis of destruction of old activities and old products, and creation of new ones, is confirmed: France is experiencing a period of creative destruction rather than destructive creation: old activities are destroyed, before new ones create as much employment and growth.

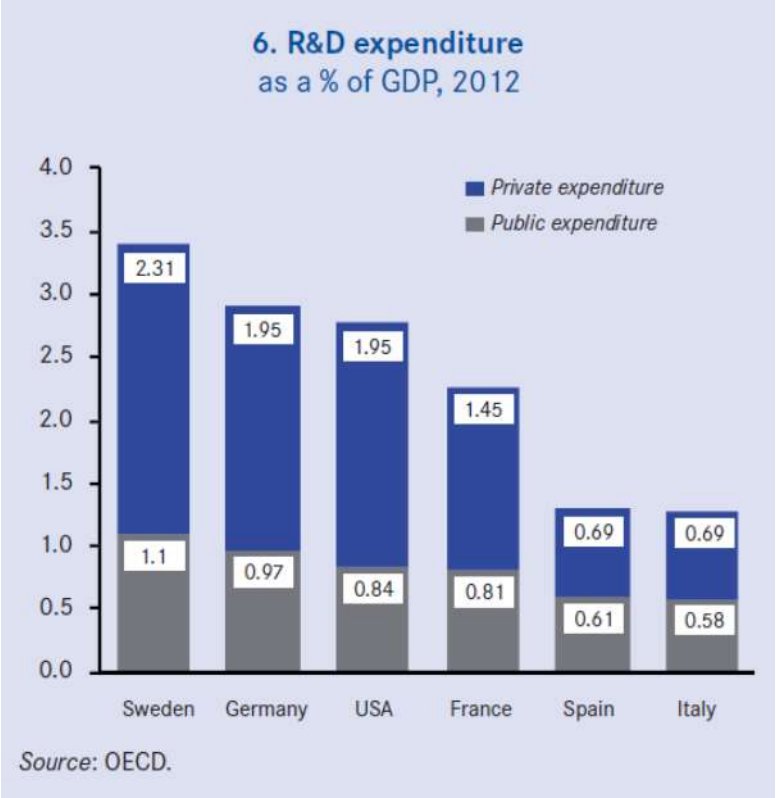
[17] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Policy initiatives

The reduction of the cost of labor, a solution applied in Spain, is not considered by many French economists neither possible nor efficient to implement.

For the French Council of economic analysis, possible solutions are the improvement of the functioning of the labor market, of stimulating competition in the goods and services market, of reviewing industrial policy as well as making public spending more efficient.

For many analysts, France might and should allocate more resources to research and development, and the part of research funded by the private sector should be increased.



For OPECST, this decline of productivity, as well as an insufficient level of growth and an unsatisfactory level of unemployment, can be opposed and reversed only through a dynamic innovation policy. Such a policy is necessary if we want to develop the new products, new technologies and new services that will have an impact on our image and could create a differentiation based on reputation.

The promotion of innovation, a fundamental solution

Two years ago, OPECST published a report of MM. Jean-Yves Le Deaut and Claude Birraux on “innovation at the light of fears and risks”. In June 2014, it organized the already mentioned colloquium on an innovation principle.

The main question is to respond to fears in society, and to control the risks that are linked to any form of economic activity and to the appearance of new products, new services and new processes.

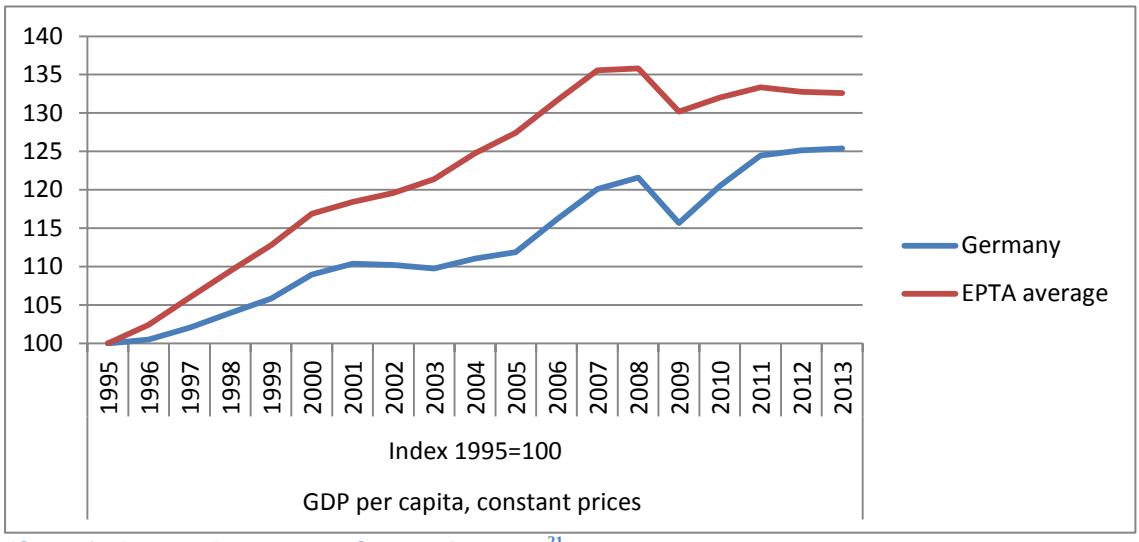
The main policy guidelines promoted by OPECST include the development of capital risk, the help to start-up companies in order to survive the death valley (this special moment in their growth when they have to change the scale of their operations and therefore need new sources of financing; the development of research; another organization of the school system, and of universities; the valorization of research; the development of a more transversal, multidisciplinary and cooperative research; a valorization of PhDs; a better diffusion of scientific and technical culture; a better transfer from research to innovation, thanks to the development of new relations between scientists and engineers.

Some of these policies have already started to be implemented by the ministry of industry (that has defined 34 sectors that correspond to its priorities), and the ministry of Higher education and Research. The law on Higher education and Research, passed a year ago, includes measures proposed by OPECST.

Germany

German productivity at a glance[18]

Despite of the economic crisis which has followed the global financial crisis in 2007-2008 Germany's economy is at the forefront of the European Union with one of the lowest unemployment rates in the Eurozone (5.5 % compared to the OECD average of 7.9 %). Even youth unemployment is at 8.2 %, considerably below the OECD average of 16.2 %. The hitherto remarkably good economic performance heavily builds upon Germany's competitive and innovative manufacturing sector and its export oriented economy (mainly high added value products). In 2013 Germany reached its highest export surplus ever (199 billion euros).[19] Labour productivity in Germany's manufacturing sector has developed positively in the last decade and underpins the international competitiveness of this sector, whilst labour productivity in Germany's service sector does not reach the level of the international champions at all. Labour costs in Germany however are currently at its all-time high, but still below the average of the Eurozone.[20] Despite the positive economic situation in the recent past, Germany is currently facing a number of serious challenges. Growing labour costs, the decreasing rate of productivity which is now clearly below the average of the European Union and the weakening export market foster the recent trend towards GDP contraction. If this trend persists, negative effects on the labour market are presumably inevitable.



Change in German GDP compared to EPTA average[21]

[18] Unemployment rate and labour productivity, Source: OECD Economic Surveys Germany, May 2014
[19] Export surplus, Source: Die Zeit, http://www.zeit.de/wirtschaft/2014-03/deutschland-export-eu
[20] Labour costs, productivity, Source: Trading economics, http://www.tradingeconomics.com/germany/labour-costs
[21] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Productivity challenges

Germany is facing great economic and financial policy challenges. The international competition for knowledge, talents, technologies and market leadership will continue to intensify. Global challenges such as climate change, demographic development, the spread of common diseases, shortages in the global food supply and the finiteness of fossil energy sources require viable solutions. These can only be provided with the help of research and new technologies and through the diffusion of innovations.

Germany's ageing population
Germany has one of the fastest ageing populations in the European Union. Due to a steadily low birth rate, statistical forecasts predict that almost half of the population in Germany will be over 50 and almost a third will be over 65 by 2030. If Germany does not continue to reform its economic and social systems and if it fails to attract the best trained and the most highly-skilled workers of the international labour market, Germany's economic growth rate will presumably decline in the next 20 years to come. This will lead to a socio-economic vicious cycle: while the need for encompassing social and care services as well as the pressure on the pension system are increasing due to the ageing population, the public budget to bear the burden is decreasing due to lower tax revenues. Even today Germany's employers already complain about the shortage of highly-skilled workers and report about problems to find suitable apprentices. Hitherto, labour migration towards Germany is however constrained by its strict policies regarding the recognition of foreign professional and vocational qualifications.

Socio-economic bias in education outcomes
After Germany's "PISA Shock" (Program for International Student Assessment) in 2001, when it became apparent that German pupils clearly performed below the OECD average, German Länder implemented several reforms to improve the quality and the equity of the education system. However, the link between socio-economic and immigrant background and academic achievement still remains. Germany therefore has to continue its educational reform work, yield more effective support and training programmes for disadvantaged pupils, invest more in early childhood education (full-day care is still extremely limited in Germany) and reduce the amount of early school drop-outs. Otherwise the labour market loses an important proportion of potential workers and thereby impairs the already existing shortage of qualified workers in an ageing society.

Demand for new qualification in the manufacturing sector of the future – Industrie 4.0
German factories will be more and more influenced by the two following trends in manufacturing: first, by the integration of software, sensors, and communications in so-called cyber-physical systems («Industrie 4.0») and second, by the additive manufacturing technology (3D printing) challenging the world of mass production. These two trends will require extremely different skills and knowledge from the worker of the future compared to what is needed today. This is mainly because of the expected increased flexibility and

network-style production combining the real and the virtual world. The rigid production lines of the present will disappear and be replaced by transformable production lines and assembly stations. Future workers must be able to work at different assembly stations and understand each step of the production process. Germany's international competitiveness in manufacturing will therefore also depend on whether it manages to adapt its vocational and educational system to the needs of the production of the future in due time.[22]

The "Energiewende" (Transformation of Germany's Energy system)
One of the main societal projects in Germany is the transformation of Germany's Energy system to guarantee nuclear-free energy supply by 2022. For the German production sector, it is of utmost importance that energy prices remain affordable in the phase of transition. Currently, the German government invests intensively in renewables, energy efficiency and grid development (transmission and distributions grids) as well as in R&D concerning these research fields. The success of the "Energiewende" is critical for preserving Germany's economic strength.

Policy initiatives and parliamentary TA-projects

Germany increased its government expenditure on R&D even more than other government spending despite the economic and financial crisis. In absolute figures, Germany spent EUR 75.5 billion and this accounted for 29% of the EU-27 expenditure in R&D in 2011. Germany has made good progress towards achieving the 3% EU-target of R&D expenditure as a share of the Country's Gross Domestic Product (GDP). The respective numbers were 2.80% in 2011 and 2.92% in 2012. Federal and regional governments set themselves the target to spend altogether 10% of GDP on education and research (7% and 3%, respectively 'Qualification Initiative').[23]

Policy Initiatives

The New High-Tech Strategy – Innovations for Germany
The aim of the High-Tech Strategy (HTS) is to make Germany a leader in solving global challenges and to provide convincing answers to the urgent questions of the 21st century. The HTS was adopted in 2006, reaffirmed by the Federal Government in 2009 and expanded into the High-Tech Strategy 2020 in 2010. In September 2014, the HTS was updated to boost more targeted innovation and integration between the research and economic sectors to enable the rapid and efficient commercial exploitation of scientific findings. It will continue to

[22] For further Information to German policy initiatives related to «Industrie 4.0» see http://www.bmbf.de/de/9072.php/ http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf
[23] Research and Innovation Performance Data, Source: European Commission, http://ec.europa.eu/research/innovation-union/pdf/state-of-the-union/2012/countries/germany_2013.pdf

promote exchanges between institutions of higher education, non-university research institutes and companies, and will strengthen the process of knowledge and technology transfer.

This strategy bundles together all of the German government's actions in the fields of innovation and technology policy. The newly updated High-Tech Strategy aims to take effective policy action in six sectors in which particularly high growth is expected: large-scale data processing, security of digital communication, energy storage and transport, medicine and transportation. A comparatively new target will be the strategy's funding for research analysing changes in the workplace due to digitisation. The goal is to improve general working conditions, as well as those in training and continuing education. The Federal Ministry of Education and Research and the Federal Ministry for Economic Affairs and Energy are the two main ministries responsible for designing and implementing the High-Tech Strategy.[24]

Digital Agenda 2014-2017

As an integral part of the high-tech strategy, the German government in August 2014 passed its first "Digital Agenda 2014-2017" bill[25], aimed at helping Germany to become a worldwide leader in expanding high-speed data lines, internet security and fostering cyber-related entrepreneurship. The plan aims at providing nationwide access to fast internet by 2018 and to increase the number of newly established IT firms from the current annual rate of 10,000 to 15,000 per year. Data security complements the government's targets. The federal government will involve the Bundestag, regions (Länder) and municipalities, industry and academia in implementing and further developing the Digital Agenda. The same applies to social partners, authorities responsible for data protection and representatives from the cyber-community. The details on funding the expansion project are not yet specified in greater detail.[26]

Program "Innovations for production, services and work in the future"

The goals of the new programme of the Federal Ministry of Education and Research from 2015 onwards will be the exploration of practicable measures for establishing sustainable conditions for good, secure and fair work by funding R&D projects to stimulate co-evolution of technological and social aspects of work and labour. This shall create generally accepted, scientifically based results from R&D in working life matters and essential knowledge about transfer activities and opportunities deriving from relevant pilot cases. At the same time, implementation and economic valorisation in both big companies and SME will be reinforced. The programme will be supported by the third phase of the federal High-Tech Strategy and

[24] For more information regarding Germany's High-Tech Agenda see http://www.hightech-strategie.de/
[25] For more detailed Information regarding the Digital Agenda see http://www.bmwi.de/DE/Themen/Digitale-Welt/digitale-agenda.html
[26] "German Digital Agenda is better late than never", Source: EurActive.com, http://www.euractiv.com/sections/innovation-enterprise/german-digital-agenda-better-late-never-307876

the Digital Agenda. It will be co-financed by the European Social Fund (ESF) and is part of the operational programme established by the ESF.[27]

Current parliamentary TA projects

With the start of the new working period 2013-2018, the Office of Technology Assessment at the German Bundestag (TAB) has commissioned several TA projects related to analysing the potentials of new productivity and technology related developments. Reflecting some of the currently debated topics and policy initiatives regarding the increase of productivity through digitization in production, workplace and education environments, TAB initiated four specialised TA projects focusing on opportunities and threats of mobile and digital communication of the workplace, 3D printing, data mining and digital media in education.

Opportunities and risks of digital and mobile communication at the workplace
The aim of this TA project is to illustrate the impacts of digitization on the nature and quality of employment relationships and the associated potentials and problems for employees and companies in Germany. Furthermore, an analysis is to be conducted into whether and how existing labour law can and must be further developed in order to adapt to the new working environments and the resulting changes in the nature of work. A horizon scanning is planned to identify options and limits with regard to the workplace digitization and the associated follow-up factors with particular reference to knowledge-based small and medium-sized companies. The intention of the TA study is to identify what policy framework conditions and prerequisites have to be created in order to cope with the changes in the working world.

TAB-project 3D printing
The aim of this TA project is to examine the technological, social and legal aspects of the further development and widespread diffusion of additive manufacturing processes (3D printing). Safety and security aspects are also to be addressed in order to anticipate the possible safety and security hazards of these new technologies and to discuss options for action and regulation in dealing with them. The project is divided into two parts. The first part will consist of an extensive horizon scanning with the goal of determining the prospective range of operations and specific application fields or potential uses of additive manufacturing processes and, on that basis, then identifying potential positive and negative consequences for industrial and commercial sectors (trades, retail, transport etc.). The horizon scanning results will be used to identify main themes which will be addressed in depth in a second part.

[27] For more information about this programmesee http://www.bmbf.de/en/398.php

Data mining– social and legal challenges

Based on two case studies, this TA project presents, discusses and analyses, legal, ethical, political and socio-economic issues raised by data mining. The first case study will examine the use of data mining techniques in medicine and healthcare, which particularly involves the use of personal health data. The second case study is to address the use of data mining methods in performing public-sector tasks, with particular reference to the use of geodata for observing and monitoring various processes on Earth (e.g. meteorological services, environmental changes, surveillance of public spaces). In addition to the case studies, important international TA studies and public discourse and participation processes on data mining will be evaluated to obtain an overview of the debate, activities and assessments in other countries.

Digital Media in Education

The importance of digital, increasingly internet-based information and communication systems ("digital media") in education and training is growing constantly. This TA study will on the one hand examine the access and use requirements as a substantive precondition in enabling educational opportunities to be taken up and on the other hand, it will look at issues relating to appropriate media literacy, new educational forms, but also data protection and personal rights. Further investigations are planned into the issue of new digital media related education policy and the need for regulation in the individual education spheres. Finally, options for policy-related action in the education sector are to be identified.

Greece

Greek productivity at a glance[28]

The level of per capita GDP of the Greek economy has remained below that of the EU-15 (as well as of the Euro area) over time (Figure 1). However, the advent of the recent crisis worsened the position of the Greek economy, as the growth rates of per capita GDP have been particularly negative (Figure 2). The main reasons for the relatively low productivity of the Greek economy can be attributed to the low technology diffusion across most sectors of the Greek economy, as well as the low intensity of innovation activity. However, it is expected that after the implementation of several structural reforms that favor entrepreneurship and competition in the markets, productivity will start growing.

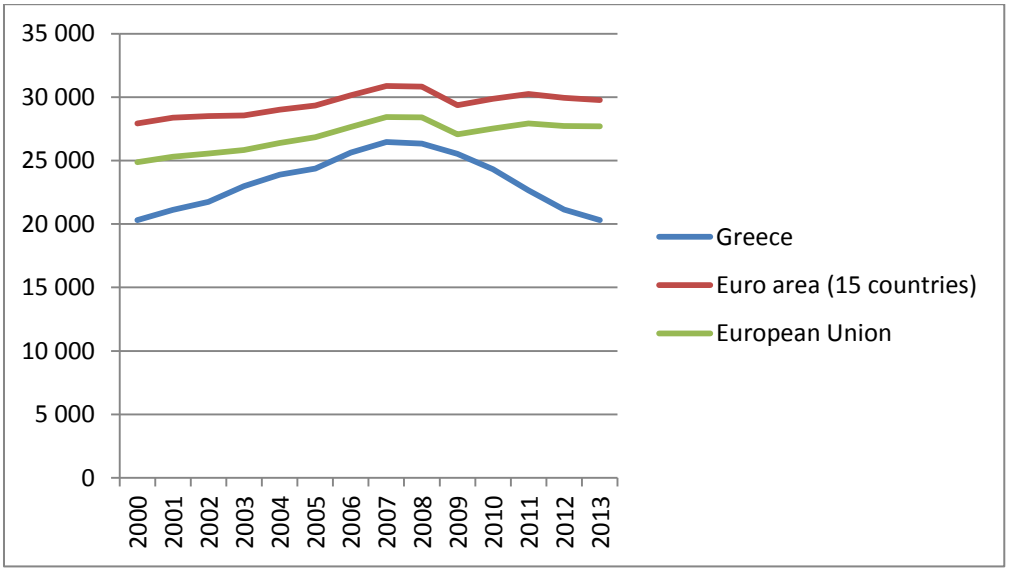


Figure 1: GDP per capita (2005 PPP, dollars)[29]

[28] This report has been prepared from Sotiris Papaioannou, Research Fellow at the Centre of Planning and Economic Research. Special thanks to Fotini Economou and Alexandra Kontolaimou (Research Fellows at KEPE) for their valuable contribution in writing this report.
[29] Source:OECD, http://stats.oecd.org/Index.aspx?DataSetCode=PDB_GR# See also: http://www.oecd.org/std/productivity-stats/

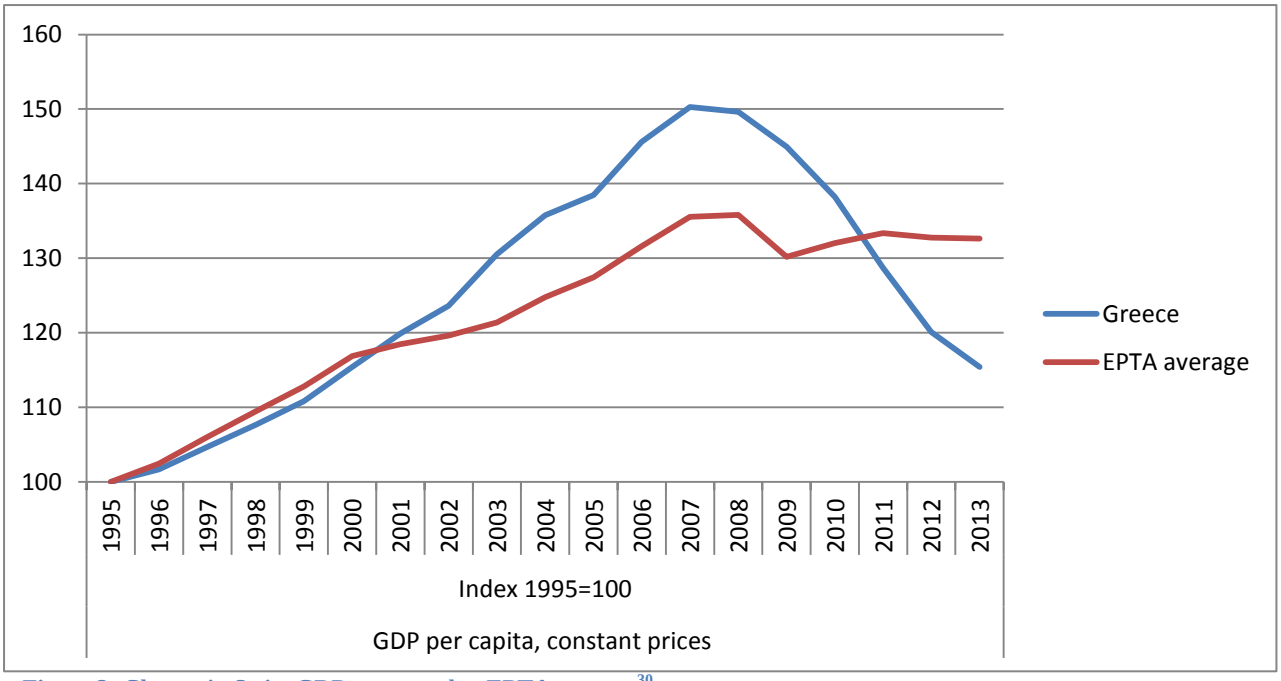


Figure 2: Change in Swiss GDP compared to EPTA average[30]

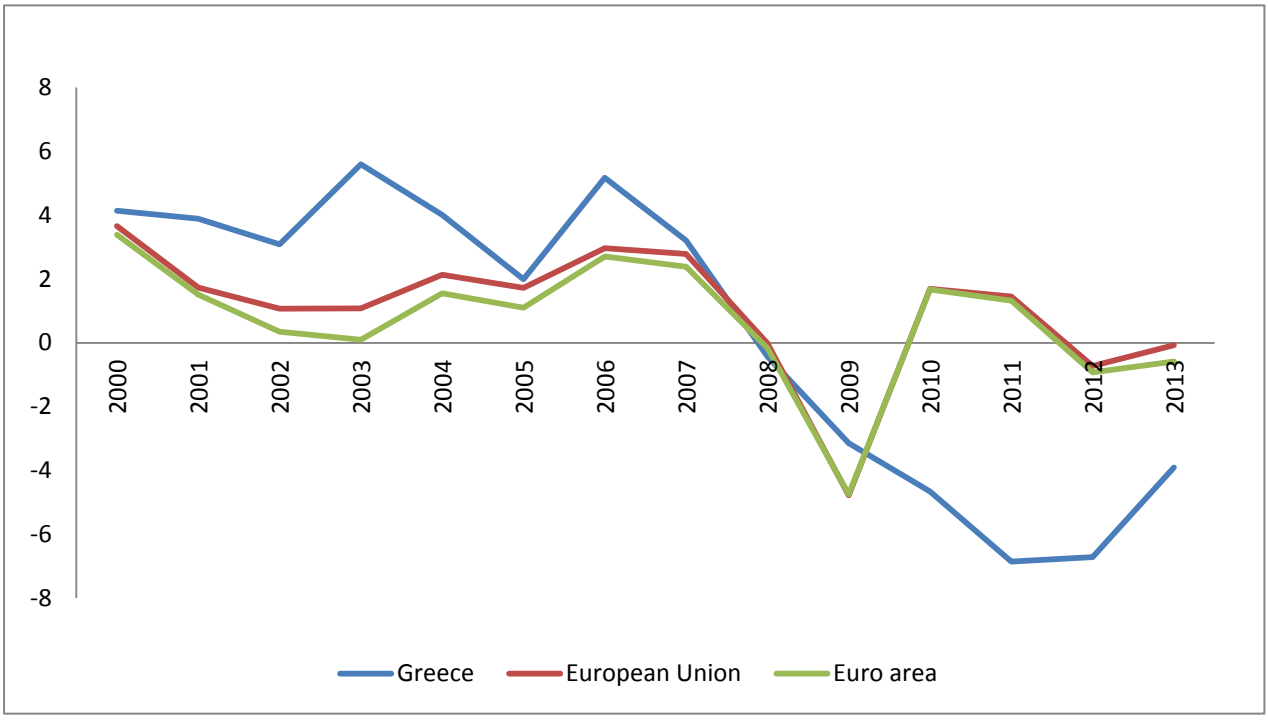


Figure 3: GDP per capita, annual % change (constant prices)[31]

[30] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559
[31] Source: OECD, http://stats.oecd.org/Index.aspx?DataSetCode=PDB_GR#See also: http://www.oecd.org/std/productivity-stats/

Productivity challenges

Low levels of labor productivity

Greece is currently one of the countries with the lowest hourly labor productivity levels. As seen from Figure 3, the output per hour worked in the Greek economy in 2013 reached 20 Euros, when for the Euro area, as a whole, as well as for the EU-15 was just under 40 Euros. Greece also lags significantly, compared to other countries that were affected by the recent crisis (e.g. Ireland, Italy and Spain). The recent crisis had significant adverse effects on hourly labor productivity, as well as on the growth rate of labor productivity, especially during 2009-2011. However, for the last two years there has been observed a weak recovery in Greek labor productivity.

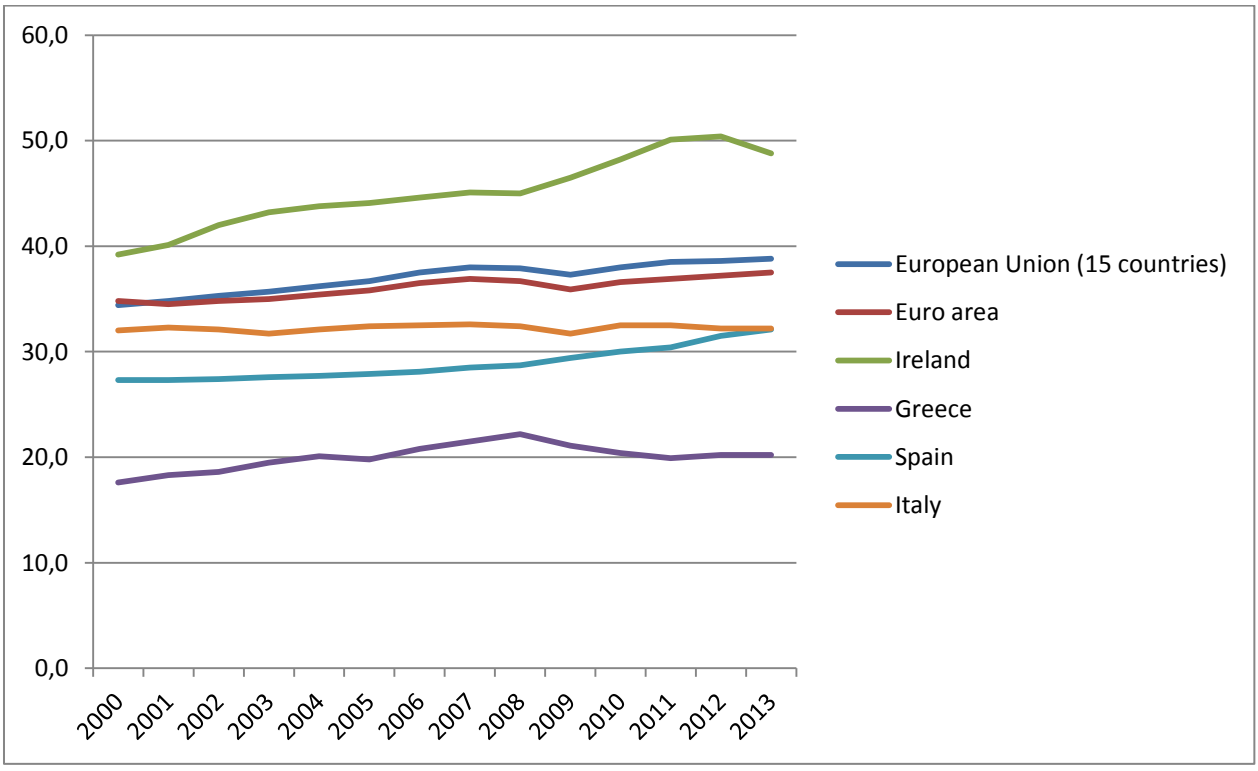


Figure 4: Labor productivity (Euro per hour worked, constant prices)[32]

[32] Source: Eurostat http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_aux_lp&lang=en

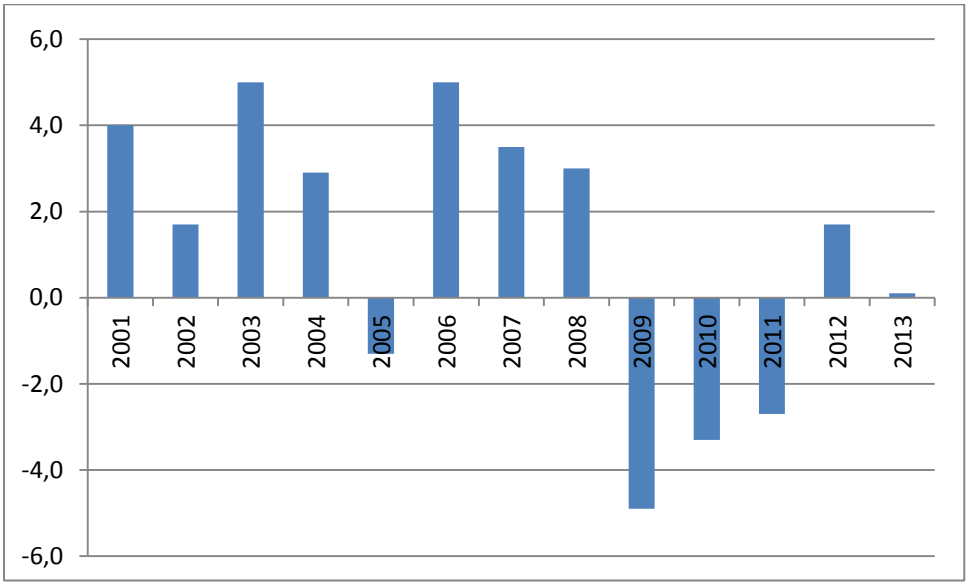


Figure 5: Annual % change of labor productivity (Greece, euro per hour worked, constant prices)[33]

Low R&D spending

As shown in Figure 5, Greece ranks 24th in EU-28 for 2012 in terms of its R&D intensity, outperforming only four European countries, i.e. Cyprus, Romania, Bulgaria and Latvia. Specifically, Greece appears to spend a total of 0.69% of GDP on R&D which is significantly less than the EU-28 average which exceeds 2%. However, there seems to be some progress compared to previous years (2000-2007), during which R&D intensity had been stagnating at around 0.60% of GDP.

[33] Source: Eurostat http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_aux_lp&lang=en

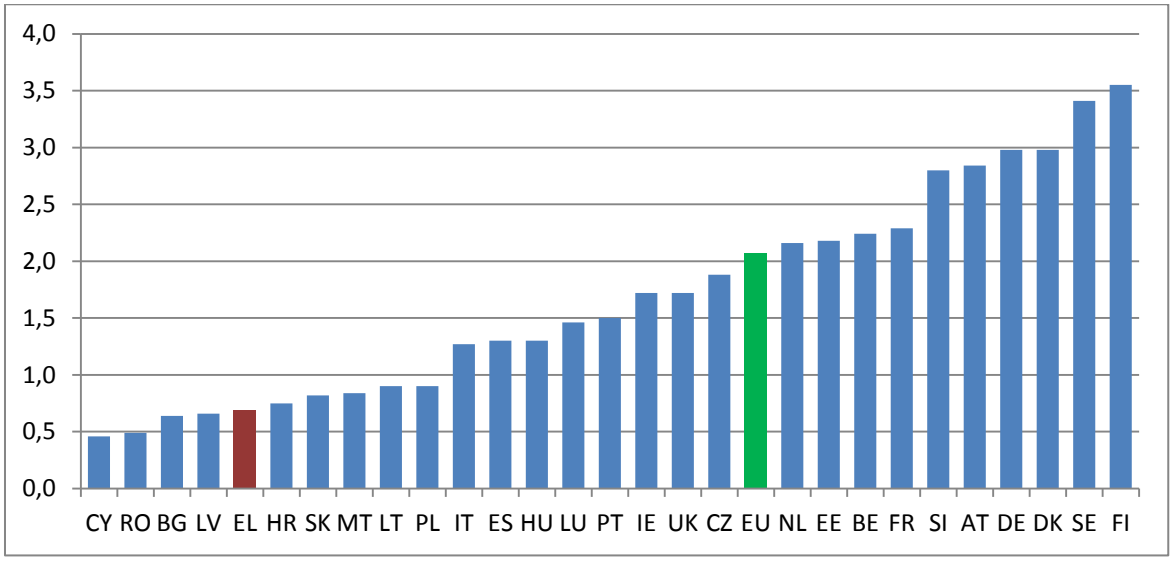


Figure 6: Gross R&D expenditure as a percentage (%) of GDP in EU-28, 2012[34]

Concerning the sources of funding for R&D in Greece we observe that there is an imbalance, with the public sector significantly outweighing the private sector (Figure 6). In particular, the public sector contributes more than 50% of total spending on R&D, as against 31% from the private sector, while the European averages are 33.4% and 54.9% (for 2011) respectively. The adverse effects of the recent crisis are evident on both public and private investment on R&D and, as a result, EU structural funds constitute the primary source of financing R&D activities in Greece.

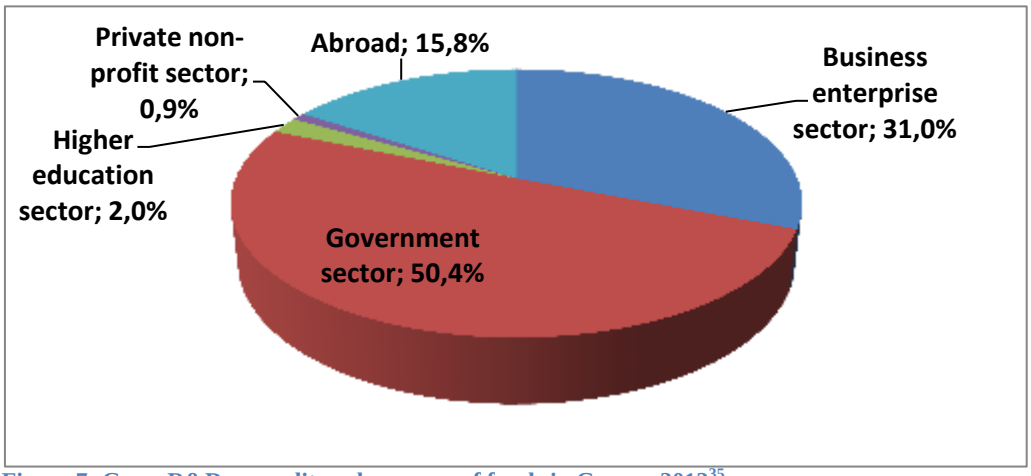


Figure 7: Gross R&D expenditure by source of funds in Greece, 2012[35]

[34] Source: Eurostat http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsc00001
[35] Source: Eurostat http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsc00031

Future challenges

Despite the significant decrease in unit labor costs observed in recent years (Figure 7), the Greek economy faces a number of significant challenges to increase its productivity and cover the lost ground vis-a-vis its European partners. The major challenges include:

1) The modernization of the Greek public administration in order to increase the public sector productivity, with beneficial effects for the private economy.

2) The increase in R&D spending and innovation performance, which remain at comparatively very low levels over time.

3) The increase in private investment, which has been significantly reduced during the years of crisis.

4) The diffusion of information and communication technology.

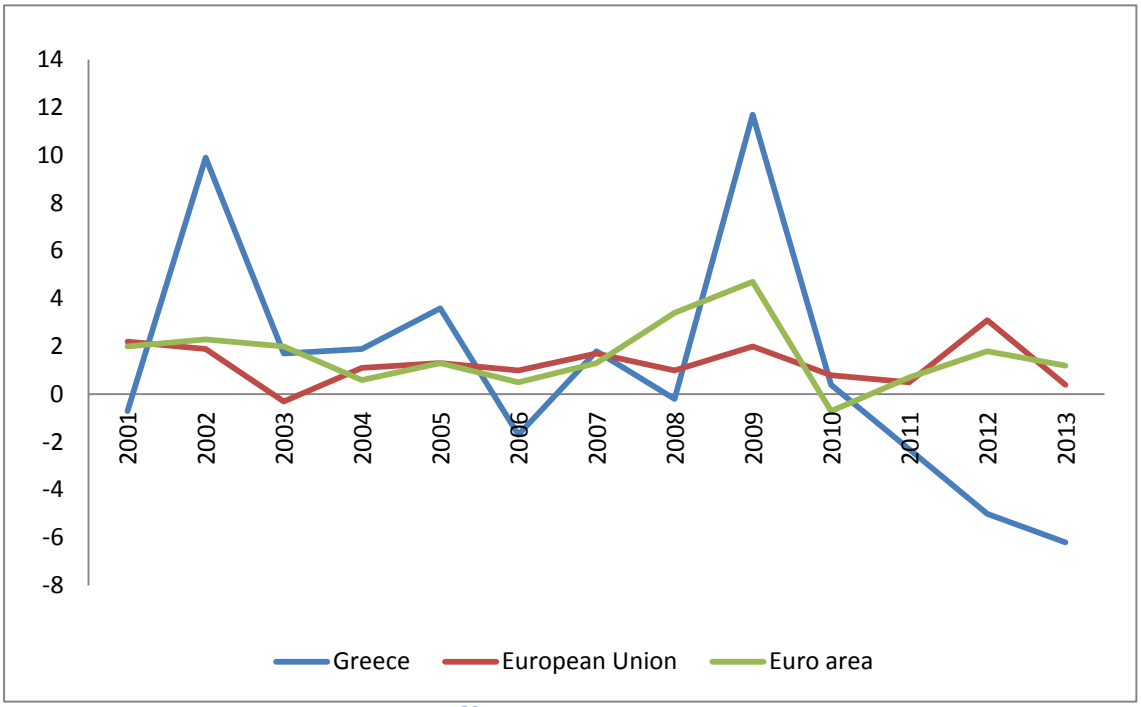


Figure 8: Unit labor costs (annual % change)[36]

[36] Source: OECD, http://stats.oecd.org/Index.aspx?DataSetCode=PDB_GR#
See also: http://www.oecd.org/std/productivity-stats/

Technology trends and policy initiatives

Productivity of the public sector

Although in recent years there have been efforts to improve the workings of the public sector, its productivity remains at very low levels, compared to that of most EU countries, with the main causes being the bureaucratic and complex procedures. The increase of public sector productivity, the reduction of the response time and the provision of quality services to citizens and businesses will contribute to the increase of the productivity of the private sector of the economy and thus, to long-term economic growth.

A number of initiatives have already been implemented or are planned by the Greek government. One of these, the "SYZEYXIS" project, has the following objectives: a) the modernization of the Greek public administration by providing advanced telematic services (including advanced voice, data and video services) and high value added services, b) the efficient use of information through the interconnection of the information systems of Greek public sector bodies, c) the reduction of communication costs between bodies of the Greek public sector while increasing the speed and security of information diffusion, d) the elimination of the "digital divide" in the context of the information society and e) the improvement of services provided to citizens as regards i) the easy and fast retrieval of information, ii) the use of automated and user-friendly transaction processing systems, particularly for services that require the involvement of more than one bodies.

Other initiatives include TAXISNET for the electronic submission of tax returns of the Ministry of Finance, the initiative of IKA (the largest Greek pension fund) for the digitization of services provided to its members, as well as the electronic interconnection of information systems for the exchange and verification of information.

Innovation

Greece is one of the countries lagging behind most EU economies as regards most innovation indicators. In specific, according to the Innovation Union Scoreboard 2014, Greece is grouped under the "moderate innovators", performing below the European average and ranks 19th among the EU-28 countries. This poor performance is likely to be related to adverse effects on the productivity of the private sector.

The General Secretariat for Research and Technology operates under the supervision of the Ministry of Education and has as its primary objective to strengthen the research activities of the Greek economy through several research programs. It also has as its purpose the transfer and diffusion of advanced technologies in the production and service sectors of the country. In order for researchers to implement research projects in the private sector the initiative for the "Strengthening of employment of research staff in firms" partly covers their salary costs. The main purpose of this initiative is the dissemination of research activities to Greek enterprises and the improvement of the access to employment for researchers, in order to acquire professional experience.

Most of the recent financing and institutional tools for the next programme period 2014–2020 (e.g. the National Strategic Framework Programme for research and innovation and the new law on 'Research, Technological Development and Innovation') have set innovation as a key objective and strategic priority. The main targets include the attraction of students and doctoral candidates from abroad, the incentives for conducting high quality research and the encouraging of participation in mobility programs. Additionally, the economic exploitation of research results produced in universities and research centers is very important through the creation of networking and connecting links between the research community and the industry. Finally, it is necessary to promote R&D in the private sector through tax incentives, the development of alternative sources of funding (e.g. hybrid funds, financial engineering tools, business angels) and the creation of structures for vesting of intellectual property.

Private investments

In recent years, the share of private investment in GDP has significantly declined mainly due to the great recession and the decline in economic activity. However, according to recent data released by the Bank of Greece, foreign direct investment in the Greek economy for 2013 was at €2.1 billion.

Strengthening the private investments remains a major challenge for the Greek government, as it is important for higher productivity and growth of the Greek economy. Over the last years, the Ministry of Development and Competitiveness has undertaken several initiatives to increase market liberalization, to remove obstacles for the establishment and operation of businesses and to simplify licensing of firms. It is worth noting that with the new investment law, the Greek government aims to accelerate the investments, providing investors with an effective institutional framework, while ensuring transparency and increased liquidity.

Also, the new National Strategic Framework Programme as well as numerous co-funded EU programs which support SMEs, have set the strengthening of competitiveness and the increase of the openness of enterprises, as a key priority. Also, the 'Enterprise Greece' agency is a strong business hub for the promotion and support of direct investments in Greece.

Technology diffusion

As part of the national strategy for the 'Information Society', several initiatives have been taken for the diffusion of technology to businesses, with significant expected impact on the productivity of the Greek economy. We mention some of the actions which are currently in progress:

a) ICT4GROWTH aims to enhance business and operational technological innovation, to support entrepreneurship through the use of ICT and to substantially strengthen the ICT services sector (in terms of openness and competitiveness).

b) DIGI MOBILE mainly focuses on enhancing the use of innovative applications for mobile devices and tablet pcs for existing businesses. The aim is to reduce the operating costs and improve productivity, to build applications for ‘smart’ devices that facilitate the mobility of workers and to allow direct access and use of corporate data from anywhere. It also seeks to bring together existing and new customers to provide personalized and targeted information.

c) DIGI CONTENT. The action is intended to provide (to the greatest possible extent) the supported firms with the conditions for technological advancement, for digitization of content and electronic distribution, as well as the creation broadband services in order to improve their competitive position.

d) DIGI LODGE. This action involves the implementation of investments in the tourism sector by hotel or accommodation firms and aims to the international promotion of our country, the elimination of seasonality and extension of the tourist season, as well as the adoption and use of modern ICT tools from tourist units. In this direction, the tourist units will develop new applications for web promotion and communication systems for online booking and, therefore, will achieve a qualitative and comprehensive presentation of their tourist facilities in the areas in which they are located.

e) DIGI RETAIL. The action involves the implementation of targeted investments in the retail sector from existing businesses to reduce operating costs through the use of information technologies, for the automation of warehouse, sales’ and purchases’ management, the automation of marketing campaigns, the personalized and integrated access to customers, the support of product differentiation against the competition and the creation of conditions for export led growth and improvement of competitive position.

The Netherlands

Dutch productivity at a glance

Given the lack of extensive in-house economic expertise within the Rathenau Instituut, in the following two sections we rely heavily on a set of reports stemming from the OECD (2014)[37] and HCSS &TNO (2012)[38]. According to the OECD the Netherlands has one of the most advanced economies in the world. It is one of the most open economies and ranks ninth among OECD countries in terms of GDP per capita, with a gap of 13% *vis-à-vis* the United States, which is largely accounted for by labor utilization. The main contributing factors are low average working hours, owing in part to the prevalence of part-time work, an early effective retirement age and high numbers of disability recipients. Labor productivity, measured as GDP per hour worked, is just 2% below the level of the United States.

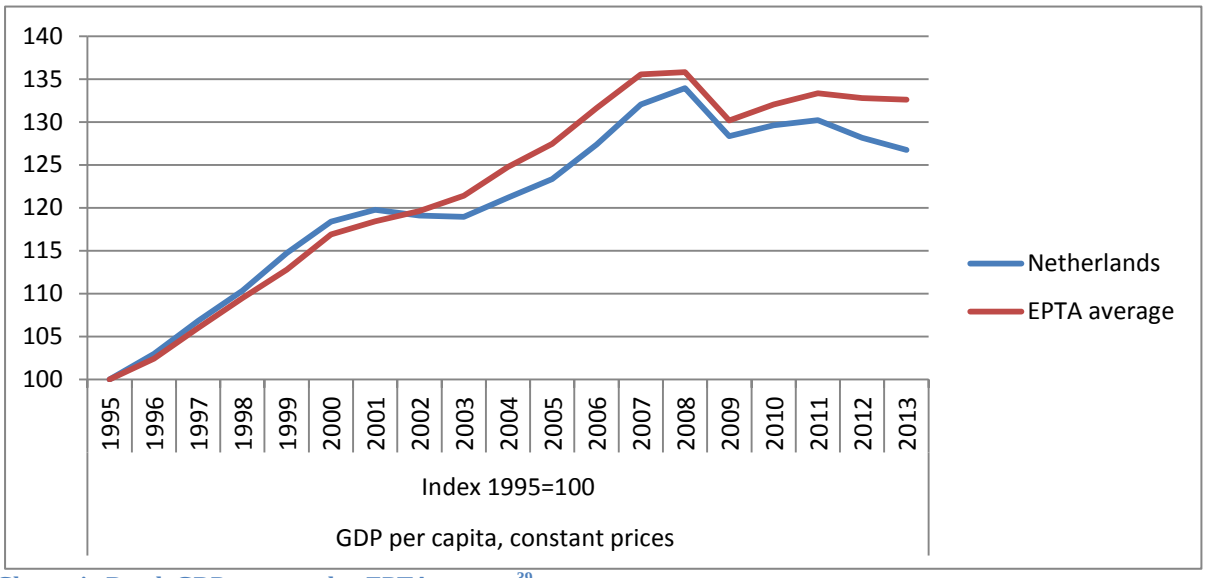
Traditionally, the Netherlands has derived much of its wealth from trade and other international transactions and is tightly integrated in the global economy through trade and foreign investment. Dutch exports have grown rapidly in recent decades corresponding to the expansion of EU and world trade. The port of Rotterdam and Schiphol airport play a major part herein. Relatedly, openness to international trade (measured as the average of imports and exports of goods and services over GDP) is one of the highest among OECD countries and has increased over the past decade.

Furthermore, the OECD observes that the Netherlands proved – so far – to be able to keep up with developments by continuously strengthening transport and information and communication technology (ICT), that have underpinned contemporary globalization. Services (trade, transport and logistics, but also financial and other business services) account for nearly 40% of total Dutch value added. Dutch industry has important strengths in food processing, chemicals, petroleum refining and electrical machinery.

The last observation of the OECD we would like to mention is that during difficult times, the Netherlands has proven to be quite resilient, owing to the population's willingness to take a pragmatic and consensual approach confronting and adapting to changes in the economic environment and related social, technological and economic challenges. The so-called "polder-model" thus provided the institutional framework for much of the Dutch growth.

[37] OECD (2014). *OECD Reviews of Innovation Policy: Netherlands 2014*, Paris, OECD Publishing. *http://dx.doi.org/10.1787/9789264213159-en*

[38] The Hague Center for Strategic Studies & TNO (2012). *De Staat van Nederland Innovatieland 2012.* Amsterdam, Amsterdam University Press.



Change in Dutch GDP compared to EPTA average[39]

Productivity challenges

The former does not derogate the fact that Dutch productivity is facing challenges. As labor market participation has a natural limit, higher labor productivity is the only source of sustained economic growth. Relatedly, while Dutch productivity levels are high overall, the country's multi factor productivity (MFP) the OECD raises the issue of their sustainability. MFP growth in the Netherlands has namely been one of the lowest among selected OECD countries in the last 25 years. In this regard, the call for innovation is becoming more and more urgent.

Similar to other developed countries, the Netherlands is facing demographic changes that are expected to constrain labor market participation in the years to come. In the past, Dutch productivity profited from the increased influx of women on the labor market (HCSS &TNO 2012). However, in the nearby future the ageing of the Dutch society will become a major challenge.

In terms of sectorial challenges, contributions to the Netherlands' high productivity level vary across sectors and industries. Transport, logistics and wholesale trade in the services sector and the food, chemicals and metals industries in the manufacturing sector have been doing very well. However, construction, the energy sector and, more importantly, the relatively large business services sectors still have a way to go to reach international best practices according the OECD. Challenges for the medium to long run include boosting productivity growth in laggard sectors, such as business services, telecommunications and construction, and keeping the best-performing sectors (transport, logistics, wholesale, food and chemical industries) at the international frontier through continuous innovation.

[39] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Last, the Netherlands' productivity is challenged by drastic changes in the markets. First, Dutch exporters have benefited less than some other EU countries from the expansion into emerging markets, (e,g. the BRICS). In addition, globalization by means of ICT, shifts in production processes are changing the nature of markets (OECD 2014; HCSS & TNO 2012).

Technology trends and policy initiatives

This section does not to any extent aims to be complete. Instead we only focus on two relevant technology trends the Rathenau Instituut has been involved in: 1) the influence of technology on labour, and social justice; 2) the role of so-called platforms in shaping innovation and our economy.

1. Robots, employment and social justice

On September 29 in 2014, the Dutch minister of Social Affairs and Employment held a speech that put the issue of innovation and the future of labour and social justice prominently on the public and political agenda.

In this speech the minister referred to a study by Carl Benedikt Frey and Michael A. Osborne at the University of Oxford who have analysed what smart machines will be capable of doing in the future and compared this to the human skills that jobs today require. They found that almost half of all jobs in the United States could potentially be replaced by computers or robots in the next twenty years. For the Netherlands their research method delivers roughly the same picture: forty percent of all current jobs are in danger. How worrisome is this prospect, considering that the unemployment rate is already so high (in the Netherlands currently 8.7 per cent)?

One crucial political question is what innovations mean for the future of labour and social justice. Opinions are hugely divided on this question. For most economists, the pattern is a familiar one; innovation puts jobs at risk, but in the long run it also generates new jobs. The argument is that robotics will increase labour productivity and that robots will lower the price of products, thereby generating more sales and making manufacturers richer. Wealth creates new needs, and meeting those needs will create new jobs. These optimists have history on their side. Nevertheless, lessons from the past offer no guarantee for the future. More recently, a new phenomenon has arisen: jobless growth. Linking this trend to the idea that robots and computers can quickly take over many jobs gives rise, at least at first glance, to a politically thorny scenario: a high long-term unemployment rate, greater social inequality, and more public unrest.

The Dutch government has acted wisely by acknowledging the fact that innovation causes many uncertainties with respect to the future of labour and social justice. That will permit

open discussion about the future of labour, the role of technology and social justice. The study carried out by Frey and Osborne represents a provocative starting point for serious debate and research. The researchers themselves are careful to state that their study paints an incomplete picture, because they do not include all sorts of economic, social, ethical and legal factors. The biggest problem at the moment is that we do not have an informed picture of the dynamics of innovation and its influence on labour (and the division of labour) in the Internet era.

On October 9, 2014, the government has asked the Social and Economic Council of the Netherlands (SER) to come up with an advice on how technology will influence the labour market and what kind of skills people will need in the future. The SER is an advisory and consultative body of employers' representatives, union representatives and independent experts, that aims to help create social consensus on national and international socio-economic issues. Moreover the Scientific Council for Government Policy (WRR) has started a project on The future of work.

2. Platforms: New forms of innovation require new policy schemes.

As part of the ongoing digitization process, virtually all economic and social sectors will be affected by ‘platforms’. This new form of innovation requires attention from the government and an update of its policy schemes.
Apple, Google, Facebook, Airbnb and Uber: these are all companies that have created new markets and businesses. They have disrupted traditional markets by platform-based innovation strategies. A platform is a foundation of products, services or technologies upon which other parties can build further products, services and technologies. In many cases, platforms are digital marketplaces which facilitate transactions between buyers and sellers, and which draw upon the knowledge and input of their users to promote further development.

Platforms can speed up the innovation process. New business models and networks are created. Public institutions, businesses and industries, companies of all sizes and individuals can all be involved in the joint development of new products and services.

Platform-based strategies are driving innovation in many sectors. They are also responsible for a convergence of markets and a restructuring of value chains. They create new power relationships. This generates countless opportunities for private sector companies of all sizes, including sole traders and social entrepreneurs, and for innovation in important domains such as healthcare, energy, 3D printing and DNA technology.

Platforms can be very influential. But this strength also has a downside. If platforms become too powerful, economic and societal interests are at risk. Whether there is indeed any adverse impact depends in part on the conditions that the providers impose in terms of

who can make use of their platform, and how. Closed platforms exclude other companies, smaller businesses and civil initiatives, thereby severely restricting competition. Consumers who make significant use of one platform provider's products will find it extremely difficult to switch to another provider whose products are not compatible.

Recommendations

The Rathenau Instituut has analysed innovation strategies in various domains. To gain the full benefit of platforms, it is essential that government updates its policy. There currently is no specific policy on innovation platforms. Platforms affect several policy areas (such as competition). In our recommendations we focus on specific areas and advice the government how to update these. It can:

- Support businesses, allowing them to take the lead in the development of new platforms and technologies, in forming consortia and in establishing standards.

- Amend competition policy. Proposed mergers and acquisitions should be assessed in terms of their impact on new and existing markets. Ongoing digitization results in market convergence. Where necessary, force the separation of the platform providers' bundled products and services, ensuring access for other parties.

- Prevent switching barriers. The integration of products and services within a single platform makes it difficult for users to seek alternatives. Examine whether the current regulations intended to ensure consumer choice are adequate, particularly in highly dynamic domains such as healthcare, manufacturing and agriculture.

- Safeguard public interests. Where platforms become a 'public good', examine whether additional requirements should be imposed. Such requirements may relate to conditions of use, the stability of the underlying infrastructure, and accessibility. When designing a regulatory system for platforms, lessons can be drawn from past experience in regulating internet access, telephony and net neutrality.

Norway

Norwegian productivity at a glance

Norway currently enjoys the highest rates of productivity in the OECD, supporting correspondingly high rates of real wage growth. Globalization has played to the Norwegian economy's advantages, with a high global demand for raw materials and cheap imports, leading to a consistently positive balance of trade. The effects of the financial crisis have been very limited with unemployment rates stabilizing around 3.5 percent.

During the past decade however, there has been a decoupling of the real wage growth rates and labor productivity growth. As in most European countries, between 2004 and 2005 productivity growth started slowing, a trend that was accentuated by the effects of the economic crisis in 2008. At the same time, the real wage growth rate remained mostly unchanged. The consequences have been a rise in unit labor costs in most sectors, which is critical for the competiveness of the exposed sectors of the Norwegian mainland economy. If the current trend continues, exports and employment in the exposed sectors are likely to drop significantly.

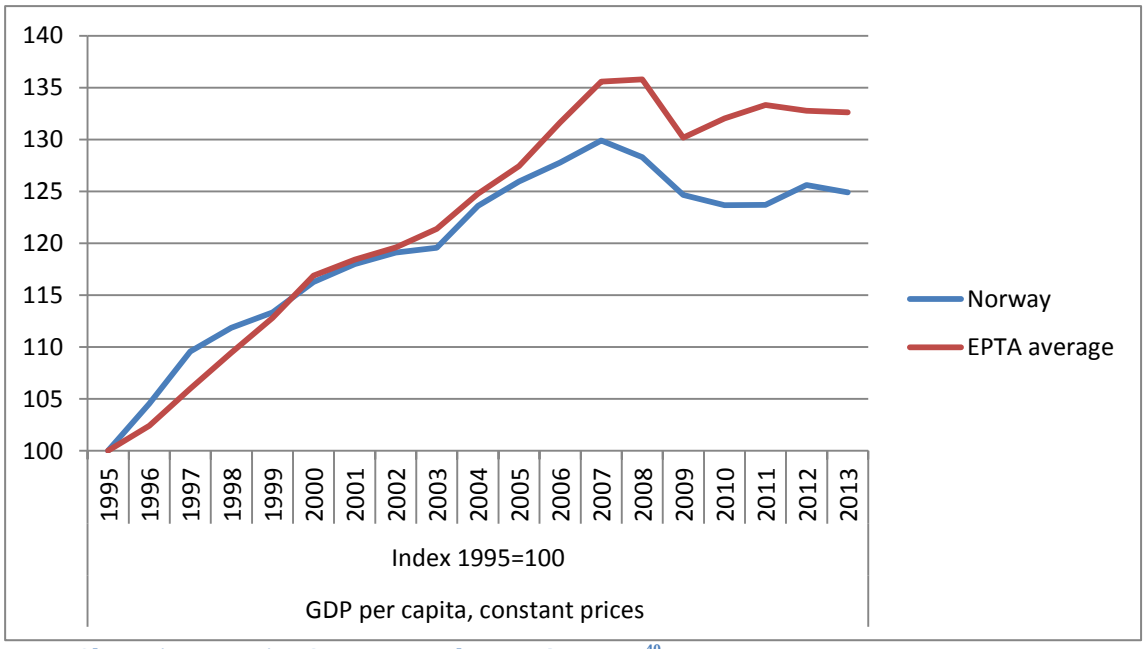


Figure 1: Change in Norwegian GDP compared to EPTA average[40]

[40] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Productivity challenges

The two-track economy: petroleum and the rest

Norway is facing a decrease of the oil and gas industry's share of the total economy in the coming years. Nonetheless, the Norwegian economy remains dominated by and dependent on the petroleum industry. The oil and gas sector provides 2/3 of all export income, and has been the main driver of economic growth for the past thirty years.

It is also central to the significant growth in productivity in the mainland economy oriented towards the petroleum industry, and has considerable macroeconomic and financial effects on the non-petroleum economy, such as driving the annual increase in real wages.

However, the success of the petroleum industry also produces detrimental effects to the non-petroleum economy, creating what is called the "two-track economy". Because of its size and profitability, the oil-and gas sector attracts investments, human capital and innovation away from the non-petroleum economy and industries that do not depend on finite natural resources to grow.

Productivity growth in the non-petroleum economy is essential to uphold current levels of welfare and GDP growth in the future, but the lock-in effect exerted by the oil and gas sector on the economy hinders such prospects.

Not enough private R&D

The Norwegian private sector spends less on R&D than its overall economic performances would suggest, with a larger share of total R&D spending being funded by the public sector compared to other OECD countries. Although, a recent study by Statistics Norway indicates that many Norwegian companies are good at increasing productivity by investing in new and more efficient technologies, innovation activities are declining in Norwegian industry.

A growing public sector and a shrinking workforce

Because no single source of income may replace the oil and gas sector, the most likely economic projections indicate that the public sector also has to increase its productivity. Due to its size, productivity gains applicable across the public sector may yield significant overall productivity growth. Much of the pressure on the public services will be concentrated on the traditionally labor intensive health and care sector.

Also, as in many other European countries, the Norwegian population is ageing, posing a host of challenges. The most critical are increasing pension and health costs, and the diminishing share of the economically active population. Maintaining the projected average productivity growth rates in the economy as a whole is seen as essential in the efforts to mitigate the effects of the decreasing ratio of the working population to those outside the labor force. Additionally, it is important that more of the available workforce get access to the labor market and that they work longer to mitigate the effects of the decreasing share of the active population.

Technology trends and policy initiatives

Productivity commission
In 2013, the minister of Finance established a commission tasked with comprehensively assessing and identifying the underlying causes of the slowing productivity growth rates of the past decade. The commission will produce recommendations for how to promote stronger economic and productivity growth to counteract the effects of the two-track economy and the demographic challenge in the context of the post-petroleum transition. It is to deliver its final report in 2016.

The focus of the commission is broad, covering issues such as the impact of educational policy, market regulations (labor and competition), innovation policy, measurement issues, and investment policy and sector specific challenges. It is composed of mainly academics, members of the business community and government officials.

Digitalizing and simplifying
The government addresses the productivity challenges notably by making the interaction between the public administration and the private sector more efficient. The government has since the early 2000s implemented a strategy of digitalizing the public sector, especially at the interface between individuals and businesses, and the public administration, such as:

- The portal "Altinn", established in 2003, allows businesses and individuals to access and handle official documents, forms and tax forms from 39 different government agencies on one website.
- The personal health portal "Health Norway" allows the individual user to handle health related forms online, review medical journals, book medical appointments, access health related information etc.

Public-private partnership in research and innovation
The Norwegian government is following a comprehensive public-private partnership innovation strategy which embeds the public R&D policy into the private sector. The Government envisions a dual role for the public sector. On the one hand the public sector must convey challenges that need innovations to be solved. On the other hand it must cooperate with private sector organizations, through for instance, financial means.

- **"21-strategies"**
  The so-called "21-strategies" gather actors from the industry, the public sector, NGOs and the research community to identify the different sectors' biggest challenges and possibilities in the 21st century, and how authorities and businesses can collaborate to stimulate the desired developments through research and innovation. Such grand strategy processes have been carried through in the oil and gas sector, in energy, health, maritime and ocean-based industries, and in climate research.

- **Centers of excellence and industrial expertise**
  There is a concerted effort from the government to promote the development of highly qualified expertise in different fields of applied research and innovation – with an emphasis on privat-public partnerships. The Norwegian Centres of Expertise Programme (NCE) is established to enhance sustainable innovation and internationalization processes in the most dynamic and growth-oriented Norwegian clusters. Another notable example is the "User-driven Research based Innovation»-arena, which is targeted at industry and supports high-quality R&D projects with good business and socio-economic potential.

- **Private sector R&D tax deduction schemes**
  SkatteFUNN is a tax incentive scheme aimed at promoting R&D and innovation in the private sector, with a "tax deduction of up to 20 per cent of the eligible costs related to R&D activity". It is open to all industries and companies that are subject to taxation in Norway, and is granted on a project specific basis, with companies applying online.

Advanced manufacturing – "made in Norway"
In the report "Made in Norway? How Robots, 3D-printers and Digitalisation Bring New Opportunities for Norwegian Industry" the Norwegian Board of Technology analyzed how flexible robots, 3D-printers and digitalisation of the production process will be crucial for competitive, advanced manufacturing in high-cost countries such as Norway. Norway still lacks an overall strategy for how the Norwegian government, industry and higher education institutions should adapt to these technological developments. The new technologies will change the traditional industrial workplaces radically.

In the report NBT outlines the following key elements of a new strategy for how Norway can stay a leading and innovative economy in the future:

- A best practice analysis" in how optimally to use new technologies for improving competitiveness.
- Survey of the general state of Norwegian industry.
- A foresight project into the development in advanced manufacturing.
- Stimulating greater cooperation between research, manufacturing and government authorities.
- Boosting digital competence in manufacturing.
- A research strategy.

Long term strategy for research and higher education
The Norwegian Government has recently published a long-term strategy for research and higher education. The strategy presents clear commitments towards 2024. Among the prioritized areas are research and competence in advanced manufacturing. These are

considered essential to increase competitiveness and flexibility in the Norwegian economy, as well as securing jobs.

The strategy highlights the importance of ICT competence to enhance productivity and competitiveness. It also stresses the need to strengthen the ability of Norwegian companies to implement the most advanced production technologies, which the strategy sees as an important means for enabling Norwegian industry to "homeshore" production from low-cost countries.

Welfare technology and mobile health

In order to fully exploit the potential of welfare technology, a *national programme for the development and implementation of welfare technology* in the health and care services was launched in 2014. The programme will make welfare technology an integral part of care services by 2020, through universal design making homes and surroundings suitable for the elderly and utilising technology for security, skills mastering and rehabilitation for daily life.

A related development is in mobile health. In a user and consumer friendly way, it is now possible to purchase clinically approved measuring devices for your smartphone. For those with chronic diseases, this may anticipate a more practical life: diabetics can purchase devices which measure blood glucose levels and control their insulin levels, and those with high blood pressure can purchase blood pressure monitors.

Mobile health technology has the potential of improving the preventive work, the measurement, diagnosing, and the treatment and communication within the health sector. It will allow saving time, resources and lives. Norwegian authorities are thus preparing to receive health app generated data. The aim is to make it possible to share personal health data with health personnel, relatives, first line volunteers and patient networks.

Poland

Polish productivity at a glance

Poland's GDP growth outpaced the growth of the most developed economies in Europe (graph 1). As a result, the gap in economic development between Poland and the most developed OECD countries and EU-15 has been significantly reduced. It was the only EU member state to avoid the 2008–2010 recession. According to Eurostat, in 2009 Poland achieved a GDP growth of 1.6 percent when the EU-27's contracted by 4.5 percent. Diversified economy, big internal market and strong domestic consumption, productivity gains, lower dependence on exports, flexible exchange rate and depreciation of the Polish currency (PLN), utilization of the EU structural funds (especially for upgrading notoriously lagging infrastructure), and counter-cyclical fiscal policy all contributed to that result. Despite these achievements, Poland remains one of the least affluent countries in the EU with the GDP per capita at 68 percent of the EU-28 average in 2013.

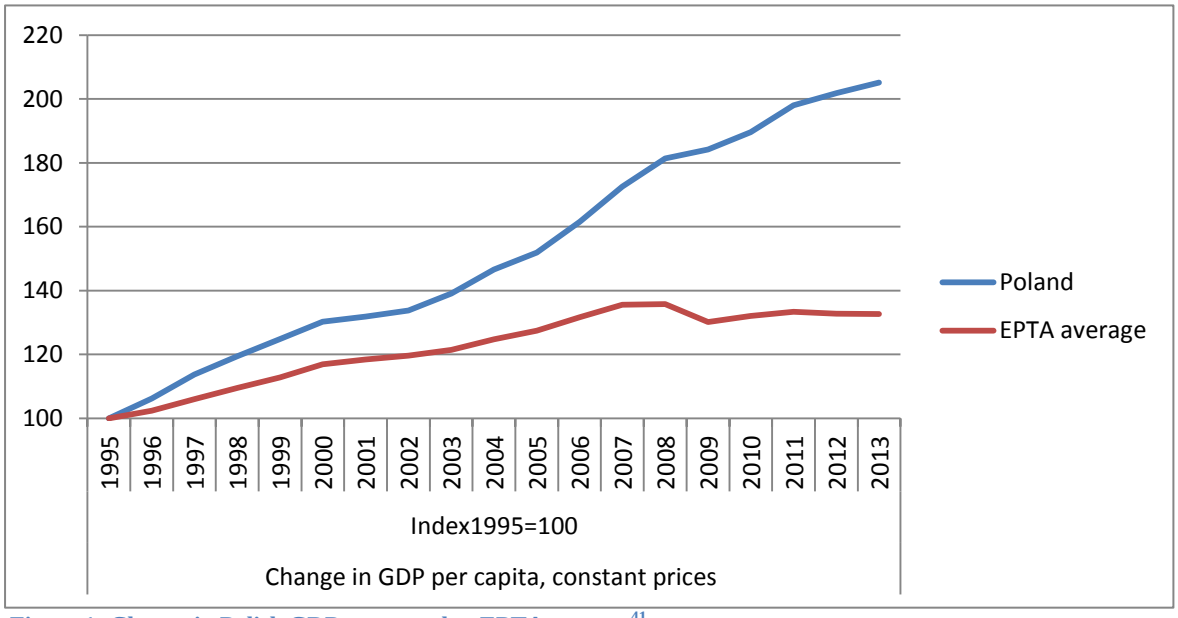
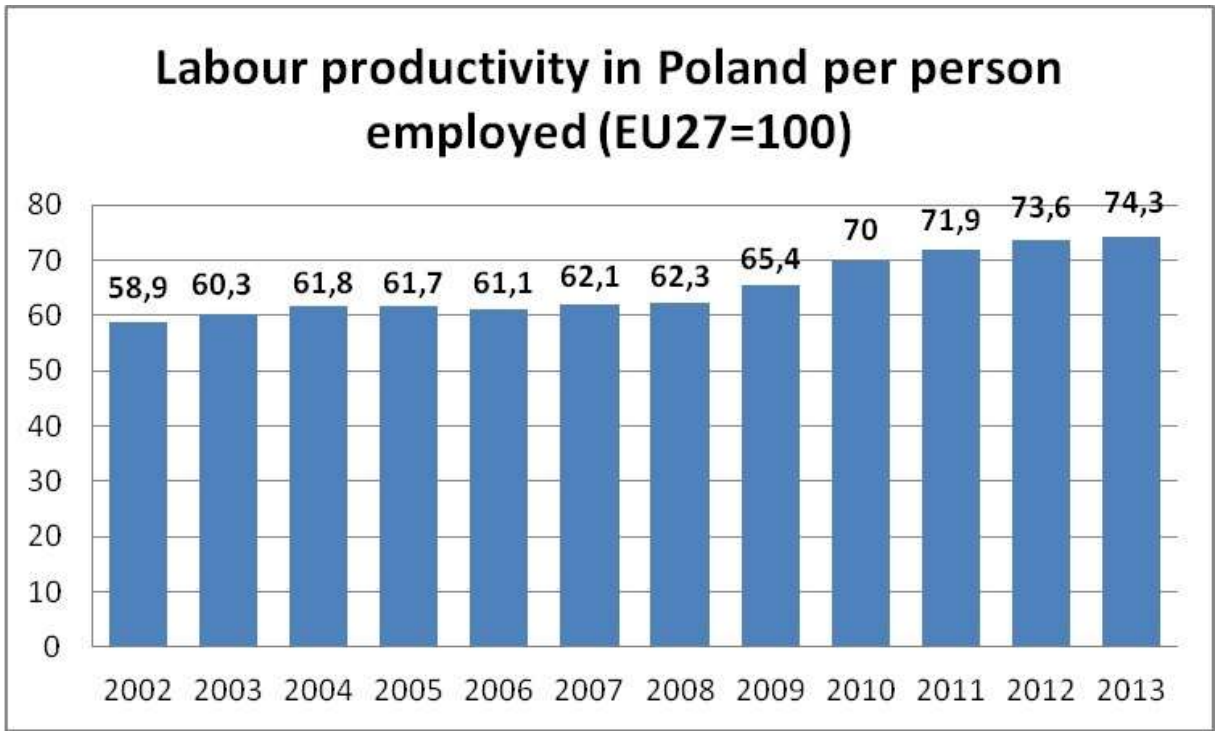


Figure 1: Change in Polish GDP compared to EPTA average[41]

Over the last years productivity growth reinforced GDP growth rate. However, Poland is still among the least productive EU countries (graph 2). The current growth is still fuelled by the

[41] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

lower prices (cheaper factors of production), slow growth of real wages (which did not match the gains in productivity), and relatively long working hours[42].



[43]

Productivity challenges

Not enough research and development

Poland is lagging behind developed countries regarding research and development (R&D) expenditure. Currently it is approximately 1 percent GDP. What is worse, only one third of the R&D activity is financed by the private sector (companies), and ineffective and infrequent co-operation between business and academia remains one of the fundamental weaknesses of the Polish innovation system.

Middle income trap

Poland's income levels are converging with the EU income levels. However, many economists argue that it is now in danger of getting stuck in a middle income trap, as the engines of current growth and cost advantages will soon wane. In order to continue to grow the country has to become more productive and more innovative.

[42] According to OECD, in 2013 average annual hours worked per worker in Poland was 1918 versus OECD average 1770
[43] Source: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tec00116&plugin=0

Aging and shrinking workforce
As in most of Europe, Poland's population is ageing. This is due to the increase in life expectancy, alarmingly low total fertility rate (1.25 in 2013) and work immigration of young Poles to the EU-15. It creates a growing pressure on pension and healthcare systems, and starts to be felt in the labour market.

Low participation in the labour market
Productivity increases when the real GDP increases faster than the number of employees (hours worked). Unfortunately, Poland's participation rate of the working population[44] is one of the lowest among the developed countries (56 percent in 2013 according to Central Statistical Office; 64 percent for men and 49 percent for women). This is partly a legacy of the recent lenient regulations regarding disability and early retirement, which resulted in early withdrawals from the labour market. Also women often retire earlier than they had planned to take care of their parents or grandchildren, while younger Poles continue to study. As a result Poland still has one of the lowest effective retirement ages in the OECD (59.5 years in 2013).

Technology trends and policy initiatives

Strategy for innovation and efficiency of the economy "Dynamic Poland 2020"
Government can influence productivity growth by, *inter alia*, adopting regulations regarding labour market flexibility (ease of firing and hiring), unions' bargaining power over wages, creating effective public institutions, stimulating R&D in the private sector, improving the education system and creating an attractive investment environment for foreign investors. In January 2013 the Council of Ministers approved a new development strategy called "Dynamic Poland 2020" which echoes the goals of the "Europe 2020" strategy: smart, sustainable and inclusive growth. It is based on four pillars: improvement in regulatory and financial environment for entrepreneurs, stimulating innovation, increased resource and raw material efficiencies and internalization of the Polish economy.

Digitization
Over the last years the government initiated many IT programs and projects aimed at streamlining its operations, reduce costs and the bureaucratic burden for the citizens. Although the system is still a far cry from a fully-fledged *e-government*, the number of matters which Polish citizens can resolve over the Internet is steadily on the increase. Most recent examples include:

- free downloading of extracts from the National Court Register (KRS) and remote access *via* Internet to the Land and Mortgage Register; both previously required visits to the courts;

[44] Men aged 18-64 and women 18-59.

- thanks to waiving the obligation to use electronic signature, more friendly software and the Ministry of Finance's promotional campaign, 5.2 million Poles submitted their annual 2013 tax return in electronic form (1.6 million more than the year before); the Ministry informed that a few tens of thousands of these taxpayers were over 80 years old;
- establishing a limited liability company *via* the Internet in 24 hours (under so-called S24 procedure);
- in 2010 an *e-court* was created at the Regional Court Lublin-West which was granted a nationwide jurisdiction for all electronically-filled cases (mostly payment claims); in 2013 it handled 2.5 million lawsuits.

Encouraging people to work more

Population ageing and the need to increase the participation rate in the labour market were approached from a few different angles. In 2012 the retirement age in Poland was increased to 67 years for both sexes (previously it was 60 years for women and 65 for men). It has been a gradual process: the pension age is extended by 3 months every year. Also Social Insurance Institution (ZUS), a state body responsible for cash social insurance benefits, has been tightening its internal regulations regarding eligibility for disability pensions. As a result, the number of people in Poland who receive those benefits hit an all-time low.

In 2013-2014 access to 140 professions was made easier in Poland as the obligation to pass state exams, obtain licenses, having a prior check of professional qualifications were reduced, as were some educational requirements for candidates and required periods of professional internships. They were mostly legal and financial professions, but also tourist city guides, driving instructors, detectives, architects, taxi drivers, real estate brokers, commercial aviation professionals and railway specialists.

The third deregulation bill regarding some additional 101 professions was sent by the government to Parliament in April this year. Easier access to regulated professions should stimulate competition, help lower prices and make some services more accessible and affordable. It should also attract unemployed people (especially young), as well as people already employed to take up some additional or part-time activities and positions, which should help labour utilization. OECD predicts that productivity will probably also rise in those deregulated professions[45].

In order to discourage unauthorized absence from work, sickness allowances were reduced in 2014 from 100 to 80 percent of wage (the latter being the standard in Poland) for some working groups such previously privileged in this respect (uniformed services: policemen, soldiers, Border Guard agents, but also judges and prosecutors). Also, *electronic sick leave* will be implemented in 2015 to crack down further on short-term sick leaves. Thanks to this

[45] B. Egert, A. Goujard, *Strengthening competition in Poland*, OECD Economics Department Working Papers No. 1125, Paris 2014, p. 29.

solution the employer will know immediately about an employee's illness and could ask ZUS to send him or her for additional medical check-up (currently sick leave certificates in Poland are often sent by ordinary mail, which leaves the employer no time for reaction).

Deregulation: power of small steps

Productivity is a measure of the efficiency with which available resources are used in production of goods and services. Many regulatory changes in Poland are minor, but as they reduce or eliminate non-value added activities and release resources which can be used in a more productive way elsewhere in the economy, they continuously add to the incremental increase in productivity both in private and public sectors. A program of deregulation which was started by the previous government in 2011 resulted in many changes to the existing regulations. Examples with different types of impact:

- many certificates required from citizens in administrative matters that were previously issued by the civil servants (state and regional offices and institutions) were replaced by simple declarations/statements (signed by the citizens themselves);
- financial reporting obligations for the smallest entities (micro-enterprises) were significantly reduced;
- obligatory checkouts at the separated alcohol units in the supermarkets were removed;
- social security reports are now handed over to employees just once a year (until 2013 it was on a monthly basis, which was a burden for HR departments)
- time-consuming price tagging of each item in retail sale has been abolished in 2014

Continuous improvement in the private sector

Polish industry has also undergone significant changes in recent years in terms of increasing physical capital, technology absorption and implementation of good management practice. It was done mostly thanks to foreign investments and positive spillover effects. For example, Polish companies are among the leaders in Central Europe in implementation of *lean management* philosophy which aims to eliminate all forms of waste from the processes in order to maximize efficiency and productivity, improve quality, reduce costs and increase value for the customer. *Lean management* was pioneered by Toyota after World War II, and discovered and further developed by the Western companies in the 1980s. Known for its emphasis on continuous improvement, simplicity, common sense, employee involvement and empowerment, as well as "doing more with less" approach, *lean management* is considered one of the most influential concepts in operations management. In Poland it appeared with foreign manufacturers after 1989, and is now being adopted by the service companies. However, lean thinking is yet to be discovered by other important branches of Polish economy, namely public administration (*lean government*) and healthcare (*lean healthcare*).

Attracting more high value foreign FDI

Much of the R&D activity in Poland is conducted by the transnational corporations (TNCs), which decided to establish their business presence in the country after 1989, very often starting with labour-intensive manufacturing and then moving up the value chain towards more value-added activities. Overall, Poland has been relatively successful in attracting foreign direct investment (FDI). It helped to increase labour productivity, as foreign companies are bigger than their domestic counterparts (such companies are more productive and more innovative due to, *inter alia*, their larger pool of physical and human capital and overall competitiveness stemming from participation in global value chains).

In 2011 the governmental program of investment incentives for investors was overhauled to attract more FDI in the sectors considered to be important for Polish economy: R&D, automotive, electronics, aviation, biotech and business support services. This seems to be a relatively economical way of supporting growth and R&D in particular, as public funding contributes marginally to enterprise research in Poland: 88 percent of R&D activity is financed by companies themselves. Also, public support contributes mostly to low- and medium-tech enterprise expenditure[46].

What is encouraging is that foreign R&D centers in Poland are growing by themselves. For example, General Electric's Engineering Design Center in Warsaw, established in 2000 with just 5 employees, currently employs 1600 engineers. Also, being a regional hub for business process outsourcing (BPO) and information technology outsourcing (ITO), Poland now attracts more investment which require higher qualifications (knowledge process outsourcing). An excellent example is a McKinsey's knowledge center for Europe, Middle East and Africa established in Wrocław.

[46] N. Kapil, M.Piatkowski, I. Radwan, J J. Gutirrez, *Poland - Enterprise innovation support review: from catching up to moving ahead*, World Bank 2013, pp.4, 34.

Sweden

Swedish economy and productivity[47] - Swedish productivity at a glance

Sweden is a diversified, export-oriented economy. Traditionally, timber, hydropower and iron ore has constituted the resource base of the Swedish economy. Today the Swedish economy is more oriented toward high technology and engineering. Telecommunications, electronics, and the pharmaceutical and chemical industries are the main branches of the manufacturing industry.

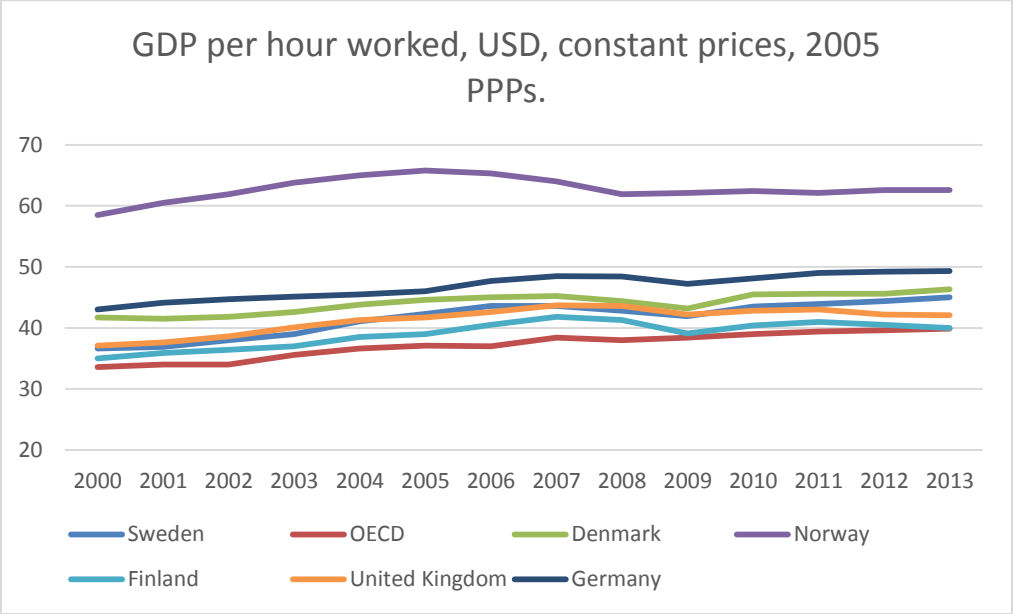
The service sector is also of great importance – every other Swedish employee can be found in the private service sector. One third is working within the public sector, and 12 per cent in the industrial sector. 2 per cent work with forestry, fishing or agriculture. The only sector currently growing is the private service sector.

The Swedish Institute of International Affairs points out that during much of the 20th century, Sweden was often associated with a large public sector, high taxes, and a low degree of differences in income. The standard of living was among the highest in the world, as with the per capita GDP. Beginning in the 1970s and culminating with the deep recession of the early 1990s, Swedish standards of living developed less favorably than in many other industrialized countries.

From the mid-1990s, radical measures were carried out in order to create a balanced budget and break the trend of a growing national debt. The rehabilitation of the economy led to lower interest rates and increased real wages, due to low inflation.

In 2006, the new Centre-Right Government began to implement its program of income tax cuts for workers and stricter policies in the social welfare system. The Government also carried out major sales of state companies.

[47] The Swedish Institute of International Affairs (2014). Government Offices of Sweden. OECD (2012). *OECD Economic Surveys: Sweden*. Government Offices of Sweden (2008). *Sveriges ekonomi. Scenarier på lång sikt*, SOU 2008:108 (*The Economy of Sweden. Long-term future scenarios*). Statistics Sweden, Labour Force Survey.



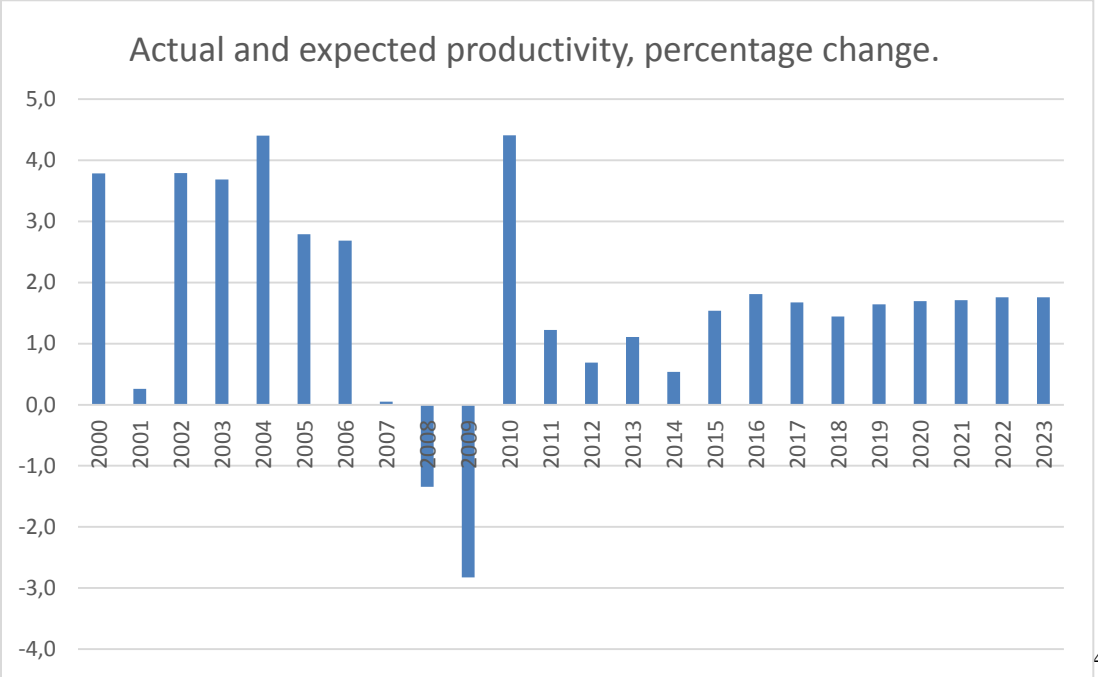
[48]

During the international financial crisis in 2008, unemployment soared, investment fell and interest rates were at an all-time low. Growth was negative; GDP fell by almost 5 per cent in 2009. The Swedish Government gradually increased grants to municipalities and took other labour market initiatives, and the curves started to turn upward. A contributing factor was the tight fiscal policy from the 1990s, and the budget surplus that existed before the crisis. The present situation is characterised by low public debt, high per capita income and a stable GDP growth rate.

The productivity development has shown a steady growth. One important reason is the significance of the telecom industry. Historically, the knowledge-intensive manufacturing industry has taken the lead, whilst some parts of the service sector (educational and health services) and the construction industry have presented a weaker productivity increase.

This difference will persist in the future, according to The National Institute of Economic Research (Konjunkturinstitutet). The highest growth rate will continue to be among the knowledge-intensive parts of the manufacturing sector, while the service sector will show a slower productivity growth. Since the Institute's future scenario anticipates a growing service sector, it might have a dampening effect on aggregate national productivity.

[48] OECD (2012). *OECD Economic Surveys: Sweden*.



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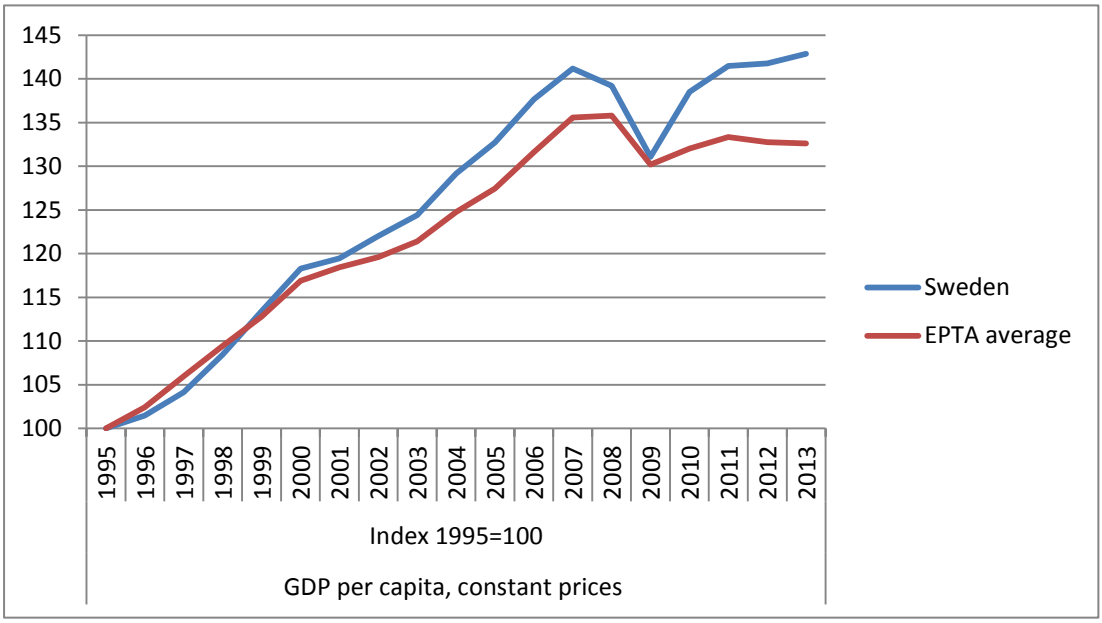


Change in Swedish GDP compared to EPTA average[50]

[49] National Institute of Economic Research (2014). *Swedish Economy August 2014*.
[50] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Productivity challenges[51] – Low growth in local services and the public sector

McKinsey Global Institute (MGI) has published an analysis of the status of the Swedish economy. The report brings attention to some productivity problems. Even though the main conclusion is that the economy is strong, MGI points at a number of challenges. For example, it is only the international sector and manufacturing industry that has experienced a strong growth. Growth in the Swedish local services sector has only been in line with the EU-15, while the Swedish public sector has experienced a negligible growth in its value added in the same period.

This is worrying, says MGI, especially as these sectors together account for about two thirds of the Swedish economy. There are also a number of concerns about Sweden's long-term growth outlook, such as the increasing competition from emerging economies, the declining quality of the Swedish education system and an ageing population.

One important measure, according to MGI, is to increase productivity in the public sector. MGI expects that the productivity in the public sector could be raised by 25–30 per cent over the next ten years. Key elements include more ambitious targets, greater transparency on results, consolidation of Sweden's public administration structure (primarily the municipalities) and a national centre of excellence for public procurement.

Another step, as said by the MGI report, would be to sustain the high growth in the international sector through increased innovation productivity. Competition from companies in emerging markets is increasing rapidly, as is the pace of innovation globally. Sweden should therefore ensure that it maximizes the return on its R&D investments by becoming a leader in innovation productivity in the same way as it has become a leader in production efficiency in many industries.

Except from these measures, MGI recommends three more solutions. First, improved growth in the local services sector through a second wave of deregulation and regulatory reforms. Second, actions to improve the Swedish school system. Third, increase the share of the population in employment.

According to MGI, Sweden's stable fiscal position gives it a good opportunity to build an even stronger foundation for robust future growth over the next few years. Sweden also has a culture of consensus and less political tensions than many other countries, which, if this tradition is maintained, should improve the prospects of finding pragmatic solutions.

[51] McKinsey Global Institute (2012). *Growth and renewal in the Swedish Economy. Development, current situation and priorities for the future.*

Technology trends and policy initiatives

Steps toward increased productivity[52]

The recently resigned Centre-Right Swedish Government has taken several measures in order to try to improve the nation's productivity. Above all, the intention has been to create favourable conditions for competition, research, innovation and learning. According to the Government, a high degree of competition increases productivity, which leads to new products and services as well as new companies and sectors. Thus, increased competition creates employment and growth. The aim has been to make it easier for new companies, for example by reducing the corporate and payroll taxes and by making the registration process of limited liability companies faster. New markets have been opened up for competition, e.g. education, health care, transports and pharmacies.

Mobility and flexibility are necessary conditions for competition. Investments in infrastructure – motorways, ring roads and railways – are intended to facilitate travel between home and work, as well as the transportation of goods and commodities. A program for housing is supposed to increase choice and improve the ability to move for education or work.

Different arrangements to improve the conditions for entrepreneurship have been made to help the Swedish economy remain competitive. These includes a reduction of administrative obligations for businesses, improvements in the social security system for self-employed, as well as encouragements and incentives for women and immigrants to become entrepreneurs.

The Ministry for Enterprise, Energy and Communication asked OECD for a review of the Swedish innovation policy[53]. One of the major threats identified by OECD was a failure to maintain productivity growth. OECD identifies a number of problems within the Swedish education and research system.

National strategy of innovations[54] – A better Climate for Innovation

A national strategy of innovation was launched by the former Government in 2012. Increased productivity is a prerequisite for growth and welfare and will be achieved by a "world-class" innovation climate. This climate will be realised by identifying obstacles to innovation, by protecting and developing strong areas and by improving coordination between different policy areas. This is particularly important for a country like Sweden, an export-oriented economy with a relatively limited domestic market.

[52] Government Offices of Sweden (2014). *The Government's policy for enhanced competition* (www.government.se/sb/d/13166/a/145853).
[53] OECD (2013). OECD Review of Innovation Policy: Sweden 2012.
[54] Government Offices of Sweden (2012). *The Swedish Innovation Strategy*.

The strategy highlights the growing importance of small companies within the private sector, as well as knowledge-intensive goods and services.

The strategy is intended to achieve three main goals:

- Meet global societal challenges.
- Increase competitiveness and create jobs in a global knowledge economy.
- Deliver public services with increased quality and efficiency.

The new Social Democratic/Green Government (October 2014) will probably continue along the same lines. The new prime minister wants to establish so called "innovative councils" in order to increase collaboration between research, business and the public sector. Also, one of the ministers in the new Government is called the minister of industry, trade *and innovations*, which might be interpreted as a substantial interest in the field.

The Government's research and innovation bill[55]

The research and innovation bill of the former Government (2012) stresses the utilisation of research-based knowledge as a way to increase the competitiveness and productivity.

According to the Government, innovation strengthens the productivity and competitiveness of the Swedish business sector while the utilisation of research-based knowledge contributes to development and efficiency. Increased cooperation between different stakeholders, such as higher education institutions, trade/industry and research funders, can help improve the effectiveness of the utilisation.

The former Government has identified a number of areas where targeted research initiatives are needed. The initiatives should focus on research that maintains a high scientific standard and takes account of the need for long-term competence-building. The selected areas are:

- Mining
- Minerals and steel
- Forest products and biomass
- Sustainable urban management
- Infections and antibiotics
- Ageing and health

Sweden is one of the countries that invest most public resources in research, relative to its population. The last decade has shown an even more extensive resource increase. In 2014, publicly financed research constitutes 1.06 per cent of GDP.

In 2001, the Government established an innovation agency, Vinnova. Vinnova promotes collaborations between companies, universities, research institutes and the public sector by

[55] Government Offices of Sweden (2012). Research and innovation. A summary of Government Bill 2012/13:30.

stimulating a greater use of research, making long-term investment in strong research and innovation milieus and developing meeting places.

Not on top

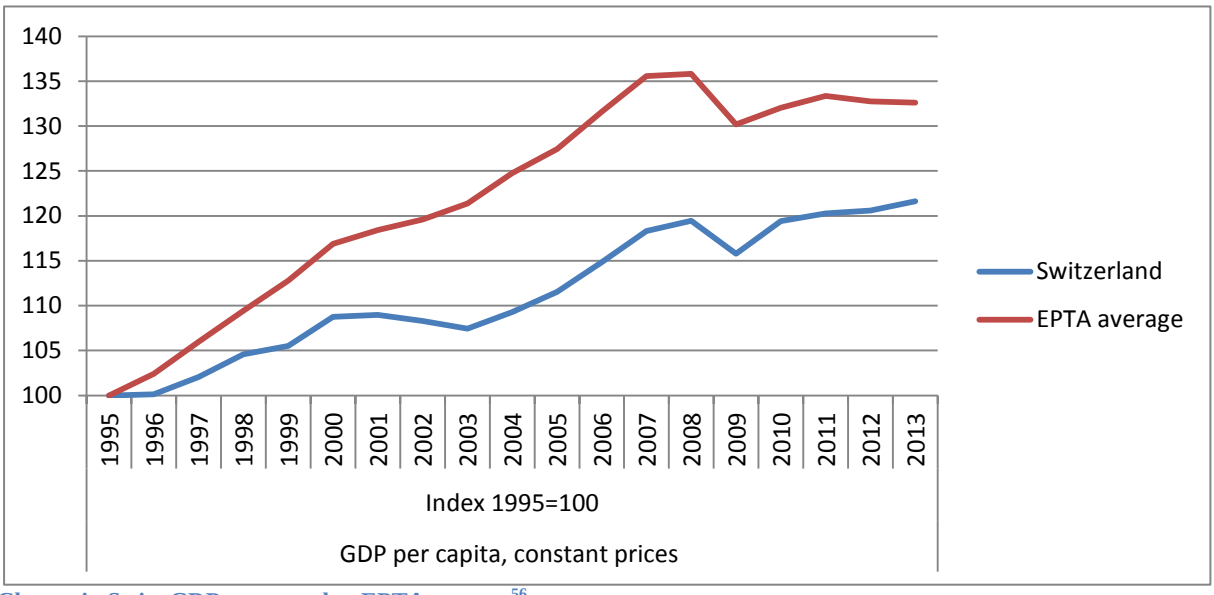
To summarize, in Sweden there is a general awareness of the importance of an increasing productivity. Still, productivity is not on top of the list when it comes to economic worries. More attention is brought to, for example, household debts, a vulnerable banking system, weaker export markets due to international insecurity, the question of future pensions, and the increasing economic inequalities.

Switzerland

Swiss productivity at a glance

In absolute terms, Switzerland currently lies in third position in the 2013-OECD ranking of productivity, with a GDP of US$ 54,133 per capita, after Luxembourg (US$ 90,457) and Norway (US$ 65,515). Compared to other countries, the Swiss productivity rate increased only moderately since 1995 (see graph), but it was already on a high level (3rd after Luxembourg and the United States) at the beginning of the time interval considered. The productivity growth was stable and only little affected by the financial crisis; the unemployment rate rose to a peak of 3.7 percent (2009) and is now at 3.0 percent.

But this focus on GPD may be limited. Other indicators, e.g. the Global Competitiveness Index of the World Economic Forum provide a larger view. It measures not only the output in terms of money, but, in a future-oriented view, it assesses competitiveness as the set of institutions, policies, and factors that determine the level of productivity in a country. For this purpose 4 factors are considered in addition to 8 economic variables: Institutions, infrastructure, health and primary education, and higher education and training. Switzerland holds the first position in the 2014–2015 ranking, followed by Singapore and the United States.



Change in Swiss GDP compared to EPTA average[56]

[56] Source: OECD, http://stats.oecd.org/index.aspx?queryid=559

Productivity challenges

Switzerland – an island in Europe?

Switzerland is not a member of the European Union, but is surrounded by EU countries. So far, this has been no problem, because the relations of Switzerland to the EU are governed by a whole structure of bilateral agreements concerning important domains such as free trade (1972), free movement of persons (1999) and research (1999).

Because of the importance of R&D, engineering, and high-tech industry for the Swiss economy, Switzerland is dependent on highly-skilled manpower. In some areas, such personnel are already scarce. In the past years, this shortage could be compensated for by immigration, mainly by specialists coming from EU countries. But the restriction of immigration – which currently is high on the Swiss political agenda – may threaten productivity growth in the future and cause higher labor costs. During the last decade, the real wage growth rate in Switzerland has been only moderate with an average of 0.7 percent per annum.

Too many regulations

Switzerland's burden of regulations has increased markedly over the years, threatening competitiveness and productivity growth. Each year, an additional 7000 pages of new requirements are added to the federal rule book. And that's excluding all the separate measures being added by individual cantons and municipalities, not to mention regulators like Finma (financial markets), ElCom (electricity), or the Competition Commission.

Attempts to stem the regulatory tide have so far proved ineffective. A regulatory reassessment, introduced under the revision of the Federal Constitution has been shown to be of limited practical value. In the view of the Swiss think-tank Avenir Suisse, three factors explain why new rules and regulations keep coming. First, there is an inherent conflict of interest: bureaucrats abolishing rules risk putting themselves out of business. Secondly, globalisation has boosted the regulatory burden via ever more international treaties. And thirdly, for companies, regulations can actually be a blessing in disguise by creating additional barriers to new entrants.

In its discussion paper of September 2014, Avenir Suisse proposes some practical measures to tackle the regulatory fever. The top three are: (1) A preliminary regulatory «Quality Check». The impact of new regulations in Switzerland is often assessed relatively late, via elaborate and expensive means. Introducing an early, simple and standardised cost benefit analysis, in the form of a «Quality Check», would help greatly. (2) An independent assessment unit. Entrusting quality checks to an independent entity would avoid bureaucratic conflicts of interest. The Netherlands has already moved in this direction with its independent Advisory Board on Administrative Burden (ACTAL). Britain, Sweden and Germany have similar set-ups. (3) Introducing a «regulatory brake». Ceilings could be put on the amount of new rules being implemented and limits defined on the extra administrative burden on companies.

An ageing population and a shrinking workforce

The Swiss population is ageing. Life expectancy at birth rose from 72.4 to 80.5 years for men and from 79.2 to 84.8 years for women in the time period between 1981 and 2013; it is now one of the highest worldwide. But the retirement age for men remained unchanged (65 years) and the retirement age for women rose from 62 to 64 years between 1981 and now. This will cause a decreasing ratio of the working population to those outside the labor force.

To maintain the workforce on a level required by the economy, the Federal Department of Economic Affairs, Education and Research has launched the «Fachkräfteinitiative» (initiative for qualified employees). It's goals are as follows: (1) Promotion of qualification; (2) Promotion of innovation to alleviate the effects of scarce workforce, (3) Improvement of the working conditions for elderly employees, and (4) Improvement of the compatibility of family and occupation.

In September 2014, the government confirmed these goals and commissioned the administration to implement them in collaboration with professional associations. The Swiss Business Federation Economiesuisse issued new guidelines on education, research and innovation in October 2014. Concerning innovation, it recommends to keep the labor market open for qualified employees and to stimulate activities in the private sector instead of government planning by industrial policy.

Technology trends and policy initiatives

Promotion of innovation: Example energy research

As the Swiss Confederation's innovation promotion agency, CTI lends support to R&D projects, to entrepreneurship as well as to the development of start-up companies. CTI helps to optimise knowledge and technology transfer through the use of national thematic networks. Support is generally available for R&D projects relating to scientific innovations in all disciplines.

Project proposals are submitted using the bottom-up principle and are mainly selected on the basis of their innovativeness and market potential. As an example, the efficiency of renewable energies must be increased and new opportunities in this area must be exploited, because government and parliament have decided to phase out nuclear power by 2035. The government intends to boost energy research under the «Coordinated Energy Research in Switzerland Action Plan». The key element in this plan involves setting up inter-university research networks. This task has been given to the CTI, with the support of the Swiss National Science Foundation.

Productivity in health care: E-Health-Strategy, electronic health records, and robotics

The digitalization of health services promises large gains in productivity. A coordination body called «E-Health Switzerland» has been created to implement the goals of the «Swiss E-Health Strategy», i.e. to introduce electronic health records and to promote online-services, including telemedicine. This effort is necessary, because in Switzerland, the competence for organizing the healthcare system lies with the 26 cantons and not at the federal level. Federal authorities only set the legal framework in certain domains.

The advantages of information and communications technology (ICT) can only be realized if compatibility of the systems is given, but the coordination of the cantonal systems makes the proceeding complicated and slow. At least, a new federal law concerning electronic patient records is under way. One chamber of parliament, the Council of States, has already approved it in June 2014. Robotics may contribute to more efficiency in health care in the long run, but as the TA-SWISS study «Robotics in healthcare and support care» (2013) shows, the use of such devices is limited at the moment by high costs, lack of liability regulations and lack of acceptance among staff.

Industry 4.0

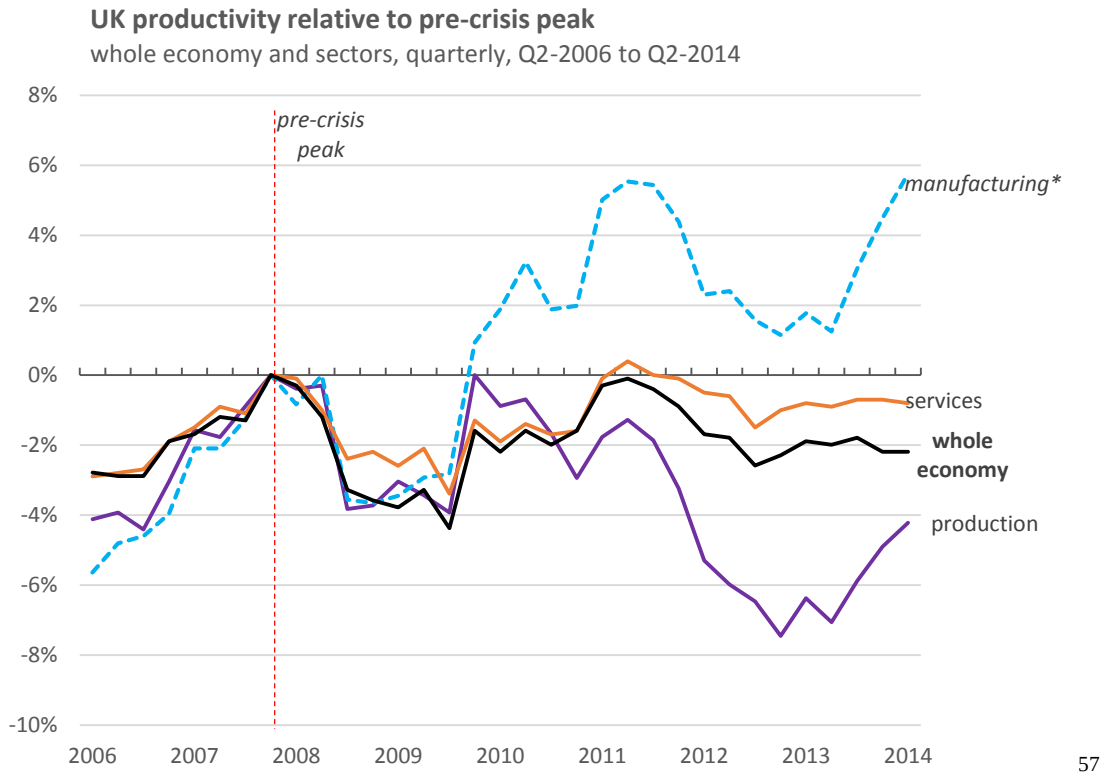
The integration of digital processes and production, also called smart manufacturing, is widely recognized as the next big step in the industrial world. It will be important for any production process – independent of the size of a company. A considerable customization of products and a highly flexible scale of production will be possible. Small and medium enterprises, which are very important in the Swiss industry, should also get access to these technologies, although they often have a comparably low R&D budget. Thus new promotion initiatives would be very welcome in a phase of technology development that is not covered by such supporting measures so far, because it lies in the gap between basic research (supported by the Swiss National Science Foundation) and the commercialization of prototypes (supported by the innovation promotion agency CTI).

United Kingdom

UK productivity at a glance

The UK has the third largest GDP in Europe. The latest data from the UK Office of National Statistics (ONS) estimates that: following the 2008 financial crash, the UK economy shrank by 6%; in 2013 the UK economy grew by 1.7%, reaching pre-financial crash levels; and in 2014 the UK economy will grow by 3.2%, and is now 2.7% larger than before the downturn.

Following the 2008–09 recession, productivity across the whole UK economy fell (see chart below). More recently, despite the strong recovery in output, productivity has stagnated, and across the whole economy, it remains 2.2% below its pre-recession peak in Q2 2014 (the latest data available). There are differences between the major sectors, however: productivity in the manufacturing sector is now well above its previous peak, while in the production sector as a whole (including mining, and electricity, gas and water supply), it is substantially below its previous highs.



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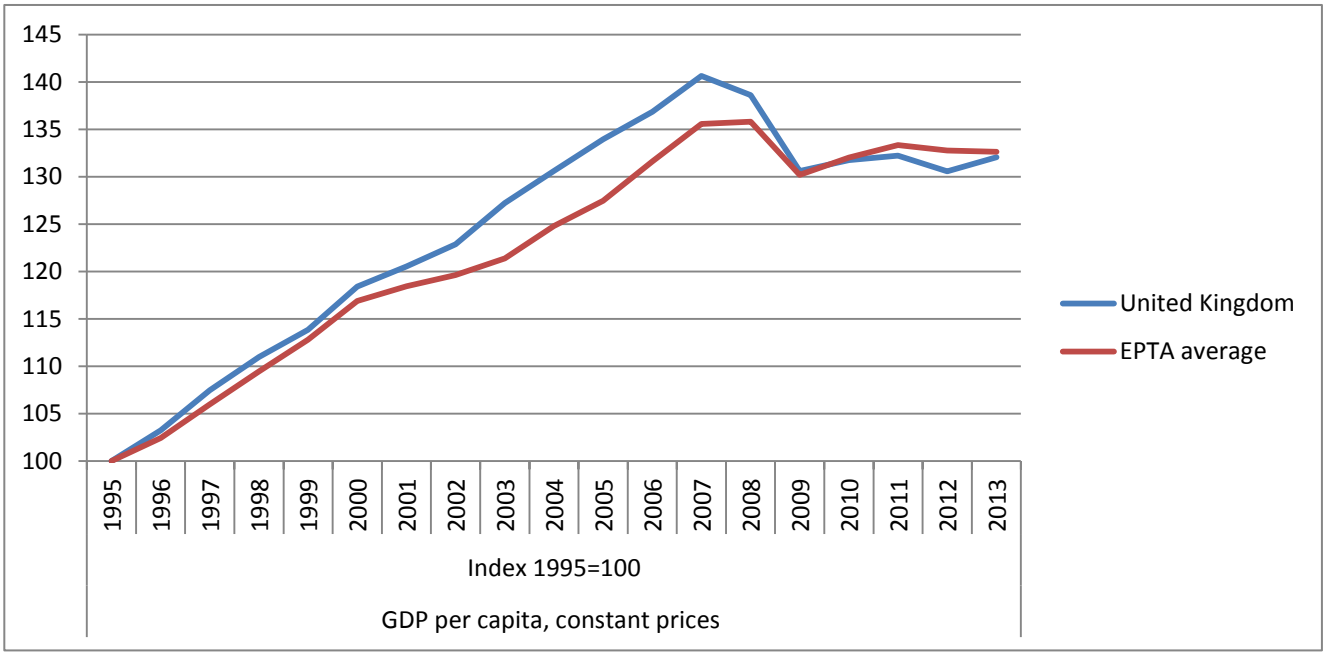
[57] Source: ONS, Labour Productivity Q2-2014 dataset



Change in UK GDP compared to EPTA average[58]

Productivity challenges

Explaining the trends

The failure of productivity growth to resume or return to its pre-crisis rate is often termed the 'productivity puzzle'. In one sense, there is no puzzle at all: the fact that productivity is stagnating follows mathematically from the growth in labour input outpacing output growth. The 'puzzle' lies in the fact that recent trends are unusual. Until the 2008–09 recession, productivity had risen steadily in the UK for at least forty years. If productivity growth had maintained its pre-crisis trend, rather than stagnating as it has done, it would be 16% higher than it is now.

A number of explanations have been put forward for the UK's weak productivity performance. They are not necessarily mutually exclusive and fall into three broad categories.

1. **Mismeasurement of output** may have exaggerated the extent of the weakness. Recent GDP revisions have painted a slightly better picture of productivity trends.
2. **Cyclical patterns of productivity** may explain some of the weakness. This may be because firms held on to staff during the recession in an expectation of a recovery in demand; in effect, they were oversupplied with labour. As demand picks up, these excess workers will be put to better use and become more productive. In this case, as

[58] Source: OECD, http://stats.oecd.org/index.aspx?queryid=559

this spare capacity is used up, productivity may in the future grow more quickly than its pre-crisis rate and make up some of the ground 'lost' since 2009.

3. **Structural issues** might explain some of the weakness in productivity; in effect, certain factors may have disrupted the capacity of the economy to supply goods and services, by causing an inefficient allocation of resources. This may have occurred, for instance, because economic uncertainty caused firms to be firms more cautious when investing, or because the financial system impaired the movement of resources across the economy. In this case, even though productivity growth may return to pre-crisis trends, some of the productivity 'lost' may never be made up.

Regional productivity

London has the highest level of productivity of any region or country in the UK, 31% higher than the UK average in 2012. The only other region with productivity above the UK average in 2012 was the South East (8% above the UK).

In 2012, four regions or countries (Scotland, North East, Wales and the South East) had lower levels of productivity then they did in 2007 relative to the UK. The largest relative fall between 2007 and 2012 was in the Yorkshire and the Humber region.

Technology trends and policy initiatives

Eight Great Technologies

A key part of the Government's Industrial Strategy is supporting technologies where the UK has the depth of research, expertise and the business capability to develop and exploit commercially. In 2012, the Government set out 'eight great technologies' to address challenges such as climate change, energy storage, food production and population growth. These included big data and energy-efficient computing, satellites and commercial applications of space, robotics and autonomous systems; synthetic biology, regenerative medicine, agri-science, advanced materials and nanotechnology, and energy and its storage. It set out expenditure of £600 million (additional to the £4.6bn ring-fenced for R&D) and policies to support research, development and commercialisation in these areas. The Government recently consulted on proposals for long-term capital investment in science and research.

Tax Relief for Research and Development

The UK forgoes more than £1bn of tax income in credits paid to firms claiming for eligible R&D investments, but their effectiveness is disputed in terms of how much actual additional R&D investment they generate and because they are not focused on public priorities and major societal challenges. The James Dyson report recommended refocussing the tax credits to high technology manufacturing firms and smaller companies, but the UK government has only amended the scheme to increase the benefits for SMEs.

The Translation Problem

Innovate UK is the Government agency responsible for translation of research and development in: agriculture and food; emerging technologies; health and care; space applications; built environment; enabling technologies; high value manufacture; transport; digital economy; energy; resource efficiency; and, urban living. A mixture of different approaches is being used including:

- **Catapult Centres** are a network of technology and innovation centres that provide locations for businesses and academic researchers to work together in a 'critical mass of expertise' to commercialise product and service innovations. At present, seven centres have been set up on high value manufacturing, cell therapy, offshore renewable energy, satellite applications, connected digital economy, future cities and transport economies.
- **Small Business Research Initiative** supports small and medium-sized enterprises (SMEs) to develop of innovative products and services through the public procurement of research and development. This is a more modest version of the much larger US Small Business Innovation Research programme. It was criticised by the House of Commons Science and Technology Committee for failing to assist companies to gain Government commercial contracts. **Catalysts** provide research and development funding on a competitive basis that focuses on in priority areas where the UK research base has a leading position and where there is clear commercial potential and are jointly funded by the Research Councils and Innovate UK. At present, there are four catalysts on Agri-tech, Biomedical, Energy and Industrial Biotechnology.
- **Launchpads** help technology-themed clusters of young, early-stage companies to develop and grow in specific locations around the UK. There have been seven Launchpad competitions so far based on different technologies including: the internet of things; London techcity; materials and manufacturing North-west; Harwell space; Digital and Creative Clyde; Motorsport Valley and Greater Manchester Creative and Digital. Severn Valley Cyber Launchpad is in the process of being developed.

Advanced Manufacturing

One area of focus for the UK Government has been Advanced Manufacturing. Innovate UK has identified high value manufacturing as one of its 'priority areas'. £72 million has been allocated this year to help businesses innovate and grow in this area. This money is split across: the High Value Manufacturing Catapult, the Bio-technology Catalyst, the North East cluster in process industries, feasibility studies and various collaborative R&D programmes.[59]

These projects aim to increase the role that manufacturing plays in the growth of the economy and are complementary to the Advanced Manufacturing Supply Chain Initiative (AMSCI). In

[59] www.innovateuk.org/high-value-manufacturing

this fifth round of AMSCI, £100 million will be allocated to companies to help them strengthen their domestic supply chains and help bring manufacturing back to the UK. Four previous rounds of funding secured nearly £500 million of public-private investment to 44 projects including more than 180 organisations, directly creating or safeguarding more than 15,000 jobs.[60] For example, previous recipients of funding from the Advanced Manufacturing Supply Chain Initiative (AMSCI) included technology for increasing the scale of 3D printing of metals; and reshoring the manufacture of cats' eyes from overseas to the UK.

Government as a Customer

Public bodies in the UK spend approximately £200 billion on goods and services from the private sector each year. One of the major public bodies for this expenditure, is the National Health Service. The House of Commons Science and Technology Committee has recommended that a significant proportion of the NHS procurement budget should be made accessible to small innovative companies and that NHS Trusts should be incentivised to engage with SME companies for innovative technology solutions such as integrated care supported by telehealth and telecare. It also recommended that a Minister in HM Treasury be given responsibility for the delivery of procurement-driven benefits. However, outside of defence, pharmaceuticals and medical technologies it remains unclear the extent to which this can be balanced against the competing objective of delivering value for public expenditure.[61] Finally, the Government is making NHS (medical records) and administrative data available to researchers in an anonymised form to encourage innovation.

[60] www.gov.uk/government/news/vince-cable-100-million-to-support-domestic-supply-chains-and-create-new-jobs
[61] Uyarra, E.; Flanagan, K, 2010, Understanding the Innovation Impacts of Public Procurement European Planning Studies,18(1):123-143

United States

U.S. productivity at a glance

U.S. productivity has grown steadily for the past two decades, except for the downswings after the "dot-com" bubble in 2001 and the global economic and financial crisis of 2008. In recent years, after reaching a low point in 2009, productivity has picked up again, currently growing above the pre-2008 highs. Recently, the unemployment rate dropped below 6% for the first time since surging to over 10% in the wake of the 2008 recession.

Over the long run, a boom in consumption spending has fed the U.S. economic growth. The U.S. GDP grew at an annual rate of about 2% during the past two years and it is now expected to be reaching a 3% growth rate. However, the wages have not grown fast enough and job creation has been at the extreme skill levels -- either low-skilled jobs or ones for the highly educated. Poor job creation and flat wages are holding back consumer spending, which can be a problem for the U.S. economy because of its dependence on consumer spending.

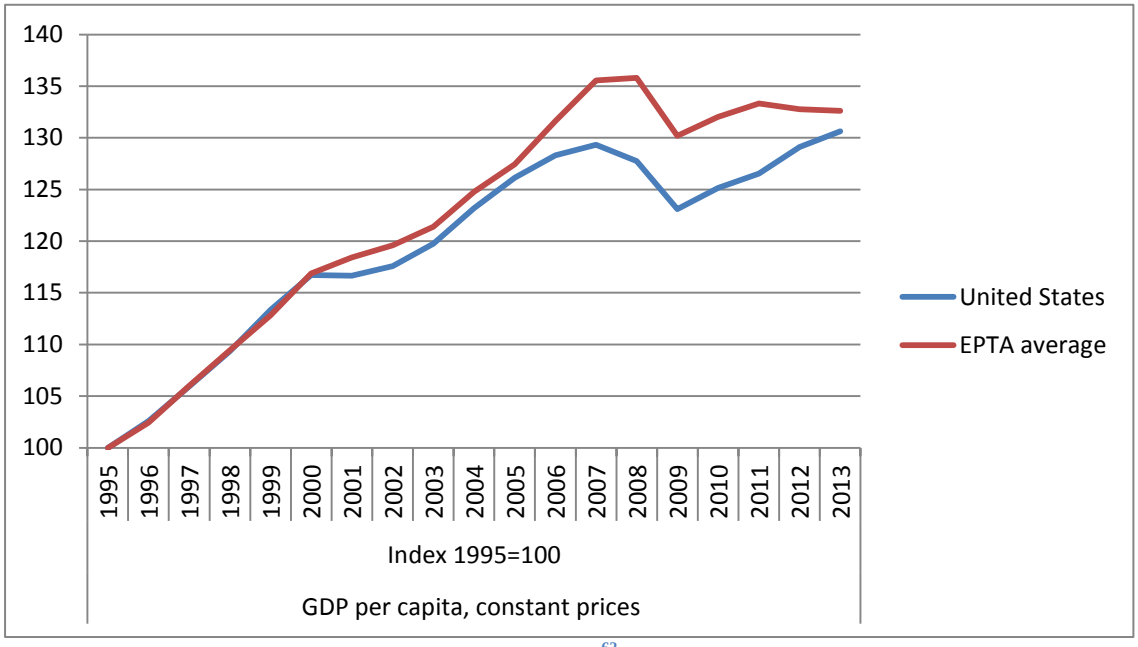


Figure 1: U.S. GDP per capita compared to EPTA average[62]

[62] Source: OECD: http://stats.oecd.org/index.aspx?queryid=559

Recent economic developments point to a shift towards increased spending by firms on facilities and big-ticket equipment. This could be sign of sustained economic growth as well as improved productivity. Increased job openings coupled with low unemployment rate could force companies to raise wages as they compete for a smaller pool of workers, which could, in turn help sustain the economic recovery.

Productivity challenges

Underemployment
Although U.S. national unemployment rate has gone down and productivity continues to improve, there is significant *underemployment*, which refers to the percentage of population that includes the unemployed as well as those not seeking employment and those employed part-time for economic reasons. Some of the underemployment is caused by the bifurcation in the job market with low-paying service jobs on one end and high-paying jobs requiring higher education and skills on the other end, with not many jobs in between.

Student loans
Higher education provides a path to high-paying jobs that require advanced skills, but increasing student loan debt levels pose a problem. In the United States, over 70 percent of bachelor's degree students in 2014 had student loan debts, each with an average debt of over $30,000. Over a four year period, from 2008 to 2012, this debt load increased at an average rate of 6% each year. For many professions, the wages are not rising fast enough to counter the increasing debt load. As a consequence of high student loan debt, it is less likely that young professionals will get mortgages and buy houses. This, in turn, may adversely affect the housing market, which is a significant part of the U.S. economy.

Technological advances
The U.S. economy is also in the midst of changes brought about by technological advances, especially advances in computing and information and communication technology (ICT) that promise to boost economic output and productivity, but may do so in a disruptive manner whose effects will take some time to settle down. These technological advances are bringing about new business models and helping economic growth, but creating lesser number of jobs with different skill requirements than before.

For example, new technology companies such as Facebook or Twitter do not create as many middle-class positions as earlier ones such as Microsoft or Apple did. Other new ICT-enabled businesses such as Zillow, Uber, and Airbnb are respectively changing the traditional business models of how we find houses to buy, get rides around town, or rent apartments. These new ways of doing business promise economic growth and also provide employment opportunities, but potentially in different ways than previously expected -- destroying jobs in some sectors while creating new ones elsewhere. The new jobs are fewer in number and

require higher skills, especially in the areas of science, technology, engineering, and mathematics (STEM).

STEM
Workers with STEM skills are necessary for innovation and productivity growth, but not enough Americans are studying STEM to meet the economy's needs. Less than 20% of students study undergraduate STEM and the percentage of students intending to study computer science has been dropping over the past ten years; yet studying computer science is critical for the ICT-driven economy of the future.

Technology trends and policy initiatives

Science, technology, and innovation play a big part in the U.S. economy. Consequently, the U.S. federal government has a wide range of initiatives to enable innovation and productivity improvements that support economic growth and job creation, including programs to create a strong science and engineering workforce and improve STEM education. The U.S. Congress plays a crucial part in federal science, technology, and innovation policies; by authorizing programs, providing funding, and conducting oversight activities. Although the complete list of federal government initiatives and programs are too long to enumerate, a number of structural changes and government initiatives are worth citing since they relate to improving U.S. economy and productivity.

Increasing energy production
The U.S. has been going through a dramatic increase in domestic energy production combined with a shift in the use of energy that represents an important opportunity for the economy. According to the 2014 *Economic Report of the President*, current projections indicate that the United States became the world's largest producer of oil and gas in 2013, exceeding both Russia and Saudi Arabia.

Domestic production of crude oil rose above imports in October 2013 for the first time since 1995, and further increases in domestic production and reduced oil imports are expected in the coming years. Natural gas production also continued to rise in 2013 from the 2012 record high and is up more than 20 percent over the past five years. Electric power generation is changing over from coal to natural gas, which was responsible for 27 percent of our overall energy consumption in 2012, up from 24 percent in 2008. This structural change in energy production and use is beneficial not just for the economy, but also for America's security and climate, and should support growth on a sustained basis into the future.

Accelerating advanced manufacturing
Manufacturing is about 13% of the U.S. GDP and as such a significant driver of economic growth. For every dollar spent in manufacturing, another $1.32 is added to the economy,

which is the highest multiplier effect of any economic sector. The U.S. federal government has a number of initiatives to reinvent the American manufacturing sector.

For example, the U.S. Department of Energy has a *Clean Energy Manufacturing Initiative* and an *Innovative Manufacturing Initiative* to support the American manufacturing sector and double U.S. energy production by 2030. These initiatives provide guidance and resources, including funding, to advance technologies aimed at helping U.S. manufacturers improve energy efficiency of their manufacturing facilities, lower costs, and develop new manufacturing technologies.

Additive manufacturing (also known as 3D printing) is a simple twist on building products where, instead of machining away parts that are not needed, a product is built layer-by-layer, by adding only the material that is needed. That small change portends massive changes in manufacturing, speeding up production, making it easier to build customized, complex parts, and changing the paradigm from "manufacturing products in a factory and shipping them around" to "shipping the designs around and building products everywhere." In 2012, the U.S. federal government established the National Additive Manufacturing Innovation Institute (NAMII), now called *America Makes*, with $50 million initial funding to accelerate the adoption of additive manufacturing technologies in the U.S. manufacturing sector and to increase domestic manufacturing competitiveness.

Another federal initiative called, *Materials Genome Initiative*, aims to promote discovery, manufacture, and deployment of new materials. Since the launch of this initiative in 2011, the Federal government has invested over $250 million in new research and development (R&D) and infrastructure to increase the use of advanced materials in existing and emerging industrial sectors in the United States.

Expanding broadband Internet access

The telecommunications industry in general, and broadband wired and wireless Internet access, in particular, are important for fostering productivity growth because widely accessible broadband communications networks, coupled with ICT, enable important technological advances in business, health care, education, citizen services, entertainment, and much more.

The U.S. has the most 4G wireless broadband services such as Long Term Evolution (LTE) in the world and it is one of the top countries when it comes to the amount of currently licensed spectrum available for mobile broadband. This mobile broadband infrastructure is at the heart of an ecosystem of smartphone design, mobile applications development, and use of mobile technologies that promotes innovation and economic growth. Wireless and mobile Internet connectivity is also ushering in an era of Internet of Things (IoT) that's bringing about smart utility meters, road traffic sensors, robots, autonomous vehicles, unmanned aerial systems, agricultural equipment, household appliances, and more. These new technologies are widely predicted to bring about profound changes in how we work and live. They also raise policy

questions covering issues such as employment, training, education, privacy, cybersecurity, and R&D.

Federal government is supporting innovation and investment in telecommunications through direct R&D funding, promoting private investments through the *Research and Experimentation Tax Credit*, and making more spectrum available either by reallocating spectrum used by federal agencies as well as making more unlicensed spectrum available for unlicensed wireless devices.

Improving nanomanufacturing competitiveness

Nanotechnology refers to the science, engineering, and applications that harness the unique physical, chemical, and biological properties of nanoscale (billionth of a meter) materials in new and useful ways. United States began the world's first national nanotechnology program in 2000 and through 2013 the federal government invested approximately $17.9 billion through the U.S. National Nanotechnology Initiative (NNI). Besides the federal government, U.S. companies and state governments have invested billions more on nanotechnology.

In 2013, U.S. GAO had conducted a forum[63] on *nanomanufacturing*, a nanoscale manufacturing technology that is now in its formative phases but that many expect to grow in the years ahead. Experts said that the United States likely leads in sponsorship and overall quality of nanotechnology R&D today as well as in some areas of nanomanufacturing—for example, nanotherapeutic drug development and the design of semiconductor devices. But they cautioned that the United States faces global competition and is struggling to compete in some industry areas (notably, advanced batteries).

Challenges facing U.S. nanomanufacturing include (1) U.S. funding gap in the middle stages of the manufacturing-innovation process; (2) lack of commercial or environmental, health, and safety (EHS) standards; (3) lack of a U.S. vision for nanomanufacturing; (4) extensive prior offshoring in some industries, which may have had unintended consequences; and (5) threats to U.S. intellectual property.

Forum participants suggested that U.S. nanomanufacturing competitiveness can be improved by one or more of the following actions: (1) strengthen U.S. innovation by updating current innovation-related policies and programs, (2) promote U.S. innovation in manufacturing through public-private partnerships, and (3) design a strategy for attaining a holistic vision for U.S. nanomanufacturing. Key policy issues include the development of international commercial nanomanufacturing standards, the need to maintain support for basic research and development in nanotechnology, and the development of a revitalized, integrative, and collaborative approach to EHS issues.

[63] NANOMANUFACTURING: Emergence and Implications for U.S. Competitiveness, the Environment, and Human Health, GAO-14-181SP (Jan 31, 2014). http://www.gao.gov/products/GAO-14-181SP

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