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The Impact of Research on Greek Economic Growth

German Institute for Economic Research
DIW Econ

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Executive Summary

Technological progress and innovations are key drivers for sustainable economic growth in developed economies. But the Greek economy lacks crucial innovative and internationally competitive industries and large enterprises with high value added and sophisticated jobs. This is in stark contrast to the rich intellectual and scientific potential of the country. Instead, the Greek economy is to a large extent based on less knowledge-intensive service activities in the transportation, trade and tourism sectors. The industrial base, consisting mainly of small and medium sized enterprises, has become weak and focused on supplying the domestic market.

In order to shift the economy on a higher - and in the long-term sustainable - growth path, fundamental political reforms and sizeable investments are required. To foster such a tectonic shift, Greece needs to develop an effective innovation system. However, the successful development of an innovation system requires a long-term development strategy. Hence, Greek policy makers should work towards a lasting national consensus, which includes all relevant stakeholders. A flourishing innovation system cannot be created by governmental decree or by providing huge amounts of public funding. Instead, the innovation system needs to grow slowly but steadily from the bottom up in a conducive environment.

The main policy areas which need to be addressed are (i) the improvement of the regulatory and business environment and (ii) a reform of the Greek R&D system. Many studies and institutions provide policy recommendations on how the Greek government could improve the regulatory situation: a market friendly regulatory setting, macroeconomic stability, reliable economic and fiscal policies, a stable and predictable tax policy, simplified and codified legislation, regulations of market exit of firms, and improved (intellectual) property rights are essential elements of such efforts. Moreover, the Greek government should focus on capacity building in applied research and, more specifically, on the foundation of further translational and applied research institutes, and provide opportunities for both start-ups and established businesses to locate close to these institutes. Policy makers should also develop financial tools and provide a better regulatory environment to attract capital and to provide funds to researchers and

institutes and venture capital, and grants to start-ups and innovative entrepreneurs. A reform of the Greek education system is necessary with regards to practical training. The development of a targeted Diaspora policy towards Greek innovative individuals living outside Greece can further accelerate the goals of the Greek innovation policy. The policy should include labor market policies for recruiting talented individuals abroad and policies aimed at opening interaction and cooperation between those going abroad and those staying in Greece.

Table of contents

Index of Figures

Index of Tables

Index of Abbreviations

DE	Germany
EL	Greece
EC	European Commission
ERC	European Research Council
FI	Finland
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GVA	Gross Value Added
HR	Croatia
HU	Hungary
ICT	Information and Communication Technology
IMF	International Monetary Fund
ISI	Fraunhofer Institute for System and Innovation Research
LV	Latvia
MIT	Massachusetts Institute of Technology
NIS	National Innovation System
NL	Netherlands
PCT	Patent Cooperation Treaty
PL	Poland
PT	Portugal
R&D	Research and Development
RIS	Regional Innovation System
RU	Russia
SE	Sweden
SME	Small and Medium-sized Enterprise
WEF	World Economic Forum
WIPO	World Intellectual Property Organization

Introduction

A. Introduction

Despite initial signs of an economic recovery in 2014, eight years after the beginning of the financial crisis, the Greek economy continues to suffer. Economic output (GDP) decreased massively in these years. In 2016, unemployment, especially among the youth, is still remaining very high, and Greek government debt is close to reaching 200 percent of GDP. Instead of focusing on the exports of specialized products, the economy is dependent on tourism, trade and agricultural products. The vast majority of Greek firms is of small size which is impeding a strong export orientation. The business environment is characterized by a complex and contradictory bureaucracy and by corruption inhibiting investments and entrepreneurship. Since May 2010, Greece has been receiving emergency financial support in form of three economic adjustment programs from the Euro area member states and the International Monetary Fund (IMF) of a total of EUR 293 billion (European Commission, 2016). The aim of these programs was to address economic imbalances and social challenges and pave the way for economic growth. However, as Greece´s current economic and social situation shows, financial support provides merely a short-term relief. This study argues that in order to create long-term economic prosperity, which is sustainable in preventing a relapse into recession, Greece needs to promote entrepreneurship and fast growing firms and attract foreign capital, well-educated professional staff and top scientists by building a stable innovation system.

Economic research shows that sustainable economic growth in developed economies is mainly based on technological progress and innovation. Since Joseph Schumpeter introduced the concept of creative destruction in 1942, ample scientific evidence for the positive link between innovation and economic performance has been provided.[1] In this context, one crucial problem of the Greek economy is that the share of innovative and internationally competitive industries that create value added and provide well paid jobs is much lower than in other EU economies. This is in stark contrast to the rich intellectual and scientific potential of the country that for some reason does not translate into economic growth. According to the European Commission Innovation Union Scoreboard 2015 (European Commission 2016), 9 percent of all Greek scientific publications

1. See for example Freeman (1987), Lundvall (1992) and Nelson (1993) for a theoretical analysis or Aghion & Howitt (1992) for an empirical investigation of the topic.

are among the most cited publications worldwide. However, the majority of Greek researchers and entrepreneurs do not stay in Greece, but decide to emigrate and work in neighboring European countries or in the US. The Greek diaspora includes a significant number of highly skilled scientists working at leading research institutions and high-technology companies. Therefore, this study aims to derive policy recommendations for the development of an effective innovation system in Greece in order to promote technological change and investments and shift the economy on a higher and in the long-term sustainable - economic growth path. To this end, the study will focus on the following aspects:

- What are the most important factors of an effective innovation system that will make use of the country's rich scientific potential?
- What are the strengths and weaknesses of the Greek innovation system?
- How does the Greek innovation system compare to its peer group and to innovation leaders such as Sweden?
- Which policy actions need to be taken?

The study is organized as follows. Section 2 provides a short overview of the Greek economy as well as its industrial and firm size structure, providing the rationale for the need of increased innovation. Section 3 then focuses on innovation systems. It clarifies the concepts of national and regional innovation systems and illustrates their key role for economic growth. Based on a wide range of indicators, Sections 4 and 5 provide an empirical assessment of the Greek innovation system. Section 6 presents two case studies: The technology park Berlin-Adlershof is used as a positive example for a well-functioning regional innovation system, whereas Russia serves as a negative illustration of the consequences of isolation, overregulation and corruption. The study then closes with specific policy recommendations.

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The Macroeconomic and Industrial Environment in Greece

B

B1. Macroeconomic Environment

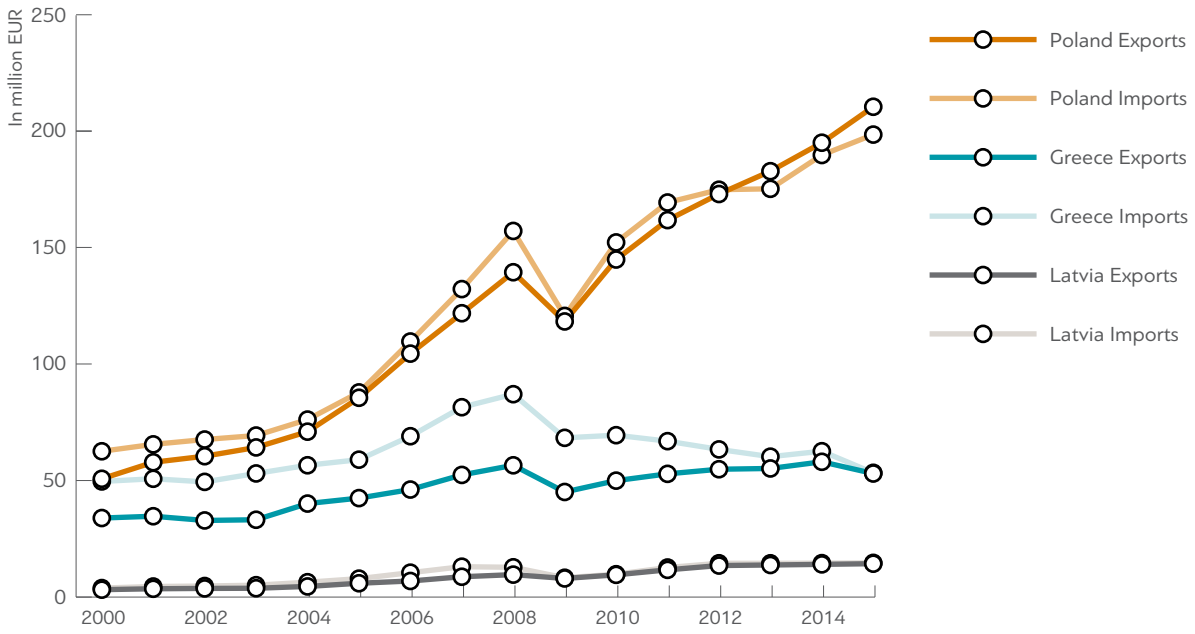
The financial crisis and the following European debt crisis hit Greece hard; the country is still struggling in the aftermath. After years of strong and consistent growth, based on a real estate boom and an increase in domestic demand, Greek real GDP per capita fell by more than 25 percent between 2008 and 2015 and has not yet started to grow again (Figure 2.1). During the crisis, a slump in GDP growth was experienced throughout the Eurozone but in contrast to Greece, most European economies went into recovery soon after. Take for instance Latvia and Poland, two countries with much lower pre-crisis GDP-per-capita levels than Greece, outpaced Greece in term of GDP growth rates in 2009 and are approaching Greece's GDP per capita level. Both its GDP level and GDP growth reflect the central problems in Greece - a weak export sector, the lack of a diversified industry structure, and the need for a well-functioning innovation system.

Figure 2.1: Real GDP per Capita Growth, 2000-2015

Source: Eurostat (2016)

As a consequence of the drop in GDP and the austerity measures imposed by the European Union, the unemployment rate increased dramatically, peaking at 28 percent in 2013. Especially young workers were affected by layoffs and hiring stops, with the result that a large part of the under 25-year olds was unemployed by the end of 2015. For years, the Greek labor market was rigid and overregulated with formal and complex legislation and a strong employee protection (Neubäumer, 2015). Although recent labor market reforms have been highly successful in increasing flexibility on the market, unemployment remains high at around 24 percent (2015, Q4). Consequently, many Greeks do not see a future in their country and emigrate. Between 2008 and 2012, the number of emigrants tripled, from 43,000 to 124,000 and has increased to more than 200,000 in 2016.

Figure 2.2: Exports and Imports of Goods and Services, 2000-2015



Source: Eurostat (2016)

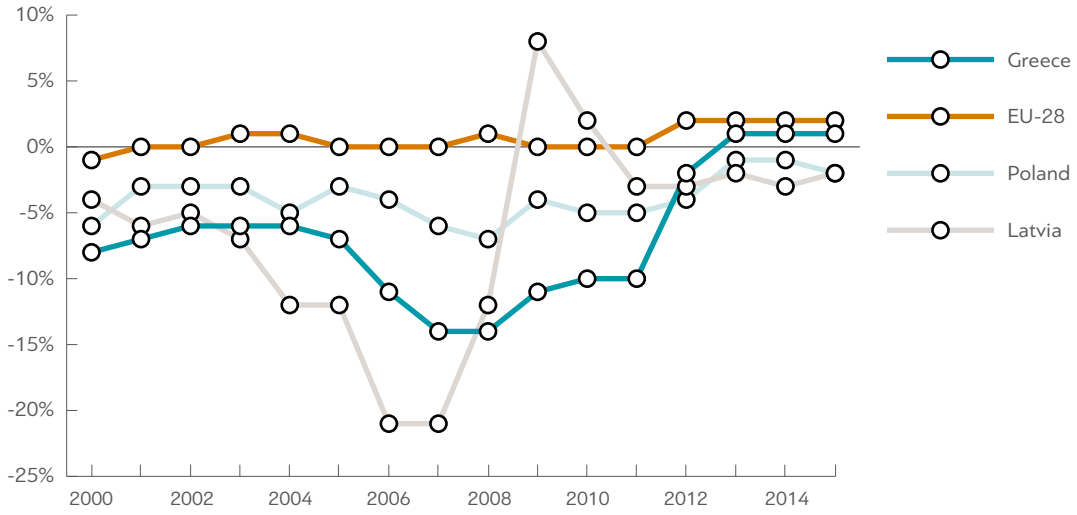
One of the main reasons for the bad economic performance of Greece is its low export performance and the resulting trade deficit. In comparison to other EU member states, which could draw on their export sectors to lift them out of the crisis, Greece remained in recession since its exports are only to a rather small extent able to compete internationally. Only a small number competitive Greek export-oriented firms quickly grew out of the crisis and still flourish.

The demand-driven expansion before 2008 was accompanied by a growth in imports, as Figure 2.2 shows. The growth of exports, however, was lagging behind. Looking at the trade structure in more detail, it becomes clear that Greece performs much better in exporting services (mainly transportation and tourism) than in exporting goods. Although Greece was able to maintain a surplus in the export of services during the past decade, this surplus was not sufficient to balance the large deficit in the exports of goods.

In contrast to the export of services such as tourism, which are reliant on low-skilled labor, the export of medium- and high-technology products bears a much higher growth perspective. However, between 2006 and 2013, only 18 percent of total Greek product exports have been medium and high-tech products (European Commission, 2016). Within the same timeframe, for instance Poland or Latvia exported medium and high-tech products with shares of 49 and 30 percent respectively.[2] The trade deficit as a result of the low competitiveness of Greek companies is reflected in its current account deficit. As Figure 2.3 shows, the Greek current account balance has been negative for several years, indicating that the country was a net borrower. Decreasing demand for imports as a result of the long recession and the austerity measures imposed by the EU in addition to a minor growth of exports, resulted in a positive current account balance since 2013 (Figure 2.2 and Figure 2.3).

2. See Figure 6.2.

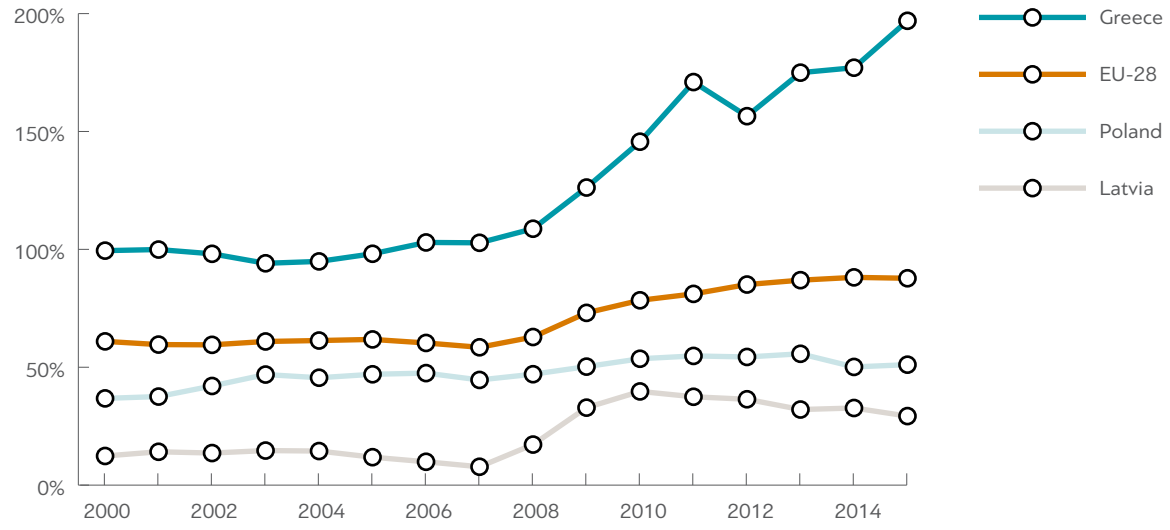
Figure 2.3: Current Account Balance as Percentage of GDP, 2000-2015



Source: World Economic Outlook – International Monetary Fund (2016)

The budget mismanagement by the Greek government further worsened the trade deficit. Excessive public spending such as expenses on a dysfunctional pension system and a complex administration have not been backed by corresponding tax revenues. Instead, the government financed their activities by loans, maintaining a gross debt of about 100 percent of GDP between 2000 and 2008, a level well above the EU-28 average (Figure 2.4). When the debt became unsustainable during the crisis years, the European Union and the IMF had to step in by providing three bailout packages. However, as high deficit and debt rates, high unemployment and slow GDP growth show, these programs provided a short-term relief but were not successful in bringing the Greek economy back on a long-term sustainable economic growth path.

Figure 2.4: Gross Government Debt as Percentage of GDP, 2000-2015

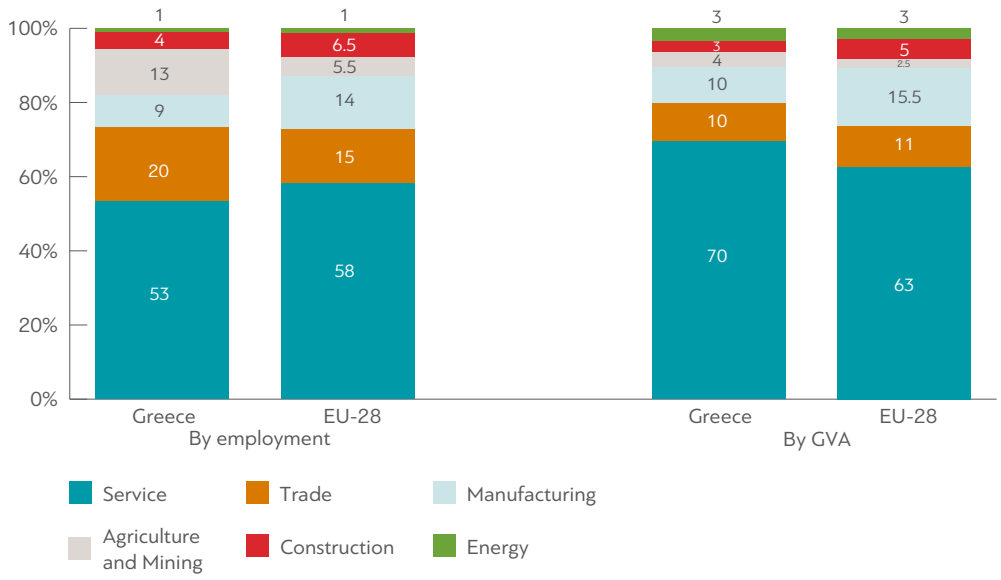


Source: World Economic Outlook – International Monetary Fund (2016)

B2. Industrial and Business Size Structure

One main reason for Greece´s weak economic position is the lack of a diversified industry. Figure 2.5 shows that the service sector contributes a much larger share to total Gross Value Added (GVA) in Greece than in the EU. The reason for this above-average share is the structure of the Greek economy, which relies heavily on transportation and tourism activities, a large real estate sector and a bloated public administration. In 2014, these activities contributed more than 40 percent to total GVA, whereas the EU average was at 25 percent. Most of the service sector is based on labor-intensive activities. Knowledge-intensive services such as Information and Communication Technologies (ICT) or the financial and insurance sectors are relatively small. About one fifth of the working population is employed in the trade sector, which includes wholesale and retail trade activities. In addition, the agricultural sector is still a very important employer in Greece, with values far above the EU average. However, it contributes only 4 percent to total GVA, illustrating the low productivity in the sector. Both the trade and the agricultural sectors are again mainly based on less knowledge-intensive activities.

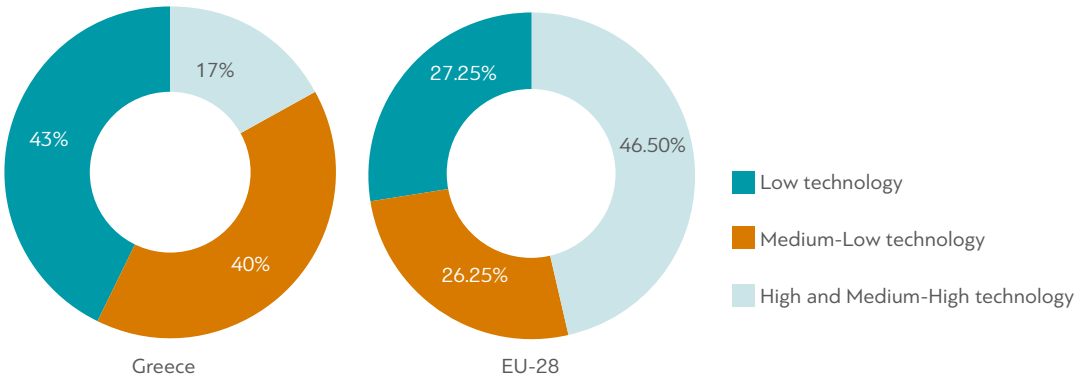
Figure 2.5: Industry Structure Greece vs. EU-28, 2013



Source: Eurostat (2016), calculations by DIW Econ

In stark contrast to the service sector, the Greek manufacturing sector is less developed. Manufacturing does not play an important role in the Greek economy and includes mainly low and medium-low technology activities (Figure 2.6). Also, the manufacturing activities are labor-intensive and are characterized by very low productivity. With USD 35 GDP per hour worked (adjusted for purchasing power parity), Greek productivity was almost 30 percent lower than that of the EU average (McKinsey, 2012). The production of food, beverages and tobacco products; basic metal products; wood, paper and printing, as well as the processing of mineral oil constitute the largest part of Greek manufacturing. In the rest of the EU, these industries are relatively small.

Figure 2.6: Technology Intensity of the Manufacturing Sector, Measured in Terms of Gross Value Added, 2013



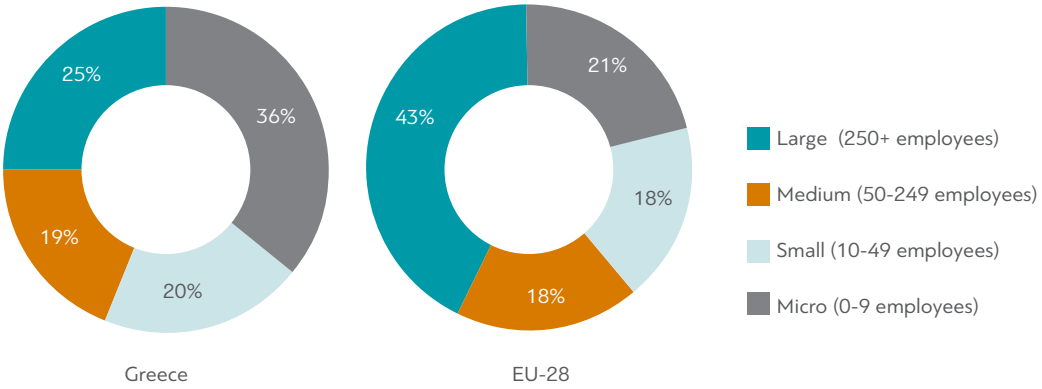
Source: Eurostat (2016), calculations by DIW Econ

Manufacturing can be an important driver of economic growth. Research and development activities, high-paying jobs and export activities, which provide potential for innovation and prosperity, often originate in this sector (Schrader, Benček, & Laaser, 2015). However, the small size of the industry and the type of goods produced demonstrate that the industrial production in Greece is oriented towards the domestic market. The industry is therefore currently only to a small extent able to compete with its European neighbors, limiting economic growth through the promotion of its exports goods in the short-run. Another reason for the problems of the Greek economic structure is its highly inefficient public sector and the very slow justice system, as has been often emphasized, for instance by the World Bank in their "Ease of Doing Business Report".[3] Corruption, a weak tax collection system and an inflated pension system are further problems. Overregulation, for example, puts additional pressure on Greek firms and entrepreneurs, which is also reflected in the country´s business size structure as shown in Figure 2.7.

One of the main reasons for the weak Greek export performance is the fragmented, small size business structure in Greece as the Greek economy consists mainly of micro and small enterprises (Figure 2.7). Large enterprises constitute merely 25 percent to value added, much less than in the other EU countries. The results also hold when looking at the number of persons employed and the number of enterprises. Explanations for the high share of Small and Medium-sized enterprises (SMEs) are the possibility to avoid taxes and the fear of a predatory state, imposing rules and regulations on large businesses. The disadvantages of an economy with a high share of SMEs are numerous. As SMEs are often family-run, they lack the necessary management expertise and experience, which large and multinational companies own. Moreover, due to their size, SMEs have difficulties in attracting and training skilled human capital. Their size also prohibits SMEs to take advantage of economies of scale and scope, which have an important positive effect on productivity. Economies of scale and scope occur when fixed costs that are associated with running a business can be reduced as the size of the firm increases or businesses sections share centralized functions, reducing the overall costs of production and, thus, increasing productivity. These productivity increases then facilitate export activities as they allow large firms for example to establish sales and distribution departments abroad. With respect to innovation activities, large companies have easier access to capital and are more likely to cooperate with other innovating businesses and institutions. Therefore, they can be seen as "gatekeepers", connecting regional innovation activities to national and international knowledge streams and promoting networks and clusters.

3. http://www.doingbusiness.org/.

Figure 2.7: Firm Size Structure, Measured in Terms of Gross Value Added (estimation 2015)



Source: Eurostat (2016), estimations by DIW Econ

Based on the current industry and business structure, it will be a great challenge for Greece to emerge from a low-skilled, low-technology economy with mainly SMEs to an economy on a sustainable growth path based on medium- and high technology and providing high-paying jobs. In order to be able to achieve this development, multiple structural changes will be necessary, including the establishment of a well-designed innovation system.

B3. Industries with Growth Potential

Nevertheless, the situation in Greece is not as hopeless as it seems. A small but effective part of an innovation system already exists in Greece. Previous studies identified out of the existing economic structure some promising industries with the potential for becoming new drivers of economic growth.

The logistics sector and especially the merchant marine industry have always been strong in promoting growth. A study conducted by the Boston Consulting Group (2013), estimated the Greek shipping industry to have contributed 6 percent (EUR 13.4 Billion) to GDP in 2010 and employing over 165,000 people. Additionally, Greek ship owners support the economy by investing in other sectors of the economy such as energy, transportation and tourism. As the ports in Piraeus and Thessaloniki are strategically located on one of the three largest intercontinental routes worldwide, there is potential for creating a regional cargo and logistics hub in Greece according to McKinsey (2012). Investments in infrastructure and capabilities to increase cost efficiency are estimated to add EUR 1.3 Billion to annual GVA and provide a minimum of 9,000 new jobs within a 10-year horizon. In the meantime, the port of Piraeus was successfully privatized. This step in the right directions will trigger much needed investments.

Another industry area with the potential to promote growth is the ICT sector. Although the sector is currently not showing promising growth, investments in the promotion of ICT adoption and digital growth can have beneficial effects on the Greek economy. ICT could potentially strengthen Greek exports by supplying much needed IT solutions for the digitalization of industries in other developed economies, a process labeled in Germany, for example, as “Industry 4.0”. According to a study by the Greek Foundation for Economic & Industrial Research (2014), digitization in the Greek public administration is expected to cut costs by about EUR 380 million. Additionally, ICT adoption by SMEs increases their probability to innovate by about 4-9 percentage points and facilitates their internationalization.

The Greek generic pharmaceutical manufacturers have a high export and growth potential. The workforce is highly skilled, R&D is well established and recent policy changes made the market more competitive. But generics

accounted for just 18 percent of total pharmaceutical volumes in Greece in 2012 (McKinsey, 2012). Domestic producers would benefit from a campaign to promote the wider use of generic drugs.

Additionally, generic manufacturers can use the high export potential as the market is relatively open and niche opportunities abroad exist. Closely related to the growing generic pharmaceutical market is the opportunity of promoting medical tourism in Greece. Investments in infrastructure and more importantly in the reputation as a quality destination would provide an opportunity to extend the tourism season and generate additional EUR 450 million in annual GVA (McKinsey, 2012). The Greek experience in the tourism industry will thereby provide an important comparative advantage. Further growth industries could be energy, innovative tourism and agriculture and health services including long-term and elderly care.

However, beyond the sectors identified by previous studies, Greece needs to broaden its comparative advantage base. By the same token, a newly developed innovation policy would contribute to Greece's existing product mix to move up the quality ladder. To this end, Greece needs to restructure and promote its research and development policy to unleash the country's potential.

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National and Regional Innovation Systems

C. National and Regional Innovation Systems

Innovation goes far beyond R&D.[4] It is the implementation of a new or significantly improved product, process, marketing method, or a new organizational method in business practices, workplace organization or external relations. In contrast to an invention, which is the first occurrence of an idea, an innovation is the first commercialization of this idea. Innovation activities are all scientific, technological, organizational, financial and commercial steps that lead to the implementation of an innovation. Therefore, an innovation offers a marketable method of increasing productivity, making it a crucial component for sustainable economic growth.

4. For an economic definition of innovation see for instance OECD (2005).

However, innovation cannot be planned and organized, it can merely be supported by a well-developed environment increasing the probability that an innovation input transfers into knowledge and is then successfully introduced in the market, increasing the productivity of a firm. Thus, the basis of innovation is a creative and interactive process that surpasses education and R&D and occurs within a system of norms, institutional regulations and organizations. The concept of innovation systems as a means of effectively supporting innovation processes was first mentioned by Friedrich List in his book "The National Systems of Political Economy" in 1841. Formally, the term "National Innovation System" (NIS) was developed in the 1980s by three main authors – Freeman, Lundvall and Nelson.

Freeman (1987) used his definition of NIS as "networks of institutions in the public and private sector whose activities and interactions initiate and diffuse new technologies" to analyze Japan´s innovation performance. Lundvall (1992) then moved away from the sectoral view and focused on the role of the state by defining them as "the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge [...] and are either located within or rooted inside the borders of a nation state" (Schrempf, Kaplan, & Schroeder, 2013). Nelson (1993) puts an emphasis on the set-up of and interaction between actors. Despite their individual interests, all authors agree on a holistic view by focusing on the non-linear interaction of actors and how these interactions are shaped by social, institutional and political factors (Fagerberg & Verspagen, 2009).

The main finding from all studies is that a properly functioning innovation system requires the involvement and unambiguous support from all relevant stakeholders, i.e. policy makers across party lines, scientific institutions, firms and the society as a whole.

Because regions across a country differ significantly, researchers developed more fine-tuned concepts for regional innovation systems to explain local differences in innovation capacity and economic strength (Schrempf, Kaplan, & Schroeder, 2013). The spatial concentration of private and public institutions within a regional system allows for more informal interactions in smaller groups, emphasizing the networks between private and public firms and institutions. Examples of well-working regional innovation systems are Silicon Valley, the start-up scene of Tel Aviv and Berlin-Adlershof (see section D1). These examples demonstrate the importance to establish successful networks and clusters between universities, research institutes, innovative start-ups, and established businesses.

THE IMPACT OF RESEARCH ON GREEK ECONOMIC GROWTH

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An Indicator-based Assessment of Innovation Systems

D. An Indicator-based Assessment of Innovation Systems

A well-functioning innovation system requires various elements, ranging from systemic factors such as education, research and development to institutional factors. DIW Berlin developed the initial concept for an Innovation Indicator. This Innovation Indicator allows an empirical assessment of different innovation systems, comparing initially Germany with its main trading partners. Later the concept was further developed to compare different regions and other subsystems. The Innovation Indicator informs policy-makers, business executives and society about the innovative capacity in the context of an international or regional comparison and about relevant developments over time. But it informs also about the ingredients of a successful innovation system.

The following assessment of the present Greek innovation system draws on insights derived from the Innovation Indicator, containing the following sub-systems:

- **Education:** Skilled human capital is one of the major prerequisites for a working innovation system. The sub-system education is a proxy for the quality of the Greek education system and its capacity to increase the aggregated knowledge, skills, and abilities of entrepreneurs and workers, who ultimately become innovative.
- **R&D:** R&D is one main requirement for innovation with the output of R&D measured in patents and publications, and more importantly, in increases of the stock of knowledge in a firm, leading to innovation, and eventually improving the output of firms through increased productivity. R&D activities can be differentiated into basic research (aiming to increase the understanding of fundamental principles) and applied research (aiming to yield practical benefits or technical solutions to specific problems with the goal of commercial use), which are often conducted in different types of research institutions. Public research institutions and university-based institutes often focus on basic research and the early stages of applied research (such as in applied research institutes like Fraunhofer in Germany or in applied research universities like EPFL in Switzerland), whereas the private sector is often focused on applied research at later stages of innovation

chains. Moreover, so called translational institutes combine basic and applied research as they are funded by both sectors, thereby further fulfilling an important step along the innovation chain.

- **Networking:** Cooperation and interaction between universities, research institutions, firms and other agents of the innovation system provide economic advantages for all actors. Regional proximity of actors facilitates networking activities, e.g. by building up a critical mass of talent. Geographic and contextual proximity (still important in times of digital economies) between public funded researchers and private entrepreneurs facilitate communication and accelerate the innovation process. Indicators such as the number of public-private co-publications are used to provide a quantitative measure of the qualitative aspect of cooperation.
- **Financing:** Financing of innovation is essential all along the innovation process. Public and private funding are of equal importance. This sub-system includes indicators for the availability of financial capital for public institutions and private businesses and the ease of obtaining financing for innovation projects.
- **Regulation:** Even if the above-mentioned conditions are met, any innovation will still not perform successfully in the markets if entrepreneurs face an environment that is adverse to the venturing of new businesses and the protection of property rights. A suitable regulatory setting, macroeconomic stability, reliable economic and fiscal policies and a stable and predictable tax policy are essential elements of such an environment. Strong formal and informal institutions, non-exploitative networks, and the enforcement of contracts within a short period of time help to reduce transaction costs and facilitate the opening of internal markets to new products and international competition. Good regulation may not be confused with no or very little regulation. Instead, optimal regulation should be in place where necessary, enhance the functioning of competition and secure property rights while providing as much economic freedom as possible.
- **Quality of Governance and demand for innovation:** This sub-system captures the openness of society towards innovation and change, trust towards innovators and entrepreneurs and a generally positive attitude towards science and technology. In terms of the DIW key factors, it proxies the demand for innovation and technology. Only if there is potential demand from customers, firms are willing to invest in innovation activities.

Table 4.1 Innovation Indicators Describing the Six Sub-systems (Data Source in Parenthesis)

Education	R&D	Networking	Financing	Regulation	Governance and Demand for Innovation
Quality of the education system – *Global Competitiveness Report 2015, WEF* (Figure 5.2)	R&D Intensity – *Eurostat* (Figure 5.4)	Innovative enterprises co-operating with research institutes – *Community Innovation Survey, Eurostat* (Figure 5.7)	Ease of access to loans – *Innovation Union Scoreboard 2015, EC* (Figure 5.9)	Ease of doing business – *The World Bank* (Figure 5.10)	Political Stability and No Violence – *Worldwide Governance Indicators, The World Bank* (Figure 5.12)
Graduates at doctoral level – *Eurostat* (Figure 5.3)	Scientific Publications among the top 10% most cited publications worldwide – *Innovation Union Scoreboard 2015, EC* (Figure 5.5)	Public-private co-publications – *Innovation Union Scoreboard 2015, EC* (Figure 5.8)	Venture capital availability – *Innovation Union Scoreboard 2015, EC* (Figure 5.9)	Level of Corruption – *The World Bank and Transparency International* (Figure 5.11 and Figure A.5)	Government Effectiveness – *Worldwide Governance Indicators, The World Bank* (Figure 5.12)
Mean of PISA results in Science, Reading and Mathematics – *OECD* (Figure A.1)	PCT patent applications – *Innovation Union Scoreboard 2015, EC* (Figure 5.6)	International scientific co-publications – *Innovation Union Scoreboard 2015,* EC (Figure A.4)		Regulatory Quality – *Worldwide Governance Indicators, The World Bank* (Figure A.6)	Demand for technology and Innovation – *Global Competitiveness Report 2015, WEF* (Figure 5.13)
	Quality of the research institutions – *Global Competitiveness Report 2015, WEF* (Figure A.2)			Product Market Regulation – *OECD* (Figure A.7)	Country Capacity to attract talent – *Global Competitiveness Report 2015, WEF* (Figure 5.14)
	R&D expenditure in the public sector – *Eurostat* (Figure A.3)				Country Capacity to retain talent – *Global Competitiveness Report 2015, WEF* (Figure A.8)

Source: DIW Econ

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Assessment of the Greek Innovation System

E1. The Greek Innovation Performance in International Perspective

As a first step, we provide an overview of the Greek innovation performance relative to other countries. To this end, the results of different innovation rankings are examined. Most information is taken from:

- The innovation indicator, as developed by DIW Berlin and its current application.
- European Innovation Scoreboard 2016 by the European Commission.
- Global Innovation Index, published by Cornell University, INSEAD and the World Intellectual Property Organization (WIPO).

The 2015 Innovation Indicator ranked Greece 29th out of 35 countries around the world.[5] The ranking is based on an economic model with 38 input and output factors which cover a number of factors relevant to a national innovation system (Frietsch, Rammer, Schubert, Som, Beise-Zee, & Spielkamp, 2015). In all years covered (2000, 2005, 2010, 2013 and 2015), Greece ranked between 28th and 30th as it performed rather poorly across the five sub-systems: education, society, state, enterprises and public research. But in some areas Greece performs better: share of employees with tertiary education (7th), publicly funded R&D in enterprises as a share of GDP (13th), share of university R&D financed by enterprises (13th), share of employees in knowledge-intensive services (14th), share of international co-patents (13th), public funded science sector patents per inhabitant (7th). However, these results need careful interpretation. First, R&D investments in Greece are relatively low in absolute numbers. A high share of university R&D financed by enterprises does therefore not imply a strong overall R&D position in comparison to other countries. Second, the shares of employees in the knowledge intensive services constitute merely input indicators. A high input share does therefore not necessarily imply a high output. However, the results provide first hints about potential strengths of knowledge-intensive services of the Greek economy.

5. http://www.innovationsindikator.de/fileadmin/2015/PDF/Innovationsindikator_2015_Web_en.pdf

The European Innovation Scoreboard 2016 (formerly known as Innovation Union Scoreboard) assesses the innovation performance of the EU-28 member states and of several other countries.[6] The report categorizes Greece as a “Moderate Innovator”, along with countries such as Croatia,

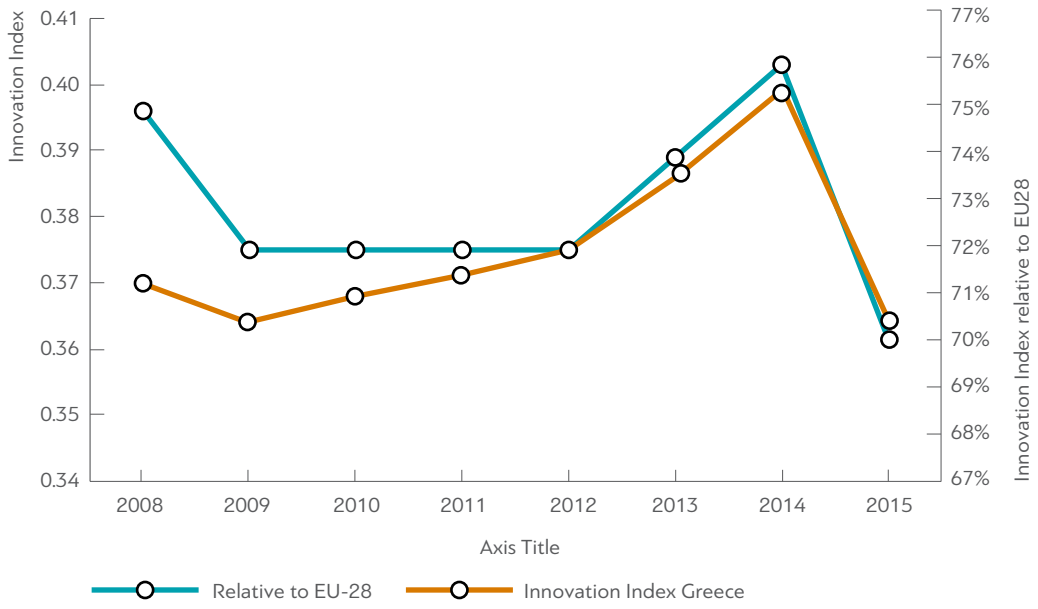
6. http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

Hungary, Poland and Portugal, all of which perform below EU average (European Commission, 2016). After a gradual increase between 2007 and 2013 (with a minor interim dip) the country's performance dropped dramatically in 2014 to 70 percent of the EU average (Figure 5.1).

The overall European Innovation Scoreboard consists of eight dimensions[7], which each include several individual indicators. In 2015, Greece performed below EU average in all dimensions.

7. The dimensions are Human Resources, Research Systems, Finance and Support, Firm Investments, Linkages & Entrepreneurship, Intellectual Assets, Innovators and Economic Effects (European Commission, 2016).

Figure 5.1: Innovation Performance – Greece, 2008-2015



Source: European Innovation Scoreboard 2016 – European Commission (2016)

The 2015 Global Innovation Index (Cornell University, INSEAD, and WIPO, 2015) examines the innovative capacity of 141 countries worldwide, using 79 indicators across seven input and output pillars.[8] In this assessment, Greece ranks 45th, showing a strong performance in the area of "Education", but pronounced weaknesses in the area of "Business sophistication". In particular, its scores on university/industry research collaboration, cluster development and FDI net inflows are low. In the area of "Knowledge and technology outputs", Greece performs poorly on the number of utility model applications filed by residents in Greece relative to GDP, labor productivity growth, and FDI net outflows, but achieves relatively high scores on the number of scientific and technical articles.

In all three innovation assessments Greece performs below the EU average and also low if compared with other highly industrialized countries.

8. The input pillars are Institutions, Human capital and research, Infrastructure, Market sophistication and Business Sophistication. The output pillars are Knowledge and technology outputs and Creative outputs.

E2. Analysis of Sub-systems

Next, the strengths and weaknesses of the Greek innovation system are assessed in more detail, using selected indicators from the sub-systems outlined in Section G1. We compare the Greek performance on these indicators with a set of other countries:

- Peer group, which are countries of similar size and innovation performance: Croatia (HR), Latvia (LV), Poland (PL), Portugal (PT) and Hungary (HU).
- Innovation leaders: Finland (FI), Germany (DE), Sweden (SE) and the Netherlands (NL)[9].
- Russia (RU) as a country that made efforts to improve its innovation capacity but was largely unsuccessful.

9. The Netherlands exhibits a particularly high dependence on the service sector and in particular maritime logistics.

Education

In the course of the financial crisis, education has been one of the public goods that have been affected by austerity measures (Dassiou, 2015). The result of surveys with decision makers conducted by the World Economic Forum (2016) shown in Figure 5.2 illustrate that the Greek education system is far from being fit to train a competitive labor force. In the same vein, the Greek education system shows a rather weak performance of high school students, as the PISA results depicted in Figure A.1 in the Appendix clearly indicate.

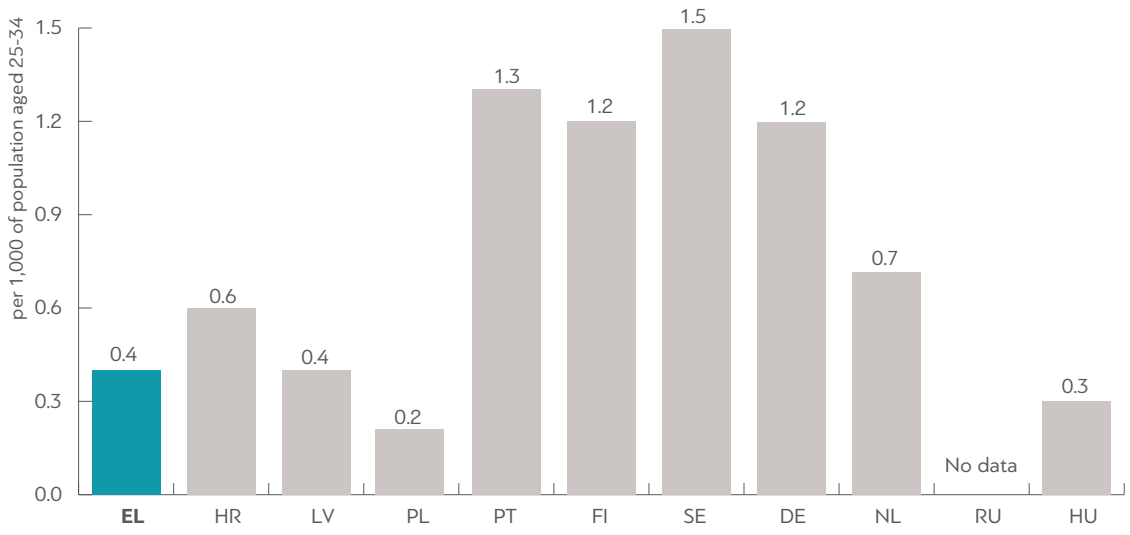
Besides this general assessment of the Greek education system, the number of doctoral graduates per 1,000 population aged 25-34 (see Figure 5.3) gives an impression of the availability of highly qualified and skilled professionals, who are an important resource for an innovation-driven economy. They are a driving force behind cutting-edge research and innovation and can make a major contribution to the development of innovative products and services. Doctorates in science, mathematics, computing, engineering, manufacturing and construction are considered as excellent human resources and a crucial input factor for the innovation system. But, in this area too, Greece does not exhibit a strong performance, either.

Figure 5.2: Quality of the Education System, Average 2014-2015

"In your country, how well does the education system meet the needs of a competitive economy?"

Source: Global Competitiveness Report 2015-2016 - World Economic Forum (2016)

Figure 5.3: Graduates at Doctoral Level in Science, Mathematics, Computing, Engineering, Manufacturing and Construction, 2013

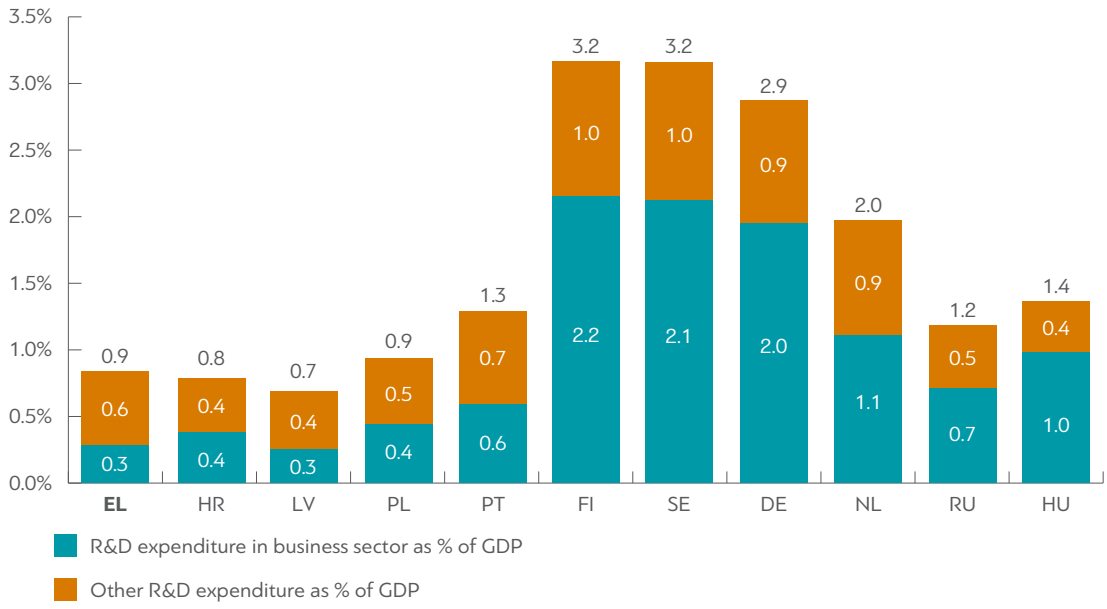


Source: Eurostat (2016a)

Research & Development

Investments in R&D are vital for a functioning innovation system and contribute to the creation of innovative products and services. Figure 5.4 presents the R&D intensity of Greece and the comparative countries and gives a sense of the effort each of them puts into improving its innovative capacity.

Figure 5.4: R&D Expenditure as a Percentage of GDP, 2014



Source: Eurostat (2015a), calculations by DIW Econ

In 2014, Greece invested 0.9 percent of its GDP in R&D (Figure 5.4). At the same time, innovation-driven countries of similar size, like Finland or Sweden, invested approximately 3 percent of their countries' much higher GDP. The poor Greek performance is due to both low public and low private R&D activities. Business (or private) R&D investments in Greece amounted to only 0.3 percent of GDP, which is considerably lower than what in the aforementioned innovation-driven countries. R&D expenditure in the public sector as a percentage of GDP is also significantly lower than among innovation leaders (see Figure A.3 in the Appendix).

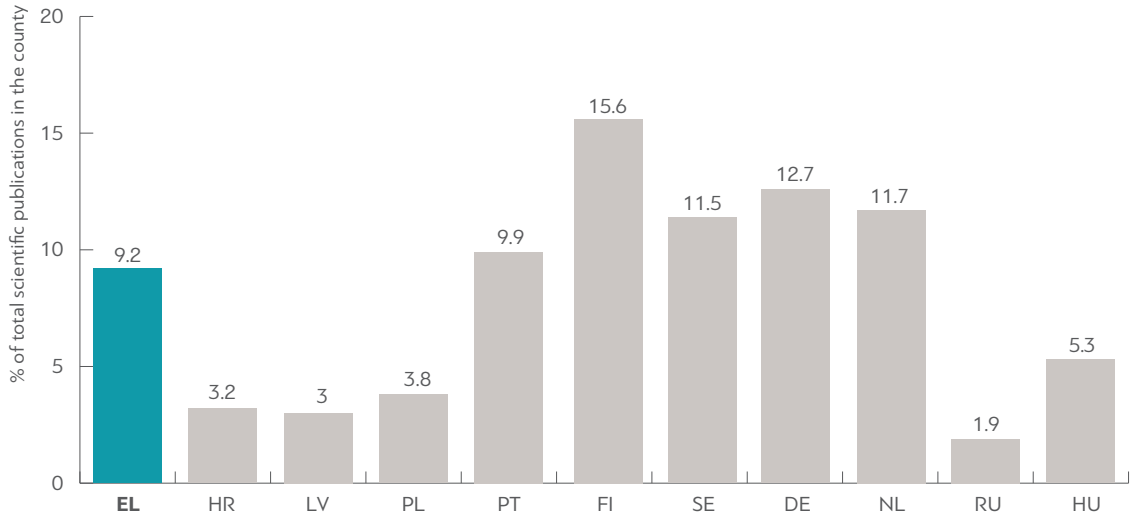
The lack of private sector R&D hampers the ability of firms to create new knowledge and to make use of knowledge created by research institutions as well as to transform this into new products and services. Business R&D is pivotal for introducing innovations to the market. Moreover, universities

and research institutes in Greece are very much focused on basic research. A lack of applied research that builds upon the results of basic research contributes to the wide gap between excellent research and meager innovation output and commercialization of research results.

Even though R&D investments in Greece are relatively low, the country has a small number of research institutions conducting cutting-edge basic research. For instance, five of the Top-50 research organizations that receive funding through the EU's Framework Program for Research and Innovation (Horizon 2020), are from Greece.[10] The Framework includes programs to foster excellent science (European Commission, 2016a). The capacity of Greek research institutes to conduct excellent research is reflected in the relatively good performance in terms of outstanding scientific publications (Figure 5.5). Nevertheless, even if there are a few outstanding research institutes, the overall quality of research institutions is still relatively low, as the results of surveys with experts and stakeholders illustrate (Figure A.2 in the Appendix).

10. Foundation for Research and Technology Hellas (FORTH), Center for Research and Technology Hellas (CERTH), National Center for Scientific Research "Demokritos", Institute of Communications and Computer Systems (ICCS), ATHENA-Research and Innovation Center in Information, Communication and Knowledge Technologies.

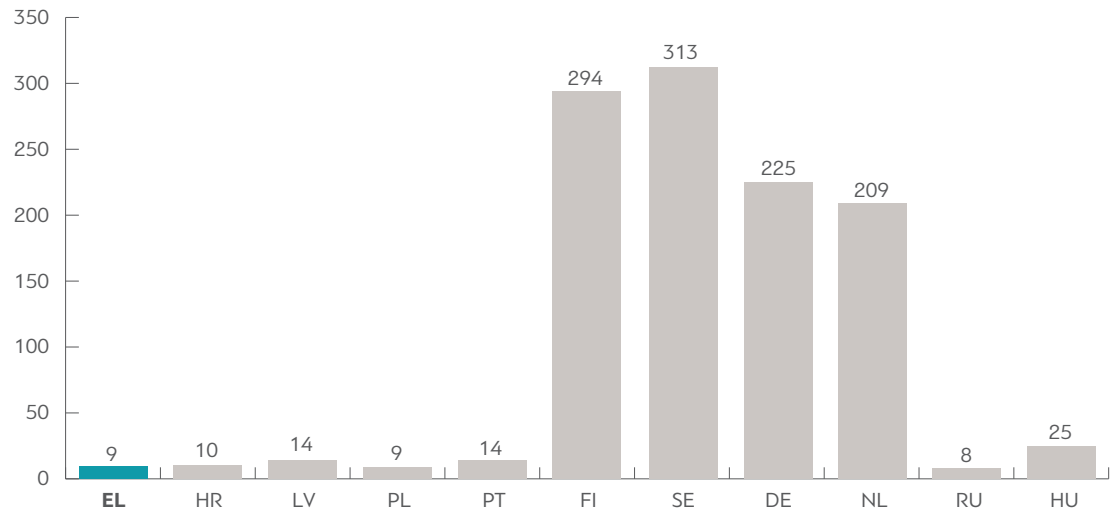
Figure 5.5: Scientific Publications Among the Top 10% Most Cited Publications Worldwide, 2002-2009



Source: Innovation Union Scoreboard 2015 – European Commission (2016)

The number of patent applications in a country relates to the introduction of new products and services and is a common indicator of its technological performance. The number of applications filed under the Patent Cooperation Treaty (PCT), illustrated in Figure 5.6, indicates the lagging Greek performance in terms of innovative output compared to the innovation leaders. Figure 5.5 and Figure 5.6 show that there exists a great disparity between research output of research institutions (scientific publications) and the innovative output of businesses (for instance in terms of patents), the latter of which is connected to poor output in terms of marketable products. Although there is some excellent basic research in Greece, the understanding of fundamental principles can only be of limited help to create practical benefits or to find technical solutions to problems, which can be sold as products or services. This is due to a paucity of applied research, which constitutes a vital link in the innovation chain and facilitates exploitation of fundamental research findings. A lack of cooperation among institutes and researchers further magnifies this issue.

Figure 5.6: PCT Patent Applications per Million Population, 2011–2012 Average



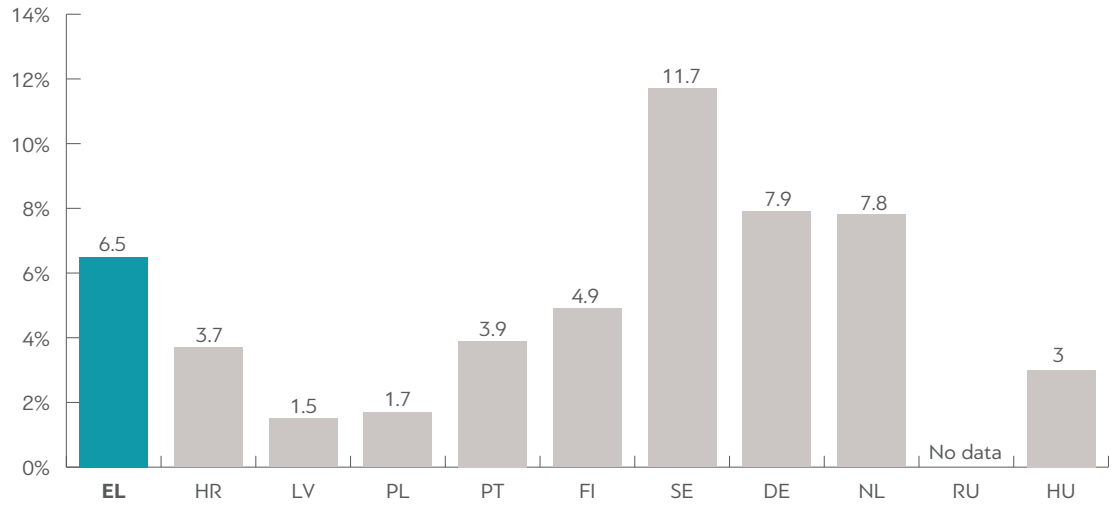
Source: Innovation Union Scoreboard 2015 – European Commission (2016)

Networking

External R&D funds, as discussed above, can help conduct basic research, link it with institutes conducting applied research and support knowledge transfers to private enterprises and increase their stock of knowledge, which may then develop marketable products based on the previous steps in the innovation chain. Networking is a crucial component of a functioning innovation system, as outlined in Section G1. We examine data on cooperation of innovative firms with research institutes collected as part of the European Community Innovation Survey, as well as the number of public-private co-publications relative to population.

In Greece, research networks are only rarely existent and cooperation between public research and industry is currently weak. Still, a considerable part of the small number of innovative companies in Greece reported to collaborate with research institutes, as indicated in Figure 5.7, clarifying that this small number of companies is able to create a network and to gain something out of it. Given the disproportionally small percentage of large enterprises (as illustrated in Figure 2.7) and of innovative companies in general, the relatively high percentage of innovative companies that do cooperate with research institutes does not imply that Greek enterprises are performing well in terms of innovative output. Greece still lacks large innovative enterprises that can make use of economies of scale and scope and generate significant levels of innovation.

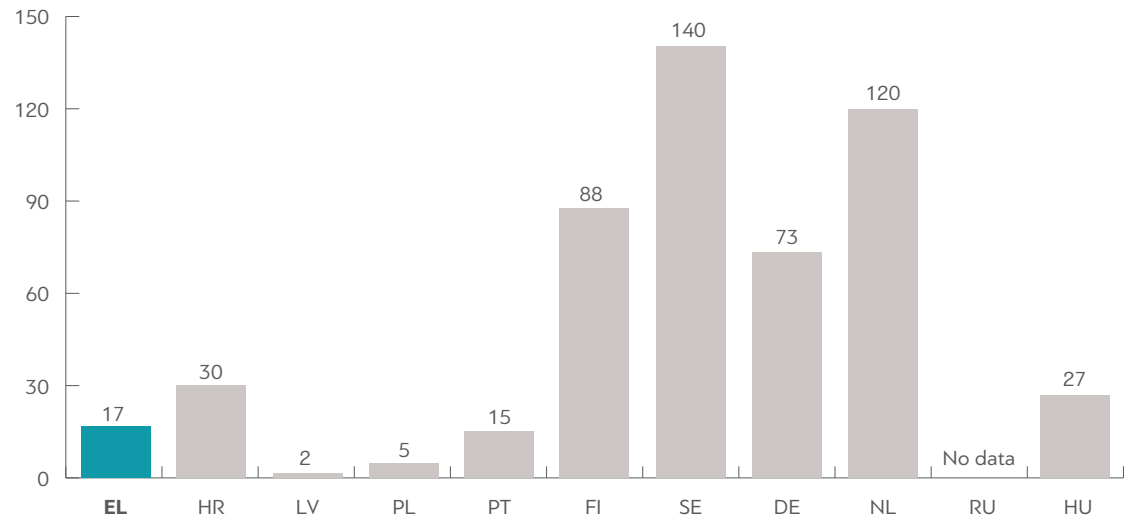
Figure 5.7: Innovative Enterprises Co-operating with Government, Public or Private Research Institutes as a Percentage of All Enterprises, 2012



Note: Innovative enterprises are product and/or process innovative enterprises, regardless of organizational or marketing innovation (including enterprises with abandoned/suspended or on-going innovation activities.
Source: Community Innovation Survey – Eurostat (2015), calculations by DIW Econ

Also public-private research linkages in Greece are weak, as the small number of academic co-publications of public and private sector researchers in Figure 5.8 indicates. However, there have been at least some very preliminary ideas to develop research clusters, e.g. driven by the Demokritos National Center for Scientific Research (Kanellopoulos, 2012), which, however, were not pushed any forward during recent years.

Figure 5.8: Public-Private Co-Publications per Million Population



Source: Innovation Union Scoreboard 2015 – European Commission (2016)

A decent number of international scientific co-publications, shown in Figure A.4 in the Appendix, provides a silver lining for Greek research. The indicator shows that Greece is, to some degree, integrated into international research networks and involved in high quality research. Nevertheless, Greece is still far from the level of integration of innovation-driven economies like Finland, Sweden or Germany.

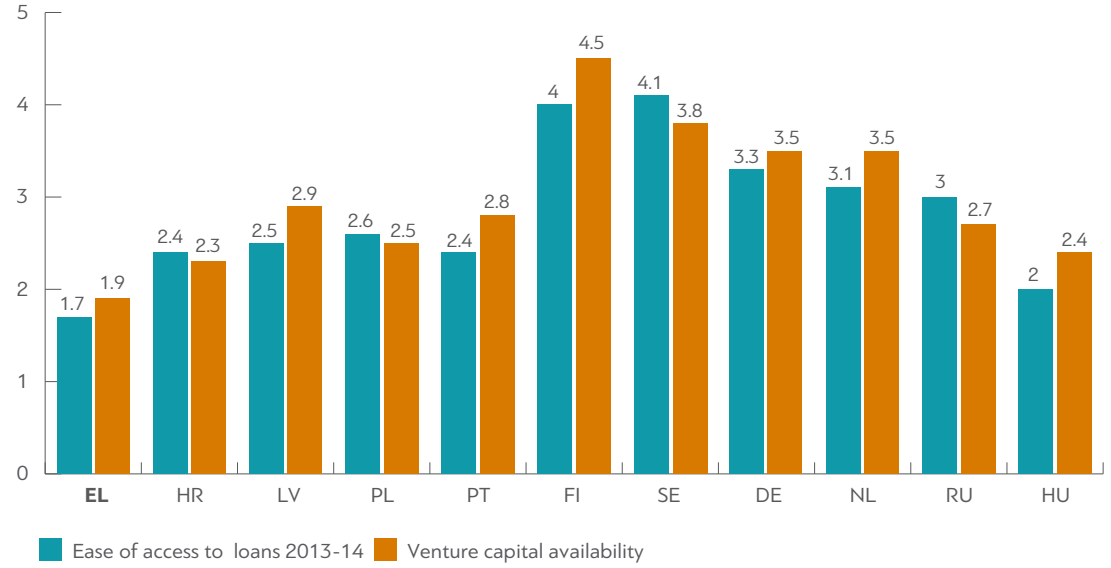
Greece's integration into international academia is also related to the large number of outstanding Greek researchers, who have left Greece in favor of leading research institutions and high-tech companies in other European countries or the US. The exodus of Greek researchers is visible in the number of grants awarded by the European Research Council (ERC): more Greek recipients work in other countries than in Greece (Herrmann & Kritikos, 2013). Besides Greece researchers of no other nationality in the EU receive more grants abroad than in their home country in considerable amount when related to their population. While "brain drain" currently affects Greece negatively, the country could benefit from its excellent scientists abroad. However, Greek universities, research institutes and firms need to motivate these expatriates to support brain circulation by at least partly returning to Greece or to cooperate even closer with researchers in Greece.

Financing

In order to commercialize scientists' research results and inventions that have been made in research institutes, firms need access to finance, as innovation is costly. Entrepreneurs require venture capital, as launching an

innovative business is risky, if not uncertain. Many private investors of Greek nationality have placed their equity in other countries (Evans-Pritchard, 2012). Hence, access to loans as well as the availability of venture capital is very limited in Greece (see Figure 5.9).

Figure 5.9: Access to Financing



1= extremely difficult
7= extremely easy

"In your country, how easy is it to obtain a bank loan with only a good business planand no collateral?"

"In your country, how easy is it for start-upentrepreneurs with innovative but risky projects to obtain equity funding?"

Source: Innovation Union Scoreboard 2015 – European Commission (2016)

Even if the country's innovation chain were well functioning with strong research networks, a lack of access to finance would inhibit the introduction of innovative products and start-up firms to the market.

Regulation

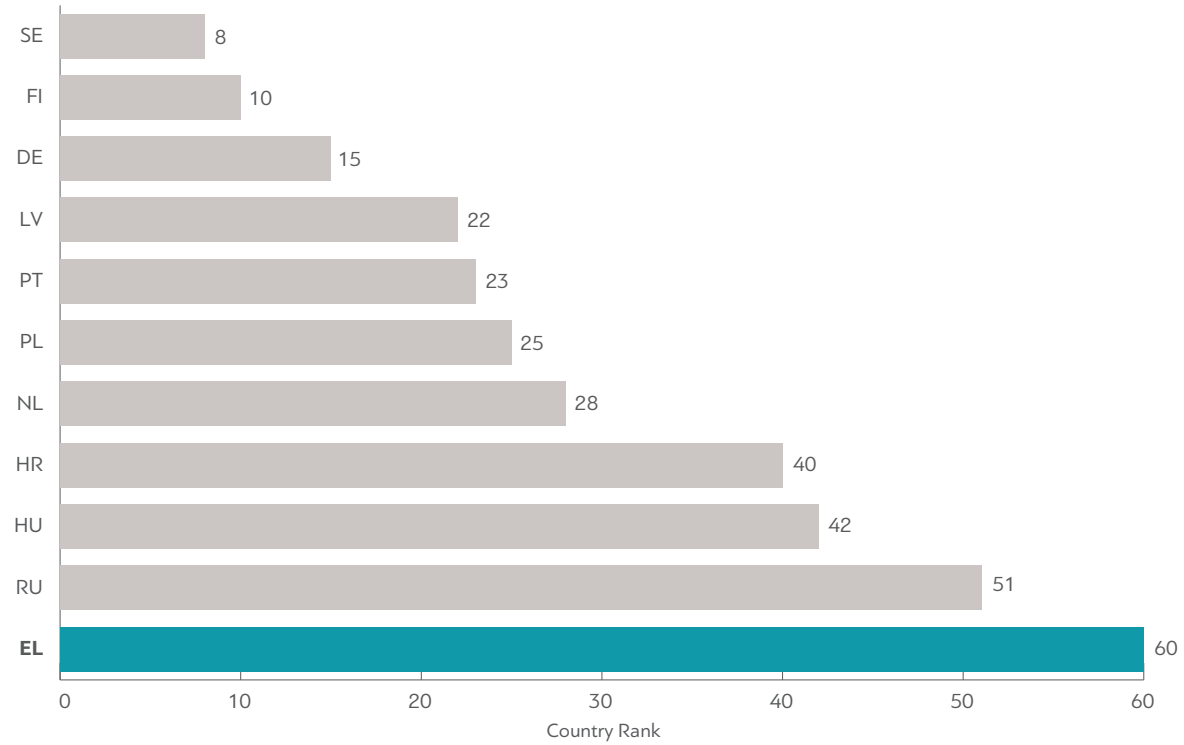
One of the most important reasons why Greece is performing so poorly in the area of innovation is that innovative companies in Greece face an adverse regulatory system, which discourages investors, managers and entrepreneurs. It constitutes a main reason for the continuous exodus of capital, labor and entrepreneurship from Greece. Greek businesses face a multitude of regulatory hurdles, restrictions, and red tape. This holds true for start-ups as well as for large companies. Product market regulations have impeded investment and exports for decades, for example through price rigidity, market entry restrictions as well as an ineffective spatial planning

system (Richter, Giudice, & Cozzi, 2015). Complicated regulations in different areas as well as time- and cost-intensive procedures create uncertainty and hinder business activity, and in particular innovation and entrepreneurship.

The annual "Doing Business" report of the World Bank assesses economies with regard to underlying factors relevant to their economic performance, such as the regulatory system, the functioning of the bureaucracy and business governance (The World Bank, 2016). In 2010, Greece ranked 109th of 183 and managed to improve – also partially because of "strategic" changes in the regulatory environment – to 60th of 189 in 2016. Despite this improvement, Greece is still heavily regulated in comparison to other countries (see Figure 5.10).[11] In recent years, Greece has improved in the following areas: "starting a business", "protecting minority investors", "trading across borders" and "resolving insolvency". Nevertheless, Greece's performance is still extremely poor in some areas: "registering property" (rank 144), "enforcing contracts" (rank 132). The degree of overregulation in Greece is underlined by the recommendation of an OECD (2014) report to delete without replacement more than 550 regulations in the food processing, retail trade, building materials, tourism and other sectors. In order to make further progress in its effort to reduce overregulation, Greece could also harness feedback from businesses, NGOs, authorities or other stakeholders, as part of simplification and codification measures of the European Commission (2014).

11. The OECD (2015a) provides a composite indicator of product market regulations that reflects the degree to which state control of businesses, legal and administrative barriers to entrepreneurship and barriers to international trade and investment hamper competition. The indicator shows that such regulation in Greece is strong (Figure A.7 in the Appendix). Further, the Worldwide Governance Indicator on regulatory quality (The World Bank, 2015) shows that policies and regulations in Greece are not conducive to private sector development (Figure A.6 in the Appendix). This is in stark contrast to the innovative nations Finland, Sweden, Germany and the Netherlands.

Figure 5.10: Ease of Doing Business, 2016

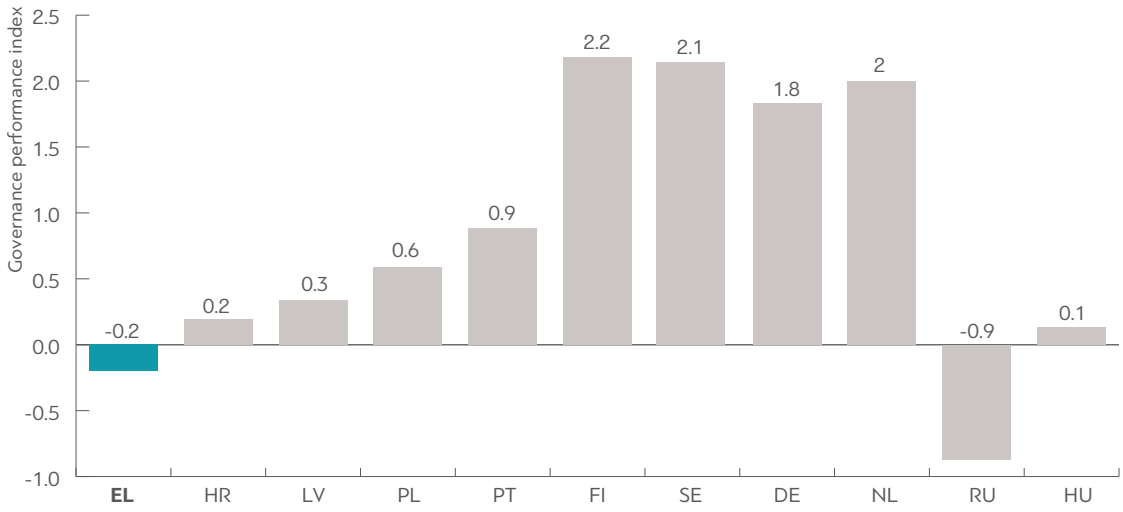


Source: The World Bank (2016)

Overregulation provides incentives for corruption, which is present throughout Greece. Based on the Worldwide Governance Indicators (The World Bank, 2015), Figure 5.11 illustrates that control of corruption – the use of public power for private gain and control of the state by elites and private interests – is perceived to be weak in Greece. In contrast, the innovation-driven countries Netherlands, Finland, Sweden and Germany, show a strong performance.[12]

12. These results are in line with the results of the Corruption Perceptions Index 2015 by Transparency International (2015) (Figure A.5 in the Appendix).

Figure 5.11: Control of Corruption, 2014



Note: The Worldwide Governance Indicators report survey respondents' perception of governance quality and ranges from approximately -2.5 (weak) to 2.5 (strong).
Source: Worldwide Governance Indicators - The World Bank (2015)

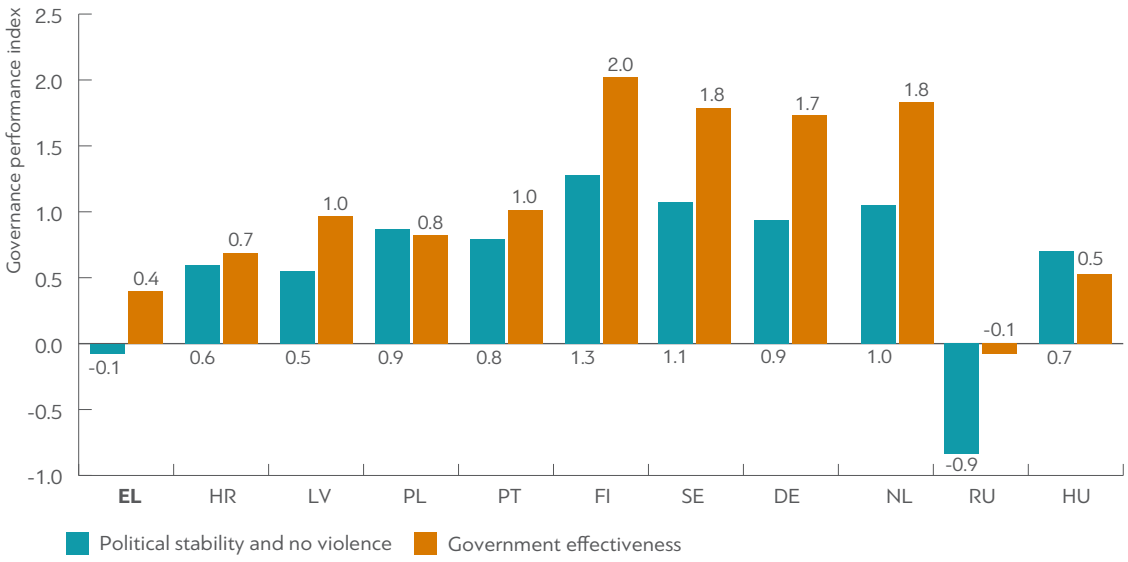
Corruption is particularly problematic for innovative activities, as a problematic legal system can lead to serious doubts about the protection of intellectual property rights and a lack of trust in the institutions enforcing them (Audretsch & Feldman, 1996). Moreover, enforcing a contract in court in Greece may take ten years, or even more than that. Further, tax legislation is not enforced consistently, sparing many small businesses while burdening larger firms. Such uncertainties in combination with corruption cause prohibitively high risks for inventors and deter them from commercializing their inventions in Greece.[13] As a consequence, many entrepreneurs – even if they developed their ideas in Greece – are motivated to relocate to countries where they have more legal certainty and a better innovation environment.

13. For an overview of the overregulation, the bad legislation and the corruption in Greece see diaNEOsis' research available at: http://www.dianeosis.org/research/polynomia-kai-kakonomia/ (in Greek).

Quality of Governance and Demand for Innovation

Any innovation system is influenced by the general attitude in society towards innovation as well as by the overall quality of governance. The Worldwide Governance Indicators (The World Bank, 2015) include two dimensions that reflect the quality of the political environment. "Political Stability and No Violence/Terrorism" measures perceptions of the likeliness that the government might be overthrown by unlawful and/or violent means. The dimension "Government Effectiveness" provides a measure for the quality of public services, their independence from political pressures, the quality of policy formulation and implementation and the credibility of the governments' commitment to such policies. Greece performs poorly on both of these dimensions, far behind the innovation-driven economies in the peer group (Figure 3.12), which corroborates that the current political environment in Greece is not conducive, but harmful to innovation. In particular, innovators, entrepreneurs and top researchers are very sensitive to the independence from political pressures and will move to other countries when such independence is not guaranteed.

Figure 5.12: Governance Quality



Note: The Worldwide Governance Indicators report survey respondents' perception of governance quality and ranges from approximately -2.5 (weak) to 2.5 (strong).
Source: Worldwide Governance Indicators - The World Bank (2015)

Greece comes in last with a very high score of 61.1 % in the category "fear of failure", a common indicator measuring the social acceptance of individuals who failed with entrepreneurial activities on the market for a given society. It also measures the reaction of potential entrepreneurs in turn towards the bad or partly even non-existent regulation of failed (insolvent) companies. In short, such a high score limits the supply of productive entrepreneurs with ambitions for growth.

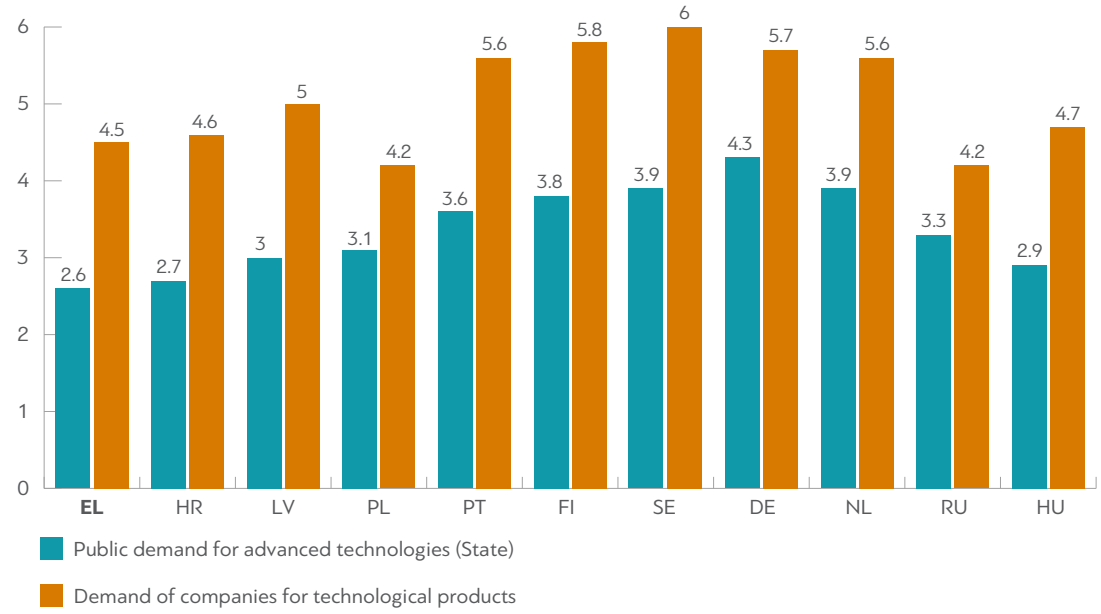
Non-existent regulations of bankruptcy procedures, sanction or market exit of firms further limit the supply of entrepreneurs, start-ups and innovators to the Greek market (see GEM 2014, p.33.f).[14]

14. Γhttp://www.gemconsortium.org/report.

Demand for Innovation

Demand for high-tech products in a given country creates financial incentives to translate research results and inventions into marketable products, i.e. to innovate. Figure 5.13 shows that the Greek state, as a significant driver of aggregate demand, supports innovation through purchasing new products or technology less than the governments of innovation leaders. Enterprises in Greece are more open to new technology, but demand for innovative products in Greece is still weaker than in Finland, Sweden, Germany and the Netherlands.

Figure 5.13: Demand for Technology and Innovation



1=not at all
7=extensively

"In your country, to what extent do government purchasing decisions foster innovation?"

"In your country, to what extent do businesses adopt new technology?"

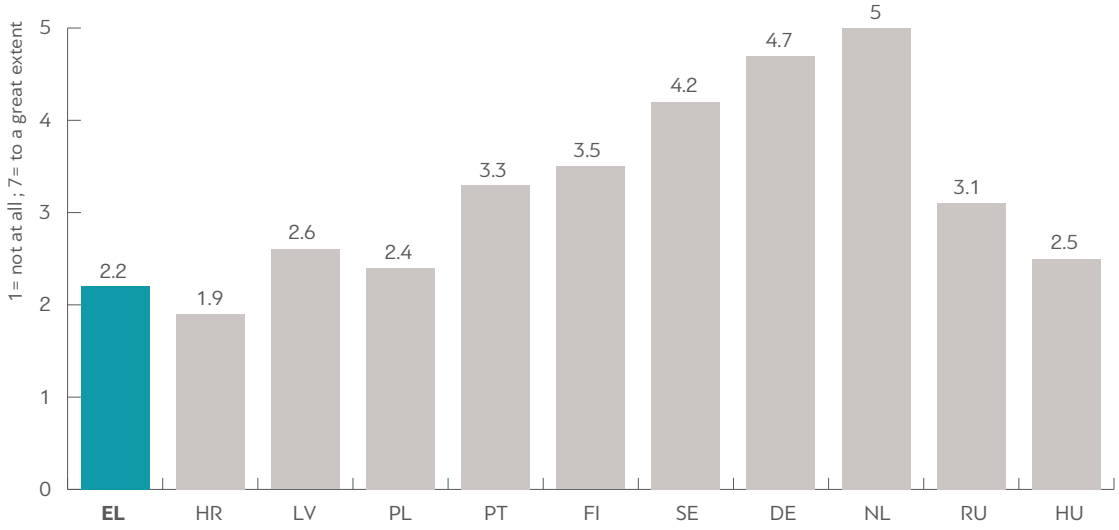
Source: Global Competitiveness Report 2015-2016 - World Economic Forum (2016)

Capacity to Attract Talent

For a proper functioning of the innovation chain four types of talented individuals are necessary: excellent researchers, competent entrepreneurs that have the relevant personality traits such as uncertainty acceptance, managers that support the creation of marketable products as well as well-skilled employees driving the practical issues of an innovation process. As Figure 5.14 indicates, Greece is barely able to attract talent from abroad and further struggles to retain its own talent (Figure A.8 in the Appendix). This is mainly due to the poorly functioning innovation system.

Figure 5.14: Country Capacity to Attract Talent, 2014-2015

"To what extent does your country attract talented people from abroad?"



Source: Global Competitiveness Report 2015-2016 - World Economic Forum (2016)

E3. The Greek Innovation System: Summary of the Main Findings

The comparative analysis of the different European innovation systems based on the methodology of the Innovation Indicator allows to identify the weaknesses and strengths of the present Greek innovation system. Even though some elements of an effective innovation system are present in Greece, crucial factors are missing and several obstacles exist. Greece has neither competitive high-tech industries, nor an innovation-friendly environment, but suffers from institutional and structural problems:

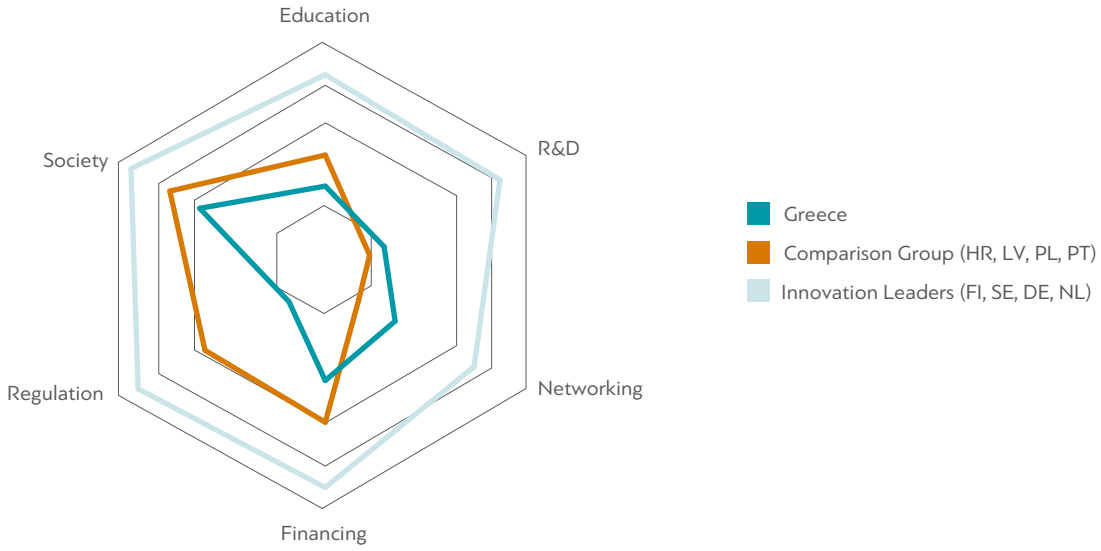
- On average, Greek schools, universities and research institutes are not competitive on an international scale,
- R&D expenditures, public and even more so private investment into R&D, are too low,
- networks among basic research, applied research and business need to be extended in number and quality by a massive increase of basic and applied research institutions towards the creation of regional clusters,
- the financial sector does not provide sufficient risk capital for start-ups and loans for established companies,
- the regulatory framework suffers – on the one hand – from too many (wrong or outdated) regulatory restrictions while – on the other hand – many areas are not regulated in an adequate manner, and
- the political and societal environment do not support and often even impede innovation and entrepreneurship.

Despite these shortcomings, Greece has some valuable assets that can help to make the transition to an innovation-driven economy:

- a small number of leading research institutions,
- a small number of medium and high-tech firms, e.g. in the IT and pharmaceutical sector, as well as a certain number of innovative startups in the information technology sector in Athens, and
- a considerable diaspora in research, finance and business,
- an attractive climate and high quality of life, which constitutes a unique comparative advantage towards most EU member states.

The comparison with the group of European innovation leaders shows that Greece is trailing behind in all sub-systems (Figure 5.1). Greece is in particular very weak in “Regulation”, with a very low score and the greatest distance to both peer groups, the innovation leaders and the comparison group.

Figure 5.15: Innovation Performance According to The Sub-systems



Note: To estimate the innovation performance of each country, the innovation indicators presented above were normalized. For each sub-system, we then calculated the mean of the respective individual indicators and averaged the results for the comparison countries and Innovation Leaders.
Source: Calculations by DIW Econ

Very poor regulation is the biggest obstacle of the Greek innovation system. The best thing about this bad assessment result is that the government is in charge of regulation and could improve the situation relatively quickly and autonomously.

In the category "R&D" Greece outperforms the comparison group, but remains far behind the innovation leaders. As identified above, "R&D" is mainly constrained by poor regulation.

The third biggest gap compared to the innovation leaders is "Education". Again, education is the domain of the government and reforms could improve the situation.

The Greek scores in the subsystems "Financing" and "Networking" appear relatively small if compared to the other categories. In networking, Greece significantly outperforms the comparison group.

The shortest distance to the leaders and the strongest Greek performance in all subsystems is measured for "Society", implying that the Greek society as a whole could be supportive to an economic development strategy based on innovation and export growth and starting with improvements in the regulatory sub-system.

THE IMPACT OF RESEARCH ON GREEK ECONOMIC GROWTH

German Institute for Economic Research
DIW Econ

November, 2016

Digression: A Tale of Two Innovation Systems

To gain further insights in factors shaping the establishment a well-working innovation system, the following case studies are used as illustrative positive and negative real-life examples. The Science City Berlin-Adlershof is a research cluster located in Germany´s capital Berlin and is used as a positive example for a regional innovation system. In contrast, the Russian attempt to increase the attractiveness of its innovation system is considered a failure, and serves as a negative example.

F1. The Science City Berlin-Adlershof

Berlin-Adlershof Science City emerged as one of the prime examples for well-working regional innovation systems in Germany. Berlin-Adlershof serves as a good example for the Greek situation because the project started right after the German re-unification which required a fundamental structural change of Berlin's re-united economy. The Berlin-Adlershof Science City is by now well-regarded as an international best practice of an innovative regional growth center.

Since its foundation in 1991, the Berlin-Adlershof Science City has attracted more than 1,000 companies and local scientific institutions, which are located in an area of more than 4 km^2. Around 16,000 workers and 6,500 students work and study at the multiple private and public institutes and businesses in the Science City Berlin-Adlershof, contributing to a total of EUR 1.6 billion in private firm revenues.

The Berlin-Adlershof Science City consists of the Science and Technology Park, the Media City, multiple commercial businesses in addition to a landscape park and private housing. The Science and Technology Park is the largest part of the Science City, employing around 6,000 workers. In addition to hundreds of companies, 6 scientific institutes of the Humboldt University Berlin (Chemistry, Geography, Computer Sciences, Mathematics, Physics and Biology) and more than 10 non-university research institutions are located in the Park. The non-university research institutes complement the areas of basic research conducted by the institutes of Humboldt-University and focus on five areas:

- Photonics and optics,
- Renewable energies and photovoltaics,
- Microsystems and materials,
- IT and media,
- Biotechnology and environment.

In 1991 the state government of Berlin took the decision to develop Adlershof into an integrated landscape, combining commerce and science. A management company (WISTA GmbH), was established as a

development agency, leading Adlershof to become Germany´s largest Science and Technology Park.

Placing the Science City Berlin-Adlershof in the context of an effective regional innovation system (compare Section 3) explains how and why it was successfully developed. On the one hand, the high numbers of graduates and researches in science, mathematics, computing, engineering, manufacturing and construction (Figure 5.3) provided skilled human capital input. On the other hand, the collaboration with Humboldt-University ensures the regional availability of high quality education. In addition, the university´s research institutes, which are located at Adlershof, provide basic research. Basic and applied research is conducted by the non-university institutes. Berlin, as Germany´s capital and an important research and cultural center, is attractive for both national and international talent.

The geographic as well as contextual proximity between research, established companies and innovative start-ups allow networking activities and provide one of the most distinctive characteristics of the research cluster. Short and efficient communication channels, enabled by cluster management at Adlershof, are a key factor for the success of these activities. Figure 6.1 shows how closely the different areas are located to each other, which increases the likelihood of knowledge and technology spill-over effects. A combination of public and private capital secures the necessary financial funds. The availability of funds was supported by a continuous willingness of regional and national political systems to support the project, through the so-called “institutional memory”. This implies that the organization and implementation of projects is continued even after a change of government, one of the most crucial factors for a successful development of a cluster. The strong regulatory environment in Germany further facilitated the success of Berlin-Adlershof. Lastly, the location of the Science City in Berlin provides a unique comparative advantage in terms of society´s attitude towards innovation and technology. Nowhere else in Germany more self-employed persons live than in Berlin, which is also now considered as one of the top three start-up centers in Europe.

The Science City Berlin-Adlershof actively supports students and entrepreneurs who want to start their own company. Five start-up centers and programs offer support reaching from networking possibilities and professional coaching to providing office spaces that are readily equipped with the necessary infrastructure. The innovation and start-up centers IGZ and OWZ are located at Adlershof as well as the Gründerhaus (start-up house) of the Humboldt University. The Adlershof Accelerator Program provides tailored support for a selection of high-potential start-ups. Lastly, the Inkulab focuses on scientists in the field of life sciences, green chemistry and nanotechnology and closely cooperates with all universities of Berlin.

Figure 6.1: Map of The Cluster Management at Berlin-Adlershof Science City

Source: WISTA MANAGEMENT GmbH (2016)

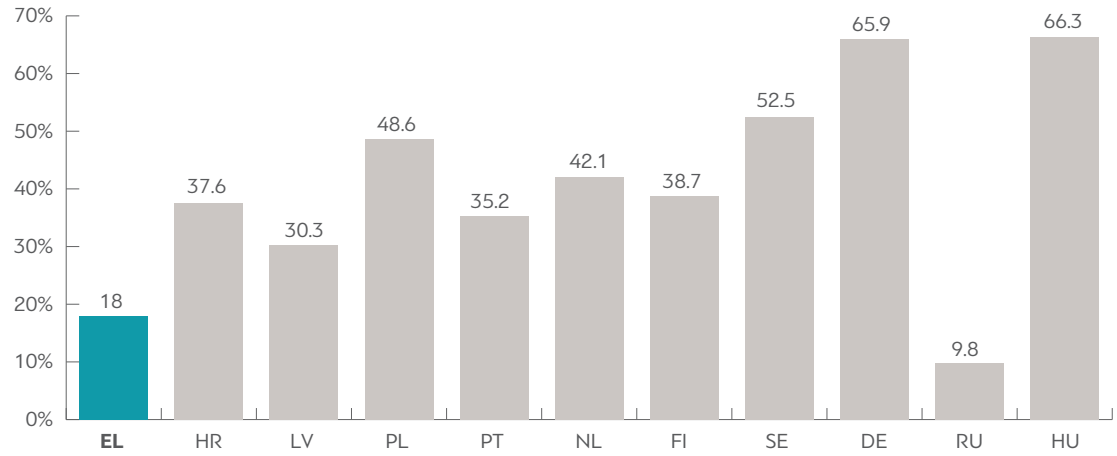
The networking activities between research institutes and businesses have regional economic effects on GDP, employment and tax revenue. According to calculations by DIW Econ, in 2013, the direct and indirect effects of the Adlershof Science City contributed EUR 391 million to gross value added, provided employment for additional 6,500 workers and generated tax revenue amounting to EUR 78 million in Berlin. However, this is only the demand-driven effect. Much more important is the impact on dynamic economic growth due to research and innovation.

F2. Some Observations of the Russian Innovation System

Roughly 25 years ago the Russian Federation became the main successor of the socialist USSR and subsequently went through fundamental reforms (Klochikhin E. A., 2012). Russia became more integrated into global chains of production, although it is still largely focused on exports of raw materials rather than innovative products and services. Exports are dominated by oil and gas, whereas medium- and high-technology products such as machines, equipment and automobiles remain of minor significance (Figure 6.2)

In that sense, Russia has some similarities to Greece. While the main natural resource of Greece is the Mediterranean location and a landscape favorable for high shares of tourism, Russia is relying on the export of natural resources, mainly oil and gas.

Figure 6.2: Exports of Medium and High-Technology Products as Share of Total Product Exports, 2006-2013



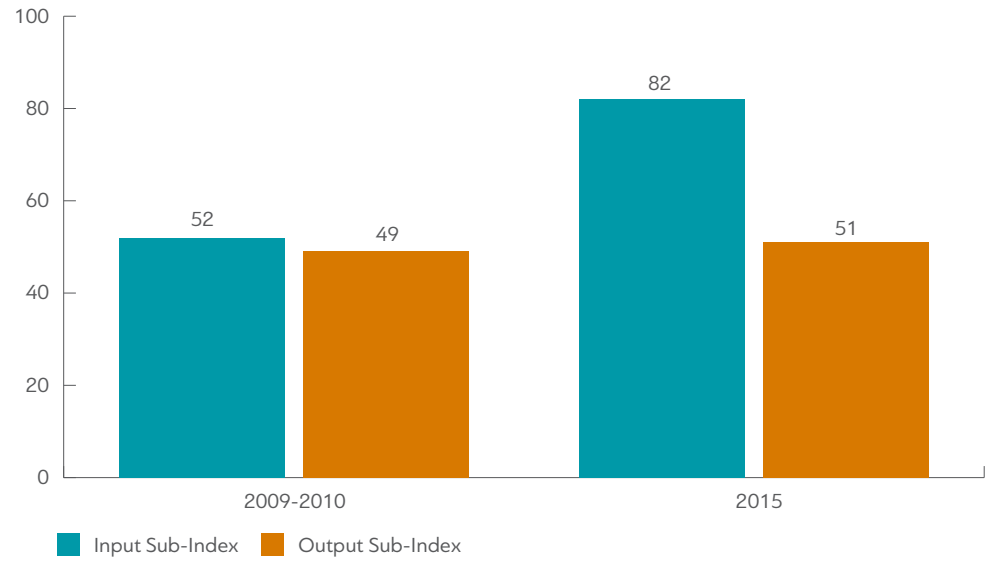
Source: Innovation Union Scoreboard 2015 - European Commission (2016)

Although Russia inherited strong capacities in science and technology with a large base of theoretical research and highly qualified technical personnel (Klochikhin E. A., 2012), the country exhibits relatively low productivity, limited innovative capacity and technological capabilities that lag behind those of highly developed industrial countries. Due to the monopolistic structures of the Russian markets, companies are less likely to increase their competitiveness. Further, impediments to entrepreneurship, inadequate intellectual property protection and lack of trust among businesses inhibit cooperation and hamper innovative capacity and economic growth (Gokhberg & Roud, 2012).

For many years, Russia has allocated enormous amounts of resources to strategic innovation projects, but the country's position in global science and innovation performance has been declining (Balzer & Askonas, 2016). Russia's comparatively weak position with regard to innovation output is reflected for instance in the low number of PCT patent applications (Figure 5.6) or international scientific co-publications (Figure A.4 in the Appendix).[15] Russia´s weak performance with regard to innovation is further depicted by its rank in the Global Innovation Index, as shown in Figure 6.3.

15. These indicators additionally suffer from Russia's weak international integration.

Figure 6.3: Russia's Innovation Performance in Global Innovation Index 2009-2010 and 2015



Source: INSEAD (2010), Cornell University, INSEAD & WIPO (2015)

In Russia, several factors impair the functioning of its national innovation system and render the government initiatives as well as the allocation of research funds ineffective. Below we examine the Russian innovation system according to the six sub-systems identified before and point out distinctive strengths and weaknesses.

Education

The Russian education system as well as research institutions are perceived to be of mediocre quality (Figure 5.2, Figure A.1 and Figure A.2 in the Appendix). Antiquated curricula, poor teaching as well as differences in education expenditure between regions are some of the issues that hold back performance (Amini & Commander, 2012). In recent years the Russian Ministry of Education and Science has focused on developing some elite institutions, while either reducing funding for underperforming ones, merging or even closing them (Balzer & Askonas, 2016).

R&D

In its efforts to promote innovation, the Russian government relies strongly on top-down programs, with government policy emphasizing central control and focusing on the state sector, instead of facilitating dynamic bottom-up development (Balzer & Askonas, 2016). Coerced cooperation on R&D projects between state businesses and universities often result in mere "faked innovation", meaning the presentation of old inventions as new ones (Bychkova, Chernysh, & Popova, 2015).

Many technology parks, Special Economic Zones, the Russian Venture Corporation and other organizations have been established by the government to support the commercialization of inventions in SMEs and university spin-offs. But, instead of becoming innovation incubators, science parks tend to become industrial parks over time (Balzer & Askonas, 2016). The main reason for Russian firms to relocate in such parks is to benefit from granted tax reliefs and to avoid red tape.

Despite plenty of government initiatives[16], R&D expenditure in 2014 totaled 1.2 percent of GDP, which is relatively low, as Figure 3.4 displays. A large portion of R&D in the business sector (0.7 percent of GDP) is due to the heavyweight state enterprises.

Networking

The Russian innovation system suffers from a separation of research and business: Scholars, particularly older ones, avoid engagement in business activity and avoid cooperation with firms, as "commercial considerations are viewed as alien to the pursuit of real science". Firms regard cooperation

16. A prominent example is the massive nanotechnology program. Several nanotechnology centers and research facilities were founded. But despite enormous public investments the number of publications in the area of nanotechnology barely increased and no major achievements were made (Balzer & Askonas, 2016).

with research institutions mainly as a means to obtain government funding and not as a way to develop innovative products. As part of the Soviet legacy, academies of science and research institutes focus on research, while universities are primarily confined to teaching. Scientists seldom engage in interdisciplinary research and a "tradition of 'scientific schools'" hampers researcher's mobility between institutions. Reforms to the Russian Academy of Sciences have been subject to strong resistance by the scientific community. Many researchers in favor of reforms, often those with ties to the international scientific community, have left the country. Moreover, legislation kept the worlds of academia and business apart: Russian universities have been allowed to found startups and commercialize results of their research only since 2010 (Bychkova, Chernysh, & Popova, 2015). Of the 35 technology platforms, which the federal government has founded as a tool to foster cooperation between research, firms and the state, only about one fifth appears to be functioning properly (Dezhina, 2016). The 25 Russian regional clusters exhibit weak competition and put emphasis on large and state enterprises, while there are few private firms and SMEs (Dezhina, 2016).

The Russian government tries to address the lack of networking between science and business. The most prominent of initiative is the Skolkovo Innovation Center. The technology park was intended to become a Russian Silicon Valley. But a very short-term orientation on behalf of policy makers and rival pet projects of individual decision makers undermine the long-term development of such initiatives. By now, Skolkovo's future has become uncertain, while the current trend centers around the Moscow State University, which is launching an initiative similar to the Skolkovo Foundation (Dezhina, 2016).

Regulation

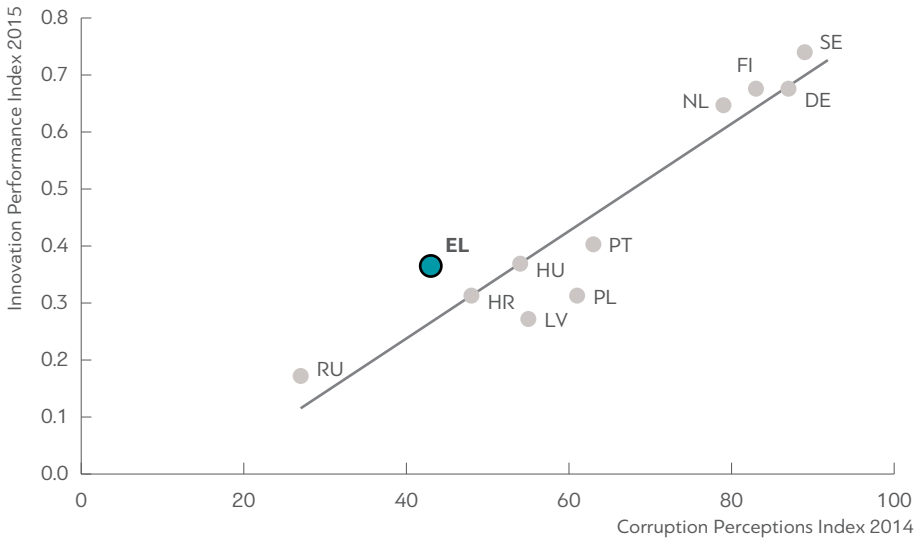
Russian firms that are willing to innovate, especially SMEs, face bureaucratic hurdles and unclear regulations. For instance, universities have difficulties to set up business incubators as they retain a 33 percent stake in the spin-offs. This results in the need to conform to more complex accounting standards and other regulations, which in turn deters investors. Further, companies that collaborate with universities on R&D projects are burdened with exceedingly strict and time-intensive reporting requirements, including additional audits and inspections (Bychkova, Chernysh, & Popova, 2015). Reforms to the Russian Academy of Sciences that were intended to increase the effectiveness of public research institutions added even more bureaucracy (Yablokov, 2014). Overregulation also provides ground for corruption and nepotism, which is reflected in Russia´s alarmingly poor results in the Corruption Perceptions Index 2014 as seen in Figure A.5. Related to the issue of corruption is the lack of trust among entrepreneurs and inventors, which presents an obstacle to the development of innovative

products: scientists fear that business partners could steal their ideas (Viljakainen, 2015).

The points made above illustrate that overregulation and ineffective policies in Russia are the underlying causes for its poor innovation performance despite the explicit aim of the government to create a "Russian Silicon Valley". Regulatory requirements discourage cooperation between research and business, while R&D funds provided by the government seep away without being utilized according to their purpose. Overregulation provides fertile soil for corruption. Corruption, in turn, harms the innovative capacity of these countries, as Figure 6.4 shows.

A survey that asked managers to assess the quality of the Russian business environment identified corruption as the main business constraint (European Bank for Reconstruction and Development, 2013). In an overregulated system a fight against corruption bears the risk of harming the overall functioning of the system, as actors are obliged to be corrupt in order to be able to work.

Figure 6.4: Innovation Performance and Corruption



Note: A higher corruption perceptions index corresponds to a lower level of corruption in a given country.
Source: European Innovation Scoreboard 2015 – European Commission (2016), Transparency International (2015)

F3. Main Findings from the Two Tales

The main insights from the case studies are that a successful development of an innovation system rests on a long term development strategy embedded in a lasting consensus of all relevant stakeholders. The development of an innovation-oriented research environment requires a stable and reliable public policy towards the private sector. Supported by a trusted and efficient regulatory, legal, and tax environment, the grooming of innovative firms requires further input ingredients like the availability of talent and stable long term funding. International openness and networking need to be fostered by close proximity of the different public and private actors. The market success of innovations requires the combination of entrepreneurial spirit with access to financing. Moreover, start-up firms will only start to grow if the regulatory environment is conducive to growing companies. Under such conditions, innovative systems may develop from the bottom up and over a long period of time. Innovation systems do not develop quickly. More importantly, innovation does not develop by government decree. In sum, Greece could move towards an innovation-driven economy, but only if all stakeholders are persistent and focused in their efforts.

THE IMPACT OF RESEARCH ON GREEK ECONOMIC GROWTH

German Institute for Economic Research

DIW Econ

November, 2016

Policy Recommendations

First and foremost, before going into details: the most crucial point for a successful development of an innovation system is that it requires a long-term development strategy. Greek policy makers must work towards a lasting national consensus, which includes all relevant stakeholders. A flourishing innovation system cannot be created just by governmental decree or by providing huge amounts of public funding. Instead, the innovation system needs to grow slowly but steadily from the bottom up in a conducive environment

What is thus most important for the overall success of the Greek innovation policy is the continuous implementation of an innovation strategy over the long-term. This is only possible if Greece is able to create an "institutional memory", the continuation of projects after a change of government over the next two to three decades. This also means that Greek policy needs a completely new approach. The challenge is to disrupt path dependencies and the self-conception of all previous policy approaches in Greece irrespective of whether they were coming from the so called right or left side of the political spectrum or not.

In order to start forging national consensus over a long-term innovation strategy, key players of innovation need to create awareness among Greek decision makers and society as a whole regarding the crucial importance of strengthening the Greek innovation system. It should also be emphasized that if Greek governments do not start trying to transform the country into an innovation driven economy soon, the country will continue to stagnate and may experience more growing differences in performance and productivity compared to other EU member states which are now at a similar wealth and productivity level, but which decided to follow the innovation path. Given the increasing speed of digitization in the economies, Greece might otherwise become the loser of future developments. A good starting point might be to create a well-prepared and targeted Greek innovation summit where representatives of all parts of an innovation system take part, i.e. science, business, politics.

Turning to more specific fields, we identified in this report several innovation subsystems with urgent need of improvement. In the following sections we provide proposals for concrete actions to address these problems.

G1. Regulation

In this study, the present state of regulation of the Greek economy is identified as one main obstacle for investment, innovation and economic growth. The detrimental effects of overregulation, conflicting legislation, and corruption are well established. And there is no shortage of policy recommendations on how the Greek government could improve the regulatory situation: a market friendly regulatory setting, macroeconomic stability, reliable economic and fiscal policies, a stable and predictable tax policy, simplified and codified legislation, regulations of market exit of firms, improved (intellectual) property rights are essential elements of such possible efforts. A general effort in slashing red tape and lifting the administrative burden for the opening, operating and closing of businesses would significantly reduce the costs of businesses while not harming society. Further, digitization of the government, like the introduction of e-government and e-administration for businesses, could both help implementing this vast number of reforms and improve the efficiency of Greek public administration.

The reform of the entire regulatory framework in Greece is a demanding task and this outside the scope of this report to cover all aspects in detail. However, the following list presents selected concrete policy recommendations which have the potential to address certain pressing problems:

- In a report published in 2013, the OECD **identified 555 potentially harmful regulatory restrictions** in Greece and proposed **more than 300 specific recommendations** how to mitigate this harm for competition. These recommendations should be implemented as far as possible.
- Establish a **regulatory control council** following the example of the German National Regulatory Control Council (Normenkontrollrat), which was founded by the German government as an independent body in 2006, as a part of a consistent overall approach through its program for «Bureaucracy Reduction and Better Regulation».[17] The intention was – inter alia – to avoid any new information obligations for citizens, businesses and public authorities – through complete

17. https://www.normenkontrollrat.bund.de/Webs/NKR/EN/Home/home_node.html.

transparency of such costs as early new laws were being drafted. The Regulatory Control Council also proposes actions to improve public governance, e.g. e-government solutions for administrative processes, such as parental benefit applications or by simplifying the administrative regulations for housing benefits.

- **An initiative to reduce conflicting legislation:** There is a high level of conflicting legislation creating particular uncertainty and additional costs for innovative businesses. Codification means bringing all amendments to a given law, adopted at different times, into one law. A swift and comprehensive codification of Greek legislation will eliminate contradictions and simplify administrative legislation. This should include the reduction and unification of the number of administrative procedures relating to any single business activity. The European Union has developed a specific unit supporting all countries in aiming to start in this direction.[18]
- **An initiative to reduce red tape in the process of starting up, running, and closing down firms:** the exchange of business owners with bureaucrats should be reduced to nearly zero with all company-related regulation in opening, running and closing down a business. The process should be organized online with the help of state of the art e-administration for all businesses (e.g. registering online new businesses, tax declaration, running a business, etc. each within one hour). Administrative efforts need to be substantially reduced. This should include reducing the number of days needed to register new businesses, the number of bureaucratic steps involved in the further process of running a business, as well as the number of regulations, fees and reporting duties.
- A modern **insolvency law and regulation:** at the moment, the hurdles to close down a company are rather high; this impedes start-ups and business activities in general.[19] Hence, an insolvency law following international best practice (e.g. Finland) should be introduced.
- **An initiative to speed up the legal system:** Currently it takes up to 10 years to enforce contracts. This needs to be substantially reduced to 1 month by streamlining the legal process, but also by reforming the court system. The details of such a reform could be worked out by a national regulatory control council (see above).
- **Provide a share of local tax revenues to cities and municipalities:** For successful innovation economies, municipal leaders committed to create an excellent local business climate (efficient, fast administration, excellent primary and secondary education, and good health services) are essential as they create «hands on» the right environment for innovative entrepreneurs. In most successful innovation economies, municipalities are therefore entitled to a share of the locally produced tax-income mostly via receiving shares from business or trade taxes, rewarding their efforts to create an attractive business environment. Greek municipality leaders are excluded from business revenues

18. DiaNEOsis's study regarding the overregulation and bad legislation in Greece arrives at some important recommendations to address this issue, which are divided into three categories, with respect to the timeframe of their implementation. The study is available at: http://www.dianeosis.org/research/polynomia-kai-kakonomia/ (in Greek).

19. See for example, the article about the new bankruptcy and enterprise restructuring laws that will come into force in Greece, available at: http://www.dianeosis.org/2016/10/bankrupt/ (in Greek).

produced in their municipality, reducing their interest thereby in caring for the local business climate. Greek municipality leaders will transform to active advocates of an excellent business climate when municipalities get a significant share of tax revenues from business activities in their municipalities. The collection of taxes should still be subject to central authorities.

- **Adjust national taxation:** the burden of company taxation and the level of the value added tax (VAT) needs to be reduced down at the EU average. Furthermore, firms will only invest into R&D and innovation projects in a stable tax environment. In particular, R&D promotion by tax reliefs or credits will only deliver results if national tax policies are reliable and predictable. Hence, the Ministry of Finance could **establish a credible rules-based framework for future tax reforms**.

G2. Research & Development

R&D expenditures, public and even more so private investment into R&D, are too low in Greece. Political initiatives should focus on both areas and improve public R&D output as well as private R&D investments. A long term strategy needs to be developed to increase R&D investments to a total of 3% of GDP over the next years. First unofficial information points to an increase towards 0.95% of R&D investments in 2015, which is an important signal given the adverse economic environment in Greece. A long term strategy needs to make sure that R&D investments will also be stepwise increased over the next years to 3%, even if the GDP should start rising again.

Moreover, there is currently a political initiative introduced by the Greek minister of Research and Innovation that aims at establishing institutions supporting the development of a knowledge-based economy. As a first step, the Hellenic Foundation for Research and Innovation (HFRI) has been founded to improve public R&D spending. The foundation will be mandated to finance independent excellent research and resembles in its structure and processes to some extent the German DFG (the German Research Foundation[20]), which is successful in supporting cutting-edge research in Germany. For research results which are relevant for entrepreneurial activities, the same initiative aims at a second step to finance start-up activities through providing innovation funds financed by the European Investment Fund among others. As a third step, the initiative seeks to establish cooperation with private venture capital funds to finance high-tech start-ups which successfully survived the seed period.

20. See http://www.dfg.de/en/index.jsp.

This is a crucial and very important initial step to improve the Greek R&D system and has the potential to provide capacity building in the Greek research system. As further steps, we suggest to complement the capacity building by an institution-building strategy, where new research institutions should be created to conduct excellent basic and applied research next to the small number of already excellent institutions. Eventually, when increasing public and private spending of R&D investments to 3%, these investments should focus on the massive expansion of the research capacity with a strong emphasis on ensuring high quality in those areas where Greek research shows already some specialization.

Important further steps to expand and improve Greek R&D activities include:

- **Opening up of four new applied research institutes** (similar to the example of the German Fraunhofer institutes) next to basic research institutes in Athens (Demokritos), Crete (FORTH), Thessaloniki (CERTH) and at the Technology Park in Patras, with a special focus on research areas covered by these institutes (among them one institute focusing on ICT). These institutes could be organized along the following lines:

  - **Financing:** use of funds from EU Horizon 2020 "teaming for excellence"-program in combination with EU structural funds. Greece needs to apply for eligibility for the "teaming for excellence"-program, something which Greek governments have not done so far. Further on, the financial instruments of the EIF and EIB which are currently used to fund the HFRI should be further included when designing a strategy to expand R&D investments in Greece.
  - **Organization** of the new institutes following European standards in the sense that independent commissions consisting of top scientists decide on the selection of the leading positions in the institutes.
  - **Development of incubators** in the same locations open for high-tech start-ups, opening up of the locations for the establishment of new firms interested in the exchange with research. Development of management board for the complete location (for example like the WISTA Management GmbH[21] in Berlin-Adlershof) making sure that the optimal mixture of high-tech start-ups and new companies are located around these research institutes.
  - The **regulatory environment** should be examined with regards to the extent that the location of private companies is allowed in the premises of Demokritos, CERTH, and FORTH.

- Once further research institutes are established, a long-term innovation strategy calls for the further **strengthening of such clusters**. Clusters in other countries often consist of a dozen research institutes, strongly cooperating with research-driven universities and the local high-tech start-ups and established innovative companies.
- **Quality initiative:** There exists a small share of researchers who conduct very high quality research in the above mentioned three Greek research institutes. Policy makers should aim at increasing this share. To this end, Greek stakeholders must – in addition to the newly started HFRI – remove the barriers that discourage Greek researchers from staying home and other researchers from coming to Greece. Thus, working and research conditions have to be designed appropriately to stop the brain drain. Attractive conditions contain three aspects:

  - **independent research** with the target of maximizing top quality research output,
  - **salaries that compete** with similar institutions in Europe, and
  - **a low regulatory burden** for starting research in Greece.

21. http://www.adlershof.de/en/wista-management-gmbh/about-us/.

- **Implement an external evaluation system:** In addition to the extension of research capacity, a restructuring of the public research system using an evaluation system (e.g. similar to the system established at internationally leading universities such as Stanford University or comparable to the evaluation system of the German Max Planck Society[22]) based on measuring performance in terms of internationally recognized publications and patents would allow a reallocation of resources and researchers from inefficient initiatives to more productive ones. Too often, public funds have been thinly spread in the past with little regard to efficiency considerations.
- **Improve autonomy of researchers, in particular young researchers:** The Greek government should further improve the autonomy of researchers and the independence of science from politics, for example with the help of independent commissions and the institution of objective, external evaluation criteria. Further, young, excellent researchers should become principal investigators and gain independence not too long after their dissertation by installing research driven tenure-track professorships. This can be supported by extensions of the European Marie Skłodowska-Curie actions and EU-ERA chairs[23].

22. See https://www.mpg.de/9704077/Evaluation2015.pdf.

23. See http://ec.europa.eu/research/era/era-chairs_en.html.

G3. Education

A reform of the Greek education system is necessary with regards to practical and professional training to reduce the present labor market mismatches. Currently market entry of new ideas is also hampered because the Greek education and professional training systems does not focus on practical skills. But such skills are necessary for transforming ideas and discoveries into marketable products and services. Existing technical colleges or universities of applied sciences need quality improvements and more focus on market demand. Concrete policy actions include:

- **Provide a stable environment for education policy:** From the transition to democracy in 1974 until today, the average service of Ministers in the Ministry of Education hardly exceeds one and a half years. This reflects a highly problematic discontinuity of educational policy (Panitsides, 2014). Hence, an important first step is to provide a stable and reliable framework for universities and schools.
- **Implement recommendations for modernising the Greek education system:** In light of this report, it seems especially important to modernise school education with a particular focus on improving digital skills. In 2012, 65% of Greeks had few or no digital skills, compared to only 39% on a EU28 average. Therefore, the European Commission strongly suggests improving digital training and education since a lack of skills in those areas is very likely to hinder the development of a Greek digital economy and consequently economic growth in general (European Commission, 2015).
- **Improving digital skills as a part of life-long learning:** Promoting digital literacy may not be restricted to schools. The UK initiative Doteveryone[24] (formerly GO ON UK) aims at improving "digital skills for everyone, at every level" via massive open online courses, online information, but also through local actions. This initiative could serve as a good example for Greece.
- Furthermore, **higher education should be modernised,** aiming for centres of excellence with higher innovative power. This can be achieved through rationalizing scientific fields and strengthening leading, well-performing departments and institutions. The consolidation logic of the recent ATHINA project could offer an interesting example in this regard.

24. See https://doteveryone.org.uk/.

- **Introduce entrepreneurship as an integral part of the education system:** the spirit of entrepreneurship should be a component of education. Young people need the mindset, skills and knowledge to generate innovative ideas, and the entrepreneurial initiative to turn these ideas into real firms and products. Therefore, schools and universities should include entrepreneurship into their curricula. The "Entrepreneurship in education" program of the Nordic Council could serve as a showcase.[25] Also, the European Commission provides a helpful publication on how to implement such projects: "Entrepreneurship Education - A Guide for Educators".[26]
- **Support start-ups in the university context:** establish business incubators at universities and research institutions (e.g. such as "HIGHEST" at the Technical University of Darmstadt[27]). Moreover, set up a program supporting young, knowledge-intensive start-ups, e.g. following the example of the German EXIST program. This program supports universities in implementing strategies for increasing entrepreneurial culture, supports students, graduates and scientists in preparing innovative technology and knowledge based start-up projects, and funds both the development necessary to prove the technical feasibility of start-up ideas based on research and the preparation necessary to launch such a business.[28]
- **Focus on STEM (Science, Technology, Engineering and Mathematics):** in order to increase innovative power, it seems judicious for the public sector to provide points of contact for prospective scientists, engineers or mathematicians early on in their academic career. In Germany, great success has been achieved through youth science and technology contests such as the "Jugend forscht" initiative. The project encourages pupils and young students to pitch innovative ideas in fields such as physics, chemistry, biology, mathematics and computer science with a prospect of sponsorships, internships or cash prizes.

25. https://www.norden.org/en/theme/former-themes/themes-2015/haallbar-nordisk-vaelfaerd/education-and-work-for-welfare/entrepreneurship-in-education.
26. http://ec.europa.eu/DocsRoom/documents/7465.

27. http://www.highest.tu-darmstadt.de/highest/index.en.jsp.
28. See http://www.exist.de/EN/Home/home_node.html.

G4. Financing

Access to finance is among the most restrictive problems of research and of young innovative companies in Greece. The current economic situation in Greece puts a further strain on researchers and innovative businesses in attracting the necessary funds for their projects. On the one hand, one future target for public policy will have to be increase finance for public R&D investment, as, unfortunately, it is currently among the candidates for further budget reductions. This will necessitate a major shift and reorientation in the political agenda, away from social transfers when designing fiscal spending. On the other hand, policy makers should develop initiatives to attract foreign venture capital. The strongest instrument for attracting risk bearing finance is again pushing forward regulatory reforms which will make the country more attractive for investors and entrepreneurs. In the short term, such a policy could be combined with grants and guarantees to start-ups provided by the government and potentially funded from EU sources, as well as specific tax laws aligned at the particular needs of risk bearing capital investments. Concrete actions beyond regulatory reforms could be:

- **Introduce tax incentives for corporate R&D activities:** The R&D activity of Greek enterprises needs to be expanded by a factor of 6 at least and should reach 2 percent of GDP within the next 15 years (from 0.3 percent at the moment). A tax credit such as the US Research & Experimentation Tax Credit or the UK Research and Development tax relief[29] could improve firm-level R&D activities in Greece with relatively low transaction costs and does not introduce as much red tape as project-based public R&D support. A so-called research payment anchored in the Greek income tax would enable companies to be subsidized in their innovation efforts even if they are still making a loss. Young companies in innovative industries could receive a payment on, e.g., 50 percent of their expenses (up to a certain maximum amount) for research and development.
- Moreover, as there **is a strong link between public and private investment**, an increase of productive public investments often induces an increase of private R&D investments: for instance, public investment creates more favorable conditions for private businesses

29. See, e.g., https://www.gov.uk/guidance/corporation-tax-research-and-development-rd-relief.

by providing better infrastructure. The existence of facilities and of common public goods can raise the productivity of private investment, which can take advantage of improved business conditions. Public investments in energy, telecommunications, or other network industries can thus stimulate private investment.

- **Grants for innovative entrepreneurs:** By rewarding entrepreneurial activities with grants that cover the basic costs of living during the first months, this policy aims at increasing the overall probability of survival of start-ups, thereby increasing the attractiveness of starting a business. The EXIST Business Start-up Grant in Germany – co-financed by the European Union – may serve as an example.[30]
- **Break the "curse of transfer":** The funding of new research institutions calls for a better and more extensive use of EU funds (like the structural funds and funds from Horizon 2020). In contrast to the past, the Greek government needs to break the "curse of transfers" and to be strongly concentrated on the improvement of the competitiveness and productivity of the Greek economy, i.e. by building clusters for research and innovation (see next subsection).
- **Improve the Greek venture capital market:** A functioning venture capital market could lead to more young innovative companies, e.g. in the ICT economy or pharma industry. Venture capital plays an important role in financing innovative companies which have a high capital requirement for research and development. The recent example of the JEREMIE seed funds in the area of ICT, could serve as an example, for other industries as well.
- **Attract external venture capital competences:** The example of Germany, and Berlin-Adlershof in particular, show that for the initial development of the national and regional venture capital market foreign venture capital pioneers are a key ingredient, as specific know-how and experience is necessary. The Greek venture capital market will emerge over a long-term and develop alongside the Greek innovation system. The Greek diaspora in Silicon Valley has the potential to be extremely helpful in this endeavor.
- **Favorable treatment of losses carried forward:** There are often considerable fiscal losses to be carried forward particularly in the initial phase of capital-intensive start-up companies. Hence, the tax environment for venture capitalists should address this issue and allow for the deduction of such losses.
- Last but not least, the strongest requirement for attracting private R&D-investments is having an **attractive regulatory environment.** Therefore, the regulatory reforms mentioned in section G1 are of crucial importance. Without these reforms, private R&D investment will always remain low.

30. http://www.exist.de/EN/Program/EXIST-Business-Startup-Grant/content.html.

G5. Networking

The development of R&D and innovation networks is related to the development of clusters but goes far beyond and also has an international dimension. Possible areas of action include:

- **Relocate research institutes to foster cluster development:** Existing Greek research institutes are still geographically scattered, which implies longer communication channels and lower probabilities of knowledge spill-overs. Although relocating institutes and businesses is associated with costs, they will be exceeded by the long-term monetary and intellectual benefits.
- **Focus on the creation of translational research institutes:** As discussed in the R&D section above, the Greek government should focus on the creation of translational research institutes such as the German Fraunhofer institutes and provide opportunities for businesses to locate close to these institutes. It is in particular the small and young firms, which need an easier access to public (and private) R&D services. Such an approach will promote the transition from basic to applied research, strengthen the collaboration between the world of research and business, and will allow small young firms and high-tech start-ups to absorb the knowledge which needs interactions with public research.
- **Open universities and basic research institutes for cooperation with business partners:** Endowed chairs at universities (e.g. such as the endowed chair of entrepreneurship[31] at the University of Oldenburg), joint research centers (such as the Rolls-Royce University Technology Center[32] at the Technical University of Darmstadt), active acquisition of third-party research funds from business partners, and strategic alliances with R&D intensive firms are measures to open up university research for economic cooperation and knowledge transfers.
- **Establish national cluster support programs:** These efforts need to be complemented by an efficient cluster strategy similar to strategy pursued in Berlin-Adlershof (see case study). Clusters are characterized by interacting research institutions and firms in related areas in close spatial proximity. Cooperation-based cluster support programs focus on facilitating the development process of emerging and existing

31. https://www.uni-oldenburg.de/en/entrepreneurship/.
32. http://www.glr.tu-darmstadt.de/glr_forschung/utc/index.en.jsp.

clusters, on improving the environment for cluster success and on maximizing the impact of clusters. For example, the Germany Ministry of Economic Affairs and Energy and the Ministry of Education and Research provide an online platform[33] which links different actors and clusters in Germany. The Ministries offer a range of support programs, such as the "Leading-Edge Clusters Competition", the go-cluster program or a specific policy measure that focuses on developing particular technology, science and business skills in the former East German regions; this initiative aims to lay the foundations for the development of regional business clusters.[34]

- **Create regional cluster management structures:** The initial main focus of a Greek cluster support program should be on setting up cluster management structures at the regional level. Such cluster management firms should include key stakeholders from the private and public sector and academia to leverage synergies. Cluster management firms provide services like start-up and business development support, infrastructure and skills training, internationalization/export promotion and common branding. Cluster development should start with a rather limited number of pilot clusters. Particular emphasis should be given to structuring new clusters in the IT sector and linking it to the global markets, helping to position Greece in the global value chain. Positive examples of cluster management structures are WISTA Management GmbH in Berlin-Adlershof (see case study) or the OptoNet cluster structure in Jena (Eastern Germany).[35] OptoNet is organized as a registered association (e.V.) with about 100 members in the area of optical engineering, ranging from large enterprises such as Carl Zeiss and many SMEs to three Fraunhofer institutes and several university institutions. It represents the leading players of Photonics in Jena region, creates a communication and cooperation platform, strengthens the international visibility of the cluster, initiates activities for talent promotion and is committed to marketing of the Photonics region. It is member of the above mentioned national go-cluster program. Its subsidiary company OptoNet CoOPTICS GmbH provides consulting and support services in the area of project and innovation management as well as subsidy application.
- **Improve permeability between research and business:** the talent of researchers should be used in science as well as in the private sector. Therefore, it should be easier for a researcher to take up a job in a start-up or in an established firm and to return to a research institute or university after some months or years. Social security institutions should support such job transitions in both directions.

33. http://www.clusterplattform.de/CLUSTER/Navigation/EN/Home/home.html;jsessionid.
34. http://www.unternehmen-region.de/en/6499.php.
35. http://www.optonet-jena.de/english-pages/.

G6. Society

The overall social attitude to science, innovation and entrepreneurship is an important factor for the functioning of an innovation system. By closing the gaps of the innovation system, the above mentioned policy proposals will also help to improve the social innovation climate. However, Greek society as a whole and policy makers in particular still lack a vision of an innovation-driven Greek economy. Establishing such an overarching vision is a cross-sectional task which should be kept in mind in all policy decisions. Further, Greek society and general public need a positive view of science-based entrepreneurship and risk-taking in innovative projects.[36] Setting up a company and investing into innovative, high-tech projects bears large risks and most start-ups fail within a short period of time. However, a limited number of start-ups thrive and grow, generate huge profits and many jobs, conquer the world markets and are leaders of structural change. Even if the founders of these companies – who also bear the risk of failure – may become very rich, the economy and society as a whole will benefit from such entrepreneurs to a large extent if the country of origin, in this case Greece, will be able to keep the fast growing firms and production processes in the country. Hence, policy actions should contribute to create a supportive environment for entrepreneurship and fast growing firms and the utilization of research results in such projects.

Further measures could be the following:

- **Attract talent:** The development of a targeted Diaspora policy towards Greek innovative individuals living outside Greece can further accelerate the goals of the Greek innovation policy. The policy should include labor market policies for recruiting talented individuals abroad and policies aimed at opening interaction and cooperation between those going abroad and those staying in Greece. By attracting top researchers, either through "brain gain", the immigration of researchers, or through "brain circulation", the general movement of researchers into and out of countries, the establishment of research institutes of excellence and of clusters can be enhanced. This will in turn attract (venture) capital and promote the implementation of innovative products in the markets, eventually resulting in economic growth. The

36. For a primary fundamental research regarding the Greeks' attitudes and perception towards entrepreneurship and risk see "Risk, Permanence, Greeks: a Story with Roots and Duration", available at http://www.dianeosis.org/2016/03/greek_society_risks/ and the overall research of "What do Greeks believe?" available at: http://www.dianeosis.org/research/greek_values/ (both in Greek).

Mercator Fellows Program[37] of the German Research Foundation aims at inviting highly-talented foreign researchers as visiting professors for a limited time to Germany and could serve as an example for a similar Greek program.

- **Fight against the fear of failure:** one major social barrier for potential innovative entrepreneurs is the fear of failure, i.e. the fear of consequences of a failed start-up project. Greece faces very high levels of fear of failure. Consequences of this include financial burdens, social costs or legal problems. However, the majority of start-ups – and in particular innovative, high-tech projects – fail within the first years of their existence. A prominent Silicon Valley motto of such projects, after all, is "fail fast". This reflects the high uncertainty of innovation. Hence, a pro-entrepreneurship initiative by the Greek government should include i) measures to reduce the actual costs of failed start-up projects for the entrepreneur and ii) a campaign aiming at improving the social attitudes regarding business failures ("second chance").

37. http://www.dfg.de/en/research_funding/programmes/international_cooperation/mercator_fellows/.

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German Institute for Economic Research

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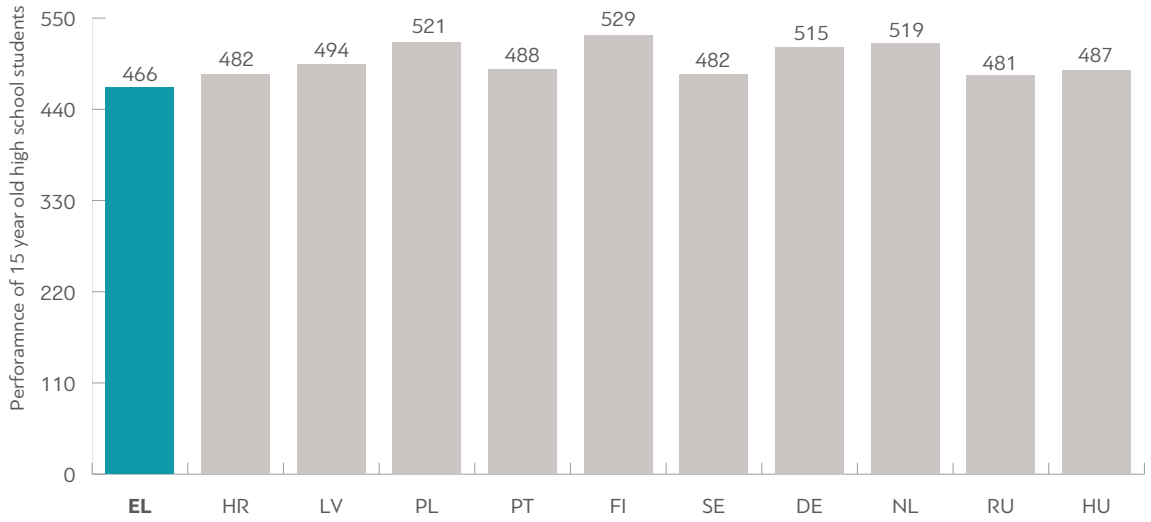
Annex

Annex

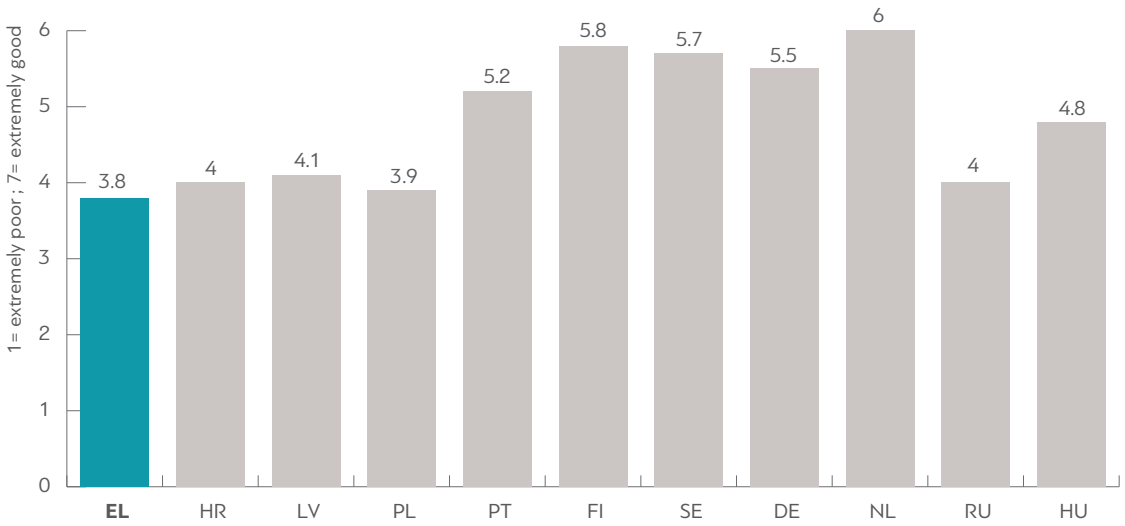
Figure A.1: Mean of PISA Results in Science, Reading and Mathematics, 2012



Source: PISA surveys 2012 – OECD (2014)

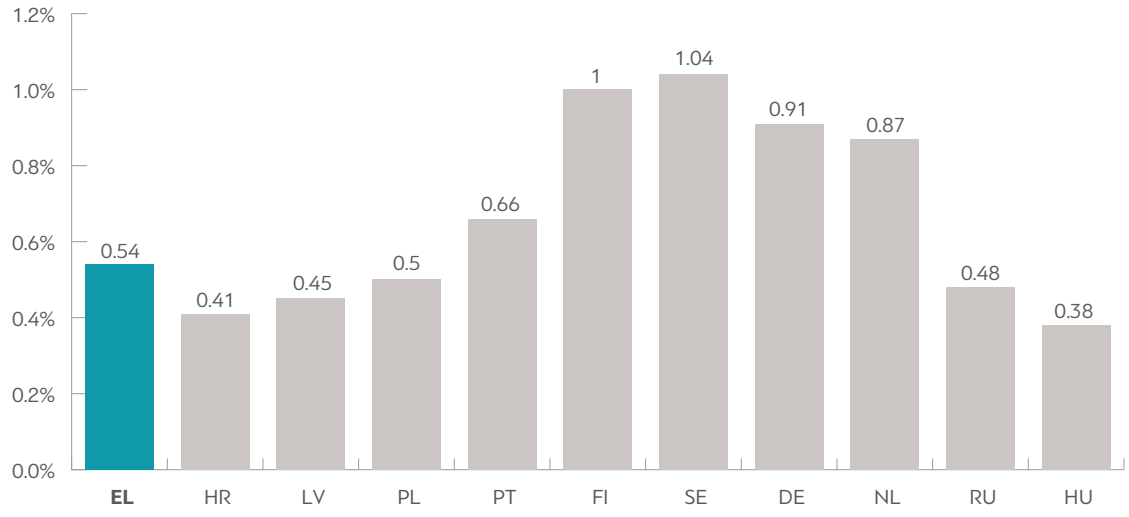
Figure A.2: Quality of Research Institutions, 2014-2015

"In your country, how do you assess the quality of scientific research institutions?"



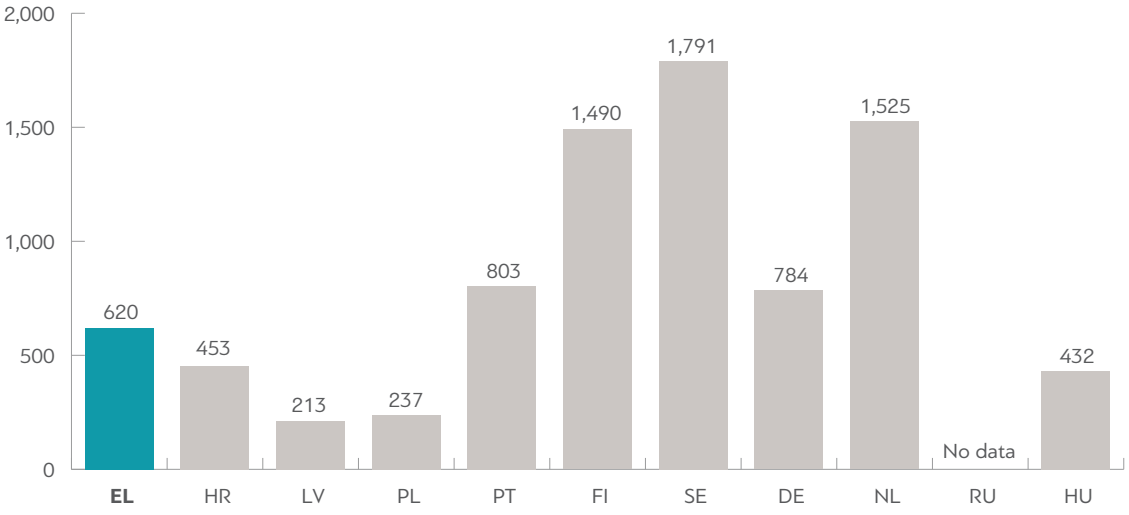
Source: Global Competitiveness Report 2015-2016 - World Economic Forum (2016)

Figure A.3: Sum of R&D Expenditure in the Public Sector as a Percentage of GDP, 2014



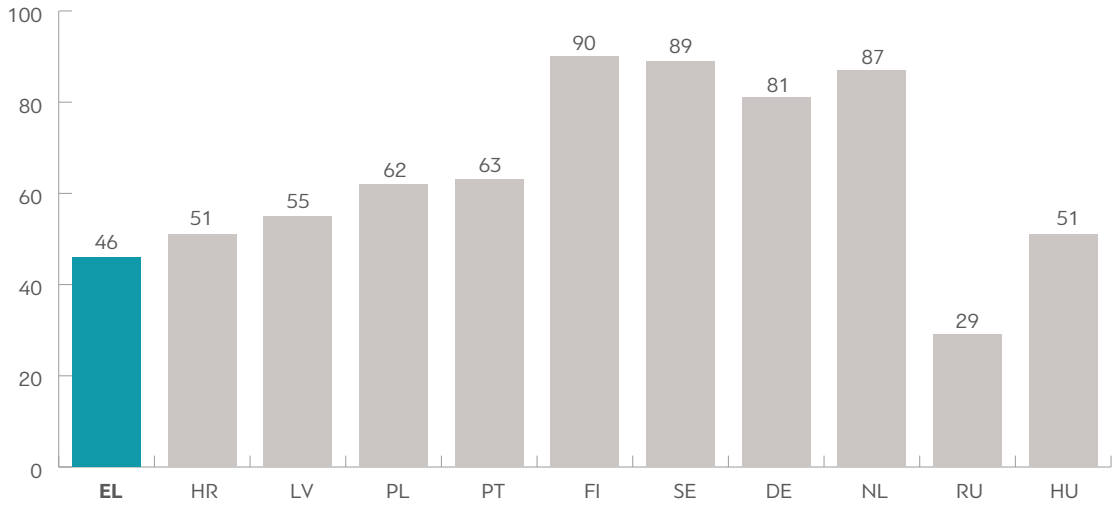
Source: Eurostat (2015a)

Figure A.4: International Scientific Co-Publications per Million Population, 2005-2012



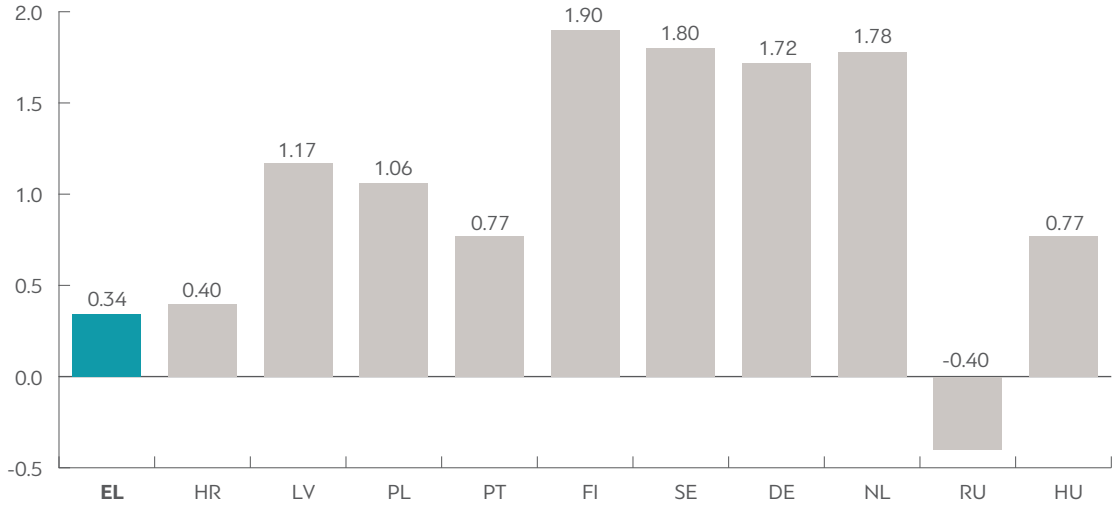
Source: European Innovation Scoreboard 2015 – European Commission (2016)

Figure A.5: Corruption Perceptions Index 2015



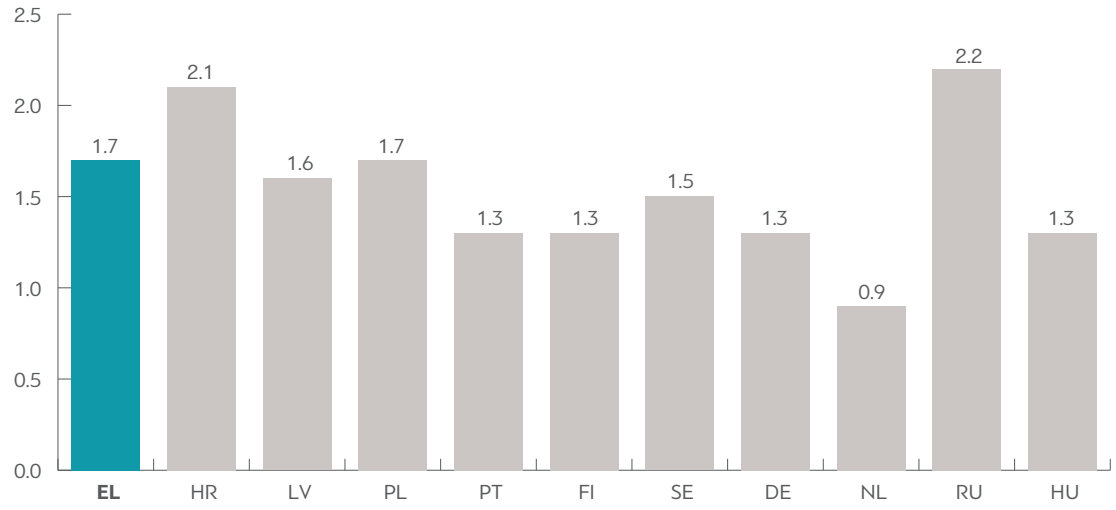
Note: A higher corruption perception index corresponds to a lower level of corruption in a given country.
Source: Transparency International (2015)

Figure A.6: Regulatory Quality, 2014



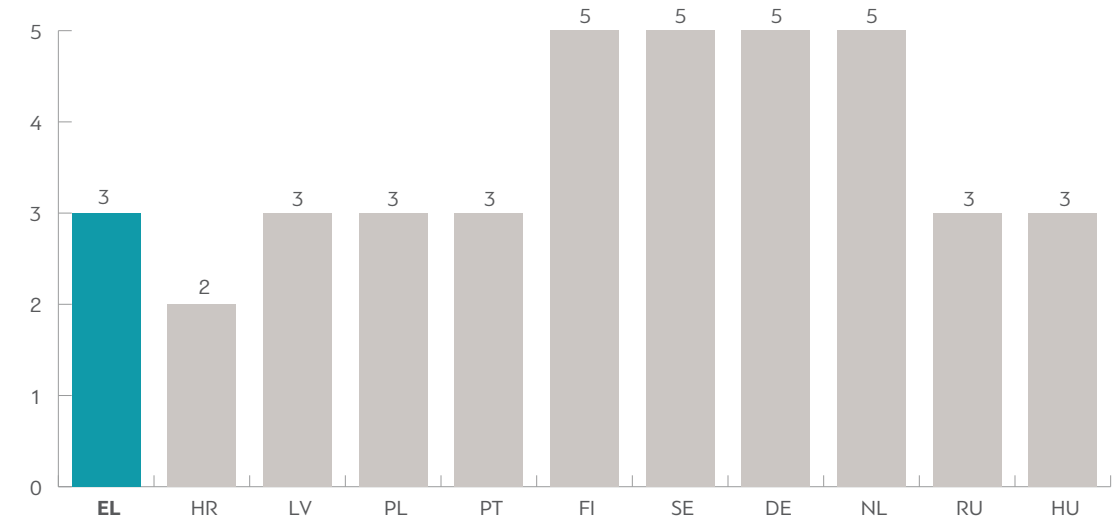
Note: The Worldwide Governance Indicators report survey respondents' perception of governance quality. The Index ranges from approximately -2.5 (weak) to 2.5 (strong).
Source: Worldwide Governance Indicators - The World Bank (2015)

Figure A.7: Product Market Regulation, 2013



Source: OECD (2015a)

Figure A.8: Country Capacity to Retain Talent, 2014-2015



1= not at all
7= to a great extent

Source: Global Competitiveness Report 2015-2016 - World Economic Forum (2016)

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