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An assessment of research system and policies

Greece

Nikos Maroulis

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An assessment of research system and policies
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ERAWATCH Network – Logotech SA

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Executive Summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs which aims to increase and improve investment in research and development, in particular in the private sector. The report aims at supporting the mutual learning process and the monitoring of Member States efforts. The main objective is to characterise and assess the performance of the national research system of Greece and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

Several efforts have been made the last 20 years mainly at the policy level for the improvement of the Greek research system although the main drawbacks still remain. One of the main strengths of the research system is its strong internationalisation and participation in international knowledge circulation mechanisms. At the government level the importance of R&D for the business sector has been recognised and several mechanisms have been developed for increasing R&D spending in companies and improve the supply of qualified R&D personnel. Furthermore, efforts have been made for improving the exploitability of research.

Despite the efforts, the research system faces several deficiencies across all policy-related domains. The main drawback, which has significant cross-domain implications, is the low demand for scientific and research based knowledge from the business sector due to its orientation towards low risk, low knowledge intensive activities and its low level of absorptive capacity.

Until recently, neither policy nor public interests regarded research and innovation as priorities; institutional inefficiencies in the governance of research have reduced policy effectiveness. The most important inefficiencies are: lack of strong leadership and weak coordination over budgeting and priority setting; strong dependence on Structural Funds; not yet well established mechanisms for ensuring quality in universities; ad hoc and not well developed mechanisms for identifying, channelling and monitoring knowledge demand; weak circulation of knowledge; and poorly developed lifelong learning system.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	The justification for R&D investments is well established and a commitment to increase R&D expenditures to 1.5% of GDP has been made by government in line with the Barcelona target, although the time frame has now been shifted twice.
	Securing long term investment in research	High dependence on Structural Funds' funding and management mechanisms, while overall investment in R&D and especially by the business sectors is among the lowest in Europe. Lack of coordination between government and regions in mobilising the resources for research at regional level.
	Dealing with barriers to private R&D investment	The policy for reducing barriers to business R&D investments is well developed, however mobilisation of resources for R&D remains low priority for the business sector due to its orientation towards low risk, less knowledge intensive activities.
	Providing qualified human resources	Despite the strong supply of PhD graduates significant shortcomings related to the quality and alignment with economic needs exist.
Knowledge demand	Identifying the drivers of knowledge demand	Demand for knowledge by the private sectors is very low due to its orientation to less knowledge intensive segments of the economy. Efforts are being made to improve the methods used to identify demand. Coordination with EU over identifying demand is good.
	Co-ordination and channelling knowledge demands	Mechanisms for systematically responding to knowledge needs, especially in the private sector, are not well developed and lack coordination.
	Monitoring of demand fulfilment	Evaluation culture and mechanisms are not sufficiently developed although some progress has been made in this direction in research centres and very recently in universities.
Knowledge production	Ensuring quality and excellence of knowledge production	Overall the quality of research is lagging in terms of excellence although there are niches of recognised scientific excellence. Excellence is systematically monitored in public research centres and is linked to funding. However, only very recently mechanisms for ensuring excellence in universities have been introduced.
	Ensuring exploitability of knowledge	Strong policy focus on the exploitability of research and existence of a sufficient set of mechanisms. However, the orientation of universities and research centres towards the production of exploitable research results remains weak.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	Although there are sufficient measures and institutions in place, circulation of knowledge among local research actors remains weak due to lack of professionalism and the existence of institutional inertia and inefficiency of the actors involved.
	Profiting from international knowledge	The public research sector has an international orientation and participates in international knowledge circulation mechanisms. However, knowledge spillovers in the national economy are low.
	Enhancing absorptive capacity of knowledge users	The absorptive capacity of the business sector is weak, the mechanisms for its improvement are not well developed and there is a misalignment between supply and demand for graduates.

Recent policy initiatives have addressed many of the weaknesses and most aspects of the Lisbon Strategy's research related Integrated Guidelines. The resources mobilised to fund R&D and innovation have been doubled compared to the previous programming period; new mechanisms that improve the channelling of knowledge demands have been introduced; a new national instrument for funding basic and

applied research has been created and this is expected to improve the efficiency and effectiveness of R&D expenditures in the long run; institutional changes are being introduced in universities and research centres to improve their operations and research quality. In addition the Strategic Plan for Research, Technology and Innovation introduced programmes: that support networks of excellence; improve the effectiveness of technology transfer offices; and support collaboration between public research organisations (PROs) and businesses in research and technology transfer.

Despite the significant changes and the opportunities for improving the research system the summary table below indicates that there are still some risks that are threatening the effectiveness of policy measures.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• New funding mechanisms with long term orientation could improve mobilisation of resources • NSRF almost doubled project based funding, funding of infrastructures and development of human resources in research. • The new research priorities provide incentives to firms in less knowledge intensive sectors to shift to more knowledge intensive segments.	• Dependence on Structural Funds remains, as the new funding mechanism is not related to specific source of funding • Public resource mobilisation through NSRF and the existing incentives might not leverage spending from other sources, especially the private sector, to the extent anticipated. • Increasing funding for development human resources in the research sector will not be sufficient to increase the supply of researchers in areas relevant to the economy, if not supported by additional measures.
Knowledge demand	• The new set up of the NCRT and the thematic advisory councils will systematise the identification of needs. • The new instruments for research policy making and priority setting will increase coordination among ministries and other policy making bodies and improve the channelling of demand. • The creation of the research council (NORT) and of the new research and technology programme for supporting basic and applied research (NPRT) will increase efficiency and effectiveness of public expenditure	• Organisational complexity is being introduced in the governance system, putting efficiency at risk. • The institutionalisation of the participation of academics and research community in the prioritisation of research and the allocation of funds, threatens the ability of the system to recognise and effectively channel the needs of the business sector.
Knowledge production	• The reforms in the university and non-university public research sector in the long run it is expected to improve the effectiveness and quality of the knowledge production system.	• Lack of consensus among the academic community regarding the assessment of universities is jeopardising the introduction of assessment and the effectiveness of the measures. • The improved framework of measures for improving exploitability is being hindered by the low demand for knowledge from the business sector. • The reforms of the public research centres do not affect their 'academic' character.

Domain	Main policy opportunities	Main policy-related risks
Knowledge circulation	• The access to international knowledge is further improved as cross-border cooperation is specifically supported. • Circulation of knowledge between research organisation and business is facilitated through the improved efficiency of TTOs	• Despite the improvement in the access to international knowledge, spillovers to the local economy may be prevented due to inefficiencies in knowledge circulation and the low absorptive capacity of the business sector. • Efforts to improve knowledge circulation are being hampered by the low absorptive capacity of the business sector and the pursuit of low-tech business strategies. • The new legislative framework does not address the weak and occasional collaborations of research centres and business. • The effectiveness of the new mechanisms aimed at improving lifelong learning will follow the unsatisfactory trends of the past.

Among them the most important is the high dependence on Structural Funds and the risk that the existing incentives might not leverage spending from the private sector, to the extent anticipated. Furthermore, the institutionalisation of the participation of academics and research community in the prioritisation of research and the allocation of funds, threatens the ability of the system to recognise and effectively channel the needs of the business sector.

Concluding the success of these efforts and the achievement of the target of 1.5% is uncertain, as both are also dependent on developments in other policy domains than research and innovation, such as the improvement of competition policy, the creation of entrepreneurial culture, the advancement of SME policy and improvements in financial and fiscal instruments.

The concept of ERA was welcomed by both government and the academic community as an opportunity to profit from international knowledge, to tap additional sources of funding and increase the local research capacity. Gradually, Greece has become more aligned with main dimensions of the ERA by promoting the mobility of researchers, opening-up national programmes to cross-border co-operation, participating in joint programming with other Member States within the framework of bilateral agreements, and most recently by participating in the ESFRI roadmap and the preparatory phase of 13 Joint European Infrastructures.

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1 - Introduction and overview of analytical framework

1.1 Scope and methodology of the report in the context of the renewed Lisbon Strategy and the European Research Area

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts.

The main objective is to analyse the performance of national research systems and related policies in a comparable manner. The desired result is an evidence-based and horizontally comparable assessment of strength and weaknesses and policy-related opportunities and risks. A particular consideration in the analysis is given to elements of Europeanisation in the governance of national research systems in the framework of the European Research Area, relaunched with the ERA Green Paper of the Commission in April 2007.

To ensure comparability across countries, a dual level analytical framework has been developed. On the *first level*, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions of the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: needs for knowledge have to be identified and governance mechanisms have to determine how these requirements can be met, setting priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of a research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Figure 1: Domains and generic challenges of research systems

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
• Justifying resource provision • Long term research investment • Barriers to private R&D funding • Qualified human resources	• Identification of knowledge demand drivers • Co-ordination of knowledge demands • Monitoring of demand fulfilment	• Quality and excellence of knowledge production • Exploitability of knowledge production	• Knowledge circulation between university, PRO and business sectors • International knowledge access • Absorptive capacity

On the *second* level, the analysis within each domain is guided by a set of generic "challenges" common to all research systems that reflect conceptions of possible bottlenecks, system failures and market failures (see figure 1). The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective, helps to deal with the considerable institutional diversity observed, and eases the transition from analysis to assessment. Actors, institutions and the interplay between them enter the analysis in terms of how they contribute to system performance in the four domains.

Based on this framework, analysis in each domain proceeds in the following five steps. The first step is to analyse the current situation of the research system with regard to the challenges. The second step in the analysis aims at an evidence-based assessment of the strengths and weaknesses with regard to the challenges. The third step is to analyse recent changes in policy and governance in perspective of the results of the strengths and weaknesses part of the analysis. The fourth step focuses on an evidence-based assessment of policy-related risks and opportunities with respect to the analysis under 3) and in the light of Integrated Guideline 7; and finally the fifth step aims at a brief analysis of the role of the ERA dimension.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory[1] and other important publicly available information sources. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis.

After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains five main subsections in correspondence with the five steps of the analysis. The report concludes in chapter 6 with an overall assessment of strengths and weaknesses of

[1] ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home. Other sources are explicitly referenced.

the research system and governance and policy dynamics, opportunities and risks across all four domains in the light of the Lisbon Strategy's goals.

1.2 Overview of the structure of the national research system and its governance

In terms of GDP, Greece is categorised among the medium countries of the EU-27. However, measured in terms of R&D expenditure, it falls among the small countries. GERD in 2006 represented only the 0.57%[2] of GDP while, for the same year, the EU-27 average was 1.87%.[3]

Governance of the research system is somewhat fragmented with coordination at the political level rather weak. The inter-ministerial committee, outlined in the law for the co-ordination of R&D and innovation policies was operating occasionally and finally has been inactivated (GSRT, 2007). The Ministry of Economy and Finance controls the flow of funding to ministries and sets management and accountability rules. Policy making and funding are mainly implemented at the operational level by the General Secretariat for Research and Technology (GSRT) of the Ministry of Development (MoD). GSRT is also responsible for supervising 12 of the 18 public research centres in Greece.

The National Council for Research and Technology (NCRT) is the main advisory body for research. It is attached to the GSRT and contributes to priority setting for research funding and to the selection of management for the public research centres supervised by GSRT. Members of the NCRT are all academics although participation of industry is stipulated by law.

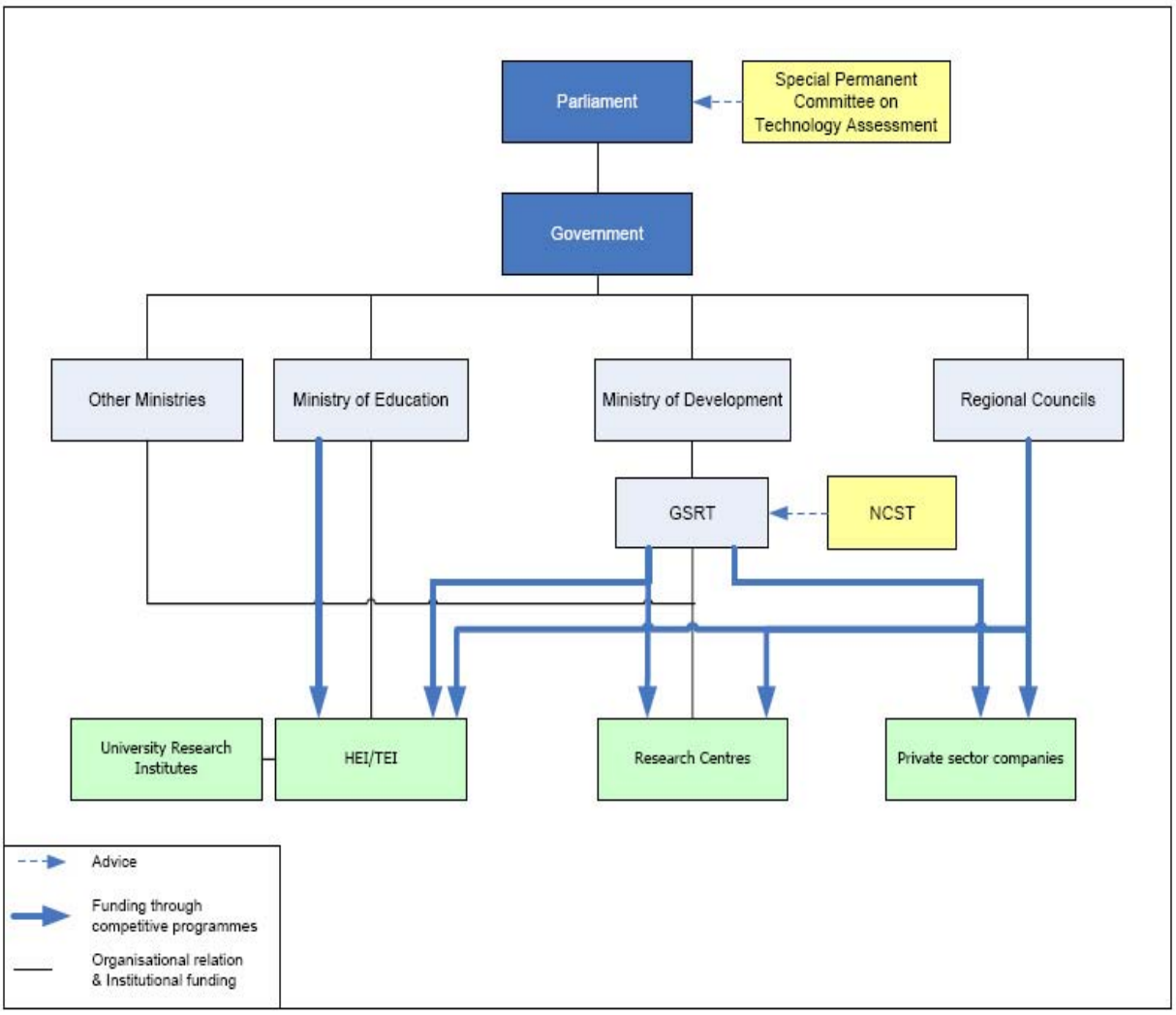
Parliament has a Special Permanent Committee on Technology Assessment.

The Ministry of Education is the second biggest contributor to R&D; however, its involvement in policy making is rather limited and mainly reactive, with research priorities in the academic sector defined bottom-up, based on requests from the academic community. Other ministries with involvement in the governance of research include the Ministry of Rural Development and the Ministry of Defence. Each of the three ministries has it own research centre(s). The Ministry of Economy and Finance has indirect involvement in R&D policy making mainly through tax incentives for R&D and its central management of the Structural Funds, one of the main sources of R&D funding.

At regional level the Regional General Secretariats, which are part of the Ministry of the Interior, play a limited role in R&D policy making due to lack of policy making and implementation capacity (GSRT, 2007). Although part of the central administration, since 1999 they have had increasing freedom to shape policy priorities, including R&D, within the general national policy framework and to adsorb funding from the Structural Funds for their implementation. However, only a few regions have exploited this possibility to any great extent, while management of the measures for all regions has been relinquished to GSRT.

[2] GERD as a percentage of GDP was revised downwards recently as a result of the upward revision in Greece's GDP by 9.6%.
[3] Unless stated otherwise, all quantitative indicators are based on Eurostat data sourced April 2008.

Figure 1: Overview of the governance structure of the Greek research system



Source: ERAWATCH Research Inventory, http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=35&countryCode=GR&parentID=34

The 22 universities of the country are the main research performers accounting for approximately 48% of GERD, while the Technological Educational institutes (TEI), which recently became part of the higher education system, make a limited contribution to research. Together, universities and public research centres are responsible for 69% of GERD, while private R&D performers have the lowest share (approximately 30% of GERD) among the EU member states after Cyprus and Lithuania (DG Research, 2008).

Currently the system has entered a transition period, with a new law for the organisation of research governance approved by Parliament, that introduces new structures and bodies. Research policy will be coordinated through an inter-ministerial committee by the Prime Minister; a National Council will formulate the main policy directions, and a National Agency will be responsible for funding and coordinating research. GSRT will be integrated in the new structure, although it is not yet clear what part of its current responsibilities will be transferred to other bodies.

2 - Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges related to the provision of inputs for research activities are addressed by the national research system. Its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, with the Barcelona EU overall objective of a R&D investment of 3% of GDP and an appropriate public/private split as orientation, but also highlighting the need for a sufficient supply of qualified researchers.

Four different challenges in the domain of resource mobilisation for research which need to be addressed appropriately by the research system can be distinguished:

- Justifying resource provision for research activities;
- Securing long term investment in research;
- Dealing with uncertain returns and other barriers to private R&D investment; and
- Providing qualified human resources.

2.1 Analysis of system characteristics

Greece is one of the EU countries with the lowest spending on R&D, both in absolute values and as a percentage of GDP. In 2006, overall spending amounted to approximately €1.2b accounting for only 0.6% of the aggregate EU-27 R&D expenditures. Despite the fact that the rate of growth of these expenditures in Greece was two times higher than that of EU-27 during the period 2001 -2006 (7.5% and 3.6% respectively) R&D intensity (measured as a percentage of GDP) remained around 0.58%[4] which is significantly below the EU average of 1.84%.

A major part of Greece's R&D expenses (20% on average) is furnished from abroad, mainly from the Structural Funds and the 6th Framework Programme for Research.

2.1.1 Justifying resource provision for research activities

The role of research in restructuring a country's economy towards the production of high value-added products and services and the transition to the knowledge based economy has been broadly recognised in policy documents. The position of research on the policy agenda has significantly improved in the last decade, although it has remained relatively low, clearly indicated by the mobilisation of public resources. Despite the increase after 2001, total government funding of research as a percentage of total government expenditure has remained very low in comparison to the EU-27 aggregate. In 2006, government funding of research in Greece was only 0.76% while in the EU-27 it was almost the double this figure, amounting to 1.62%. Investments in R&D and innovation did not exceed 5% of the aggregate flows of the Community Structural Funds (CSFs) in all programming periods. Rather, the

[4] New revised figures adapted to the new estimations for GDP (see footnote 2).

emphasis was on building public infrastructures across the country, firm level investments and accumulation of human capital. To some extent these choices reflect the private sector's priorities and the public's preference for investments that directly affect their quality of life.

Improving public understanding of science was one of the ways adopted by GSRT for increasing public acceptance of the mobilisation of resources for research. The activities supported included: secondary technical vocational training for pupils on subjects related to R&D support; the "Open Gates" programme which provides access to research activities within universities and research centres for the public; "Science weeks" and the building of a Science Museum.

In 2000 the Greek government adopted the goals of the Lisbon Strategy, setting as a target the increase of research expenditure to 1.5% of GDP by 2010, with 40% coming from the private sector. In 2003 GSRT presented an analysis of the mobilisation of resources needed to meet the target (GSRT, 2003a) in an effort to start a public dialogue. However, neither the public administration nor the private sector expressed mach interest. The issue was raised again in 2006-2007 during preparation of the National Strategic Reference Framework (NSRF) for 2007-2013. The budget for research and innovation was significantly increased from approximately €600m in the 3rd Community Support Framework to approximately €1.3b[5] in the NSRF, corresponding to 5.1% of the total budget. The target of 1.5% for 2010 was regarded as unrealistic, and a new milestone was set for the year 2015 (Ministry of Economy and Finance, 2007).

Recently, the role of research to strengthen the competitiveness of Greek companies, and the need for further mobilisation of public resources for research has been recognised by the Hellenic Federation of Enterprises[6] despite the fact that private funding of R&D remains low.

2.1.2 Securing long term investment in research

Long term investments for public research and research infrastructures are the responsibility of the GSRT, the Ministry of Development and the Ministry of Education, while the Ministry of Rural Development and Food and other ministries with research activities have a limited role.

There are two main national sources used by the government for financing research, namely the Ordinary Budget and the Programme of Public Investments. Institutional funding of higher educational institutes covering salaries and other running costs, comes from the Ordinary Budget and is decided on an annual base. The Ministry of Education is responsible for the institutional funding, which in 2005 represented 46.5% of higher education R&D (HERD) and 42.2% of GBAORD.[7] Similarly, GSRT is responsible for the annual institutional funding of the research centres and institutes under its supervision which amounted in 2005 44.8% of GOVERD and 11.2% of GBAORD. Although institutional funding has increased rapidly, by approximately 9%

[5] Logotech's estimations based on provisional data from the NSRF's Operational Programmes.
[6] Press release from the Hellenic Federation of Enterprises of 27-7-2008.
[7] ERAWATCH Research Inventory http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=329&countryCode=GR&parentID=50

on average annually during the period 2000-2005, it was covering only a decreasing share of the salaries: in 2005 84%, compared to 100% in 2000 (GSRT, 2006). The other operational costs were covered by research projects and revenues from clients. Another 4.2% of GBAORD is directed to research centres by other ministries.

Investment in infrastructures and funding of research programmes comes from the Programme for Public Investments following short to medium-term planning. According to law 1514 of 1985 a multi-annual programme for research funded by the National Investment Programme under the responsibility of GSRT, sets the priorities for research investments at national level for all ministries. However, when Structural Funds started supporting Greece in the 1990s, the planning of research investments and the funding from the National Investment Programme was diffused to various sectoral or Regional Operational Programmes (ROPs). Although the key role was retained by GSRT and the Ministry of Development, the new funding structure and the way the Ministry of Economy organised the planning of the Operational Programmes did not allow for coordination and allocation of sufficient resources to research through the ROPs.

The seven-year budget planning horizon of the Structural Funds allows for long term investments to be implemented. However, the plan and the budget have to be negotiated with the European Commission in a complicated and lengthy process. Amendments to the budget are possible after negotiation with European Commission during specific periods of time.

The establishment of new facilities under the supervision of GSRT is based on recommendations of the National Council for Research and Technology.

Due to fiscal constraints and the very low private expenditure on research, European funding became a significant source of R&D support representing approximately 21.6 of GERD. Almost half of it this comes from the EU Framework Programme. It is estimated to be approximately 10% of GERD, one of the highest shares in EU-27 (GSRT, 2007). The rest comes from the Structural Funds. If the general university funds (GUFs) are excluded, then funding from the Structural Funds will be 42% of direct government funding of R&D (ERAWATCH Network, 2008). These sources are the major contributors to project-based public R&D funding. As a result of Greece's weak position in the European research system the exploitation of positive spillovers from abroad from participation in international organisations was always on the research policy agenda. Greece participates in CERN; the European Molecular Biology Organisation; and the European Science Foundation and in 2004 Greece became a full member of the ESA. Total funding flows from ESA to Greece for 2002-2006 was €4m while Greece contributes in ESAs budget €11m per year.

To conclude, the mechanisms securing long-term investment in R&D are heavily dependent on Structural Funds' funding and management mechanisms, and are not effectively coordinated. Furthermore, the annual budgeting process for the ordinary budget for universities and research centres does not allow for the development of a long term strategy for human resource development, which is necessary for the exploitation of long term investments supported by the Public Investment Programme and the Structural Funds. One of the consequences for universities is the rapid increase in the number of academic staff on short term contract (see section 2.1.4). In addition, due to fiscal constraints and the relatively low priority of R&D in the policy agenda until recently (see also section 2.1.1), public investments have remained low in comparison to other European countries. This has not allowed Greece to reach a

critical mass of local technological capabilities, which is needed for the country's catching up process (Bartzokas, 2007). Publicly funded GERD as a percentage of GDP was only 0.27 in 2003, one of the lowest levels in the EU (DG Research, 2008). In the same year, the EU-27 aggregate was 65% while only the very small countries (Luxemburg, Cyprus and Malta) and Romania performed worse than Greece.

2.1.3 Dealing with uncertain returns and other barriers to business R&D investment

The business sector is the weak link in the Greek research system. Business expenditure on R&D (BERD) as a percentage of GDP has stagnated around the very low level of 0.18% since 2000. Only 0.2% of Greek business funds R&D activities (GSRT 2003b). Research activity is mainly concentrated in the big enterprises which perform 40% of BERD, and they finance 85.4% of industry financed BERD (ERAWATCH Network 2008). According to the EU Industrial R&D Investment Scoreboard (European Commission, 2007a, b) only one Greek company was among the European top 500 R&D investors in 2006 and only six were included in the top 1,000, while in 2007 there were no Greek companies among the top 500 and the number of the companies in the top 1,000 had fallen to three. Multinational firms play a marginal role in R&D.

The low research intensity of the private sector reflects the structural characteristics of the Greek economy. Despite high growth rates over the last 10 years, the expansion of the economy is not innovation driven and the contribution of technology intensive sectors in value added is marginal. A combination of structural characteristics, and significant institutional and bureaucratic obstacles together with a volatile policy environment lead business to invest in activities either with high rates of return in the short-term, or with very low risk (Bartzokas, 2007).

Private funding mechanisms traditionally have focused on low risk investments. Greece ranks 18th in the EU-25 regarding the availability of venture capital investment in new, high-risk companies (GSRT, 2007). However, this funding is not directly related to R&D investments.

These problems have been recognised by government since the first steps of the research policy in the country. Emphasis was given to research subsidies for intramural research, research subcontracting and collaborative research in priority areas with research organisations. Since 2000 efforts have been made to establish financial mechanisms to support R&D directly or indirectly. These measures include tax incentives for R&D and support of the creation of venture capital funds in incubators to support, among others, R&D investments. During the programming period 2000-2006 all project-based R&D must have at least one private partner - even academic projects such as PENED.

The position of business R&D on the research policy agenda is also reflected in the share of public funding of business R&D which is higher than the EU-27 aggregate. Government funding of BERD (4.4% of BERD in 2003), together with Structural Funds funding represented 14.7% of BERD in 2003 (GSRT 2007). This figure is comparable only to the funding patterns in the new Member States.

In conclusion, increasing R&D in the private sector is one of the most important and well recognised challenges. GERD financed by the business sector as a percentage of GDP is among the lowest in EU. In 2003 it was only 0.16% while the EU-27

aggregate was 1.01%. Funding of R&D by the business sector is lower only in Cyprus and Bulgaria and marginally in Poland. However, an appropriate response needs to go beyond the domain of resource mobilisation to include the domains of knowledge demand (Chapter 3) and knowledge circulation (Chapter 5). Even more, the efforts should extend beyond the boundaries of research and innovation policy.

2.1.4 Providing qualified human resources

The production of high quality researchers and postgraduates cannot be seen in isolation from the overall quality of the Greek higher education system which is one of the most centralised and least flexible systems in the OECD (OECD, 2007) (for more details see the discussion in section 4.1.1).

Doctoral level education is offered by universities and the research centres supervised by GSRT. Approximately 700-1000 PhD students graduate every year (GSRT, 2007). Equally important for the Greek research system is the inflow of Greek PhD graduates from abroad amounting to 600-700 per year.

Demand for postgraduate and especially for doctoral studies has increased significantly over the last few years. Between 2004 and 2005 the number of PhD students increased by 25% amounting to 19,000 in 2005, which represents 11.1% of all students. An increasing share of PhD students, (amounting 48% in 2003), is studying social sciences and humanities while the share of engineering and natural sciences students has decreased by 6% reaching 36.2% in 2003.

Although the orientation of the students towards PhD studies has increased rapidly, demand for researchers from the economy remains low. According to GSRT's estimations (GSRT, 2007), only 24% of researchers (approximately 66 persons) who are hired annually by the private sector hold a PhD degree. In total around 770 new researchers with PhDs are hired by the private and the public sectors combined, while supply is 1,300-1,700 new researchers. From the employment trends by science and technology field, it is clear that part of the surplus could be attributed to the relatively low demand and also to a misalignment between supply and demand. PhD graduates in engineering fields represented only 19.7% of the PhD graduates in 2003. The same year they represented 68.9% of the researchers in the business sector. In terms of input-output, 197 PhD students in engineering fields graduated in 2003, while the employment of researchers in engineering fields increased by 256 persons in the business sector. At the same time the employment of researchers in all the other fields, which represents 75.7% of the PhD graduates, has reduced or remained stable. The surplus of doctoral graduates is directed to non-research jobs or it expatriates. However, no specific estimation can be made about brain drain as data on international mobility of researchers are not available[8].

Due to low demand from the private sector, most PhD graduates are pursuing academic careers where a PhD degree is a prerequisite. Approximately 73% of the researchers are employed in the university sector and only 15.6% in the business sector. The high supply of researchers, the rigidities in the recruitment systems of universities and the low institutional funding, has worked to increase the number of

[8] Indicative of a brain drain is the number of Greek born S&T graduates who live and work in the US. According to the latest available data which goes back to 1997, Greece ranks 24th out of 40 countries based on this indicator and the total number of Greek S&T graduates living in the US is 11,700.

academic staff working on short term contracts[9] by 211% between 1998 and 2005. In 2005 the short term staff represented 24% of the academic staff, affecting negatively the quality of research and teaching, the organisation of the curriculum, and the independence and the self-governance of the HEIs (Nikolaidis, 2007).

The brain drain problem has been recognised by the government and since 1997 mobility grants are available to researchers from abroad to work in universities or research centres in Greece. Initially these measure targeted only Greek-speaking researchers, but since 2001 all researchers working abroad are eligible. Despite the demand for grants, long-term mobility has remained low as the unattractive regulatory framework and working conditions discourages researchers and academics from seeking permanent jobs in Greece (National Council for Education, 2006).

2.2 Assessment of strengths and weaknesses

Mobilisation of resources is one of the weaker domains in the Greek research system. So far the system has failed to address effectively the main challenges resulting from the existing significant weaknesses. Research is low on the policy agenda and among the priorities of society and the economy, although there are signs that this is changing. Lack of appreciation of research, results in very low (among the lowest in the EU-27) private sector funding and only modest funding by government.

Public funding of research is mainly short term while long term investments are highly dependent on Structural Funds, leading to rigid and bureaucratic management structures and long negotiation procedures.

Despite the increasingly strong supply of PhD graduates, provision of qualified human resources is suffering from a misalignment between demand and supply and also quality has been criticised heavily.

Main strengths	Main weaknesses
• Well established justification for R&D investments and commitment to increasing R&D expenditure to 1.5% of GDP by government in line with the Barcelona target, although the time frame has been shifted twice. • Research policy for reducing barriers to business R&D investments is well developed. • Strong and increasing supply of PhD graduates.	• Lack of coordination between government and regions for mobilising resources for research at regional level • High dependence on Structural Funds funding and management mechanisms. • Mobilisation of resources for R&D remains low priority for the business sector due to its orientation towards low risk less-knowledge intensive activities. • Existing mechanisms for the provision of qualified human resources in the research system are facing significant shortcomings related to quality and alignment with the needs of the economy.

[9] Teaching staff are hired under law 407/08 for only one or two semesters with mainly teaching responsibilities only.

2.3 Analysis of recent policy changes

In the last two years significant reforms have been initiated in the governance and funding of the research system and the organisation of higher education. The National Strategic Reference Framework for the period 2007-2013 developed in 2007, is affecteing the mobilisation of resources by doubling the budget of the Operational Programmes for research from €600m in 2000-2006 to €1.3b for the period 2007-2013. The Strategic Plan for Research Technology and Innovation, which was developed the same year, made a significant contribution as well, by documenting the need for an increased budget within NSRF. Also, the new strategic plan and the Operational Programmes which followed gave increased attention to the production of qualified human resources and reemphasised past policies for the development of R&D in the business sector. The new research priorities aim at providing incentives to companies in the low and low-to-medium tech sectors that dominate the Greek economy, to shift their interest to the most knowledge intensive segments of their sectors.

Law 3649, after a period of consultation when stakeholders failed to agree on the challenges and on the necessary reforms, in 2007 introduced reform of the higher education system. The new framework reformed the mechanisms for the mobilisation of resources at the levels of ministry and university by linking the institutional funding of each university with a four year development plan negotiated with the Ministry of Education. Thus, the existing one year budget is being replaced by a medium-to-long term financial and development mechanism. In addition, professionalisation of the administration and financial management of universities is being promoted with the introduction of a professional manager in each university. Efforts to improve the quality of teaching and research include increased transparency in the election and promotion of academic staff.

Challenges	Main policy changes
Justifying resource provision for research activities	• The role of research has been recognised and an increased share of NSRF's budget has been directed to research (2007).
Securing long term investments in research	• Restructuring of research system governance and establishment of new funding mechanisms through Law 3653/2008. • A first Strategic Plan for research and Innovation has been developed (2007) coordinating allocation of budget to research. • The NSRF directs an increased share of its budget to research (2007). • The new law for HEIs (2007) replaces the one year budget for HEIs with a four year development plan.
Dealing with uncertain returns and other barriers to business R&D investments	• Special attention is given to supporting research in the most knowledge intensive segments of the low-tech sectors dominating the Greek economy. • The new Strategic Plan for Research and Innovation intensifies past policies providing research subsidies and fiscal incentives.
Providing qualified human resources	• A new law 3549/2007 on the organisation and operation of the HEIs addresses some of the deficiencies identified in the analysis. • Increased funding directed by the NSRF for the development of human resources for research.

Another legislative initiative in March 2008 (law 3653/2008) introduced significant changes to the organisation of funding and governance of the research system. According to the new law the budget for research is decided at the highest possible level by an inter-ministerial committee. Also a new four year National Programme for Research and Technology (NPRT) was created to fund basic and applied research. Applied research will continue to be funded by the NSRF so, until 2015[10] more than 75% of funding will still come from the Structural Funds. In addition, 1% of the public procurements for defence will go annually to funding research on defence. Funding for new infrastructures and the creation of new research organisations will be based on a medium-to-long term National Road Map.

2.4 Assessment of policy opportunities and risks

The Greek government has responded to the Lisbon strategy by setting the target of 1.5% for research intensity with 40% coming from the private sector. However, research expenditure has stagnated at below 0.6% of GDP and BERD remains approximately 31% of GERD. The NSRF programming period 2007-2013 started with a commitment from government to double research funding to approximately 5% of the total budget. Despite the increased public funding, mobilisation of private expenditures is negatively affected by low absorptive capacity and demand for new knowledge in the private sector and, therefore, policy effectiveness is dependent on development in other domains.

The new research priorities aim among other things at lowering the barriers to entry to the more knowledge intensive segments, for companies in the low and low-to-medium technology sectors. Increased funding for the development of human resources has not yet been combined with measures that could attract graduates towards research areas relevant to the economy.

Main policy opportunities	Main policy-related risks
• New funding mechanisms with long term orientation could improve mobilisation of resources • NSRF has almost doubled project based funding, funding of infrastructures and development of human resources in research. • The new research priorities provide incentives to firms in less knowledge intensive sectors to shift to more knowledge intensive segments.	• Dependence on Structural Funds remains, as the new funding mechanism is not related to specific source of funding • Public resource mobilisation through NSRF and the existing incentives might not leverage spending from other sources (especially the private sector) to the extent anticipated, • Increasing funding for development human resources in the research sector will not be sufficient to increase the supply of researchers in areas relevant to the economy, if not supported by additional measures.

The reforms introduced in the university sector and in the governance of the research system should improve funding mechanisms and long term planning which could be

[10] Due to delay in spending of NSRF budget the rule of n+2 will be most possibly applied and therefore the spending will be prolonged till 2015.

in favour of further mobilisation of public resources. However, based on current commitments the dependence on Structural Funds will continue to 2015[11].

2.5 Summary of the role of the ERA dimension

The concept of the ERA was welcomed by the policy making and the academic communities.

Participation in the EU Research Framework and in international research organisations is seen by both government and academia as an opportunity to strengthen the outwards orientation of the national research system and increase local research capacity. Pressure from the low public and private funding for research has aggressively directed the research community to participate in the EU Framework Programmes. Currently annual inflows from these programmes correspond to approximately 10 of GERD. The Greek government has actively promoted participation by providing the necessary national contribution of the public research organisations. Similarly, research funding by Structural Funds substituting for national public funding amounts to approximately 10 of GERD.

Greece is also participating in a number of European initiative and International organisations such as the CERN, ESA, the XFEL project the EDCTP, the GALILEO Joint European Undertaking and the ESFRI Roadmap.

Erasmus and Marie Curie scholarships have significant contribution in the mobilisation of graduates and post graduates and the exploitation of opportunities offered abroad by Greek young researchers. Furthermore, the improvement of the quality of postgraduate studies was reinforced by an increasing number of collaborations between Greek and European Universities for the organisation of European postgraduate studies.

3 - Knowledge demand

The purpose of this chapter is to analyse and assess how research related knowledge demand contributes to the performance of the national research system. It is concerned with the mechanisms to determine the most appropriate use of and targets for resource inputs.

The setting and implementation of priorities can lead to co-ordination problems. Monitoring processes identifying the extent to which demand requirements are met are necessary but difficult to effectively implement due to the characteristics of knowledge outputs. Main challenges in this domain are therefore:

- Identifying the drivers of knowledge demand
- Co-ordinating and channelling knowledge demands
- Monitoring demand fulfilment.

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D targeted in IG7 of the Lisbon Strategy.

[11] See comment in footnote 10 regarding the prolongation of NSRF spending period.

3.1 Analysis of system characteristics

3.1.1 Identifying the drivers of knowledge demand

Structure of knowledge demand

The demand for research based knowledge is shaped by the structural characteristics of the Greek economy, which is oriented towards low- and low-to-medium technology sectors and less knowledge intensive services. Allocation of research funding among the funding sources, provides an indication of the main drivers of demand for research. Research funded by the private sector represents only 31.1% of the total funding (EU-27 aggregate amounts to 54.6%)[12] while government funding represents 46,8% of the total.

The low knowledge demand is reflected also in the R&D intensity in the business sector which is only 0.17%[13] and in the share of BERD in total gross R&D expenditures amounting to 30%; both being among the lowest in the EU-27. As mentioned in section 2.1.3, only 0.2% of Greek businesses fund R&D activities.

Due to the risk adverseness of the business sector and its preference for high, short-term returns (see section 2.1.3), business activity has been concentrated in the less knowledge intensive and low value added segments resulting in low demand for research based knowledge. The most prominent sectors are agriculture, construction, tourism, transport, trade and real estate. Among manufacturing sectors, textiles and food are the most prominent although their shares in value added do not exceed 2% and 3% respectively. R&D demand from the private sector is driven by the above sectors as well as by IT services and electrical equipment where Greece shows a strong specialisation in R&D expenditures compared to the EU (ERAWATCH Network, 2006).

Universities are the most significant performers of R&D, with HERD representing 47.8% of GERD in 2006, while GOVERD corresponds to 20.8% of GERD. The share of research expenditures in universities and public research centres financed by the business sector, and therefore it is directly related to business sector's demand for knowledge, is approximately 6.63%.

Government funding of research expresses knowledge demand originated from the policy and societal needs of Greek. Some Ministries are directly funding research in areas that are of significant policy interest by their own budget while other policy needs are covered through the research programmes funded by the Ministry of Development. The main areas public funding was directed to in 2005 were: health (7%), agriculture (5.4%), social structures (5.3%), environment (3.6%), exploration of earth (3.4%), land use (2.2%) and exploration of space (1.6%). Comparing with EU-15, Greece is also specialised in the above areas with the exception of the exploration of space which its growth the last few years is related with the participation of Greece in ESA.

An indication of the size of the demand driven by the research sector itself could be derived from the general university funds, which are directed to areas mainly defined internally by the academic community. Thus GUF received a significant share of

[12] 2005
[13] BERD as a percentage of GDP.

public funding for the period 2004-2006, amounting in average to 47%. This share is among the highest in EU-27.

Processes for identifying the drivers of knowledge demand

Significant improvement has been made the last ten years in the methods used to identify demand for research based knowledge. However, these efforts are still fragmented.

Public consultation is the method systematically used to design research programmes and set priorities. Two drawbacks can be identified. On the one hand consultation is usually used at the final stage of the process where only fine tuning is possible. On the other hand, the participation of the business sector is usually limited, reflecting the low interest of businesses in research based knowledge.

Foresight exercises have been used occasionally. Two technology foresights were implemented by GSRT at national level. The first was in 1992 and focused on nine pre-selected sectors. However, the findings made only a limited contribution to priority setting. The second national foresight programme was in 2002-2005 focusing on nine sectors and two horizontal technological fields. This exercise achieved higher visibility than the first one, contributing to raising awareness among stakeholders about certain aspects of R&D policy (GSRT, 2007). During 2000-2006 foresight exercises had been also implemented in three other regions with very low impact on policy setting. Participation of the business sector was limited in all these exercises, which were mainly driven by the academic community. GSRT is coordinating an ERANET project (ForSociety) aimed at sharing knowledge and coordinating foresight activities at European level.

The NCRT also contributes to identifying knowledge needs; however it mainly expresses the needs of the public research community as the majority of its members are academics and researchers in public research centres and interest from industry to participate in this body is low. The current composition of the NCRT includes only academics with no representation from industry (GSRT, 2007).

In 2007, for the first time, the public research centres supervised by GSRT made a significant effort to identify national and European demand for research based knowledge and set priorities for research (Conference of Research Centres' Presidents, 2007). The results were forwarded to GSRT to contribute to the development of a national strategy for research.

Parliament has it own mechanism, the Special Parliamentary Committee on Technology Assessment, for identifying, among other objectives, research and technology demand. However, the Committee has not been active in this area so far.

3.1.2 Co-ordinating and channelling knowledge demands

GSRT is the body responsible for setting priorities in research at national level while the Ministry of Agriculture defines priorities for funding research within its supervised research organisations. The Ministry of Education which is responsible for higher education has not been involved so far in any research priority setting activity and all the efforts for financing academic research follow a bottom-up approach covering all research areas according to demand.

The low level of demand from the economy is reflected in the low share of government appropriations directed towards economic objectives which

approximately amounts to 20%, while around 25% is directed to areas of social and policy interest, such as social issues, human health and the environment.

The lack of interest from the private sector has influenced the processes and methods used by GSRT for setting research priorities. For many years a bottom-up approach was followed and a high share of funding was allocated based only on the criterion of excellence (e.g. PEND). Even in the programme Joint ventures for research and technological development, which was the main instrument for priority setting in research, very broad subject areas were adopted mainly following the priorities of the 5th and 6th Framework Programmes and experience regarding demand in previous programming periods.

Efforts at coordination among ministries for priority setting until recently were piecemeal. The first systematic effort for coordinated priority setting and allocation of resources across selected sets of research fields was in 2007 with the Strategic Plan for Research, Technology and Innovation (see section 3.3).

The Ministry of Education has been considering methods for priority setting which could be applied in the current programming period.

As already stated, European trends in R&D funding were taken into consideration mainly through the priorities of the Framework Programmes. In addition, the indirect impact of European priorities on the research system has been significant as the annual funding from the Framework Programme 6 is approximately equal to 42% of government funding (ERAWATCH Network, 2008) and more than half of the project based funding through the national funding mechanisms.

In an effort to increase coordination with European research trends GSRT has participated in 19 ERANETS. However, how effectively the knowledge gained is diffusing within the organisation due to the existing organisational constraints (Euroconsultants et al, 2000), remains to be seen.

It is not clear whether bilateral research agreements with European and third countries have an impact on priorities as no evaluation has been made so far. However, as most of the priorities have been defined bottom-up and the funding is small (€27m over the period 2000-2006), it is estimated that the impact will be rather insignificant.

3.1.3 Monitoring demand fulfilment

Evaluation of research programmes was first introduced by GSRT in the late 1980s. However, evaluation is still rather ad hoc. Since 1997 only three programmes supporting research and one programme promoting spin-offs have been evaluated ex-post. All these evaluations were performed by independent experts.

The Structural Funds has introduced a systematic approach to monitoring and ex-ante, on-going and ex-post evaluation of the Operational Programmes. However, the main interest lies in the supply side focusing on absorption of funding and on the production of outputs vs planning. Furthermore, the emphasis is on the level of the Operational Programme and its measures, where more than one intervention (programme) is usually included. Therefore, the scope and the level of detail in the analysis are not sufficient to assess how the intervention meets research needs. In 2000 the “Operational Programme for research and technology 1994-99” was evaluated ex-post, although without focusing on specific programmes supporting

research. During the programming period 2000-2006 only two programmes related to research (PAVET-NE, HERON) were assessed through interviews with a small number of beneficiaries.

The research centres supervised by GSRT have been systematically evaluated at the level of the institute since 1995. The evaluations are performed every 4 or 5 years by groups of international peers. The main focus of the assessment is research excellence while the relevance of the research to the knowledge needs of the country is rather overlooked[14]. The results of the evaluations have been used to provide additional funding for the Institutes.

In contrast, the research performance of universities was not assessed till very recently. Efforts by government to establish an evaluation system were strongly criticised by the academic community, which regarded evaluation as challenging their autonomy (Asderaki, 2007). Finally, an independent agency supervised by the Ministry of Education, the "Hellenic Quality Assurance Agency for Higher Education" was established in 2005 with a mandate to develop a methodology and processes for the evaluation of HEI and to provide assistance for the implementation of assessments.

3.2 Assessment of strengths and weaknesses

Demand for research based knowledge from the business sector is among the lowest in the EU-27, due to its orientation towards to the less knowledge intensive segments of the economy.

Main strengths	Main weaknesses
• Efforts made to improve the methods used to identify demand signals. Coordination with EU for identifying demand is strong.	• Demand for knowledge from the private sector is very low due to its orientation to less knowledge intensive segments of the economy • Mechanisms for systematically responding to knowledge needs, especially in the private sector, are not well developed and lack coordination. • Evaluation culture and mechanisms are not sufficiently developed although some progress has been made in this direction in research centres and very recently in universities.

Despite the efforts made to identify society's and the economy's signals of knowledge needs, no systematic approach has been established. Furthermore, mechanisms for systematically receiving demand signals and translating them into research priorities are not in place. Efforts are occasional and the approaches used are developed ad hoc.

[14] Evaluation criteria focus on excellence and relevance to the international research community. The composition of the evaluation panel which includes international experts without experience of the Greek economy and society, does not allow serious assessment of the relevance of research to the knowledge needs of the country.

The evaluation mechanisms which are systematically applied within the framework of the Structural Funds do not suit the needs of research support measures, while those targeting research policies are used only occasionally.

Overall, the policy making cycle is fragmented, with loose connections between the various components and weak feedback loops. Furthermore, the various components have been shaped by the prevailing academic 'intrinsic' demand.

3.3 Analysis of recent policy changes

The development of NSRF and the introduction of the new law 3653/2008 reforming governance of the research system are the two main policy initiatives affecting knowledge demand.

The Strategic Plan for Research Technology and Innovation developed in 2007 within the framework of the NSRF was the first systematic effort to set priorities on the basis of an analysis of: the existing foresight exercises; the needs of the economy and policy making; and current European trends as they are reflected in the work of Technology Platforms and the priorities of the 7th Framework Programme. The exercise included a public consultation phase that included the research community and the business sector. The new research priorities try to address the issue of low demand for research-based knowledge from the business sector, by focusing on the more knowledge intensive segments of the low and low-to-medium technology sectors dominating the Greek economy (see section 2.3 and 2.4).

Challenges	Main policy changes
Identifying the drivers of knowledge demand	• Law 3653/2008 for the governance of the research system establishes new mechanisms for identifying knowledge demand.
Co-ordinating and channelling knowledge demands	• The Strategic Plan for research and Innovation (2007) coordinated funding of research priorities across different policy actors. • The new research priorities were set based on systematic analysis of knowledge needs. • Law 3653/2008 establishes new mechanisms for better coordination of priority setting and allocation of funding.
Monitoring demand fulfilment	• Law 3653/2008 defines mechanisms for the assessment of research results. It regulates internal and external evaluation procedures for the research centres supervised by GSRT. • The evaluation system established in 2005 has been further developed and is ready to operate. Law 3559/2007 for the higher education system creates a framework for the accountability of universities.

Law 3653/2008 introduced new mechanisms to achieve better coordination of priority setting among policy actors. Decisions on the allocation of funding for research across ministries, main research priorities and approval by the new National Programme for Research and Technology (NPRT) [15] will be the responsibility of an inter-ministerial committee composed of 13 Ministries and chaired by the Prime Minister. Decisions are made on the basis of proposals submitted by the NCRT,

[15] See section 2.3 for more details on NPRT.

which is composed of eight high level researchers or academics and five executives or high level researchers from the private sector. The NCRT, the GSRT and the Ministry of Education are supported by several advisory councils based on scientific field, composed of five academics or researchers from PROs and one researcher from the business sector.

The detailed planning and management of the national research programme is the responsibility of a new institution, the National Organisation for Research and Technology (NORT), which is similar to a research council. The management NORT is composed of high level academics or researchers with only one from the private sector. The national research programme is designed by NORT within the framework of priorities defined by the NCRT, and approved by the inter-ministerial committee. In addition to the new national research programme, the NORT manages those components of the research budgets of ministries and regions that are channelled to competitive funding.

The new law enacts the systematic assessment of programmes supporting research, although without sufficient differentiation between programmes and projects. The details of the evaluation and assessment methodologies will be defined by presidential decrees. Similarly, the evaluation of research centres supervised by the GSRT has been regularised (every 4 years) with specific criteria and methodological framework.

Finally, the evaluation system for the assessment of the universities set up in 2005 has been completed this year and the evaluation process has been started. Also, law 3559/2007 of the universities establishes accountability through yearly assessments.

3.4 Assessment of policy opportunities and risks

It is expected that the new policy developments will increase the effectiveness of the system in dealing with the main challenges. The organisational changes will increase the coherence of policy making and implementation and will strengthen the links between the various components by improving the identification of needs, coordination of demand and priority setting and the monitoring and assessment of demand fulfilment. Overall, the new governance structure is expected to improve the effectiveness and efficiency of public expenditure in accordance with the IG7 recommendations.

However, the new organisational setting introduces two risks. The organisational complexity and the existence of a grey area between the new roles of GSRT and the new bodies could undermine the effectiveness of the reform. The participation of the academics in decision making prioritisation of research and the allocation of funds is institutionalised (TrendChart, 2008), while participation of the business sector is marginal. The results could be a further weakening of the ability of the system to recognise and channel the knowledge needs of the business sector, identified as being one of the main weaknesses.

Main policy opportunities	Main policy-related risks
• It is expected that the new set up of the NCRT and the thematic advisory councils will systematise the identification of needs. • The new instruments for the research policy making and priority setting will increase coordination among ministries and other policy making bodies and improve the channelling of demand. • The creation of NORT and the new research and technology programme for supporting basic and applied research (NPRT) will increase the efficiency and effectiveness of public expenditures	• Organisational complexity is introduced in the system setting efficiency at risk. • The institutionalisation of participation of academics and the research community in the prioritisation of research and the allocation of funds, threatens the ability of the system to recognise and effectively channel the needs of the business sector.

3.5 Summary of the role of the ERA dimension

Due to a lack of systematic and well established processes for identifying knowledge demand and especially international demand and the demand for new areas, priorities in the Framework Programmes were taken into consideration in an effort to set appropriate research priorities. Similarly, the recent technology platform exercises have influenced the planning and research agendas of public research organisations.

Furthermore, Framework Programme priorities have had indirect effects as academic demand has been channelled towards them due to the level of funding in comparison to national research funding.

GSRT recognising the importance of coordination at the European level is participating in 19 ERANET projects; however there has been no visible impact so far (see discussion in section 3.1.2). In addition co-ordination in addressing knowledge demand is achieved through the bilateral research agreements with most EU countries.

4 - Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role to create and develop excellent and useful scientific and technological knowledge. A response to knowledge demand has to balance two main generic challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis for scientific and technological advance. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities which often emerge at the frontiers of scientific disciplines. Quality assurance processes are here mainly the task of scientific actors due to the expertise required, but subject to corresponding institutional rigidities.
- On the other hand there is a high interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable for economic knowledge producers as well as the lack of

possibilities and incentives for scientific actors to link to societal demands lead to a corresponding exploitability challenge.

Both challenges are addressed in the research-related Integrated Guideline and in the ERA green paper.

4.1 Analysis of system characteristics

4.1.1 Improving quality and excellence of knowledge production

Scientific knowledge in Greece is mainly produced in an extended university system and in research centres and independent institutes most of them under the supervision of GSRT of the Ministry of Development. Recently, the Technological Educational Institutions (TEI) were included in the higher education system (ERAWATCH Network, 2008). The research centres and institutes fall into two groups. The old generation, which includes the biggest research centres which are public legal entities operating under a strict, rigid and bureaucratic regulatory framework, especially for managing and mobilising human and financial resources. And the new generation of research centres which are under the control of the government, however their legal status is semi-public allowing more flexibility and autonomy.

The focus of scientific research in Greece is on the natural sciences and engineering (NSE). Clinical medicine accounted for more than 26% of scientific publication in 2003, while engineering came second with a share of approximately 11%. Chemistry and physics are ranked third and fourth at 10.8% and 10.5% respectively (ERAWATCH Network, 2006). Analysis of citations reveals a similar trend with the exception of engineering which is in 6th position behind biology/biochemistry and molecular biology and genetics. However, if relative specialisation is taken into consideration the picture changes. Greece compared to the EU-15 is clearly specialised in computer science, agriculture, engineering and environment, while clinical medicine is on the margin (ERAWATCH Network, 2006).

The productivity of the research system is high compared to other European countries, in terms of publications per millions of euro spent on R&D. In 2004 the rate was 3.2 times higher in Greece than the EU-25 (36.0 and 11.4 respectively). However, the impact of its publications is relatively low as indicated by the citations to publication. Citation rates to EU-25 publications are 1.5 times higher than of those for Greek publications (4.7 and 3.2 respectively) (Logotech, 2007)[16].

Recent public debate has uncovered several drawbacks in the system that reduce quality, including: low institutional funding; limited academic autonomy and strong involvement of the Ministry of Education in academic, administrative and planning issues; poor functioning of the peer review system and the system for the promotion and appointment of staff (National Council for Education, 2006). Referring to the Greek universities Prof. A. Kyriazis, Secretary for Higher Education in the Ministry of Education (Kyriazis, 2007) said that:

> …it is impossible to talk about quality when a system is characterized by obsolete structures and when it is deprived of the tools which enhance

[16] Logotech's estimations based on Eurostat data for GERD and ISI data on publications and citations.

efficiency, accountability, transparency and openness to international cooperation.

However, no public consensus regarding the problems and the solutions was achieved. On the contrary, a significant part of the academic community, both staff and students, expressed opposition to the new legislative framework which was approved by the parliament in 2007 (see also TrendChart, 2007).

Since 2005 no institutional and legal framework has existed for the evaluation of the research in the Greek higher education system. Improvement in the quality of scientific knowledge production and research in universities has been left to the academic community with no intervention from government beyond provision of funding. The research production and the teaching competences of academic staff are assessed only during their appointment or promotion in the academic hierarchy. However, sporadic efforts were made by 14 universities and 11 technological educational institutes during 1998-1999, with encouragement from government which covered the costs, to evaluate some of their departments using external experts. Since then, any efforts made by the government to establish a system for the systematic evaluation of the HEI have met the resistance from the academic community (see section 3.1.3).

In 2005 the Hellenic Quality Assurance Agency for Higher Education was established to create a methodological framework and build evaluation capacity (see section 3.1.3). The preparatory work of the agency has been completed and evaluation process has started within 2008.

The excellence of research in the research organisations supervised by GSRT has been regularly monitored since 1995. The evaluations are performed every 4 or 5 years, and conducted by international peers. The legislation foresaw that the funding of the research centres should be related to the results of the evaluation. In the Operational Programme “Competitiveness” for the programming period 2000-2006 a specific measure was included with a budget of €20m to provide additional funding for research centres with excellent performance in research according to the results of the evaluation. This budget is allocated mainly on the basis of the results of the latest evaluation, which was performed in 2005. The new evaluation methodology used was an improvement over past efforts and took account of European experience. According to the results, 15 of the 45 evaluated institutes acquired top marks for their capacity to produce scientific knowledge of high quality. Among the 15 high ranked institutes, 8 were from two research centres, namely FORTH (5 institutes) and CERTH[17] (3 institutes). The assessment revealed a dichotomy among the “younger” research centres with 12 out of the 15 top performers in this group, while the 10 of the 11 laggard institutes were from the old generation of research centres.

The Greek government has always regarded active participation of Greek research entities in European research initiatives and especially in the Framework Programmes, as an appropriate strategy for improving research excellence and increasing knowledge spillovers in the Greek organisations. Unfortunately, there are no assessments of the impact on the research excellence from this participation.

[17] CERTH since 2000 has been part of the FORTH network of institutes.

4.1.2 Improving exploitability of knowledge production

The performance of the Greek research system regarding the exploitability of research for economic uses is relatively low. Universities and research centres, with some outstanding exceptions, are inward oriented, responding poorly to economic and societal needs, while the commercial exploitation of research results is still taboo for some members of the academic and research community (GSRT, 2007).

Patent and intellectual property rights (IPR) laws and the relevant institutions have been in place since 1987. The law for the commercial exploitation of IPRs by universities and research centres provides incentives to both research organisations and researchers to exploit research results as it decrees that the researcher owns 60% of the IPR and the research organisation 40%. Furthermore, researchers in research centres are allowed to work part time for a short period on a reduced salary, while retaining their status, in order to devote time to other activities such as the commercialisation of their research. Similar provisions exist for academics.

Unlike research centres in other European countries, Greek centres have a rather academic culture and orientation and give low priority to the exploitability of their research. This orientation is reflected in the very low number of patents, spin-offs and collaborations with the business sector (GSRT, 2007). Despite the existence of a legal framework, only after 2001 did research centres and universities started developing a strategy and clear rules for IPR exploitation, patenting and creation of spin-offs as a result of the programme PRAXE, which provided significant incentives for the creation of spin-offs and commercialisation of research.

The specialisation of private expenditure on R&D is not correlated with either technological or economic specialisation (ERAWATCH Network, 2006). While the Greek economy is specialised in low- and low-to-medium-tech sectors, such as agriculture, textiles, food, petroleum, ship building and tourism, specialisation in BERD and patents follows different patterns. Specialisation in BERD exists in a mix of low-, low-to-medium- and high-tech sectors such as food, IT services, community services, electronics, furniture, and trade. Comparison of these specialisations reinforces the argument made in previous sections, that economic activity in low and low-to-medium-tech sectors is concentrated in the less knowledge intensive segments. Specialisation in patents exists only in three sectors namely pharmaceuticals, food and chemicals. Among the sectors where Greece has some specialisation, only food combines economic, technological and research specialisation. This is not surprising since food is one of the most competitive and dynamic sectors in Greece.

The development of mechanisms to bring the research community closer to the business sector and matching research activity to the country's economic specialisation has been high in the research policy agenda for the last 20 years. Efforts have included the design of specific instruments the most important being the "RTD consortia in sectors of national priority" aimed at promoting co-operation between research and the business sector through long term R&D projects. Programme AKMON was launched in an effort to develop research services and to adapt research infrastructures in university labs and research institutes according to the specific needs of the business sector. Innovation poles developed in five regions support research directed to meeting specific economic needs.

Also the economic and societal exploitability of research results were made important selection criteria for all the programmes apart from those directly promoting excellence or academic research. In addition, GSRT in an effort to further increase exploitability made the participation of companies or other types of end users that co-finance projects, a prerequisite for all the research programmes funded in the period 2000-2006[18]. In addition, the participation of researchers from the private sector in the panels that appraise research proposals has been increased in an effort to increase the quality of the evaluation regarding the exploitability of results. However, no follow-up is planned in the form of ex-post evaluation of the exploitation of the results.

In comparing Greece with other EU countries in terms of patenting as a benchmark for the effectiveness of the system to response to the challenge of exploitability of knowledge production, it can be seen that the performance of Greece is significantly lower than the EU-27 aggregate and is comparable only with Portugal and most of the new member states. The number of applications for patents to the European Patent Office (EPO) per million inhabitants, in 2004, was 6.8 for Greece; while the EU-27 aggregate figure was 112.0, Portugal 5.8, Poland 3.7 and the Czech Republic 8.9.

4.2 Assessment of strengths and weaknesses

There are niches of public research with internationally recognised excellence, including the new generation of public research centres and specific research groups in the university sector. However, the overall performance of the public research system in terms of excellence is lagging behind the European average. The lack of mechanisms in the university sector for monitoring and enhancing excellence are among the major weaknesses of the system. However, some progress has been made since 2005 with the establishment of the Hellenic Quality Assurance Agency for Higher Education. The link between additional funding and excellence in the public research centres is among the strengths of the system.

Main strengths	Main weaknesses
• There are niches of scientific excellence. • Links between excellence and funding are established in public research centres. • Strong policy focus on the exploitability of research and existence of a sufficient set of mechanisms.	• Overall, the quality of research production is lagging in terms of excellence comparing to EU. • Mechanisms for ensuring excellence in universities have not been applied • Orientation of universities and research centres towards the production of exploitable research results is weak.

The lack of demand for research based knowledge (see discussion in Chapters 2 and 3) from the business sector did not allow for the creation of incentives and selection rules based on market needs. On the contrary, for the last 25 years growth in the public research system has followed available public (national or European) funding (Bartzokas, 2007). Therefore, the current research actors have not developed the necessary skills and capacity to recognise and respond to market signals. In this context, top-down approaches have limited impact on the production

[18] Apart from 2 that were implemented in universities

of exploitable research results by public research actors, despite the high priority of the issue on the policy agenda.

4.3 Analysis of recent policy changes

The promotion of excellence is one of the five axes of research and innovation development in the Strategic Plan for Science, Technology and Innovation 2007-2013 and focuses on the creation of centres of excellence and the creation of knowledge intensive clusters. It is expected that the resources that will be directed to these goals will be significantly higher than those in the previous programming period.

Also the Strategic Plan enhances the existing support framework aiming at improving exploitability of research. Exploitability is a cross cutting issue relevant to the tools for promoting excellence. The new mechanisms include: the national thematic poles for R&D where the strong participation of the business sector is encouraged; additional funding for research groups when they achieve research results that could find practical application; financial support for patenting; improvements in the supporting of spin-offs creation; and provision of pre-seed and seed capital for the funding of spin-offs. In addition, bilateral and multilateral research collaborations are being promoted.

Law 3649/2007 for the higher education system (see section 2.3) introduced changes in the organisation of universities and the peer review process, which are expected to have a positive effect on the quality of knowledge production. The main organisational changes are improvement to the procedures for the election of the Rectors which reduce political influence; professionalisation of university management (see section 2.3); introduction of internal regulations in all institutions; and a loosening of the financial control over universities' expenditure. All of these factors will improve the quality of management and increase autonomy from the Ministry of Education. The introduction of the four year development plan (see section 2.3) introduces a long-term view and the notion of strategic planning with implications for priority setting and resource allocation.

The most direct effects on the quality of research are expected to come from the changes in the peer review system and the introduction of accountability. The existing peer review system for the selection and promotion of academics has been severely criticised in the past. The new law increases transparency and subjectivity and reduces the influence of vested interests by introducing the participation of external reviewers. Accountability is strengthened through the performance of the universities, the achievement of their goals and the efficiency of public funding of the higher education being annually assessed in a special session of the Greek Parliament.

The direct assessment of universities and the quality of their research is expected to start as soon as the overall methodological and organisational framework has been developed.

Finally, the quality and performance of universities have not been directly related to funding, however, indirect mechanisms have been put in place to do this in the future (OECD, 2007).

The new law 3653/2008 for the governance of the research system introduces the self-evaluation of the public research organisations every two years and improves the framework for their external assessment. Also the link between the performance and the funding has been made more explicit and stricter.

Challenges	Main policy changes
Improving quality and excellence of knowledge production	• The new law for universities affects quality by introducing changes in the management, strategic planning, peer review and the accountability of universities. • The methodological and organisational framework for the quality assessment of universities has been completed • The new law for research governance introduces self-assessment of the public research organisations and improves the framework for their external assessment.
Ensuring exploitability of knowledge production	• Exploitability of research results is a key selection criterion in all research programmes. • The Strategic Plan for STI add new funding mechanisms to the existing ones and improves the old ones • The new law on research governance includes among the criteria of evaluation of the public research organisations the exploitability of research results and the cooperation with industry.

4.4 Assessment of policy opportunities and risks

Significant progress has been made in creating mechanisms within universities and public research centres to improve the quality of research. However, the lack of consensus and trust between the academic community and government[19] is jeopardising the effectiveness of the reform.

The challenge of ensuring exploitability of the knowledge has been addressed by a wide number of different funding instruments that improve the scope of the already well developed framework. However, the effectiveness of the measures introduced to increase the exploitability of research is questionable as the efforts to promote collaboration with industry and co-development of research agendas are being hindered by low knowledge demand from, and the low absorption capacity of, the business sector.

The reforms introduced in the non-academic PROs does not alter the “academic” character of the work in these research centres, as they do not change the incentives for developing outward-orientation and collaboration with the business sector. On the contrary, the emphasis is on the development of the collaboration between universities and research centres.

Overall, policy developments are in line with IG7 and IGL10 recommendations.

[19] News reports and articles in newspapers regarding the straggle between the government and academic community.

Main policy opportunities	Main policy-related risks
• The upgrading of the framework for the evaluation of public research centres creates opportunities for improving excellence and research quality. • The reforms in the university sector, in the long run, will improve the effectiveness and quality of the knowledge production system.	• Lack of consensus among the academic community regarding the assessment of universities jeopardises the introduction of assessment and the effectiveness of the measures. • The improved framework of measures for improving exploitability is hindered by the low demand for knowledge by the business sector. • Reform of the public research centres leaves intact the "academic" character of their culture and research.

4.5 Summary of the role of the ERA dimension

The opening up of the research system and the promotion of an outward orientation has been the strategic choice of all Greek governments as a mechanism to improve excellence. Participation in the Framework Programmes and in other European schemes and organisations and the signing of bilateral and multilateral research agreements have been used to generate knowledge spillovers in the Greek research systems (GSRT, 2007).

In particular, participation in the European networks of excellence is attracting the attention of policy makers, and a specific funding mechanism has been included in the Strategic Plan for research.

The Bologna strategy has been accepted by the two main political parties as the basis for the reform of the higher education system. However, its appeal to the academic community is low, with both academics and students being indifferent or even hostile.

5 - Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate flows and sharing of the knowledge produced. This is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who continue working in industry, and the comparatively low cost of the reproduction of knowledge once it is codified. However, there remain three challenges related to specific barriers to this circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors to overcome institutional barriers;
- Profiting from access to international knowledge by reducing barriers and increasing openness; and
- Enhancing absorptive capacity of knowledge users to mediate limited firm expertise and learning capabilities.

Effective knowledge sharing is one of the main axes of the ERA green paper and significant elements of IGL 7 relate to knowledge circulation. To be effectively addressed, these require a good knowledge of the system responses to these challenges.

5.1 Analysis of system characteristics

5.1.1 Facilitating knowledge circulation between university, PRO and business sector

Knowledge circulation within the Greek research system is hindered by the weak links and interactions among the main actors, especially between the research community and the business sector (see discussion in Chapters 2 and 3).

Among PROs, research centres are the most inward oriented with very weak links with business. Research funded by the business sector amounted to only 1.3% of GOVERD in 2005, which is quite low compared to the EU-27 aggregate of 8.6% (DG Research, 2008). Among the public research centres, CERTH belonging to the new generation of centres has the highest share (19%) of revenues from research contracts with the business sector. Two other centres focusing on health and biomedical science, the Alexander Fleming Research Centre and the Pasteur Institute follow, with 8.9% and 5.6% respectively (GSRT, 2006). The biggest Research Centre, Demokritos, with a revenue equivalent to 20% of the revenues of all research centres, has only a very low share of 1.5% coming from research for the business sector.

Universities are more outward-oriented with statistics showing collaboration with business to be higher than the EU average. The share of HERD funded by business amounted to 8.9% in 2005, while the corresponding figure for the EU-27 was 6.3% (DG Research, 2008). However, collaborations in Greece are rather opportunistic, pushed more by the supply side (universities and research centres) and less by demand (business) and are generally based on the requirement for business participation in research programmes (GSRT, 2007 and TrendChart, 2006).

Circulation of knowledge between university and non-university research organisations has been identified by the government as insufficient (Ministry of Development, 2007) and a new legislative framework has been introduced in 2008 to address this issue.

The higher importance of universities than research centres for transferring knowledge relevant to innovation in the business sector is evident from the CIS4 data. Approximately 4.4% of firms report universities as important source of information while 6.4% of companies have cooperation agreements. The figures are much lower for public research centres, 2.3% and 2.5% respectively. The differences are more striking if we look at the collaborations of large companies. In this group approximately 13% of companies regard universities as important sources of knowledge while only 1.3% regard research centres as useful. The figures for formal collaborations are 11.5% and 5.4% respectively.

GSRT in order to boost science–industry collaborations has supported the creation of technology transfer offices (TTOs) within a number of universities, public research centres and technology parks and innovation centres. Today, 28 TTOs are operating

within universities and research centres, which is a number compared to other countries with more efficient TT systems, and if the level of expenditure on R&D of PROs is taken into consideration (Logotech, 2004). Overall, results are very modest in terms of improving collaboration between research organisations and industry as TTOs' income comes almost exclusively from public sources (GSRT, 2007).

An additional component of the institutional setting for the circulation of research-based knowledge is the Sectoral Corporations for Industrial Research (SCIR) established during the 1980s to provide research and technical services to industry in sectors where government identified market failure. In total, five corporations were established in the sectors of metals and metal working, ceramics, food, textiles and marine. Only the first four are still operating; the marine sector corporation closed due to the limited demand for its services (ERAWATCH Network, 2008). Although growth patterns differ among corporations, most of their revenue comes from testing and quality assurance services with much less coming from research and TT.

In addition to the institutional setting, GSRT has developed research programmes that focus specifically on the promotion of collaboration and set as a prerequisite for funding research projects, the participation of, and co-funding by, the private sector (for more details see section 4.1.2). In addition, the programme PAVET, which supports industrial research and encourages subcontracting of research to PROs, and programmes PRAXE A and PRAXE B promoting the setting up of spin-offs, have contributed to this goal.

Circulation of knowledge between PROs and business is also facilitated by the mobility of human resources among research actors. HERON supported the employment of research personnel in enterprises although its impact was limited due to the overlap with PAVET, which offered more attractive incentives (GSRT, 2007). Finally, networking of personnel in PROs and the business sector has been promoted by a budget of €10.5m for the period 2002-2006.

5.1.2 Profiting from access to international knowledge

Due to the small size of the Greek research system access to international knowledge has been regarded as very important by public research organisations and companies with an international orientation.

The main mechanism used for accessing international knowledge is the EU Framework Programmes. The participation and networking of local research teams is high, measured by funding received given the small size of the Greek research system. The flow of funding towards Greek participants is significant. It is estimated that around 3% of the budget of the 6th Framework Programme went to Greek research teams while the annual flow amounted to approximately 10% of GERD. Despite their significance there is no assessment of the impact of EU Framework Programmes. Bilateral research agreements are also an important mechanism for accessing international knowledge. Currently, agreements are in place with 25 countries. In addition, a programme targeting cooperation with technologically advanced countries has financed 1,000 projects from a total budget of €68m during the period 2000-2006.

Participation in international scientific and research organisations (see section 2.1.2) is another way of promoting access to international knowledge which is attracting the attention of policy makers. Participation in CERN is among the most important as

approximately 100 Greek PhD students have worked in CERN in the last ten years and several senior researchers have participated in its experiments. However, this type of access to international knowledge is almost exclusively benefiting PROs, while the benefits to the business sector have not been encouraging.

Similarly, the opening up of the national research programmes to participation of foreign researchers and research groups has increased in importance on the national research and innovation policy agenda. However, due to the fact that national research programmes have been entirely funded within the framework of Structural Funds participation of non-Greek partners has not been possible. One of the main priorities of Greek presidency in 2003 was the promotion of the opening-up of national research and innovations programmes, integration of European research organisations and the development of European research infrastructures and programmes (GSRT, 2003c).

The most outward-oriented PROs have developed their own internationalisation strategies by participating in international networks and signing bilateral agreements with European or international counterparts.

Foreign direct investments (FDI) related to research are marginal and have no spillover effects in the national economy. Funding of business R&D by foreign companies was less than 0.01% of BERD in 2005.

5.1.3 Absorptive capacity of knowledge users

The absorptive capacity of Greek companies and especially SMEs is low according to the relevant indicators. Scientists and engineers in the total labour force, aged between 25 and 64 years, amounted to 4.4% in 2006; a figure that is lower than the EU-27 aggregate (5.1%) and is comparable only to some of the new member states such as Estonia, Romania, Hungary and Lithuania. In addition, according to CIS4 data, the share of innovative firms that see lack of qualified personnel as a significant obstacle to innovation is among the highest in the EU-27 and is comparable only to Estonia, Latvia and Portugal.

The share of S&T graduates aged between 25-29 years, in the population, is 1.1% which is lower than the EU-27 share of 1.3% in 2005. However, the high increase in absolute numbers by 24% between 2004-2005 compared to the modest 4% for the EU-27, is an indication of a trend towards reducing the gap in the future. However, production of S&T graduates is not sufficient by itself to improve absorptive capacity in the business sector, level of demand is also important. According to a recent study (Lianos, 2007), the existence of overeducation[20] as a result of an abundance of highly educated individuals relative to overall demand, is a strong signal of a misalignment between supply of and demand for university graduates. The fact that overeducation is 10 percentage points lower for Greek graduates from foreign universities, indicates that apart from the problem of demand the orientation of supply of the Greek higher education system is also important. This is in line with the findings presented earlier, that the share of scientists and engineers in the total number of graduates is low.

[20] "An individual is overeducated if his or her level of education exceeds that which is required for the performance of their job" (Lianos, 2007)

The low absorptive capacity is reflected also in the low innovation and R&D activity especially in SMEs. Only 34% of the small and 43% of medium companies are involved in innovation activities, while 19% and 33% respectively are engaged in R&D. Historically, the major instruments used to increase technological capacity and enhance the participation of companies and especially SMEs in R&D activities, were: the programme for industrial research PAVE; the creation of the sectoral companies in low tech sectors significant for the Greek economy (see section 5.1.1); the promotion of demonstration projects; and incentives for recruitment of graduates by companies for a period of 1 or 2 years or for specific research and innovation projects (HERON). Despite the long period of operation of these measures (PAVE and sectoral companies have existed since the mid 1980s) their contribution to attracting more companies and especially SMEs to participate in R&D and innovation activities is low, as most firms are operating in the less knowledge intensive segments of their sectors. Taking this into consideration the focus of PAVE during the programming period 2000-2006 was shifted to supporting new firms (PAVET-NE).

Lifelong learning is another relatively recent approach to improving absorptive capacity in the business sector. However, the performance of the country is very weak and the trend is towards a widening of the gap (TrendChart, 2007).

5.2 Assessment of strengths and weaknesses

The main strengths of the Greek research system are its openness and its access to international knowledge; however knowledge spillovers in the economy are not visible as links among the local actors are weak. In addition, low knowledge demand from (see discussion in chapters 2 and 3), and the poor absorptive capacity of the business sector are hindering knowledge circulation among research organisations and business.

The last 20 years have seen several mechanisms for facilitating the circulation of knowledge although with limited results due to lack of professionalism and the institutional inertia and inefficiency of the actors involved.

Absorptive capacity of the business sector is hindered by the misalignment between demand for graduates and the orientation of supply. Furthermore, measures aimed at increasing the number of enterprises performing R&D activities has not produced the expected results.

Main strengths	Main weaknesses
• Strong internationalisation of the public research sector and participation in international knowledge circulation mechanisms. • There are sufficient measures and institutions in place for ensuring national and international circulation of knowledge	• Circulation of knowledge among local actors the effectiveness of mechanisms facilitating knowledge circulation remains low. • The absorptive capacity in the business sector is weak, while the mechanisms for its improvement are not well developed and there is a misalignment between supply and demand for graduates.

5.3 Analysis of recent policy changes

The new law for the research governance system recognises the need for a strengthening of the links between universities and research centres and creates a framework for collaboration.

The Strategic Plan for Research Technology and Innovation creates a policy mix that enhances and strengthens collaborations between research organisations and enterprises. The policy mix includes proven measures, such as research consortia in priority areas and regional innovation poles, and new mechanisms, which include: national thematic polls for R&D promoting the long term corporation in one or more scientific areas; networks of excellence with the participation of business; knowledge intensive clusters and innovation clusters in priority areas. Furthermore, efforts are being made to improve the efficiency and effectiveness of the system of technology transfer offices in PROs by reducing their number and exploring economies of scale. Details will be defined at a later stage.

Access to international knowledge remains a top priority. The new law for the governance of the research system provides the necessary legal framework for the participation of foreign researchers in national programmes and of national researchers in non-national programmes. Furthermore, the new framework defines explicitly that foreign researchers can be financially supported by the national budget.

The increase in the absorptive capacity of enterprises and especially SMEs is being further promoted by the Strategic Plan. Together with existing mechanisms for the support of industrial research, an “innovation voucher” which enables SMEs to buy knowledge from PROs is being included in the policy portfolio.

Life long learning is being further improved in the OP “Education and Lifelong Learning” while new measures will be included in the OP “Development of Human Capital” (TrendChart, 2007).

Challenges	Main policy changes
Facilitating knowledge circulation between the university, PRO and business sectors	• The new law for the governance of the research system establishes a framework for the collaboration of universities with public research centres • Networking between PROs and the business sector is further enhanced
Profiting from access to international knowledge	• The new law for the governance of the research system sets the necessary framework for the opening-up of national research programmes to foreign researchers and the participation of nationals in non-national research programmes
Absorptive capacity of knowledge users	• New mechanisms for increasing the technological and research capabilities of enterprises are included in the policy mix • Lifelong learning and vocational training is further enhanced

5.4 Assessment of policy opportunities and risks

The strength of the research system of accessing international knowledge is being further improved by establishment of a legal framework and definition of the sources of funding for opening up national programmes to foreign researchers. However, spillovers to the local economy may be prevented due to continuing inefficiencies in knowledge circulation and the low absorptive capacity of the business sector.

The Strategic Plan and the relevant OPs create an appropriate policy mix for improving collaboration between PROs and business in accordance with IG7 recommendations. However, the responses of the private sector to these incentives might be hampered by the pursuit of low-tech strategies.

Main policy opportunities	Main policy-related risks
• Access to international knowledge is further improved as cross-border cooperation is specifically supported. • Improvement of circulation of knowledge between universities and research centres within a specific framework. • Circulation of knowledge between research organisations and business is facilitated through improving the efficiency of TTOs	• Despite the improvement in the access to international knowledge, spillovers to the local economy may be prevented due to inefficiencies in knowledge circulation and the low absorptive capacity of the business sector. • Efforts for the improvement of knowledge circulation hampered by the low absorptive capacity of the business sector and the pursuit for low-tech business strategies. • The new legislative framework does not address the weak and occasional collaborations of research centres and business. • The effectiveness of new mechanisms aimed at the improvement of lifelong learning will remain low as in the past.

The new law for governance of the research system recognises the need to promote collaboration between universities and public research centres, but disregards the real problem of weak and occasional collaboration between public research centres and the business sector.

5.5 Summary of the role of the ERA dimension

Participation in the ERA and increased access to international knowledge is a strategic choice for all Greek governments and for many public research actors. Efforts include the participation in the EU Framework Programmes, signing of bilateral research agreements, participation in European and international research and science organisations, such as CERN and ESA, and more recently the opening up of national research programmes to foreign researchers.

6 - Overall assessment and conclusions

6.1 Strengths and weaknesses of research system and governance

The analysis has shown that the Greek research system faces several deficiencies across all policy-related domains. Despite the efforts of the system to respond to the main challenges, systemic weaknesses and lack of coherence among the main elements of the system hinders their effectiveness.

The main drawback which has significant cross-domain implications is the low demand for scientific and research based knowledge from the business sector, due to its orientation towards low risk and less knowledge intensive activities. In addition, the low absorptive capacity of the business sector restricts its ability to pursue alternative strategies, feeding a vicious cycle of low knowledge demand, insufficient mobilisation of resources especially in the business sector, and low knowledge circulation among the business sector and the research organisations.

The low level of interest from the business sector has created imbalances in the way the system recognises and responds to knowledge needs that favour of the academic and the public research community. Thus, a typical supply driven system has been developed where orientation and priorities are driven by funding opportunities and not by market demand. This has affected the exploitability of the knowledge produced as well as the knowledge circulation and exploitation patterns.

Research policy efforts have failed to resolve the main challenges, namely the low demand and low business R&D investment as both are determined by many factors that lie outside the traditional sphere of either R&D or innovation policies. Furthermore, for many years R&D and innovation has been low on the policy agenda while institutional inefficiencies in the governance of research have reduced policy effectiveness. The most important of these inefficiencies are: lack of strong leadership and weak coordination in budgeting and priority setting; strong dependence on Structural Funds which leads to the development of rigid and bureaucratic management mechanisms; absence of mechanisms for ensuring quality in universities; ad hoc and ill developed mechanisms for identifying, channelling and monitoring knowledge demand; and ill developed system of lifelong learning.

The main strength and weaknesses of the system are summarised in the following table:

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	The justification for R&D investments is well established and a commitment to increase R&D expenditures to 1.5% of GDP has been made by government in line with the Barcelona target, although the time frame has now been shifted twice.
	Securing long term investment in research	High dependence on Structural Funds' funding and management mechanisms, while overall investment in R&D and especially by the business sectors is among the lowest in Europe. Lack of coordination between government and regions in mobilising the resources for research at regional level.
	Dealing with barriers to private R&D investment	The policy for reducing barriers to business R&D investments is well developed, however mobilisation of resources for R&D remains low priority for the business sector due to its orientation towards low risk, less knowledge intensive activities.
	Providing qualified human resources	Despite the strong supply of PhD graduates significant shortcomings related to the quality and alignment with economic needs exist.
Knowledge demand	Identifying the drivers of knowledge demand	Demand for knowledge by the private sectors is very low due to its orientation to less knowledge intensive segments of the economy. Efforts are being made to improve the methods used to identify demand. Coordination with EU over identifying demand is good.
	Co-ordination and channelling knowledge demands	Mechanisms for systematically responding to knowledge needs, especially in the private sector, are not well developed and lack coordination.
	Monitoring of demand fulfilment	Evaluation culture and mechanisms are not sufficiently developed although some progress has been made in this direction in research centres and very recently in universities.
Knowledge production	Ensuring quality and excellence of knowledge production	Overall the quality of research is lagging in terms of excellence although there are niches of recognised scientific excellence. Excellence is systematically monitored in public research centres and is linked to funding. However, only very recently mechanisms for ensuring excellence in universities have been introduced.
	Ensuring exploitability of knowledge	Strong policy focus on the exploitability of research and existence of a sufficient set of mechanisms. However, the orientation of universities and research centres towards the production of exploitable research results remains weak.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	Although there are sufficient measures and institutions in place, circulation of knowledge among local research actors remains weak due to lack of professionalism and the existence of institutional inertia and inefficiency of the actors involved.
	Profiting from international knowledge	The public research sector has an international orientation and participates in international knowledge circulation mechanisms. However, knowledge spillovers in the national economy are low.
	Enhancing absorptive capacity of knowledge users	The absorptive capacity of the business sector is weak, the mechanisms for its improvement are not well developed and there is a misalignment between supply and demand for graduates.

6.2 Policy dynamics, opportunities and risks from the perspective of the Lisbon agenda and the ERA

An assessment of the main policy opportunities and risks related to recent policy dynamics is presented in the following summary table.

Recent policy initiatives have addressed most aspects of the research related Integrated Guidelines of the Lisbon Strategy including: the promotion of centres of excellence; improvement to the effectiveness and efficiency of public expenditure on R&D; incentives for increasing private R&D expenditures; and modernising research centres and universities. Efforts include the mobilisation of increased resources under a Strategic Plan which sets new funding mechanisms within the framework of NSRF, combined with significant institutional reforms in the governance of research and the operation of universities.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• New funding mechanisms with long term orientation could improve mobilisation of resources • NSRF almost doubled project based funding, funding of infrastructures and development of human resources in research. • The new research priorities provide incentives to firms in less knowledge intensive sectors to shift to more knowledge intensive segments.	• Dependence on Structural Funds remains, as the new funding mechanism is not related to specific source of funding • Public resource mobilisation through NSRF and the existing incentives might not leverage spending from other sources, especially the private sector, to the extent anticipated. • Increasing funding for development human resources in the research sector will not be sufficient to increase the supply of researchers in areas relevant to the economy, if not supported by additional measures.
Knowledge demand	• The new set up of the NCRT and the thematic advisory councils will systematise the identification of needs. • The new instruments for research policy making and priority setting will increase coordination among ministries and other policy making bodies and improve the channelling of demand. • The creation of the research council (NORT) and of the new research and technology programme for supporting basic and applied research (NPRT) will increase efficiency and effectiveness of public expenditure	• Organisational complexity is being introduced in the governance system, putting efficiency at risk. • The institutionalisation of the participation of academics and research community in the prioritisation of research and the allocation of funds, threatens the ability of the system to recognise and effectively channel the needs of the business sector.
Knowledge production	• The reforms in the university and non-university public research sector in the long run it is expected to improve the effectiveness and quality of the knowledge production system.	• Lack of consensus among the academic community regarding the assessment of universities is jeopardising the introduction of assessment and the effectiveness of the measures. • The improved framework of measures for improving exploitability is being hindered by the low demand for knowledge from the business sector. • The reforms of the public research centres do not affect their 'academic' character.

Domain	Main policy opportunities	Main policy-related risks
Knowledge circulation	• The access to international knowledge is further improved as cross-border cooperation is specifically supported. • Circulation of knowledge between research organisation and business is facilitated through the improved efficiency of TTOs	• Despite the improvement in the access to international knowledge, spillovers to the local economy may be prevented due to inefficiencies in knowledge circulation and the low absorptive capacity of the business sector. • Efforts to improve knowledge circulation are being hampered by the low absorptive capacity of the business sector and the pursuit of low-tech business strategies. • The new legislative framework does not address the weak and occasional collaborations of research centres and business. • The effectiveness of the new mechanisms aimed at improving lifelong learning will follow the unsatisfactory trends of the past.

The institutional reforms have addressed some of the significant weaknesses in the system by increasing coordination at the highest level; strengthening long term planning; linking quality with additional funding in research centres; and reforming universities. The identification and channelling of knowledge needs is systematised by creating specific mechanisms. However, the institutionalisation of the academic involvement in the research governance and priority setting, could further distort the weak demand signals of the business sector in favour of the needs of the academic community. Such development could further strengthen the supply driven character of the research system. Furthermore, despite the creation of a new funding mechanism, the dependence on Structural Funds will remain strong up to 2015.

At the same time the new funding schemes which are added to the existing policy mix, focus on addressing cross domain weaknesses that are outside the governance system, namely the low knowledge demand and weak absorptive capacity of the business sector. On the one hand, the emphasis is on shifting the business sector towards higher knowledge intensive activities, either through diversification of existing enterprises or by creating new knowledge intensive firms. On the other hand, the challenge of improving the absorptive capacity of business is being addressed by measures supporting the technological competencies of enterprises while the strengthening of the lifelong learning presupposes the overcoming of institutional inertia and inefficiencies in the sector.

In addition to challenging specific risks, the large number of measures creates a cross-cutting risk of duplication and overlapping of objectives and means, reducing the effectiveness and efficiency of the measures.

The success of these efforts and the achievement of the target of 1.5% is uncertain, as both are also dependent on developments in other policy domains than research and innovation, such as the improvement of competition policy, the creation of entrepreneurial culture, the advancement of SME policy and improvements in financial and fiscal instruments.

6.3 System and policy dynamics from the perspective of the ERA

The concept of the ERA was welcomed by the government and the academic community as an opportunity to profit from international knowledge, to tap into additional sources of funding and to increase the local research capacity. Today, alignment with developments in the European research scene is a strategic choice and priority and has permeated both public policy and the strategy of research actors.

The impact on the research system of participating in the ERA can be assessed along the following dimensions:

- Prioritisation of research is developed in line with the priorities of the Framework Programmes. In addition to top-down alignment, academic demand was gradually channelled towards these priorities due to the size of funding available compared to national research funding.
- Mobility of researchers has been actively promoted within the framework of bilateral agreements and the participation of the country in EU initiatives such as the Framework Programmes and European research organisations such as CERN, ESA, the XFEL project and the EDCTP. In the previous programming period two measures aimed at attracting researchers from abroad were introduced. These schemes will continue to run in the current programming period.
- The opening up of the research system is a strategic choice of the Greek government as a mechanism to improve excellence. Due to the funding of research programmes within the framework of Structural Funds the financial support of non-nationals was not possible although their participation was welcomed. Recently the new framework for the governance of research specifically supports the participation of Greek researchers in research programmes of other countries and allows the participation of foreign researchers in the Greek programmes. In order to avoid the restrictions imposed by the Structural Funds the new law specifies that non-nationals can be funded from the national budget. This provision has been adopted in the Strategic Plan and will be applied in all programmes.
- Joint programming with other Member States has been implemented within the framework of bilateral agreements with most of the EU-27 countries.
- Greece is participating in the ESFRI roadmap and a decision has been made for participation in the preparatory phase of 13 Joint European Infrastructures. Driven by this participation, the law for the reform of the research governance foresees the creation of a long term strategy at national level for the development of a national research infrastructure in the European context.

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List of Abbreviations

CERN	European Council for Nuclear research
CSF	Community Support Framework
EDCTP	Clinical Trials for AIDS malaria and tuberculosis
ERA	European Research Area
ESA	European Space Agency
FP	Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GSRT	General Secretariat for Research and Technology
GUF	General University Funds
HEI	Higher Education Institutions
HERD	Higher |Education Expenditure on R&D
HERON	Programme for the support of research human capital in enterprises
IG	Integrated Guidelines
MoD	Ministry of Development
NCRT	National Council for Research and Development
NORT	National Organisation for Research and Technology
NPRT	National programme for Research and Technology
NSRF	National Strategic Reference Framework
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
PAVE-NE	Programme for the development of Industrial research in new established enterprises
PENED	Programme for the support of the research human capital
PRAXE	Programme for the commercialisation of research results

PRO	Public Research Organisations
ROP	Regional Operational Programme
SME	Small and Medium Sized Enterprise
STI	Science Technology and Innovation
SWOR	Strengths, Weaknesses, Opportunities and Risks
TEI	Technical Educational Institutions
TTO	Technology Transfer Office
XFEL	X-Ray Free-Electron Laser

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Abstract

The main objective of ERAWATCH country reports 2008 is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports are produced for each EU Member State to support the mutual learning process and the monitoring of Member States' efforts by DG Research in the context of the Lisbon Strategy and the European Research Area. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The reports are based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.
This report encompasses an analysis of the research system and policies in Greece.

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