



ERAWATCH Country Report 2008

An assessment of research system and policies

Portugal

Manuel Mira Godinho and Vítor Corado Simões



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ERAWATCH

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ERAWATCH Network - CISEP / ISEG

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Joint Research Centre
Directorate-General for Research

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Executive Summary

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-run 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, which aims to increase and improve investment in research and development, in particular in the private sector. One task of JRC-IPTS within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems 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 are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation.

The first policy issue discussed in this report is “resource mobilisation”. Portugal has a research system that has been growing in the last years. Public statements by members of the Government suggest that a sustained increase in resource mobilisation for science is expected for the next years, in line with previous trends. This increase will be mainly based on public R&D-funding, since the growth of R&D expenditures of the Portuguese business sector is hindered by the nature of the existing economic structure. Government initiatives to encourage business sector R&D and the very development of firms' capabilities and competitive environment will eventually induce a growth trend of R&D expenditures in the business sector. The main weaknesses of the Portuguese research system in mobilizing resources for research are associated with the lack of a consensus on a strategic vision for the overall national development of research funding as well as with the difficulties in offering permanent research positions for a growing supply of younger scientists. This mismatch may result in outward international mobility of Portuguese researchers which again may jeopardize the efforts to increase the quality of the Portuguese research system.

The research system has been strongly supply-driven. The research agenda has been defined by public authorities, with some involvement of the community of Portuguese researchers, while the private business sector has been unable to directly influence national research agendas. Furthermore, in spite of the identification of some research priority areas in recent statements,¹ no clear national strategic priorities have been set in a joint process involving the innovation system stakeholders and society at large. This may lead to fragmentation of the scarce R&D-resources in the country. Coordination mechanisms have traditionally been weak. In some instances they do not exist at all; in others, advisory bodies, while foreseen by the law, have been kept un-operational. Public procurement has not been used as an

¹ The National Plan for 2008 (Grandes Opções do Plano 2008) indicated as research priorities biomedicine, biomedic engineering, nanotechnologies and network computing. Further it was indicated that Thematic S&T Networks shall be reinforced in fields such as engineering systems, including power and transportation systems, bio-engineering and advanced manufacturing methods and ICTs.

instrument to articulate a clear profile of public demand for R&D-services. The recent publication of the Public Contracts Code opens however some opportunities for a strategic use of public procurement to stimulate research, especially in the private sector.

The Portuguese research system shows clear improvements concerning both scientific production and quality of research, particularly on what concerns basic research. There has been a significant increase in the number of international publications as well as in terms of the impact index of these publications. In contrast, the record on applied research has been poor, both in terms of research expenditure and patenting. An additional problem, stemming from the supply-side bias of the system, is the insufficient concern with exploitability.

Circulation of knowledge is hindered by the coordination problems mentioned above as well as by the low cooperation propensity prevailing in the Portuguese society. There is a weak tradition of a dynamic university-industry cooperation, in spite of some recent initiatives on this regard. The Portuguese research system is becoming significantly more international and the traditional participation of Portuguese researchers in the European Framework Programs has been recently supplemented by partnership programmes with American Universities. Policies towards enhancing of business firms in-house capabilities have been put forward in the last few years, with good results. However, the development of those capabilities is still limited by strategic and managerial shortcomings since only a small crust of business firms assigns high relevance to R&D and innovation.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	There have been several public statements at the government level in favour of increasing research funding. However there is no ample consensus – the Parliament, business associations and civil society in general are not committed to this issue
	Securing long term investment in research	Over the most recent decades public funding of science has been growing, including block-grant funding allowing for overall research system growth.
	Dealing with barriers to private R&D investment	Business sector has had a weak involvement in research financing. The growth of high tech and knowledge intensive sectors has been limited. However, the new structural programmes strengthened the incentives for business firms to set up R&D units and foster R&D activities together with other entities
	Providing qualified human resources	The number of PhDs and Post-Docs has been growing. Unemployment among researchers has been growing lately. The new research positions that have been created are of a short-medium term nature and there is apparently lack of permanent researcher positions compared to the numbers of PhDs and Post-Docs in the country.
Knowledge demand	Identifying the drivers of knowledge demand	Business firms, public procurement and other stakeholders have not been active in setting the agenda for research demand in the Portuguese research system. The growth of the scientific community and the quality of the research performed in many labs offers however opportunities for fruitful university-industry collaboration and the development of a spin-off research-based company sector.
	Co-ordination and channelling knowledge demands	Coordination mechanisms have been largely absent or non-operational

Domain	Challenge	Assessment of strengths and weaknesses
	Monitoring of demand fulfilment	No mechanisms of this type exist
Knowledge production	Ensuring quality and excellence of knowledge production	There has been a sustained effort towards increasing the quality of academic research. As part of this strategy the creation of Associate Laboratories has stimulated the quality of research. In contrast, while public labs have lost relevance and financial resources. The contracts established with US universities and the Fraunhofer Society aim at stimulating both basic and applied research. These objectives are also part of the recently launched Support System for Scientific and Technological Organization (SAESCTN), which is part of the NSRF 2007-2013.
	Ensuring exploitability of knowledge	The concern with exploitability of research-based knowledge production has been very limited. Existing incentive systems (financing criteria, academic and scientific careers statutes) do not provide stimulus for exploitability, exacerbating the consequences of low demand for R&D by the Portuguese business sector. Some measures included in the new SAESCTN seem to be headed to counter this problem.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	There is a weak tradition of university-industry collaboration. There have however been some positive signs recently, including the development of cluster policies and initiatives
	Profiting from international knowledge	There has been an active policy of pushing Portuguese researchers towards "internationalisation", including the recent agreements with foreign universities and R&D organisations. However such policies concentrate mostly on purely academic activities.
	Enhancing absorptive capacity of knowledge users	The weak absorptive capacities of the majority of the Portuguese enterprises have only partially been addressed by corresponding policies strengthening the diffusion of knowledge. The existing diversity of intermediary entities has not impacted strongly in terms of mobilizing the end-users. A positive feature is the intention to strengthen the support to firms so that they set up R&D facilities

A generalised consensus in Portuguese society with regard to research policy issues is still lacking. However, a clear commitment to increasing research funding has been underlined in government public statements in recent years. These statements are in line with an increased funding of basic science in the last decades. Academic science has developed, with a growing number of researchers involved in R&D activities. Performance, as measured by scientific publications, productivity and impact indicators, has been improving rapidly. On the private side there has been a growth of R&D expenditures in the most recent years and some Portuguese firms have matured the organization of their R&D activities. Nevertheless, overall participation of business in R&D is still low when comparing with the EU average.

The most significant policy opportunities arise from the NSRF programmes whose implementation started recently. These programmes contribute to funding of new R&D activities of considerable size and they may help to move the Portuguese GERD closer to the 1 per cent target by 2010. This expected favourable financial climate represents an opportunity for new approaches in terms of stakeholders' coordination, clustering and promotion of the systemic relationships which have been by and large neglected. The main policy risks stem from the lack of a wide consensus about how to target research activities towards cultural, social and

economic needs. In particular, there is the possibility that the private business sector, public procurement and civil society organizations do not mature rapidly enough in terms of the capability to influence the country's research agendas. This situation may possibly lead to a widening gap between knowledge production and application.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	Government commitment and the provisions of the NSRF 2007-2013, together with the new Code of Public Contracts, might lead to a rise in publicly financed investment in research. New schemes for financing RTD under the NSRF have been established.	Lack of generalised consensus about research investment might jeopardise current priorities. Competitive funding increase and the incapacity to provide stable jobs may negatively impact on research system sustainability. There might be difficulties in overcoming the dependence on European structural funds for financing research.
Knowledge demand	The NSRF 2007-2013 may lead to a wider coordination scope between ministries. As consultative bodies have been inactive, there is scope for improving coordination. Establishment of cluster-based policies may stimulate knowledge demand. Initiatives such as COTEC and Health Cluster Portugal suggest an increased concern by private actors with research activities.	The focus on academic excellence <i>per se</i> might widen further the gap between research activities and societal needs. Also the persistence of public investment in large conventional infrastructure projects will not favour a dynamic public procurement policy
Knowledge production	The expected strengthening of public finance towards research shall keep scientific publication rising. In relation to applied knowledge and exploitability there is large scope for improvement. In particular the development of cluster policies may stimulate such development. Dynamic charities (foundations) are driving research agendas in a few disciplinary areas and investing significant resources in areas such as biomedicine in cooperation with FCT	The persistence on a linear model approach might not promote an integrated, systemic development. The absence of national consensus on research priorities and the passivity in making consultative councils work may limit the convergence of perspectives needed to improve exploitability.
Knowledge circulation	Besides the points mentioned above, the sustained commitment to promote company R&D units is expected to provide opportunities for knowledge sharing. The launch of innovation and R&D vouchers may entice a demand for research services.	Absence of stimulation of long term cooperation between different stakeholders, together with the inactivity of policy advisory mechanisms, may not facilitate the development of consensus and the dissemination of knowledge.

Regarding the “ERA dimension”, there has been Portuguese involvement in ERA instruments. Altogether Portuguese organisations participate in 22 ERA-NETs and 11 Technology Platform “mirror groups”. The Portuguese participation in these ERA-activities is based on the assumption that active national ERA-participation is likely to contribute to the development of the Portuguese knowledge society. At the same time, however, there is an apprehension feeling among the research community that ERA-policies might benefit more the larger and geographically better positioned Member States than countries like Portugal.

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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
<ul style="list-style-type: none"> • Justifying resource provision • Long term research investment • Barriers to private R&D funding • Qualified human resources 	<ul style="list-style-type: none"> • Identification of knowledge demand drivers • Co-ordination of knowledge demands • Monitoring of demand fulfilment 	<ul style="list-style-type: none"> • Quality and excellence of knowledge production • Exploitability of knowledge production 	<ul style="list-style-type: none"> • 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 Inventory² 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.

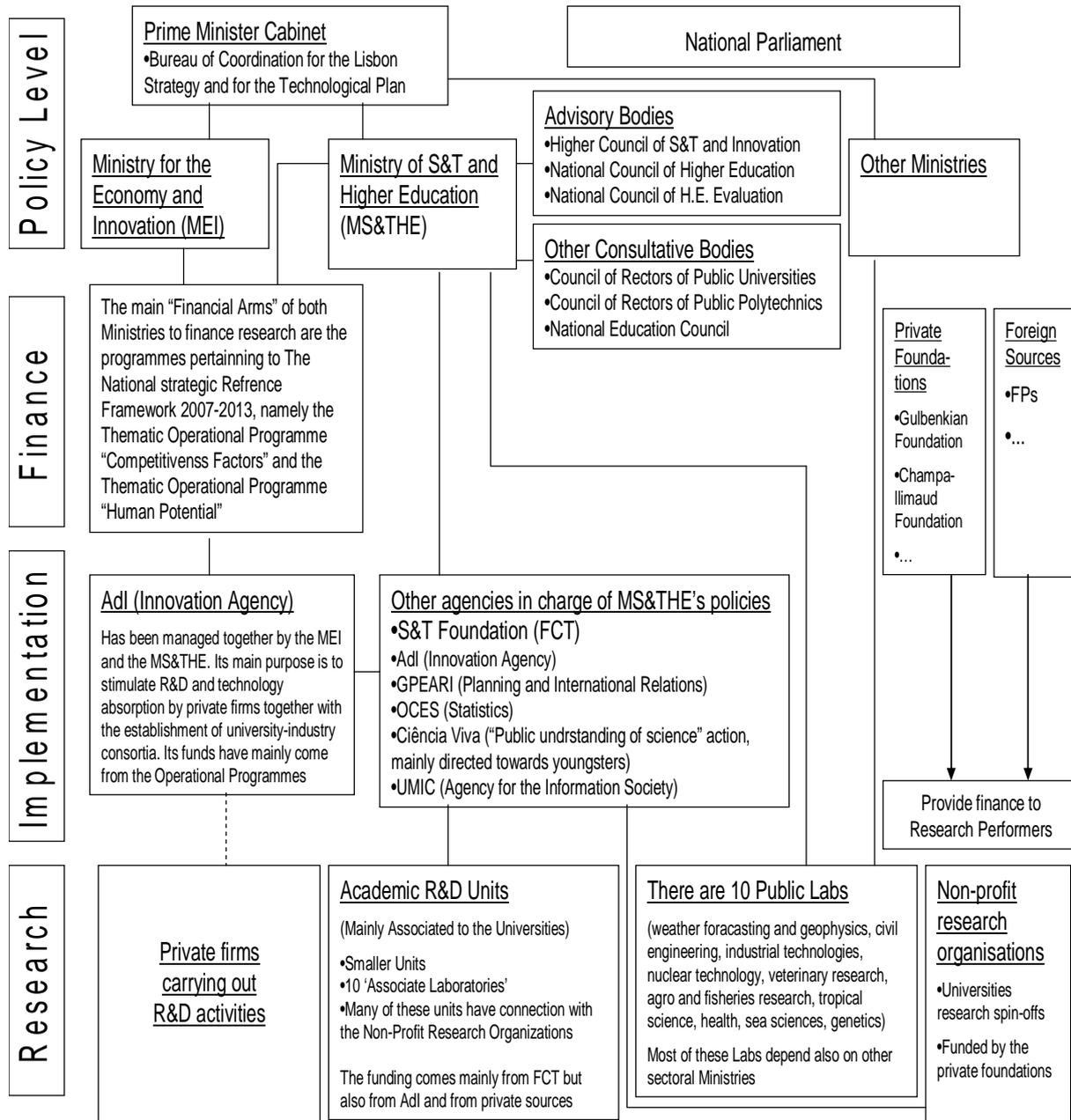
After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these chapters contains 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 the research system and governance and policy dynamics, opportunities and threats across all four domains in the light of the Lisbon Strategy's goals.

² 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.

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

The figure below portrays the national research system and its governance. Four levels are identified in the chart: “policy level”; “finance”; “implementation of the policies”; and “research activities”.

Figure 2: Overview of the governance of the Portuguese research system



Source:ERAWATCH Research Inventory 2008.

<http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=35&countryCode=PT&parentID=34>

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

Portugal is a small open economy attempting to close the development gap with the advanced EU economies. Research is seen as leverage for speeding up the catching up process, but the level of national R&D funding is still low. The Portuguese GERD amounted to €1,201m in 2005. This represents 0.81 percent of Portuguese GDP, compared to an EU 27 average of 1.84 percent. The proportion of Portuguese GERD financed from abroad is 5 percent but this does not take into account EU structural funds.

Table 1: Sectoral breakdown of R&D funds (sectors of origin and destination of funds) - Millions Euro. (2005)

Performing Sectors	Sources of Funding									
	Business firms		Government		Higher Education		Non-profit sector		Foreign Sources	
	€	%	€	%	€	%	€	%	€	%
Total	435.6	36.3	672.2	56.0	12.1	1.0	24.8	2.1	56.4	4.7
Business firms	422.1	91.4	19.3	4.2	-	-	-	-	20.6	4.5
Government	3.5	2.0	159.6	90,9	-	-	1.3	0.7	11.2	6,4
Higher Education	5.0	1.2	386.5	90.9	12.1	2,8	6.0	1.4	15.6	3.7
Non-profit sector	5.0	3.6	106.8	77.2	-	-	17.6	12.7	9.0	6.5

Source: Eurostat (2008) and GPEARI (2008).

2.1.1 Justifying resource provision for research activities

The present government has supported an increase in R&D outlays. After it took office in 2005, the government established the Technological Plan (see <http://www.planotecnologico.pt/>), an initiative aiming at the technological modernization of the Portuguese economy and society. This Plan has connections to the Lisbon Strategy and the leader for this Plan is also appointed as the national coordinator of the Lisbon Strategy, directly reporting to the Prime Minister. The Cabinet of Prime Minister and the Minister for Science, Technology and Higher Education (MCTES) have often uttered statements on the need to support research and on how decisive the role of R&D is for Portugal's future, referring to the Lisbon and Barcelona targets. In connection with the Plan an important policy document was published in early 2006, entitled *Commitment to Science for the Future of Portugal* (see http://www.portugal.gov.pt/NR/rdonlyres/44DBCA87-D664-452B-A88E-FB415A34F989/0/Compromisso_Ciencia_2007_2009.pdf).

In the core of this initiative there is the intention of increasing the funds for science in the public budget by €250m every year over the 2007-2009 period with a view of reaching the Barcelona target of 1 percent of publicly funded R&D. The fact that a new cycle of structural policies is beginning, with the start of the National Strategic Reference Framework (NSRF) for 2007/2013 (see <http://www.qren.pt/>), also creates a favourable environment for mobilizing resources in support to R&D.

Furthermore, it is worthwhile to mention some initiatives that indicate a reinforcement of the private sector resources brought to research activities. It was recently established the "Health Cluster Portugal", a consortium that brings together more than 70 research groups, business firms and private foundations in the field of health and medical sciences (see <http://healthportugal.com/>). Also the existence of COTEC (see <http://www.cotecportugal.pt/>), an association to promote innovation that resulted from an initiative of the previous Portuguese President and which involves the largest Portuguese business firms, has helped to create a favourable climate for R&D investments from the business sector in the country. Large international firms (Cisco, Microsoft, T-Systems) entered into agreements with national authorities with a view to set up research facilities in Portugal. Furthermore, some private firms are stakeholders in the agreements established between the Portuguese government and American universities and the Fraunhofer Society. Despite these positive steps, however, Portugal is still a long way from the development of a national consensus favouring a strong and sustained investment in research activities.

In general, Portuguese society does not seem to be interested in science policy matters. For example, the national parliament has not had an active involvement in discussing research priorities; neither it has been consulted in order to find politically sustainable multiannual budgetary platforms for funding R&D activities. The leading national business associations have not disclosed any policy proposals on these issues. Apart from some few remarkable exceptions, private companies have no policies or interest in participating in this debate. On a more positive side should be mentioned an increasing media coverage of science issues. Two high-quality newspapers edit a "science section" which provides news on scientific issues and on research policy developments and there is a weekly scientific magazine in RTP2 (the second public TV channel).

2.1.2 Securing long term investment in research

Formal S&T policies have been implemented in Portugal since the 1960s. These policies gained momentum since Portugal joined the EU in 1986. The coordination of European structural funds with national resources led to the establishment of three large programs since 1990. The first of them was the CIENCIA programme, carried out under the 1st Community Support Framework (1990/1993). It was followed by PRAXIS XXI (1994/1999) and POCTI/POCI (2000/2006), respectively during the 2nd and 3rd Community Support Frameworks. Each of these programmes increased the financial resources available for the research system. The first programme was mostly oriented towards scientific activities, as suggested by its name (CIENCIA). However, over its execution a complementary European initiative (STRIDE) had been established in order to develop intermediary science-industry infrastructures. Both PRAXIS XXI and POCTI/POCI, the two most recent structural programmes, had since their inception objectives aiming at stimulating S&T development and innovation. Nevertheless, the bulk of funding from these two programmes' was allocated to scientific activities and to advance scientific training (PhD and Post Doc grants). PRAXIS XXI coincides with the establishment of the new Ministry for Science and Technology and the responsibility of its implementation was placed under the new Ministry. However, also the Ministry for the Economy and the Agriculture and Fisheries Ministry allocated funds from the Community Support Frameworks to research and technological development activities. This led occasionally to duplication of R&D efforts and to poor coordination among some of the major research stakeholders. As an attempt to rectify this, the National Reference Strategic Framework (NSRF), which started in 2007, reduced the number of programmes for the period 2007-2013, with the different ministries being required to coordinate their involvement within these programmes. One of these programmes is Programa Factores de Competitividade (Competitiveness Factors Programme, see <http://www.qren.pt/download.php?id=374>) which encompasses most of the structural actions aiming at stimulating research development.

The programmes co-funded by the EU structural funds were instrumental in strengthening an important financial mechanism to support research activities, the *Multiannual Funding Programme*. This programme was launched in 1994 after the redesign of the public funding system with the merger of the national research council (INIC) in the funding agency (FCT). It provides block-grant funding through medium-term contracts with the research units mainly located in the universities. The contracts are established on the basis of proposed activities and at the end of the contract the units are evaluated by international scientific panels. In an earlier stage the programme allowed for the development of many small research units, but more recently it has stimulated mergers and the emergence of larger, better endowed, units (the *Laboratórios Associados*, see <http://www.fct.mctes.pt/pt/apoios/laboratoriosassociados/>).

The EU structural funds have represented a significant proportion of total public expenditure in research, even though other national public funds for research were available outside the scope of the EU co-funded programmes. In the programmes implemented during the three previous Community Support Frameworks the EU structural funds covered more than half of the total investment under those programmes. There is the perception that an eventual future decline in the EU structural funds available to co-finance existing policies might not be matched by

national sources. This concern has been addressed recently by an increase of the share of financing of research by national funds in the public budget.

Overall, publicly funded GERD was 0.46 percent of GDP in 2005 and 56 percent of total GERD. This proportion used to be above 60 percent in previous years. The expectation now, based on several government statements,³ is that public funds devoted to R&D will grow faster over the next few years bringing eventually the research system back closer to that 60 percent proportion. The main difference in relation to the past would be that the funds allocated on a competitive basis will grow faster than those secured as part of permanent budgetary arrangements. Until the 1980s more than two-thirds of publicly funded R&D was performed by the national labs and less than one-third by the universities. The national labs used to be funded as other public agencies, with annual basic allowances covering all their expenditures. Now the situation is the opposite, with the universities performing more than two-thirds of publicly funded R&D and relying increasingly on competitive sources. Both the longer term funds (the *Multiannual Funding Programme*) and the shorter terms funds (grants for individual research projects) for academic research are now provided on a competitive basis. In practical terms, the funding available has not been stable. It has changed in accordance to the Community Support Framework cycles, the political cycles, and the priority given to research by each government. In recent years there has been a shortage of funds in the *Multiannual Funding* that affected many of the research units supported under this programme.

In terms of long term budgeting and planning of funding, no other formal arrangements exist beyond the EU co-funded programmes which are part of the NSRF. There is a commission on "education, science and culture" in the national Parliament, but the debates on science and research within this commission are scanty. A "national S&T budget" is presented every year as part of the national budget passed by the Parliament but this budget is only established ex-post as the sum of all the foreseen expenditures related to S&T on a given year. The mechanisms for consultation and stakeholders' involvement foreseen in the existing law have also not been active since 2005.

For the near future the prospect in terms of financing is for an increase in public funds devoted to research, in congruence with the use of funds available under the National Strategic Reference Framework (2007-2013). Several government statements, both by the Prime Minister and the S&T Minister, point to this direction. These statements have been formalised in published documents such as the Commitment to Science initiative. This will bring Portugal closer to the EU 27 average of 0.65 publicly funded GERD as a percentage of GDP, but still a long way from the 1 percent Barcelona target. In relation to private business funds for R&D, the expectation is that they will also grow but eventually at a slower pace than public R&D funding. This topic will be analysed further in the next section.

³ When discussing the Government program in the national parliament, on the 21st of March 2005, the Minister for Higher Education, Science and Technology stated (our translation) that «Public expenditure on research shall grow up to the European goal of 1% of R&D on GDP. Specifically, public investment in R&D will be multiplied by two over this government term».

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

Business funded GERD as a percentage of GDP was 0.30 percent in 2005, which compares with an overall EU 27 average of one percent. The gap in relation to the EU average is therefore much larger than the one found for publicly funded GERD.

There are several reasons explaining the weak involvement of companies in R&D. The first reason relates to the structure of the Portuguese economy having small high tech and knowledge intensive sectors. There was an important structural change in the Portuguese economy during the 1990s, related to a move from a predominantly low-tech international specialization to a more medium-tech dominated economic specialization. However most of this move was led by foreign companies which retained their design and R&D facilities abroad. For example, the Portuguese companies that were stimulated within the automobile chain tended to be of a "specialized supplier" type, i.e., of small or medium dimension and with production competencies that do not rely on intramural R&D.

The second reason relates to the size of firms in the national economy. In Portugal there are no national large companies operating in medium-high tech or high-tech sectors. These companies are the ones that typically tend to heavily invest in R&D activities. This has led to a concentration of BERD in firms with less than 500 employees, which carry out 50% of total BERD in Portugal (OCES 2007). In the EU the BERD share for firms with less than 500 employees is only 25% (Grablowitz, Delicado and Laget 2007). There are just two Portuguese companies in the 2000 companies belonging to the EU Industrial R&D Investment Scoreboard, and the relative ranking of those two companies in R&D is much lower than the respective ranking based on sales and other financial indicators.

A third reason relates to the fact that domestic companies are not geographically close to large and demanding markets in which sophisticated clients play an important role. While for large multinational companies it might not be important to locate a facility producing complex products away from that sort of markets, for smaller companies such as the ones that constitute the bulk of the Portuguese economy, location is critical so that they might perceive the appropriate market incentives for innovating.

A fourth reason relates to the lack of a dynamic private venture and risk capital industry in Portugal. Commercial banks have also been reluctant to lend money to start-ups in new technology-areas. In sum, capital markets are relatively underdeveloped and 'shallow' in the country. Yet, a few firms are recently active in the area of venture and risk capital.

Public policies attempted to compensate for the poor venture capital conditions in the country. Several schemes have been set up to promote consortia linking universities, firms and other agencies. The two main measures to promote such consortia have been IDEIA ("Applied Research and Development in Companies") and the Centres of Excellence (Development of Competence Centres in ICT). In terms of indirect funding of business R&D, the most important measure has been SIFIDE, a tax credit system launched in 1997. Despite no systematic evaluations of SIFIDE (to our best knowledge), the common perception is that SIFIDE attracted several new firms to carry out and register their R&D outlays, especially in the banking sector and in other services. Despite these supportive policies, the proportion of BERD financed by

public funds has not reached yet the 5 percent threshold, which is equivalent to half or less than half of the corresponding figure in countries like Spain, France, Italy or the UK.

For the near future the expectation is that the BERD will grow in line with what has happened in recent years. There are two main factors supporting this growth scenario: (i) the new measures which are being made public under the NSRF to stimulate business investment foresee built-in mechanisms in which firms to apply for the incentives need to set targets in relation to innovation; (ii) there has been a growth in business sector R&D in recent years; and (iii) new very large public infrastructure projects granted to private firms must be carried out with related R&D activities (see more on this below). However the expected growth shall be of a moderate nature, since there are at least two important off-setting factors to this trend: (i) there have been no signs of structural change in the direction of R&D intensive activities; (ii) the recession climate that affects business expectations is not favourable to R&D investments.

2.1.4 Providing for qualified human resources

Portugal has had a consistent policy to support bright young graduates to obtain their PhD degrees since at least the 1970s. The number of new PhDs has been growing steadily from less than 100 per year in the 1970s to more than 1,000 per year in the present decade. In 2006 there were 1,276 doctorate diplomas granted or recognized by Portuguese universities. Of these diplomas 20 per cent were in the areas of Engineering and Computer Science, 41 percent in Natural Sciences and 39 per cent in all the remaining areas. At the master level the relative performance is not as bright, with less than 3,000 Master diplomas granted per year in the early 2000s (Source: <http://www.estatisticas.gpeari.mctes.pt/>). It is expected, however, that now as Portuguese universities have to adjust to the Bologna process the number of new Masters will increase significantly.

As the supply of new doctorates has increased, the labour market for researchers shows signs of saturation. Until around the year 2000 all new doctorate holders could easily be absorbed by higher education institutions. Recently, scientific unemployment started to become a noticeable problem. In a study published in 2006 but with data referring to 2002, 3% of the new doctorates were found to be unemployed (OCES 2006). No publicly available quantitative data on the evolution of that rate in recent years exists, but the qualitative information available indicates that this proportion has grown. As a response to this problem measures aiming at creating Post-Doc grants have been put forward in recent years. The problem now is that despite generous Post doc grants these researcher positions are not permanent. The existing public organizations (universities and other higher education, the public labs) have had no conditions to recruit for permanent positions and there are no perspectives that they will have the capacity to provide such contracts in the near future. This has led many of the brightest new PhDs to look for positions abroad benefiting from the academic networks they established during their PhDs. Further, in the wake of the Commitment to Science initiative (mentioned below in section 3.3) a

programme was implemented to provide funds to public and academic organizations for hiring Post-Docs with medium-term contracts.⁴

A central problem in this area is that advanced training has been seen as aiming mainly to scientific and academic professional paths. With the exception of a policy measure of modest financial size started in 2004 to stimulate PhD students to conduct their research in collaboration with firms, no other policy measure has been established to stimulate professional careers outside academia.

Over the recent years several policy measures schemes have been launched to attract Portuguese scientists who work overseas. The results so far have been marginal. The 2007 budget allocated funds for 50 “world-class” scientists to be recruited as full professors by Portuguese universities.

The most important recent initiative with regard to advanced training, has been the establishment of contracts with 3 American universities (MIT, Carnegie Melon and Texas/Austin), which were mentioned above in 2.1.4. These contracts, worth €141m for a 5 year period, involve both teaching and research activities (see http://www.portugal.gov.pt/Portal/PT/Governos/Governos_Constitucionais/GC17/Ministerios/MCTES/Comunicacao/Outros_Documentos/20061011_MCTES_Doc_MIT_CMU_UTA.htm).

The agreement with MIT, in the engineering systems area, established 4 new PhD and Master programmes. The agreement with Carnegie Mellon established a training programme in ICT and foresees the setting up of a virtual institution in the ICT area. The agreement with UT Austin involves activities in digital contents, advanced computing and mathematics, with the intention of setting up an international lab in emerging technologies, and foresees the establishment of a “University Technology Enterprise Network”. These 3 agreements are expected to involve 325 and 550 students respectively at the PhD and Master levels. More recently an agreement with similar contents was signed with Harvard Medical School. Another agreement yet was signed with Fraunhofer Gesellschaft establishing the first Fraunhofer institute outside Germany. This entity will focus on applied research in new technologies, contents and services aiming at improving quality of life.

Further to these agreements, partnerships have also been established between the RFCT and both the Gulbenkian and the Champallimaud foundations through the support to doctoral Programmes in Multidisciplinary Life Sciences, in Computational Biology (with Siemens) and in Neuroscience, Brain & Behavioural Systems.

2.2 Assessment of strengths and weaknesses

The main strengths and weaknesses of the Portuguese research system in terms of Resources mobilisation for R&D can be summarized as follows:

⁴ These contract-programmes are innovative as they are established directly with the research organisations which have the freedom to hire researchers on a medium-term basis. These contracts aim at providing 1,000 research positions.

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • Public funding of science has been growing in the most recent decades allowing for overall research system growth • Block-grant funding connected to international peer review evaluations has been implemented over the last decade • The number of PhDs and Post-Docs has been raising steadily 	<ul style="list-style-type: none"> • Business sector has had a weak involvement in research financing and as the growth of high tech and knowledge intensive sectors has been insufficient there are no expectation of very significant changes in this area in the near future • Research funding has grown but in an unstable way, dependent on structural programmes and electoral cycles and on individual governments' priorities (Basic funding has not escaped this situation) • Scientific unemployment has been raising and the new research positions created are of a short-medium term nature

2.3 Analysis of recent policy changes

The budgets of the Science, Technology and Higher Education Ministry have been rising faster than the overall national public budget. The proposed 2008 budget for S&T and Higher Education was €2,509m, raising 8.9 percent in relation to the previous year. As funds for Higher Education have been limited, the share devoted to science has been growing faster than the Ministry budget. This is in line with the targets set out in the *Commitment to Science for the Future of Portugal* presented in 2007. The overarching aim of this initiative was to reach R&D funding equal to 1 percent of GDP by 2010.

The most significant initiative that has emerged in recent months has to do with the contracts with three leading US universities, mentioned above. These contracts are worth €147m. Furthermore, the agreement signed with the Fraunhofer Society to establish a lab in Portugal is supported by an agreed annual budget of €6m over a 3 year period. Another agreement with Harvard University is in the pipe-line.

The *Commitment to Science* initiative, also mentioned above, foresaw the creation of 1,000 new research jobs through post-doc positions in research institutions. This measure will absorb part of the funds now being made available through the thematic Operational Programme "Human Potential" belonging to the NSRF 2007-2013.

The NSRF itself represents an important policy novelty, by bringing both fresh resources and a new organizational framework for public policies towards research. In this regard the Competitiveness Factors Operational Programme is the most relevant, since it provides incentives for research, technological development and innovation activities.

In 2007 it was created an office for the promotion of the Portuguese participation on the 7th Framework Programme. That office (Gabinete para a Promoção do 7^o Programa Quadro, www.gppq.mctes.pt) is a partial substitution for the former GRICES, which was in charge of international cooperation in S&T.

Some interesting developments occurred in the financing of applied research, technological development and entrepreneurship. A new legal framework for venture capital activities has been created by Decree-Law 375/2007. Relevant developments have to do with the re-organization of public capital instruments, with the creation of InovCapital (www.inovcapital.pt), and the launching of the FINICIA programme, run

by IAPMEI – Small and Medium Enterprises Institute, with a view to foster the establishment of partnerships that involve entrepreneurs, investors and intermediaries in structured competence networks. From 2006 to 2008, as many as 15 FINICIA regional platforms have been created which bring closer together different regional players (universities, polytechnics, development agencies, municipalities, business associations, business angels, science parks, business incubators, financial institutions etc). Business angels activities have experienced a positive evolution and a new frame is provided by the above mentioned Decree-Law 375/2007.

Another initiative that might have positive effects but whose impact is still difficult to assess at the present stage is the new “Code of Public Contracts” (Código dos Contratos Públicos, 2008). This law has made compulsory that all public contracts worth more than €25m shall reserve between 0.5 and 1 percent of their contracted value to finance R&D activities related to their contents. This requirement is to be put into practice for new contracts established 6 months after the publication of the new law, which happened in January 2008. The way these funds will be managed will be defined by a regulation to be established jointly by the Ministry for Public Works and the Ministry for Science, Technology and Higher Education.

The 2007 EU Commission Assessment of the Portuguese National Reform Programme noted positive progresses, namely in relation to the implementation of the Technological Plan, but it recommended to consolidate the linkages between research, higher education and industry, and to involve the private sector further. This recommendation was approved by the Council (ECOFIN/EPSCO) on its up-date of the broad guidelines for economic policies of the Member States and the Community and on the implementation of Member States’ employment policies issued on March 2008 (Council of the European Union, 2008).

Challenges	Main policy changes
Justifying resource provision for research activities	Public statements of Prime Minister and Minister for S&T and Higher Education have stressed the need of Portugal investing further in research activities. These statements have been formalised through documents such as the Commitment to Science initiative.
Securing long term investment in research	The new Code of Public Contracts foresees a completely new source of R&D financing, as all new contracts established by the Portuguese government worth more than €25m shall allocate between 0.5 and 1 percent to finance R&D activities
Dealing with uncertain returns and other barriers to private R&D investment	R&D tax incentives have been re-enacted since 2005
Providing qualified human resources	Supply of funds for 3 to 5 years contracts with research organisations to provide 1,000 post doc positions

2.4 Assessment of policy opportunities and risks

The main opportunities and risks for resources mobilization in Portugal arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • Government commitment towards increasing funds for science might lead to a significant rise of publicly financed investments in research • The provisions of the NSRF 2007-2013 to support business investments require firms to set innovation and R&D targets • The new Code of Public Contracts creates an alternative source of research funding, which might stimulate research with criteria diverse from the ones which have been applied 	<ul style="list-style-type: none"> • The lack of a consensus between the political parties on national research policy may jeopardise current priorities regarding a sustained effort on increasing R&D funding • The raise of the share of competitive funds in research financing, together with the incapacity to provide stable new jobs in the research system, may impact negatively on the sustainability of the research system

2.5 Summary of the role of the ERA dimension

Portugal has been involved in a number of ERA-activities. This includes participation in Technological Platforms, ERA-NETs and Joint-Technological Initiatives. Among these actions the ones which have mobilised more financial resources from the Portuguese side, and therefore having a potential impact of resource distribution among the research community, are the ERA-NETs. Between 2006 and May 2008 the Portuguese FCT has participated in 19 joint-calls. Each of these calls involves different numbers of other national research financing agencies and different amounts of financial resources, but typically there are 3 to 5 agencies and a FCT investment of 200,000 Euro per call, even though in a few calls the funding is well above this figure.

The establishment of an Iberian Nanotechnology Laboratory, located in Braga, Northern Portugal, follows from an agreement signed by the Portuguese and Spanish S&T Ministers in 2005. This initiative might create opportunities for further Iberian cooperation on R&D policy. As this infrastructure starts its activities in 2008, fresh resources will be available for collaborative research in the area of nanosciences area in Portugal.

In relation to the Framework Programmes it is known that the EU contribution to participating Portuguese researchers is significantly lower than the national contribution to FPs. This in part stems from an increasing domestic supply of research funds since the 1990s, which has pulled researchers from the FPs activities back to national R&D programs. The new Operational Thematic Programme on Competitiveness Factors under the NSRF 2007-2013 foresees the possibility of domestic R&D organizations being supported to prepare their participation in projects to be submitted to the EU RTDFP.

Portugal is also participating in European research infrastructures or organizations such as ESA, CERN, ESO, EMBO/EMBL and ESRF, and other European Infrastructures developed within the frame of ESFRI road-map. Except for CERN, according to our knowledge there are no studies or reports assessing these participations.

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; and
- 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.

3.1 Analysis of system characteristics

3.1.1 Identifying the drivers of knowledge demand

The Portuguese research system can be characterised as being yet in a pre-systemic stage in what concerns the capacity of making R&D responsive to knowledge demands.

As pointed out in chapter 2 the structure and the specialisation of the economy is biased towards non high-tech and knowledge-intensive sectors. Further, as indicated by a report on the Portuguese R&D specialization (ERAWATCH, 2007), when comparing with the EU average «Portugal is specialized in only two sectors of low R&D intensity, wood and publishing and textiles». This structural situation results in a BERD to GDP ratio of only 0.31 per cent. According to the 2005 national R&D survey BERD amounted to €462m, for a universe of circa 1,000 of business R&D performers. This indicates that most R&D operations are rather small and carried out in a non-permanent way or only with part-time staff dedicated to them. In fact the number of firms having a proper R&D unit is rather small. This was confirmed by studies carried out over the last decade. Those studies also pointed out that the R&D performed by business firms is more of an absorptive nature than of an innovative nature, i.e. firms invest in R&D to keep up with international competitors by absorbing state-of-the-art knowledge rather than using R&D as a competitive weapon to develop endogenous innovations (CISEP, 2001). To reverse this situation policy instruments, such as the NITEC initiative, have been established.

It should be noted that in keeping with overall structural change in which services sectors share in GDP and employment have raised significantly, the contribution of services to R&D has also increased. In 2005, according to the national R&D survey, the share of services in business R&D was 43.5%.

The structural situation is therefore the immediate cause of a fragile business sector R&D organization. A small average size of the business R&D units together with poor organization and a low degree of professionalisation of those units means that the business sector lacks critical mass to translate its needs into a proper research agenda for the university sector or the public labs. With the exception of a limited number of firms, most of the business R&D performers do not have yet the capacity to translate their R&D effort into a well-defined and purposeful demand going beyond short terms aims. In sum, the business sector lacks resources and proper associative structures that might help to overcome the limitations imposed by a shortage in terms of critical mass.

Despite this overall pattern it should be noted that some Portuguese firms have matured their R&D activities in recent years, with a more professional organization and visible outcomes of their R&D effort. The NITEC measure which was promoted in the context of the previous Community Support Framework has been instrumental in this process. A number of small and medium-sized R&D-based companies have been successfully operating in international markets. Also the initiative that arose in the health and medical S&T area, the “Health Cluster Portugal”, might bear important benefits (for more information on “Health Cluster Portugal” see <http://healthportugal.com/>). Further it should be noted that in relation to some of the most important low- and medium-tech sectors of specialization many firms have benefited from the R&D services of a network of Technological Centres that have been operating since the 1980s.

In relation to society’s demands on research at large, relatively similar systemic failures happen. The public debates in relation to potentially contentious issues involving research activities – such as GM-products or stem-cell research – are quite scarce and have not a maturity similar to the more advanced EU economies, as the civil society has not yet developed powerful NGOs with interest on the research activities carried out in the business sector or in the university or government sectors.

In addition to domestic demand for research – from the private business sector, civil society in general and government activities – another potential demand source is demand originated abroad. It is known that international companies or foreign research labs have sought partnerships and established contracts with Portuguese research institutions, but so far this sort of collaboration has been marginal and not systematically exploited. Further the peripheral geographic position of Portugal in the European continent is a factor that affects negatively the perceptions of the research system about the demands for their outputs.

As most of the R&D investment is carried out by the non-business R&D performing sectors it is pertinent to understand what sort of mechanisms these sectors use for defining their research priorities. In 2005 these sectors performed 62 per cent of total GERD, with the following breakdown: HERD accounted for 35 percent of total GERD, GOVERD for 15 percent and the private non-profit R&D institutions – most of them universities’ spin-offs – accounted for an additional 12 percent. In relation to the existing public labs, they depend on different ministries (economy, agriculture and fisheries, S&T). According to the individual statutes of these labs their strategic orientations are defined by the respective ministries. In practice most of their activities have been carried out as a continuation of their historical trajectories. Eventually, in the sequence of the recent reorganisation of the public labs system thematic consortia with other research organisations and companies will be

established. In relation to the universities and their associated non-profit institutes, the priorities stem from the financing chain in which they operate. The importance of the multiannual Funding Programme and the calls for research grants opened by the Ministry of S&T and Higher Education is therefore very relevant. In this context research priorities have essentially focused on qualitative aspects, including academic excellence and internationalisation of research. The allocation of funds among different scientific disciplines and socio-economic objectives can also be understood as an ex-post expression of research priorities.

3.1.2 Co-ordinating and channelling knowledge demands

No formal processes of priority setting and coordination have been implemented in recent years. Neither of the relevant stakeholders – the private business sector, civil society groups, government or the universities – have promoted foresight or planning exercises with a view to discuss what the longer term priorities might be or involve the different stakeholders' groups in a wider discussion so that a consensus develops in Portuguese society with regard to research priorities. Technology assessment exercises have also not been carried out.

Decision making with regard to public financing of research is centrally organized and the approach has been fully top-down. The Decree-Law n° 214/2006 published in October 2006 which defines the structure of the Ministry for S&T and Higher Education foresaw an advisory body, the S&T Coordinating Council, as a substitute of the former Higher Council for S&T. This structure is intended to bring together representatives of the universities, the public labs and the private industry. However, its members have not been appointed so far.

The FCT (Science and Technology Foundation) which performs a research council role and centralizes the management of most of the publicly competitive funds for research is led by an administrative board nominated by the Minister for S&T and Higher Education. In its structure the FCT integrates four “scientific councils” with an advisory role, whose members are all appointed by the Minister for S&T and Higher Education. The members of these councils have not been appointed either since the new statutory law of FCT issued in 2007.

Co-ordination shortages in relation to research priorities do not arise exclusively on the public-private interface. Also within the government sector itself co-ordination problems have been often diagnosed. The existence of ministry-centred structural programmes under the three previous Community Support Frameworks allowed ministries a significant independence with regard to investments in research. The Technological Plan which started in 2005 represented an opportunity to coordinate research and innovation policies. In fact, an inter-ministerial follow-up commission chaired by the Prime Minister was established to assess and evaluate the implementation of the Plan. Further the National Strategic Reference Framework (NSRF) for 2007-2013 is expected to enhance the scope for coordination in the area of research policies, since there will no longer be a specific structural programme focused strictly on academic research. Structural funding for research within the NSRF has been integrated in the “Competitiveness Factors” Operational Programme, which requires a more cooperation-oriented approach of coordination between the main ministries involved in supporting research.

In what concerns public procurement no significant actions have been promoted that have affected the demand for research. The major public investments that have been

announced for the decade up to 2018 (the new Lisbon airport, a new dual train and car bridge crossing the river Tagus in the Lisbon region, and two high speed train lines) have no foreseeable direct impacts on the R&D performed within firms or by the universities and the public labs.⁵ The technologies involved in these large public investments have been developed long ago or are available on a “turn-key” basis to be imported and used. The recent publication of the new “Code of Public Contracts”, mentioned to in 2.3 above, might however help to reverse invert this situation in the future.

3.1.3 Monitoring demand fulfilment

There have been no formal exercises to assess how research performance is fulfilling knowledge demand in Portugal. In contrast, there have been several policy evaluation exercises, namely in the context of the structural programmes within the Community Support Frameworks. Most of these evaluations have tended however to concentrate more on assessing how these programmes have met their operational objectives rather than how they have strengthened the S&T system.

The evaluations which have been carried out stress the important developments that have happened in relation to scientific advancement in Portugal, with a continued effort to train advanced human resources and furthering internationalisation of research. At the same time those evaluations (Godinho et al.i. 2003, Godinho and Simões 2005, SPI 2005) indicated that weaknesses remain in the establishment of links, in eliciting private demand and in stimulating in-house R&D capabilities in companies.

As pointed out above knowledge demand – being it originated in the private business sector, in civil society or in government activities – has been weak and the communication with the research system remains limited despite some improvements. This situation can be seen as paradoxical given the fact that research has been growing very rapidly, reaching levels much above those that existed only two decades ago, in particular with an excellent performance in terms of growth of scientific publications.

3.2 Assessment of strengths and weaknesses

Over the last few decades research policy has been concentrated on improving supply-side conditions and the preoccupation of reinforcing the links between supply and demand has in general been short-lived. So far there are no clear indications of a system response. In spite of some initiatives in this regard, the share of high-tech and other knowledge-intensive sectors in the manufacturing sector GDP has remained well below the EU average. Much of the existing business interests have partially found shelter in non-tradable sectors or in highly regulated sectors protected from international competition or dependent on policy decisions in granting contracts. The education level among adult population has also prevented the development of a participatory attitude in relation to research matters. As a result of these trends and systemic characteristics the disconnection between research supply and demand has been widening as research has moved forward while application has lagged behind.

⁵ Indirect impacts might eventually be expected, given the obligation set out by the new Code for Public Contracts of all new contracts established by the Portuguese government worth more than €25 Million devoting between 0.5 and 1 percent to finance R&D activities related to their contents.

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • The growth of the scientific community and the quality of the research performed in many labs offers potential for university-industry collaboration and development of a spin-off research-based company sector • Though still weak, business sector demand is expected to increase in the years to come as new initiatives and mechanisms of interaction arise 	<ul style="list-style-type: none"> • Despite some improvements in recent years, the structure and organization of business R&D activities is fragile and its capacity to generate clear demands for the non-business research sector is still weak • The absence of a culture of discussing research-related issues and problems translates into low involvement of citizens and NGOs in defining research priorities • Public procurement has not been used as a tool to stimulate research with practical outcomes • Coordination mechanisms have been largely absent or non-operational

3.3 Analysis of recent policy changes

The most important recent policy initiatives with impact on the research system have been the *Commitment to Science for the Future of Portugal* (see http://www.mctes.pt/archive/doc/MCTES_compromisso_com_a_ciencia.pdf) presented in March 2006, the contracts with 3 US universities implemented in 2007 (see <http://www.portugal.gov.pt/Portal/Print.aspx?guid=%7B1F51C5CD-AFD1-4D01-8D45-41CC9C1F62A9%7D>) the new law regulating Higher Education institutions passed in September 2007 (see <http://www.dges.mctes.pt/NR/rdonlyres/396A13EB-61FF-45D2-AF11-70E99B9E8A69/1350/Lei622007.pdf>) and the initiative *Ciência 2008* announced in May 2008 (see http://www.mctes.pt/archive/doc/FCT_ciencia2008.pdf).

This last initiative is a continuation of the *Commitment to Science* and aims at strengthening the research supply side. The other two initiatives, the contracts with US universities and the Higher Education statute, can be seen as having impacts in helping to link research to knowledge demand. The new Higher Education statute allows for the creation of a new entity in universities' management, the "Conselho Geral", which is a strategic council with a membership of 15 up to 35 representatives. Most of its membership is drawn from the university bodies (teachers and students), but at least 30 percent of the members should be drawn from both the local community in which the university operates and the business sector. It is expectable that such composition will be relevant in a body that will be responsible for electing the universities' presidents and approving their strategic plans, including possibly research priorities. With regard to the contracts with the US universities, they mainly involve teaching and academic research activities, but they also foresee the involvement of private companies in some of the research activities.

On a more general level, the programmes and specific initiatives that have been recently under implementation in the context of the National Strategic Reference Framework 2007-2013 (NSRF) are expected to impact demand conditions and will allow for greater coordination between government sectoral policies. The recently appointed inter-ministerial commission for the coordination of NSFR will also provide further possibilities of co-ordination.

Challenges	Main policy changes
Drivers of knowledge demand	<ul style="list-style-type: none"> • New programmes under NSRF 2007-2013
Co-ordinating and channelling knowledge demands	<ul style="list-style-type: none"> • Higher Educations institutions statute • Contracts with US Universities • New programmes under NSRF 2007-2013
Monitoring demand fulfilment	<ul style="list-style-type: none"> • No specific initiatives identified

3.4 Assessment of policy opportunities and risks

The growth and consolidation of the publicly-financed research sector offers a significant potential to develop further university-industry collaboration and stimulate the creation of a strong spin-off research-based company sector. The fact that the National Strategic Reference Framework 2007-2013 is starting its implementation also opens important policy opportunities.

Energetic initiatives are however needed in order to overcome existing systemic failures in connecting supply and demand for advanced knowledge. The implementation of effective consultation mechanisms is an easy and essential step. The promotion of new statutes for the scientific and academic careers congruent with these objectives is also a step to be taken. Additionally the launching of well thought and strategically oriented foresight exercises is needed to help future visions to arise and being shared between different stakeholders. Finally the establishment of a cluster-based approach in up to a dozen of main areas (including energy and renewable sources, urban habitat, information society, transportation and mobility, automobile "filière", fashion industries, food quality and traditional food products or forest management and forest products), replicating the initiative which has unfolded in the health S&T area, might generate appropriate dynamics to overcome the identified supply-demand gap.

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • The National Strategic Reference Framework opens the door for a wider coordination scope between the ministries that oversee investments in research over the programming period 2007-2013 • The legal framework foresees consultative bodies which have not been operational, so there is scope for easy improvement in research priority-setting • The setting up of "Health Cluster Portugal" might generate demonstration effects; replication of this approach in other areas might be possible with supportive government action • The launching of foresight exercises might help to stimulate more systemic coordination and integration 	<ul style="list-style-type: none"> • The focus on academic excellence per se might widen further the gap between research activities and societal needs • The persistence of public investment in large conventional infrastructure projects will not create a favourable environment for a more responsive research and will consolidate the structure and pattern of economic behaviours

The continuation of an excessive bias towards the supply side, on the contrary, will jeopardise the systemic development of the Portuguese research system. The promotion of academic excellence is essential, but if detached from societal needs research excellence risks to encourage a dualistic scenario of a highly educated and

internationalised scientific elite separated from the social and economic fabric. Further the longer term infrastructural policies,⁶ which will absorb a larger share of public investment in the forthcoming decade, need to be redressed towards the establishment of links with technology based companies and research institutions.

3.5 Summary of the role of the ERA dimension

Portugal has been particularly active in one of the instruments which have been used in the context of the development of the European Research Area, which are the ERA-NETs. As it is known, the ERA-NETs typically tend to concentrate on basic research, even though some of them have evolved in the direction of Technological Platforms, which have a more oriented focus. Given this pattern of participation, one might induce that those instruments have had so far a little impact in inducing a European demand upon Portuguese research activities.

This pattern does not exclude however the possibility that such demand may be finding its way through other alternative channels. Of the circa 30 Technological Platforms (TP) that exist, Portugal has been active in 11 “mirror groups” that bring together Member States representatives. In these mirror groups Portugal has been represented by individual experts invited by the MCTES from the relevant areas. This participation has stimulated the establishment of corresponding national platforms in the following areas: construction; agro-Industries; manufacturing technologies; and forest products. There is the expectation that soon Portugal will also establish equivalent national platforms for innovative medicines and bio-fuels. These participations in the TPs has been followed up by MCTES through the FCT (and formerly through GRICES as well) and by other organisations (namely AdI and INETI). The Ministry for the Economy and Innovation has followed a TP in the area of textiles and has indicated interest for the wind energy TP.

Further to the TPs Portugal has also been active in the more recent Joint-Technological Initiatives. This has happened for the immediate reason that as Portugal held the EU Presidency during the second semester of 2007 it was directly involved in the first 4 JTIs: Innovative Medicines Initiative (IMI); Embedded Computing Systems (ARTEMIS); Aeronautics and Air Transport (Clean Sky); and Nanoelectronics Technologies 2020 (ENIAC). Two other JTIs formed meanwhile, in the areas of Fuel Cells and Hydrogen (FCH) and Global Monitoring for Environment and Security (GMES), have also been followed up by the FCT.

⁶ These infrastructural policies include the construction of high-speed train lines, the continuation of the programme of building new motorways, a new airport South of Lisbon and a new dual (car and train) bridge over the Tagus estuary in the Lisbon region.

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

In line with the Technological Plan, the policy document *Commitment to Science for the Future of Portugal* defined five main orientations, some of which express a clear concern with the promotion of research quality and excellence. Such orientations, put forward in the that document as challenges to be met, are as follows: (1) develop knowledge and scientific and technological competence, assessed as being of the highest international standards; (2) invest on human resources and on S&T culture; (3) support public and private R&D institutions, strengthening them and encouraging their networking; (4) promote internationalisation, high standards and evaluation; and (5) facilitate the economic valorisation of research (MCTES, 2006).

These recent orientations can be understood as the natural development of previous policies. In fact, a significant effort has been taken for several years now to promote the quality of scientific research, as well as to encourage internationalisation. The setting up of a procedure of international evaluation has been a significant step towards improving the quality of research (Godinho et *alli*, 2003; Godinho & Simões, 2006). This procedure had positive effects on three grounds: (1) it improved the quality of the financed research, increasing international publication; (2) it led to a change in University policies on faculty selection and promotion, granting more importance to the research track record; and (3) it clarified the rules for financing basic and applied research.

While recognising the positive features of these moves, some analysts have however raised criticisms regarding an insufficient concern with research geared towards

specific challenges faced by Portugal and the absence of a clear calendar for regular application calls.

The key organisation that has been in charge of managing the evaluation procedure of research units is the Science and Technology Foundation (FCT). The Foundation is the main arm of the MCTES to support basic research as well as to provide medium-term financing for research organisations (ERAWATCH Research Inventory, 2006). The FCT mission, according to the recent statutory law of the MCTES, is to foster “the development, financing and evaluation of organisations, networks, infrastructures, projects, programmes and human resources in all scientific and technological fields”, as well as the carrying out of international scientific and technological cooperation. More specifically, the FCT is responsible for financing or co-financing research projects and programmes, as well as for the follow up of their implementation.

Regarding evaluation procedures, a distinction may be drawn between project funding and the research units' multiannual funding. Project evaluation is undertaken ex-ante, through peer reviews, including the participation of foreign scientists and researchers in the fields concerned. Multiannual funding is based on an ex-post evaluation of the research results of the organisations concerned, assessed partially by bibliometric indicators. In a 5-point scale, only research centres with 'excellent' or 'very good' receive funding. Each research centre funding is in proportion of the number of PhDs it has, being the per capita funding obviously higher for units qualified as 'excellent'.

The evidence on the system's performance and achievements indicates clear improvements in international comparisons, both in terms of the shares of international publications and citations. In fact, such improvements are revealed by the number of internationally refereed publications in science and engineering per million inhabitants. For Portugal, this indicator progressed from 118 per million in 2000 to 275 per million in 2005. These figures compare with values for Germany, in the same period, of respectively 463 and 535 per million (source: NSF, Science and Engineering Indicators, various years).

While the aggregated figure for the number of international scientific publications has been rising, some changes have been experienced in the structure of publications. In fact, Portugal's scientific specialisation, as measured by bibliometric indicators, experienced slight changes between 1993-95 and 2001-03 (ERAWATCH Network, 2006). Both indexes (number of publications and citations) point out towards a specialisation in three scientific fields: material sciences, agricultural sciences, and chemistry. For all of them, there has been an increase in specialisation between the two periods concerned (with the exception of citations in chemicals). If citations are taken as the yardstick, engineering also emerges as a specialisation area, although exhibiting a slightly declining trend. In terms of the number of publications by field, chemistry takes the lead, with more than 15 per cent of total, followed by physics, and clinical medicine. While coming fourth only, with slightly less than 10 per cent, engineering has enjoyed one of the highest growth trends.

Despite the growth of scientific publication, much remains to be done, however. Three main issues have been pointed out by research policy analysts: (1) the dispersion of efforts; (2) the weakness of interdisciplinary cooperation, and (3) the weakness of technological knowledge production.

The dispersion of efforts involves two main strands of argument. The first concerns the lack of critical mass of many research units. In fact, the average number of researchers per unit is low. Very often, they correspond to a set of very small research groups, clustered around one leading individual. Research agendas in many cases are unable to encompass the complexity of the issues addressed. Small numbers generate limited ambitions while stimulating individual, niche research agendas. The traditional support to individual projects has largely contributed towards this bias. In 2004, the government at that time voiced the intention to restrict multi-annual financial support to those units that exceeded a defined number of researchers. The fall of the government did not enable the materialisation of such intention. While not following this path, the present government has taken several steps in the same direction, namely through the encouragement of mergers, the incentive to research consortia, and the promotion of Associate Laboratories. The main example of pursuit of critical mass for international excellence is the research consortium set up by three of the leading Associate Laboratories in health sciences. INEB (biomedical engineering), IBMC (molecular and cellular biology), and IPATIMUP (molecular pathology and immunology) joined their forces to create the Institute for Health Innovation and Research (I3S); this will have a head count of more than 700, a figure hardly imaginable a couple of years ago.

The second strand of the dispersion of efforts argument is no less compelling. It concerns the wide spectrum research policy followed. Being a small country, with limited resources, Portugal needs to define research priorities, to avoid an excessive dispersion. Choices need to be made (ERAWATCH Research Inventory, 2006). The lack of priorities further compounds the negative effects of the insufficient critical mass at the level of research units.

This problem also leads to the weak inter-disciplinary approach. Portugal's collaborative tradition is extremely limited, and research is no exception. Research groups tend to be very inward-oriented, often collaborating more with a couple of organisations abroad than with their neighbours, perceived more as foes competing for scarce resources than as allies. There has been a policy encouragement of inter-disciplinary cooperation, but the incentives have clearly fell short the needs to ensure behavioural change. Some Associate Laboratories have promoted inter-disciplinarity, but again the effort has been limited. Even in the context of change-orientated programmes, like the PRIME Mobilising Programmes (Augusto Mateus & Associados, 2006; Simões, 2005), the promotion of cooperative and trans-disciplinary research endeavours has been limited.

While improvements in the production of scientific knowledge have been relevant, the same has not happened with technological knowledge. In spite of an increase in University patenting, in congruence with the activities of the GAPI (Gabinetes de Apoio à Propriedade Industrial) network, the linkages between research, on the one hand, and technological development, on the other, have been limited. The bridges between the two fields remain limited, and the promotion of international academic publishing appeared to have an implicit bias of discouraging University research units from forging linkages with the business sector. Of course, the problem is compounded by the above mentioned weaknesses of business firms capabilities and demand. This issue directly leads to the following section, on knowledge exploitation.

4.1.2 Improving exploitability of knowledge production

While significant improvements have been achieved in the field of knowledge production, the results on what regards knowledge exploitability have been meagre. The links between the research system and industry are fragile.

As mentioned above, business R&D expenditure is low. For 2005, it corresponded to 0.38% of GDP only. This figure is very far away from the Barcelona target. In relative terms, Portugal is much closer to that target in terms of public than in terms of business enterprise R&D expenditures (BERD). However, taking a longer term perspective, things appear to be moving, though slowly, in the right direction. For 2005, BERD accounted for 38.5% of total R&D expenditures from shares in the range of 21-23% during the 1990s and 32-33% in the early 2000s (GPEAR1, 2007a and 2007b).

Portugal's technological specialisation, as measured by BERD, exhibits a profile orientated towards services including financial intermediation and IT services. In manufacturing, specialization is recorded in two low R&D intensive sectors: wood and publishing, and textiles, the latter experiencing a significant increase from the 1990s to the 2000s. In contrast, the specialisation in fabricated metals and electrical machinery, evident in the early 1990s, vanished. Measuring technological specialization on the basis of patenting, the picture is sharply different. Pharmaceuticals, fabricated metals and plastics emerge as the main specialisation fields.

Data on patenting indicate that the number of filed patents has been recently growing, which is congruent with the recent BERD trend. However, patenting level is extremely modest. Godinho (2007) estimated that, if the patenting pace recorded in the recent past were maintained in the future, it would take around 150 years for Portugal to achieve EU average patenting levels. As explained elsewhere, the low R&D and patenting levels stem to a large extent from a relative specialisation in traditional, low technology intensive industries as well as from companies' weak in house capabilities (ERAWATCH Research Inventory, 2007; Simões, 2006).

Available assessments of the system's performance and achievements with regard to the exploitability of knowledge are mixed. There were some improvements on what regards the cooperation and 'transfer' of knowledge between the research sector and Industry, as a consequence of initiatives taken on that regard, namely the incentive programmes for the creation of R&D consortia involving companies, technological centres and University research centres (Godinho et alii, 2003). There have also been several good examples of new technology based companies launched to exploit research results. The sustainability and success of these initiatives appear to be closely associated to the mobilization of international networks that simultaneously work as additional knowledge sources, credibility providers, and market internationalization levers (Fontes 2006 and 2007; Dominginhos, 2007). Echoing these developments, some policy makers have spoken of an "innovating Portugal" which needs to be spread (interview to Mr. Lino Fernandes, *Diário de Notícias*, 6 Nov. 2007). However, other evaluation exercises are critical about the results achieved in this regard (Mateus & Associados, 2006), namely on what concerns partnerships and mobilizing projects.

There are several reasons for the relatively weak exploitability performance, that is, the capability to translate knowledge production into entrepreneurship and business

innovation. One concerns research units incentives. Its merits notwithstanding, the research financing system, together with the academic and scientific careers' statutes, have strengthened a closed 'research focus' of these units. Since research units get a basic financing for their more academic research activities, there is no push for them to forge links with the business sector. In a relatively non-cooperative setting, where the two fields have traditionally developed apart, the financing policies further reinforced the 'academic' orientation of research. This problem is, of course, compounded by the lack of in-house capabilities of many firms, in spite of the positive initiatives taken to support the creation of R&D teams in business firms, namely the NITEC programme. The dialog becomes therefore difficult, the more so as the issue is not just a matter of 'transferring' a complete and formalized knowledge package, but rather a process of inter-action, involving mutual learning and adaptation of the body of knowledge to a body of practice (Pavitt, 1998; Nelson, 2005).

An additional difficulty has to do with the role assigned to public laboratories as instruments for promoting knowledge exploitability and diffusion throughout the industrial fabric. The reorganization of the public laboratories has been in the agenda of successive governments since 1997. Decisions on this regard have been procrastinated, and the situation of several laboratories has deteriorated. Only by the end of 2006 a decision has been taken on that regard, significantly changing the public laboratories system, and closing INETI, the public laboratory on manufacturing technologies. This decision raised a significant public debate. An interesting feature of the reform is the support provided to the creation of R&D consortia, involving public laboratories, associated laboratories, universities, other research organisations and business enterprises, and focused on carrying out R&D activities on specific themes.

4.2 Assessment of strengths and weaknesses

For the last 15 years, a strong effort has been undertaken to improve the basic research system and funding procedures, with positive effects on the quality of the research. Three relevant aspects of such efforts have been the development of research block-grant funding, the encouragement of critical mass in research units (to fight the dispersion pointed out above), and the creation of the Associate Laboratories. The system is now relatively mature. There are, however, some deficiencies. One of them stems from the improvements in the University knowledge production system itself. The existence of funding for basic research has not contributed to improve industry-oriented research. In fact, there has been a limited concern with exploitability in the process of granting research funding. This weakness has been compounded by two additional elements of the system. First, the insufficient in-house capabilities of firms do not encourage public research to pay attention to exploitability. Second, public laboratories, which were the main [organisations concerned with research exploitability have lost significance and resources.⁷

⁷ It should be mentioned in connection to this issue that the process of reform of public laboratories was launched in 1997, but so far it has not been fully completed.

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • A sustained effort towards increasing the quality of academic research has been pursued • The creation of Associate Laboratories and the promotion of critical mass have stimulated the quality of research 	<ul style="list-style-type: none"> • The granting of research funding has strengthened the inward looking attitude of several research organisations weakening the links with Industry • Public laboratories have lost relevance and resources, and the recent reorganisation of the system does not appear to provide a reliable solution. • Limited concern with exploitability of knowledge production in the funding assignment process. • Knowledge exploitability is undermined by the weakness of companies' in-house R&D capabilities (in spite of the improvements during the last couple of years) as well as by the weak linkages between business enterprises and Universities

4.3 Analysis of recent policy changes

A look at recent policy changes, namely those stemming from the NSRF 2007- 2013, and in particular the Support System for Scientific and Technological Organisations (SAESCTN), under the Competitive Factors Operational Programme (CFOP), suggests a double conclusion. On the one hand, the earlier policy regarding the promotion of the quality and excellence of knowledge production will be pursued. The main thrusts defined in the Technological Plan and in the 2006 policy document *Compromisso com a Ciência para o Futuro de Portugal* ('Commitment with Science') are maintained. On the other hand, little focus seems to be placed on the exploitability of knowledge production. In a nutshell, the basic headlines of (academic) knowledge production policy did not change with the NSRF 2007- 2013.

The SAESCTN has four objectives dealing with knowledge production: strengthen the competencies of scientific and technological organisations; promote RTD programmes geared towards the implementation of public policies; and encourage the development of thematic networks; and international S&T partnerships. The regulation disclosed does not provide detailed information on the envisaged measures. It is possible, however, to identify the following main types of projects dealing with knowledge creation: (1) RTD projects, on all scientific fields, dealing with basic research, applied research, experimental development, and technological development; (2) RTD projects geared towards the implementation of public policies or the exploitation of scientific research results; (3) S&T thematic networks; and (4) International cooperation R&D projects. Groups (2) and (3) may be envisaged as introducing some new features. Both were, however, already mentioned in the 'Commitment to Science' document delivered early in 2007.

RTD projects geared to the implementation of public policies will be mainly addressed to the following issues: natural and environmental risks, forest fires, epidemics, and social transformations. The measure on S&T thematic networks is related to the international partnerships with American Universities. According to the 'Commitment to Science' the domains where the creation of thematic networks were envisaged were the following: energy; transports and logistics; manufacturing systems, namely in mould-making, automotive and aerospace industries; software engineering; telecommunications and information networks; robotics; digital contents and multimedia; biosciences, biotechnology, and biomedicine; and nanotechnologies, in connection with the creation of the Iberian Nanotechnology Laboratory.

Reflecting policy incentives for research units increasing their size, it should be mentioned the creation of I3S – Health Research and Innovation Institute (Instituto de Investigação e Inovação em Saúde) which brings together three Associate Laboratories based in Oporto. This is a good example on how to build international critical mass by putting together capabilities of different laboratories.

4.4 Assessment of policy opportunities and risks

Policy developments in relation to knowledge production have not been very significant. The scene is already broadly defined, and the concerns with quality and excellence, assessed by international peers, will continue to hold. Opportunities may arise mainly from the new coordination frame of the CFOP, in the context of the NSRF 2007- 2013, which may enable an increased coordination between science and innovation policy, in line with the revised Lisbon Strategy for growth and jobs. Following the reasoning developed above, the intention to espouse a cluster policy is likely to open opportunities. In fact, by creating a common ground for the interaction between S&T organisations and business firms, the CTPs may turn academic and other non-profit knowledge production organisations more aware of exploitability needs and requirements.

In contrast, some policy risks should also be pointed out. They have mainly to do with three aspects. First, there is a risk that the ‘linear model’ reasoning embedded in Portugal’s R&D policy may lead to an inability to figure out the significant intertwining between knowledge production and exploitation. Also the inactivity of consultative bodies limits the opportunities to develop coherent policies integrating different types of players. Finally, the limited selection of policy priorities may curtail the critical mass needed to achieve excellence in international terms. All the three issues mentioned above may undermine the opportunities to improve knowledge exploitability.

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • The inclusion of research support measures and business investment incentives under the same Operational Programme opens new possibilities for policy convergence and inter-action • The development of cluster policies may contribute to enhance the cooperation between companies and Universities as well as to promote exploitability of research 	<ul style="list-style-type: none"> • Risk of dominance of a linear model approach, unable to capture the complexity and intertwining of knowledge creation and exploitation • Absence of a participatory process in setting research priorities limits the capacity to mobilize research and innovation systems actors in order to achieve excellence as well as increased exploitability • The passivity in making consultative councils work undermines the convergence of perspectives needed to improve exploitability

4.5 Summary of the role of the ERA dimension

There has been active involvement in the activities aiming at the development of the European research Area, with Portugal participating in 22 ERANETs and 11 “mirror groups” of the Technological Platforms (TPs). The sheer numbers of participations might be seen as a sign of success of the national involvement in ERA activities. But as expectable, the degree of participation varies among these different initiatives. All

together the Portuguese FCT has been involved in the establishment of 19 joint calls. From a technical perspective, this has had a very positive impact in developing collaborative habits of work with other national agencies. From the perspective of knowledge production, this involvement has stimulated the setting up of projects oriented towards specific research areas and organized under criteria diverse of those that have been used by traditional national programmes. As an additional benefit, the resources brought about by the calls have also allowed the establishment of transnational consortia working under more flexible regulations than those that exist under the FPs.

The FCT has also been representing the MCTES at the ESF. In this context Portugal has been involved in 12 EUROCORES programmes.

The involvement in the TPs and in the Joint-Technological Initiatives, which was covered with more detail in section 3.5 above, might result in the production of more oriented knowledge than the participation in both the ERA-NETs and EUROCORES schemes.

To conclude this section it must be pointed out that irrespectively of the type of initiative (ERA-NETs, EUROCORES, TPs, JTIs), the novelty of most of these participations and the absence of any publicly available evaluation do not allow yet for inferring much with regard to the “production” dimension.

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 sectors

Knowledge circulation has traditionally been one of the weakest links in the Portuguese science, technology and innovation system. The cooperative drive of the Portuguese society in general is low. Parochial interests often prevail over the concern to create the future in common. The problem is, of course, stronger in a field where the need for collaboration is not obvious, having in mind the different focus of activities, the different objectives of the main actors, and the insufficient awareness of the advantages to be gained from cooperation.

A look at R&D statistics time-series confirms the weak interactions between the different sectors, particularly between business enterprises, on the one hand, and the remaining groups (Higher education, government and non-profit organisations), on the other. The analysis of such statistics shows that the degree of self-financing by the business sector is very high, always above 90 per cent. The shares of HERD and GOVERD financed by business enterprises are consistently very low. Both have remained remarkably stable between 2001 and 2005, around levels of 2.0 per cent, for GOVERD, and 1.2 per cent, for HERD.

Portuguese Universities have traditionally been inward-looking. For a long time they envisaged teaching as their main concern. Research has come as a most recent priority. And collaboration with external entities has not been yet sufficiently integrated in their agendas. As mentioned above, the positive drive of the research system towards quality and performance has not been geared in a way to promote cooperation with the business sector. The incentives provided to academic faculty, including the statute of university's careers, do not stimulate interaction with business or government organisations. On the other hand, the dominance of traditional, supplier-dominated industries, and the weakness of companies' capabilities have not generated, as mentioned in section 3, a demand for cooperation from the industrial fabric.

Public policy throughout the last twenty years has been endeavouring to promote increased knowledge circulation and cooperation between the various players. A new generation of non-profit S&T 'bridging' organisations emerged in the 1980s and early 1990s as a result of the convergence of three factors: University recruitment constraints, opportunities to participate in European projects, and inducements provided by domestic policy. The PEDIP and the CIENCIA programme, part of the 1st CSF, enabled the creation of a host of S&T organisations envisaged as promoters of knowledge circulation. However, since the basic incentives for career mobility as well as demand conditions were largely untouched, the cooperation drive remained limited. As it will be pointed out below, a set of measures to entice University-Industry cooperation has been launched.

The organisational infrastructure to support knowledge circulation includes four main types of organisations: (1) Public Laboratories; (2) Science and Technology Parks and Poles; (3) Technology and Knowledge Transfer Offices (OTICs and GAPIs); and (4) Technological Centres.

Public Laboratories have traditionally been the key organisations to generate knowledge and to diffuse it throughout the business sector. These Laboratories have

had a dual role: producing and assimilating knowledge; and transferring it to companies. Some Laboratories, like LNEC, the National Laboratory for Civil Engineering, created in 1946, have a long and very positive record in fulfilling this dual role, thereby generating a very good reputation. Others have not been so successful in ensuring the coexistence of knowledge creation and diffusion. In the manufacturing industries field there was INETI, launched in the late 1970s to develop and transfer manufacturing technologies. For years this Laboratory has been a cornerstone of the design and implementation of technology policies in Portugal. Since the mid 1990s, an increasing need to redefine Public Laboratories' missions and to adapt these organisations to new challenges, increasing the level of recourses stemming from services to business firms, was felt. A period of uncertainty about the roles and relevance of Public Laboratories started. Each new Government disclosed the intention to restructure such Laboratories. Several reports on the issue were produced, but not implemented. Meanwhile, many Public Laboratories became increasingly weak: their reputation was at stake, short-term thinking and activities became prominent, and the median staff age increased since no new recruitments were allowed.

By 2002 there were 13 Public Laboratories. In late 2006, the long-awaited reform of Public Laboratories has been defined (Council of Ministers Resolution 124/ 2006). A new legal frame was established: the Laboratories became E.P.E.s, that is, public enterprise entities, no longer abiding to public service rules. It was decided to create two new Public Laboratories: LNEG, the National Laboratory for Energy and Geology; and INRB, the National Institute for Biological Resources. This integrates the former laboratories on agrarian research, fisheries and sea resources, and veterinary research. INETI, the laboratory for manufacturing engineering and technology, will be closed, and its activity areas transferred to other laboratories, namely to LNEG.

An important feature of the new frame for Public Laboratories is the launching of project-oriented public-private R&D consortia, lasting for at least 10 years, in the following fields: biology and biotechnology; physics; risk protection; oceanography; space research; and security. A mobilising programme for the development of public laboratories will also be launched.

Science and Technology (S&T) Parks and Poles are also expected to play an important role in knowledge circulation. The first S&T Parks were created only after E.U. accession: Taguspark in Lisbon, and the Oporto S&T Park, with three locations. Pervaded by conflicting, and sometimes parochial, interests, the latter has not been able to deliver its promises. The former has been more successful. An attracting environment was created, through the location of Universities and Research and Technology organisations, such as ISQ (Institute for Welding and Quality) which has been very active in international collaboration. Several large Banks established their information and communications departments there to profit from the park potential. Incubator facilities were also set up, and several new firms emerged and took their initial steps at Taguspark. After these two pioneer experiences, others were developed. By 2002-2003 a policy of creation of regional S&T Poles has been envisaged, but it did not materialised. It was ill-designed, since it would lead to an excessive dispersion of initiatives, most of them without the institutional basis and the critical mass to make a significant contribution. TECPARQUES is the umbrella organisation of Portuguese S&T Parks, which has at present twelve members.

To promote University-Industry technology transfer, a policy measure to support the creation of OTICs (Oficinas de Transferência de Tecnologia e Conhecimento) was established. OTICs have three main objectives: (1) to stimulate University-Industry collaboration through common projects for technology and knowledge transfer, (2) to identify and diffuse the scientific and technological offer of Universities and Polytechnic Universities; and (3) to sense technological demand from business firms that might lead to technology development projects carried out by Universities and Polytechnic Universities. The initiative has generated some enthusiasm, the majority of Universities and Technological Universities having established their OTICs. In addition to the OTIC network another parallel network has been established through the setting up of the GAPIs (Gabinetes de Apoio à Propriedade Industrial). A GAPI is a specialized office working in the context of a university, a business association or a technical centre with the specific mission of stimulating the taking up of industrial property. By patenting useful inventions universities may license their knowledge and achieve dissemination through new spin-offs.

Other important entities in the dissemination area have been the Technological Centres. While they define themselves as being at the center of the Universities – Enterprises – Public Administration triangle, they are in fact closer to companies than to Universities. Their main missions are the following: (1) to support companies to enhance their productivity, quality and innovativeness; and (2) to cooperate with the public administration in designing and implementing policies for the industries concerned as well as to diffuse good practices. Technological Centres are focussed on low- and medium-tech industries and provide services going from consultancy and technical assistance to support to the development of new products and processes. RECET is the association of Technological Centres. At present there are eight Technological Centres, relating to the following industries: metalomechanics; glass and chinaware; textiles and clothing, mould-making and plastics; ornamental rocks; footwear; cork, and leather. Created in 1986, Technological Centres have exhibited different performance patterns, the cases of footwear, mould-making and plastics, and textiles and footwear being the most positive.

The support to the development of University-Industry consortia to carry out collaborative pre-competitive or industrial research projects has long been an important thrust of Portuguese S&T and innovation policies. Until 2002 there were even 'competing' measures with this objective, launched by different ministries. The starting of the IDEIA programme, in late 2002 marks the emergence of a more cooperative attitude on this regard. IDEIA, the acronym for research and applied industrial development, was part of the third CSF, and therefore arrived to an end in December 2006. It has been replaced by a new programme with very similar objectives, entitled 'Co-promotion of RTD projects', Evaluations of University-Industry consortia programmes have underline their positive role in stimulating cooperation, but have not rated high the way they were managed (Godinho et alii, 2003; Augusto Mateus & Associados, 2003 and 2005; SPI, 2005).

Other policy measures addressed to the promotion of cooperation and knowledge circulation between universities, PROs and the business sector under the third CSF, which run between 2000 and 2006, were the following: (1) Measure for supporting the creation of new technology infrastructures and to support the present technology, training and quality infrastructures; (2) DEMTEC, the incentive system for undertaking pilot projects on innovative products and processes; (3) Doctoral grants in companies; (4) Centers of Excellence, addressed to the creation of consortia

involving different stakeholders (companies, research centres, technological centres, universities and polytechnic universities, and employers' associations) to set up networks to carry out projects with a high ICT content; and (5) SIME IC&T, to promote projects of industrial research or pre-competitive development, undertaken by companies, desirably in cooperation with S&T organisations.

5.1.2 Profiting from access to international knowledge

The Portuguese research system has a significant degree of internationalisation. For years, there has been a policy of encouraging doctoral studies abroad, and most PhDs have been obtained in foreign countries, namely the UK, the USA, and France. Nowadays, the domestic education system is already mature enough to grant such degrees, but a large host of most promising young students continue to go abroad to learn and enhance their capabilities. A share of knowledge production is also undertaken in the context of cooperative projects with foreign Universities and research centres, as a result of both the linkages established with hosting groups abroad where PhD studies were carried out and partnerships in European projects. Portugal has been actively engaged in the successive Framework Programmes.

With regard to the access to international knowledge by firms, four main types of mechanisms have been used: embodied technology imports; acquisition of disembodied technology, namely through licensing, foreign direct investment (FDI); and participation in international University-Industry partnerships. Having in mind the Portuguese economic structure, in which supplier-dominated traditional industries have a dominant share and domestic machinery and equipment manufacturers are scanty, imports of machinery and equipment have been the main instrument for technology acquisition and upgrading. The acquisition of disembodied technology has been less relevant. Licensing-in is less fashionable now, but earlier research on the topic has underlined that there was a need to stimulate licensing-in as an instrument for company technological modernisation (Simões, 1989). Portugal exhibited a positive Technological Balance of Payments for 2007, with the surplus stemming from a substantial increase in disembodied technology exports. The third mechanism has been FDI. Throughout Portuguese history, and particularly in the last half century, FDI has been among the main engines of knowledge acquisition and systemic change in Portugal's economic fabric. The international transfer of a bundle of technological, marketing and managerial knowledge (resultant to a large extent of research carried out abroad) has been a key process of knowledge circulation towards Portuguese firms. It has generated significant demonstration and learning effects.

The participation in international University-Industry partnerships has been encouraged by public policy. Support is provided to the participation of companies, namely SMEs, in the Framework Programme as well as in other collaborative initiatives, such as EUREKA. Portugal has been one of the most enthusiastic supporters and promoters of the EUREKA Asia and IBEROEKA (cooperation with Latin American countries) initiatives. Besides IBEROEKA, there is also a programme of scientific and technological cooperation with CYTED, the Iberoamerican programme of science and technology for development. Actions in this framework are organised in three main groups: thematic networks, coordination of research projects, and cross-cutting actions. In the field of cooperative research projects involving University-Industry consortia there is also a specific agreement with Spain, jointly managed by the Portuguese Innovation Agency and CDTI, from Spain.

There is a wide agreement that the involvement in international partnerships is essential for Portuguese players to become involved in international movements of knowledge production and circulation. There has been an effort by public administration to encourage this sort of involvement. The Government programme specifically defined international collaboration as a key tenet of R&D policy. One central vector of such policy is the strengthening of participation in the Framework Programme and involvement in European R&D organisations, namely the European Space Agency and CERN. A second vector corresponds to the programme, launched by the present Government, of cooperation with some American Universities (MIT, Carnegie-Mellon, and University of Texas at Austin). In the context of the internationalisation of the Portuguese scientific and technological system, another agreement has been established with Fraunhofer Gesellschaft. The headlines of such initiatives will be presented in section 5.3., related to recent policy changes.

There is a widespread agreement that international cooperation has played and is bound to play a very important role for Portugal to access 'frontier' knowledge, to improve networking, and to develop and modernise the domestic scientific, technological and innovation system. Such a basic agreement notwithstanding, several observers have expressed concerns about the cost-benefit balance of the cooperation programme with US universities.

5.1.3 Absorptive capacity of knowledge users

The insufficient absorptive capacity of the generality of Portuguese business firms has been mentioned at several points of this report. The need for structural change has been emphasised by analysts of Portugal's scientific, technological and innovation policy (Godinho & Simões, 2005). The above-mentioned insufficiencies only in part stem from industry characteristics, namely the low weight of knowledge and technology-intensive activities. It is also due to companies' weak in-house capabilities, under-skilled human resources, and managerial shortcomings. The creation of some intermediate organisations has been envisaged as a way to counter the weaknesses. However, it did not address the crux of the issue. Furthermore, the way how general investment incentives have been managed did not induce a real behavioural change and a qualitative change of in-house capabilities. Also, the incentives for the recruitment of Master and PhD degree holders by companies and S&T organisations, existing since the early nineties, were not able to provide a significant contribution to improve absorptive capacity, since they have been designed more to stimulate new jobs for those post-graduates than to strengthen firms' in-house competencies. In spite of a positive assessment (Godinho *et alii*, 2003), research on the issue has found that the company demand was weak and the higher degree holders' interests were not geared towards business careers.

More recently, some policy changes have been headed towards a more positive approach to enhance companies, namely SMEs, absorptive capacity. Three main initiatives in the last couple of years deserve a mention: INOV_JOVEM, NITECs and CITECs.

The first is a broad spectrum initiative, with a view to simultaneously address young graduates' employment problems and companies' skills weaknesses. It has been used as an important electoral flag by the Prime Minister Mr. José Sócrates. The objective was to place in SMEs one thousand young graduates on engineering,

sciences, design, economics, and management. It is still too early to assess the real degree of change introduced by this initiative. To our best knowledge, no independent evaluation has been carried out so far.

NITEC and CITEC are related, both addressing the creation of R&D units in companies. However, while the NITEC measure has been launched in 2003, the CITEC is fairly recent, being designed as a consequence of the success of the original NITEC initiative. The original NITEC programme was in force until 2006. Its main objective was to support the setting up of small R&D teams in companies, especially in SMEs. The rationale for this measure is double: (1) to improve companies absorptive capacity, having in mind the dual role of R&D activities as an instrument for both knowledge creation and technology absorption; and (2) to contribute to strengthen the relationships between companies and Universities and other S&T organisations. The only independent evaluation of NITEC took place at a too early a stage to be meaningful. There is, however a broad consensus that the initiative has had a positive contribution towards the improvement of companies R&D expenditures and absorptive capacity (Simões, 2008). The initiative has been selected by OECD and PRO-INNO TrendChart on innovation as “good practice” with potential for replication in other countries.

5.2 Assessment of strengths and weaknesses

Main strengths	Main weaknesses
<ul style="list-style-type: none"> • Commitment to foster the international research cooperation • Development of cluster initiatives, such as the Health Cluster Portugal • Increased knowledge demand from several companies, both domestic and foreign owned • Emergence of a new generation of skilled entrepreneurs, providing medium/long-term linkage opportunities 	<ul style="list-style-type: none"> • Weak cooperative tradition between the research and the business sector • Insufficient concern by the University sector with companies’ needs, given the systems of incentives which they have worked with • Weakness of diffusion oriented organisations (this problem has not been solved by the recent reorganisation of Public labs) • Shortage of interface entities with the capabilities and the commitment to ensure the circulation of knowledge among universities, PROs and the business sector • Insufficient absorptive capabilities of most business enterprises • Inability to fully exploit international cooperation, due to weak strategic intent

A summary of the main strengths and weaknesses in relation to knowledge circulation is provided in the table below. The main strengths revolve around the commitment to promote the openness of the system, drawing on international cooperation to enhance research capabilities and to have access to sophisticated knowledge. The emergence of bottom-up initiatives such as the Health Cluster Portugal may be also envisaged as strength, although its replication in other fields cannot be taken for granted. Meanwhile, there are signs of the development of a more proactive attitude towards University-Industry cooperation, with the emergence of knowledge-intensive start-ups that, together with the increasing knowledge demand by some established firms, contribute to stimulate knowledge circulation.

Unfortunately, however, the minuses are no less relevant. An ‘original’ weakness undermining knowledge circulation is the weak cooperative drive of the Portuguese

society. One of its expressions is the lack of a cooperative tradition between universities, PROs and business firms. This weakness is compounded by three other problems: (1) the insufficient attention granted by Universities to company needs, a feature somewhat reinforced by financing mechanisms and university career statutes; (2) the fragility of interface entities and the weakness of organisations orientated towards knowledge diffusion; and (3) the limited absorptive capabilities of business firms. An additional shortcoming seems to be the absence of a clear strategic intent behind the involvement in international research cooperation. All these weaknesses confirm the idea that the Portuguese research system is still at a pre-systemic stage.

5.3 Analysis of recent policy changes

As pointed out above, international R&D cooperation has been a central concern of the present government. It is argued that involvement in international collaboration is to play a key role to overcome “Portugal’s scientific and technological backwardness” (Plano Tecnológico, 2005: 25). To achieve this objective, a more committed involvement in European S&T policy and in European S&T organisations was defined. Although Portugal is not an ardent supporter of the European Institute of Technology, it adopted an attitude of moderate support.

The “programme of international partnerships in science, technology and higher education” was initiated in 2006, involving the cooperation with some leading US universities and with the *Fraunhofer Gesellschaft* as well. According to Gago and Heitor (2007:413), this programme has the objective of promoting the internationalisation of Portuguese institutions “to stimulate new knowledge and exploit new ideas in collaboration with companies and internationally renowned institutions”. The areas of incidence of these agreements were referred to in section 2.1 above. It is important to remark that, from the Portuguese side, a number of business partners are expected to be involved, a feature which is likely to enable a wider knowledge dissemination. The question is, whether such an involvement is strong enough and which measures will be taken to ensure the materialization of an effective process of knowledge circulation.

Alongside with these international collaboration initiatives, there were also policy developments with regard to the facilitation of knowledge circulation between universities, PROs and business as well as regarding the development of firms absorptive capacities. They came in the context of the new NSRF 2007-2013, and particularly under the Competitiveness Factors Operational Programme (CFOP).

On what knowledge circulation is concerned, the key policy change has been the launching of a clustering policy. Since the early 1990s, when Michael Porter conducted a study on Portugal’s competitiveness, the advantages of promoting clustering initiatives were voiced but no consistent policy was implemented on this regard. The main instrument of the new cluster policy is the ‘Competitiveness and Technology Poles’ (CTP). According to the corresponding regulation, CTPs are partnerships involving companies and support organizations – namely R&D, higher education and training organizations – sharing a common strategic vision, geared towards the development of high technology intensive and internationally-oriented projects. The CTPs are therefore likely to create a new collaborative environment, enhancing knowledge demand, production and circulation. The present initiative has generated significant expectations, being regarded as a central tool to promote

cooperation, joint projects, and knowledge creation and dissemination. Its success cannot, however, be taken for granted, since effective implementation will not be an easy task. Time will show whether the hopes will turn into reality.

Other initiatives taken in the context of the NSRF 2007-2013 and aimed at promoting knowledge circulation are the following: (1) *Mobilising Projects*, corresponding to partnerships between companies and S&T organizations to exploit S&T competencies with a view to enable a transfer of knowledge and the exploitation of R&D results by enterprises; (2) *Demonstration Projects*, with the objective of promoting the domestic or international diffusion of new products, processes or services stemming from successful R&D activities; (3) *Co-promotion R&D Projects*, similar to earlier measures like R&D consortia or IDEIA, to stimulate R&D partnerships between S&T organizations and companies; (4) Collective R&D, corresponding to R&D projects promoted by employers' associations and carried out by S&T organizations, selected on the basis of an application call, to respond to problems shared by a relevant group of companies, namely in the context of an industry or a CTP; and (5) RTD Voucher, granted to SMEs to purchase R&D services from an accredited S&T organization.

Turning now to initiatives geared towards the development of companies' in-house capabilities and absorptive capacity, there are two main types of actions. One, of broader nature, supports SMEs to enhance their skills in different fields, from product development and engineering to quality and the certification of research, development and innovation (IDI) management. The second is chiefly concerned with the creation of in-house R&D capabilities. Support is provided to the creation of NITECs and CITECS. The first correspond, as mentioned in section 5.1.3 above, to small teams fully dedicated to R&D activities in companies. The latter are R&D Centres with a permanent staff set up by companies which already have consistent R&D activities, with a view to carry out research lines outside the company's current fields. CITECS may be envisaged as a step further in relation to NITECs, and as a follow up of their successful development.

5.4 Assessment of policy opportunities and risks

The launch of the new NSRF provides significant opportunities to set up a more consistent and coordinated policy capable of enhancing knowledge circulation among the various players of the Portuguese scientific, technological and innovation system. In fact, the increased coordination between the initiatives carried out by the Ministries for Science, Technology and Higher Education, on the one hand, and the Ministry for the Economy and Innovation, on the other, opens opportunities to develop more systemic approaches needed to spur cooperation and knowledge circulation. This positive feature may be further strengthened by the commitment to a cluster policy. Cluster approaches, and namely the PCTs, may provide a more integrated frame to stimulate the interaction between knowledge demand, creation, and circulation. The use of R&D vouchers may further contribute to enable the interaction between R&D organisations and business firms, increasing the financing by companies. This may be furthered by the development of companies in-house R&D capabilities, which make the dialogue and the 'bridging' with R&D organisations easier.

This is not without risks, however. A long term vision to mobilise the efforts of key players has not been achieved. The non activation of the institutional mechanisms to promote the dialogue and the convergence of perspectives among policy makers,

academics and businessmen is not conducive to stimulate knowledge sharing initiatives. This is also related with the insufficient incentives to the circulation of skilled staff between universities, PROs and business firms. So, there is a high risk that the new, well-intentioned, policy instruments do not lead to a quantum leap in collaboration and knowledge circulation.

Main policy opportunities	Main policy-related risks
<ul style="list-style-type: none"> • The inclusion of research support measures and business investment incentives under the same Operational Programme opens new possibilities for policy convergence and inter-action • The development of cluster policies may contribute to enhance the cooperation between Universities and research organisations, on the one hand, and companies, on the other • The sustained policy commitment to promote company R&D units is expected to provide more opportunities for cooperation and knowledge sharing • The launch of R&D vouchers may entice a sustained demand for research services 	<ul style="list-style-type: none"> • A long term vision for mobilising efforts and promoting a convergence of the players towards common objectives has not been promoted • The envisaged mechanisms to generate dialogue and convergence of perspectives among policy makers, academics and businessmen are still to be activated • A committed policy towards promoting an intense circulation of highly skilled people between Universities and companies is still lacking • Although significant improvements have taken place, there is insufficient integration between research and innovation policy philosophies and instruments

5.5 Summary of the role of the ERA dimension

The fact that the initiatives towards the development of a European Research Area are quite recent means that no much studies or evaluations exist yet with regard to their impact on “circulation”. However, there are some aspects to be highlighted on this regard.

The instruments and the infrastructures which have been established or developed to stimulate the European Research Area (namely ERC, ERA-NETS, EUROCORES, TPs, JTI) together with the circulation of researchers) may have a differentiated impact across the different member states. Several observers have pointed out that there is an important risk of these instruments stimulating further the concentration of resources and dynamics of agglomeration which are favourable to the larger and geographically more central EU member countries. Nevertheless, by their very nature, these same instruments may have a critical potential in favouring the circulation of knowledge, as they allow for the integration of researchers and organizations from member states with different levels of research development. As the balance between these two opposing forces will be struck in the future will depend much on how the national policies and actors will be able to get involved and benefit from those new instruments.

The Portuguese authorities have shown interest and active involvement in this area. As a matter of fact, the Portuguese Presidency of the European Union in the 2nd semester of 2007 pushed in favour of the furthering of the Lisbon Agenda in the S&T field. In this context an important document was published, with a view to gain a new momentum in strengthening European R&D policy, by combining diversity and cooperation: the book *The Future of Science and Technology in Europe* (Gago, 2007). In this book the Portuguese Minister for Science, Technology and Higher

Education argues that the vision put forward by the Competitiveness Council “recognises the critical role played by science and technology in the development of knowledge-based economies and the increasingly difficult competition for highly qualified scientists, engineers and post-graduate students that the EU is facing at world level; and welcomes the initiatives by Member States in this respect to confer high priority to public investments in science and research, to stimulate higher levels of private investment in R&D and to encourage reforms and the internationalisation of higher education and public research systems”. (Gago, 2007: 12).

6 - Overall assessment and conclusions

6.1 Strengths and weaknesses of research system and governance

Academic research has advanced in scale and scope in recent decades in Portugal and there are indications that this trend will continue in the near future. However significant shortcomings exist in relation to adapting the supply of knowledge to not-yet-articulated societal demands and ensuring exploitability. Business firms have not been able to influence the country's research agenda. This reflects the economic structure (fragility of high tech and knowledge intensive sectors, small average size of firms) and the incapacity of firms to put forward their demands. Further public procurement has not been used as an instrument to link research to practical needs. This dualistic development reflects a lack of systemic integration between the main stakeholders. Such a lack of integration has jeopardised the intended dissemination of knowledge.

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	There have been several public statements at the government level in favour of increasing research funding. However there is no ample consensus – the Parliament, business associations and civil society in general are not committed to this issue
	Securing long term investment in research	Over the most recent decades public funding of science has been growing, including block-grant funding allowing for overall research system growth.
	Dealing with barriers to private R&D investment	Business sector has had a weak involvement in research financing. The growth of high tech and knowledge intensive sectors has been limited. However, the new structural programmes strengthened the incentives for business firms to set up R&D units and foster R&D activities together with other entities
	Providing qualified human resources	The number of PhDs and Post-Docs has been growing. Unemployment among researchers has been growing lately. The new research positions that have been created are of a short-medium term nature and there is apparently lack of permanent researcher positions compared to the numbers of PhDs and Post-Docs in the country.
Knowledge demand	Identifying the drivers of knowledge demand	Business firms, public procurement and other stakeholders have not been active in setting the agenda for research demand in the Portuguese research system. The growth of the scientific community and the quality of the research performed in many labs offers however opportunities for fruitful university-industry collaboration and the development of a spin-off research-based company sector.
	Co-ordination and channelling knowledge demands	Coordination mechanisms have been largely absent or non-operational
	Monitoring of demand fulfilment	No mechanisms of this type exist

Domain	Challenge	Assessment of strengths and weaknesses
Knowledge production	Ensuring quality and excellence of knowledge production	There has been a sustained effort towards increasing the quality of academic research. As part of this strategy the creation of Associate Laboratories has stimulated the quality of research while public labs have lost relevance and financial resources. The contracts established with US universities and the Fraunhofer Society aim at stimulating both basic and applied research. These objectives are also part of the recently launched Support System for Scientific and Technological Organization (SAESCTN), which is part of the NSRF 2007-2013. The partnerships established between FCT and both the Gulbenkian and Champallimaud foundations provide support for doctoral programmes in emerging scientific fields.
	Ensuring exploitability of knowledge	The concern with exploitability of research-based knowledge production has been very limited. Existing incentive systems (financing criteria, academic and scientific careers statutes) do not provide stimulus for exploitability, exacerbating the consequences of low demand for R&D by the Portuguese business sector. Some measures included in the new SAESCTN seem to be headed to counter this problem.
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	There is a weak tradition of university-industry collaboration. There have however been some positive signs recently, including the development of cluster policies and initiatives
	Profiting from international knowledge	There has been an active policy of pushing Portuguese researchers towards “internationalisation”, including the recent agreements with foreign universities and R&D organisations. However such policies concentrate mostly on purely academic activities.
	Enhancing absorptive capacity of knowledge users	The poor absorptive capacities of the majority of the Portuguese enterprises has not been fully addressed by corresponding policies strengthening the diffusion of knowledge. The existing diversity of intermediary entities has not been matched by a proper action. A positive feature is the intention to strengthen the support to firms so that they set up R&D facilities

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

The structure of the existing NSRF 2007-2013 has enhanced the opportunities for coordination. The government public pronouncements towards increasing funding for research also create a favourable climate in this regard. The intention of stimulating a cluster-based policy, the strengthening of incentives to create research units in business firms, and the granting of R&D and innovation vouchers so that firms may purchase research and technology services are all coherent with the central aim of the 7th Integrated Guideline for Growth and Jobs in Europe (European Commission, 2005). The main risks affecting a virtuous evolution stem from the lack of consensus among major stakeholders and from the difficulties in transforming the announced intentions into practical action. Significant risks may also arise from an excessive use of competitive funding and the provision of short to medium-term contracts to younger scientists. The absence of a consistent frame, namely in terms of careers’ statutes and university funding, may affect the system sustainable evolution and lead to brain-drain.

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	Government commitment and the provisions of the NSRF 2007-2013, together with the new Code of Public Contracts, might lead to a rise in publicly financed investment in research. New schemes for financing RTD under the NSRF have been established.	Lack of generalised consensus about research investment might jeopardise current priorities. Competitive funding increase and the incapacity to provide stable jobs may negatively impact on research system sustainability. There might be difficulties in overcoming the dependence on European structural funds for financing research.
Knowledge demand	The NSRF 2007-2013 may lead to a wider coordination scope between ministries. As consultative bodies have been inactive, there is scope for improving coordination. Establishment of cluster-based policies may stimulate knowledge demand. Initiatives such as COTEC and Health Cluster Portugal suggest an increased concern by private actors with research activities.	The focus on academic excellence <i>per se</i> might widen further the gap between research activities and societal needs. Also the persistence of public investment in large conventional infrastructure projects will not favour a dynamic public procurement policy
Knowledge production	The expected strengthening of public finance towards research shall keep scientific publication rising. In relation to applied knowledge and exploitability there is large scope for improvement. In particular the development of cluster policies may stimulate such development.	The persistence on a linear model approach will not may not promote an integrated, systemic development. The absence of clear S&T and research policy priorities and the passivity in making consultative councils work may limit the convergence of perspectives needed to improve exploitability.
Knowledge circulation	Besides the points mentioned above, the sustained commitment to promote company R&D units is expected to provide opportunities for knowledge sharing. The launch of innovation and R&D vouchers may entice a demand for research services.	Absence of stimulation of long term cooperation between different stakeholders, together with the inactivity of policy advisory mechanisms, may not facilitate the development of consensus and the dissemination of knowledge.

6.3 System and policy dynamics from the perspective of the ERA

Portuguese entities have been involved in a number of initiatives promoted with a view to advance the European Research Area (ERA). This stems from a view that an active participation in ERA might be relevant to contribute to overcome the country's backwardness. The Portuguese Presidency of the EU in the 2nd semester of 2007 has also pushed towards further developments of ERA, namely with the organization of the first Joint Technological Initiatives. At the same time there are critical voices asserting that the instruments brought about by the EU ERA policies may have a polarizing effect, benefiting the larger and geographically better positioned member states. These perceptions have progressively conducted to a positioning in which participation and involvement have been stimulated so that possible benefits might be captured while at the same time possible potential costs and disadvantages of this process are reduced. Altogether there has been an active involvement in 22 ERA-NETs and 11 "mirror groups" of the Technological Platforms, which may be considered as very significant numbers for a small country like Portugal. There have been initiatives towards promoting mobility of researchers. However, existing information points out to an uneven participation in these initiatives.

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List of Abbreviations

AdI	Portuguese Innovation Agency
BERD	Business Expenditure on Research and Development
CERN	CERN - European Laboratory for Particle Physics
CFOP	Competitive Factors Operational Programme, part of the Portuguese NSRF
CSF	Community Support Framework
CTPs	Competitiveness and Technology Poles
CTP	Competitiveness and Technology Pole
EMBO	European Molecular Biology Association
EPO	European Patent Office
ERA	European Research Area
ERA-NET	A scheme envisaging the coordination and cooperation of national and regional programmes in view to the establishment of ERA
ESA	European Space Agency
ESF	European Science Foundation
ESO	European Southern Observatory
ESRF	European Synchrotron Radiation Facility

EU	European Union
EUROCORES	European Collaborative Research, a scheme offered by ESF
FCT	Foundation for Science and Technology, part of the Portuguese MCTES structure
FDI	Foreign Direct Investment
GM-products	Genetically modified products
GDP	Gross Domestic Product
GPEARI	Planning, strategy, evaluation and international relations unit of the Portuguese MCTES (Gabinete de Planeamento, Estratégia, Avaliação e Relações Internacionais, Ministério da Ciência, Tecnologia e Ensino Superior)
GERD	Gross Expenditure on Research and Development
GOVERD	Government Expenditure on Research and Development
GRICES	former international relations unit of MCTES, now part of GPEARI
HERD	Higher Education Expenditure on Research and Development
ICT	Information and Telecommunications Technologies
JTI	Joint Technological Initiatives
JRC-IPTS	Joint Research Centre – Institute for Prospective and Technological Studies
MCTES	Portuguese Ministry for Science, Technology and Higher Education
NGO	Non-governmental organisation
NSRF	National Strategic Reference Framework
OCES	Former observatory of science, technology and higher education, now part of GEPEARI
PRO	Public research organisation
R&D	Research and Development
SAESCTN	Support System for Scientific and Technological Organisations under the NSRF
SME	Small and Medium Enterprise
TP	Technological Platforms

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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 Portugal.

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