

POLICY QUESTIONNAIRE FOR THE STI OUTLOOK

PORTUGAL

Section A: General framework and trends in science, technology and innovation policy

1. Please provide a brief overview of the main directions, objectives and elements of national policies for science, technology and innovation, highlighting the following topics:

- Main features of recent science, technology and innovation policy developments (*e.g.*, including new innovation strategies) and the rationale behind them:
- Major changes in the legislative, administrative, organisational, institutional or budgetary framework for the formulation and implementation of science, technology and innovation policies (*e.g.*, new Ministerial structures, better inter-Ministerial coordination, and increased involvement of non-governmental stakeholders).
- New policy measures to foster increased innovation and productivity growth in the service sector (both services in general and specific service-sector, finance, etc.).

In February 2005 a majority (socialist) Government was elected and the Ministry of Science, Technology and Higher Education established. The challenges facing the current Government include the need to strengthen S&T, at the same time as the higher education system is promoted at a European level, making use of internationally-based quality reference terms. In accordance with the government programme, the objectives are to:

- Increase the number of researchers in Portugal.
- Increase investment in R&D in both the public and private sectors, stimulating scientific jobs in both sectors.
- Minimize and prevent risks to the public and to the security of the country, reinforcing the regulatory and monitoring institutions.
- Consolidate scientific and technological culture.

These objectives are set into specific targets in the Government Programme for the current legislative period: These are:

- Produce a **growth of 50% in human resources and R&D** and in internationally recognized scientific production.
- **Increase the number of new PhDs per year in Portugal and abroad from about 1000 to 1500;**
- **Triple private efforts in private R&D** (which comes to no more than 0.26% of GDP today), creating conditions for the stimulus needed;

- **Double public investment in R&D to achieve 1% of GDP** (which is about 0.6% of GDP today);
- Promote the creation and progressive competitive filling of **1000 additional R&D posts within the State**, to compensate for the cutting of the required number of less qualified posts in other sectors of public administration;

Further structural actions are expected in the following areas:

- Reinforce infra-structural aspects, including the support to libraries and the widespread electronic access to documentation centers, and fast and efficient access to the Internet.
- Intensify the technical and administrative support, that continued to be particularly below the European average when analyzed in terms of the personnel per researcher (respectively, 3.9 and 9.5 for every thousand inhabitants), but also because of its reduced quality in most cases.
- Complement the current lines of public R&D funding with thematic programs of multi-disciplinary nature, to be naturally associated with national priorities, namely with reference to the enormous public investments of coming years (*e.g.*, information society, telecommunications, transports, as well as public risks). It is important to note the structuring nature that these types of programs can have, namely to promote the connection of the scientific community to the civil society.
- Facilitate the scientific activity within knowledge integrated communities and networks that stimulate the institutional relationship, not only between academic centers, but also between these centers and other actors, namely State Laboratories, secondary schools and companies. The valorization of those scientific-based networks, in addition to decreasing the effects related with the reduced dimension of the units, should certainly promote the creation and diffusion of new knowledge, motivating the scientific development in a context of continuous change and growing internationalization of the scientific base.
- Privilege the national and international mobility of researchers, primarily valuing the European area and in a context of effective need to promote the internationalization of the research community.
- Implement coherent protective measures of intellectual property as a way to promote scientific impact, in addition to preserve its institutional integrity, in a context of growing importance of innovation as a critical factor of economic development.
- Develop own competences at the level of the technology management, in addition to the reinforcement of strategies that promote links with companies and the release of new technological-based companies.

Furthermore, the need to foster institutional cooperation initiatives at the national and international level, in particular as a way to promote scientific activity in networks establishing institutional relationships, is underway. International partnerships have begun with top ranking universities in a number of scientific fields. The enhancement of international scientific-based networks, besides softening the effects related to the small size of units should promote knowledge creation and diffusion, fostering scientific development in a context of constant change and growing internationalization of the scientific base. These partnerships seek to promote and boost science-industry links as well.

The strengthening of science and technology institutions, such as that carried out in the period 1998-2001 with the creation of “Associated Laboratories”, involves the sustainability of incentive programs and the continuous implementation of independent scientific evaluation models. This process will be continued under the current Government, based on peer evaluation.

During the first year in office there was a budget increase of 17% regarding the initial proposed budget for 2005 in the area of science and technology. It should be highlighted that 965 new grants were attributed for graduate training, 1237 new research projects were financed, and 77 new projects attributed for scientific equipment.

2. Please describe major shifts or changes in the priority given to different areas of science, technology and innovation policy listed below or the policy instruments used to achieve them: 1) strengthening the science system; 2) supporting business innovation; 3) linking science to innovation; 4) developing human resources for S&T; and 5) establishing framework conditions that are conducive to innovation (e.g., IPR regimes).

To foster innovation we need to promote more knowledge and innovation, and more scientific culture. These priorities are expressed in the government programme, the *technological plan*, an ambitious and demanding programme for technological and scientific development, and for progress in education, training and innovation. The *technological plan* is a real social contract for the modernisation and growth of the country. The plan considers not just the science practised in the laboratories and universities but the technology being developed and adapted in innovatory companies.

In accordance with the government programme, the objectives for this legislature include:

- To stimulate innovation.
- To increase the number of researchers in Portugal.
- To increase investment in R&D in both the public and private sectors, stimulating scientific jobs in both sectors.
- To consolidate scientific and technological culture.

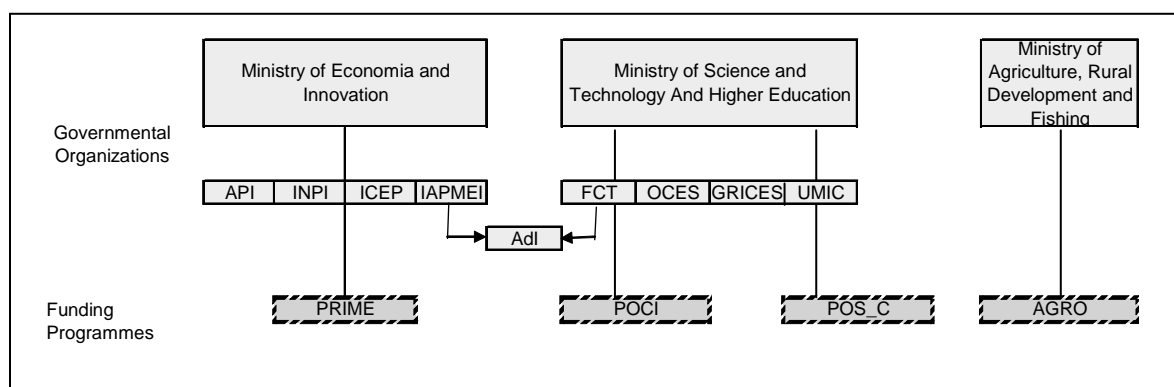
For these results to be achieved, during the current legislature it will be necessary to:

- Stimulate conditions for the development of R&D in companies and partnerships between companies and research institutions within the national and international framework.
- Stimulate and accompany the incorporation of R&D in investments and projects of public interest.
- Stimulate the creation of qualified jobs in S&T in the private and public sectors.
- Reinforce the conditions of independence and transparency of the international scientific assessment of institutions, projects and individual careers.
- Clarify the objectives of the State Laboratories and guarantee their autonomy within the framework of reform and rejuvenation.
- Establish public service contracts with the network of Associated Laboratories, to organise scientific and technical capacities to promote new public policy and the prevention of great risks to the public.
- Promote thematic science and technology networks, co-ordinating institutions of science and technology and research centres around new challenges and opportunities for the development of Portugal within Europe.
- Systematically reinforce conditions for scientific research by teachers and students in higher education. R&D activities would also be promoted in Polytechnic Institutes, in co-ordination with opportunities for economic development and public policy at regional or national level.
- Make experimental practice in science subjects in Basic and Secondary Education compulsory.

- Reinforce the Agência Ciência Viva [Live Science Agency] as a non-governmental institution of international excellence, capable of mobilising the efforts of scientists, teachers and pupils, local authorities and companies, to promote scientific and technological culture.
- Reinforce full participation in international scientific organisations and in the drawing up of policy for science and technology within the European Union, and promote the participation of national companies and research centres in international R&D programmes.
- Promote R&D oriented programmes to support sectoral public policy with inter-ministerial co-operation.
- Make viable the creation of new technology-based companies, making adjustments in the existing programmes and making the most of the opportunities brought by the SIFIDE – Sistema de Incentivos Fiscais em Investigação e Desenvolvimento Empresarial.

The following figure shows a brief diagram of major public institutions with instruments fostering innovation.

Main Governmental Organizations and Funding Programmes to Promote Innovation



List of Acronyms:

- AdI Innovation Agency
- AGRO Operational Program for Agriculture and Rural Development
- API Portuguese Agency for Investment
- FCT Foundation for Science and Technology
- GRICES Office for International Relations in Science and Higher Education
- IAPMEI Agency for Support and Investment for Small and Medium Enterprises
- ICEP Portuguese Institute for International Trade
- INPI National Institute of Industrial Property
- OCES Observatory of Science and Higher Education
- POCI Operational Program for Science and Innovation – 2010
- POS_C Operational Program for the Information Society
- PRIME Incentive Program for the Modernization of the Economy

Many of the policy initiatives are listed in the previous question. The Government has also defined general policy objectives to which include:

- Triple private efforts in entrepreneurial R&D (which comes to no more than 0.26% of GDP today), creating conditions for the stimulus needed.
- Double public investment in R&D to achieve 1% of GDP (which is about 0.6% of GDP today).
- Promote the creation and progressive competitive filling of 1000 additional R&D posts within the State, to compensate for the cutting of the required number of less qualified posts in other sectors of public administration.
- Triple the number of patents registered.

For these results to be achieved, during the legislature it will be particularly necessary to:

- Stimulate conditions for the development of R&D in companies and partnerships between companies and research institutions within the national and international framework.
- Stimulate and accompany the incorporation of R&D in investments and projects of public interest.
- Establish public service contracts with the network of Associated Laboratories, to organise scientific and technical capacities to promote new public policy and the prevention of great risks to the public.
- Promote thematic science and technology networks, co-ordinating institutions of science and technology and research centres around new challenges and opportunities for the development of Portugal within Europe.

3. Please describe the primary challenges that are expected to be addressed in future science, technology and innovation policy initiatives and/or that have been identified in forward-looking exercises, such as foresight and technology road mapping (i.e., in the 2007-08 time frame).

The primary challenges have already been addressed in the answers to question 1 and 2 in this section.

Section B: Public sector research and public research organisations

1. Please describe major policy changes related to the financing of public R&D, to include the following:

- Changes in overall levels of R&D funding for public research organisations during last few years.

If funding data is available, please provide it below:

Public R&D funding of the Intramural public R&D expenditure

Year	2003	2004	2005	2006(forecast)	2007(forecast)
R&D funding (Unit: M €)	652,5	n.a.	n.a.	n.a.	n.a.

Note: Public R&D funding of the Intramural public R&D expenditure (Government, Higher Education and Private Non Profit (PNP))

Source: OCES, National R&D Survey 2003.

Government Budget Appropriations or Outlays for R&D

Year	2003	2004	2005	2006	2007(forecast)
R&D funding (Unit: M €)	847,0	915,5	960,3 ^P	n.a.	n.a.

Note: Government Budget Appropriations or Outlays for R&D

Source: OCES, GBAORD.

Shifts in the allocation of funding across the following areas (please provide quantitative information if available):

1) different types of public research organisations (*e.g.* universities vs. government research institutions)

Intramural public R&D expenditure by source of funds in the years 1999, 2001 and 2003

Unit: M€

	Government Funds			Higher Education Funds			Private non-profit Funds			Public Funds from Abroad		
	1999	2001	2003	1999	2001	2003	1999	2001	2003	1999	2001	2003
Government Laboratories	119,5	139,3	99,0	-	-	-	0,6	0,1	0,6	4,5	4,3	4,7
Higher Education ¹	278,3	342,8	351,4	8,4	8,8	12,9	10,3	5,0	6,0	8,4	15,9	11,9

Note: ¹ All public and private universities are included.

Source: OCES, National R&D Survey.

2) different socio-economic objectives (*e.g.* general advancement of knowledge, health, national security, environment, energy)

Response:

Intramural public R&D expenditure by socio-economic objectives - 1999, 2001 and 2003

Unit: M€

Socio-Economic Objectives	Public R&D Expenditure		
	1999	2001	2003
Exploration and exploitation of the Earth	16,6	18,7	16,4
Infrastructure and general planning of land use	62,9	49,8	42,5
Control and care of the environment	45,4	45,3	41,0
Protection and improvement of human health	68,5	79,7	76,7
Production, distribution and rational utilisation of energy	7,6	11,4	8,9
Agricultural production and technology	103,8	113,6	96,3
Industrial production and technology	72,1	88,3	85,2
Social structures and relationships	54,1	62,7	63,9
Exploration and exploitation of space	3,1	3,6	2,3
Research financed from General University Funds (GUF)	-	-	-
Non-oriented research	155,8	190,0	204,2
Other civil research	13,1	9,8	11,0
Defence	3,7	9,1	4,0
TOTAL	606,8	682,2	652,5

Note : Public R&D funding of the Intramural Public R&D expenditure (Government, Higher Education - HE and Private Non Profit - PNP). In the HE the private universities were considered (representing 4% in 1999, 5% in 2001 and 6% in 2003 of the total HERD); in the PNP, the private institutions were considered (representing 9% in 1999, 14% in 2001 and 12% in 2003 of the total PNERD).

Source : OCES, National R&D Survey.

GBAORD

GOVERNMENT BUDGET APPROPRIATIONS OR OUTLAYS FOR R&D BY SOCIO-ECONOMIC OBJECTIVE

UNIT: MILLION NATIONAL CURRENCY (for the euro area, pre-EMU euro and EUR)

COUNTRY : PORTUGAL	2001	2002	2003	2004	2005	
1. Exploration and exploitation of the Earth	15,6	17,5	15,4	15,7	17,2	p
2. Infrastructure and general planning of land use	40,7	45,7	40,3	43,7	48,1	p
3. Control and care of the environment	28,5	31,9	28,2	34,2	37,5	p
4. Protection and improvement of human health	62,7	70,4	62,0	73,9	81,3	p
5. Production, distribution and rational utilisation of energy	10,5	11,8	10,4	8,4	9,3	p
6. Agricultural production and technology	102,2	116,1	101,7	108,2	105,8	p
7. Industrial production and technology	91,0	156,7	144,8	152,6	161,8	p
8. Social structures and relationships	31,7	35,6	31,4	32,9	36,2	p
9. Exploration and exploitation of space	3,9	4,3	3,8	2,0	2,2	p
10. Research financed from General University Funds (GUF)	277,0	283,7	295,1	302,5	307,0	p
11. Non-oriented research	81,6	91,6	80,8	100,5	110,5	p
12. Other civil research	16,3	18,3	16,1	33,0	36,3	p
13. Defence	16,1	17,2	16,9	7,5	6,8	p
14. TOTAL	777,8	900,8	847,0	915,5	960,3	p

Note: Breakdown by socio-economic objectives is an estimation

Source: OCES, GBAORD.

3) different fields of science and technology (e.g. information and communications technology, biotechnology, and nanotechnology.)

Intramural public R&D expenditure by Fields of Science - 1999, 2001 and 2003

Unit: M€

Fields of Science	Public R&D Expenditure		
	1999	2001	2003
NATURAL SCIENCES	166,4	202,2	196,4
ENGINEERING AND TECHNOLOGY	160,0	166,5	142,1
MEDICAL SCIENCES	63,8	66,9	71,2
AGRICULTURAL SCIENCES	81,2	85,0	76,6
SOCIAL SCIENCES AND HUMANITIES	135,4	161,7	166,2
TOTAL	606,8	682,2	652,5

Note: Public R&D funding of the Intramural Public R&D expenditure (Government, Higher Education - HE and Private Non Profit - PNP). In the HE the private universities were considered (representing 4% in 1999, 5% in 2001 and 6% in 2003 of the total HERD); in the PNP, the private institutions were considered (representing 9% in 1999, 14% in 2001 and 12% in 2003 of the total PNERD).

Source: OCES, National R&D Survey.

2. Please describe major initiatives to reform the organisation and governance of universities and other public research organisations to improve the quality of their R&D or their ability to contribute to economic growth and social objectives. Please consider reforms such as:

- Initiatives to increase the flexibility and/or accountability of universities and other public research organisations (e.g. granting more autonomy, performance measurement systems or stronger evaluation, new funding structures).
- New organisational structures for performing R&D, such as larger-scale research teams, centres of excellence, multi-disciplinary research centres, research networks, etc.
- Revised procedures for setting research priorities at the institutional level in universities and public research organisations (e.g. involvement of outside stakeholders):
- Reformed rules governing ownership and licensing of publicly-funded research results, support for technology licensing, etc., whether or not these measures are focused on a specific type of IPR (patents, copyright, etc.) or certain technological fields:

The government's main objective for higher education during the present legislature is to contribute towards the country's scientific and technological development and to fulfill the urgent need to guarantee that new generations are qualified for the requirements of the European area, guaranteeing the full integration and qualification of national institutions of higher education in the European higher education area. The challenges for Portugal include improving **access to higher education** and creating the conditions for enabling **every** citizen to gain access to life-long learning, and developing the role of the institutions of higher education in this process. In this context, the main objectives of the Government for the 2005-2009 include:

- Implementing the Bologna European process for the reform of higher education, which is an opportunity to stimulate entry into higher education, improve the quality and relevance of the training provided, and to encourage mobility and internationalization.

- Reinforcing a system of higher education with autonomous institutions, facilitating the reform of the way these institutions are governed in order to develop a culture of accountability and to make forms of organization and management more flexible, promoting the de-governmentalisation of the system and valuing partnerships between national and foreign institutions.
- Promoting the quality of the system, valuing the need to work with various types of public, which would require the structuring of an internationally recognized quality assurance system, developing the present model of assessment and financing and developing a national system of accreditation.
- Promoting equal opportunities for access to higher education, improving attendance and completion of courses in higher education, attracting new types of public, in the logic of life-long learning and the improvement of social action in schools.

For these objectives to be achieved, it will be necessary to:

- Give priority to the **consolidation** and re-organization of the system of higher education, avoiding further expansion of infrastructures without a serious **critical review of the existing physical capacity**.
- Promote the independent, transparent and rigorous **assessment** of the public and private, university and polytechnic systems of higher education, working with international standards (namely as set by OECD), to permit the necessary stream-lining and re-organization of the present system in the light of the challenges in the future;
- Stimulate the **diversity and flexibility** of the system of higher education, particularly in terms of specialization and institutional performance and guaranteeing a closer relationship between the university and polytechnic sub-systems, valuing excellence in both;
- Create and develop a system of **accreditation** for all of higher education according to international standards which, together with the progressive internationalization of the present system of assessment, may contribute to internationalizing our education system and improving the regulation of the system to benefit public interest, clarifying the role of the State in relation to the institutions;
- **Clarify the public funding** system of the institutions of higher education, guaranteeing the full implementation of a financing formula which will guarantee stability in the institutions and be an element of trust between the institutions and the State;
- Review both the laws regulating the **autonomy** of the universities and polytechnics and those regulating academic careers, in order to adapt the objectives of higher education to the European area.

Consequently, the government has initiated several projects to put into practice an overall evaluation of the higher education system: first, a system evaluation is being carried out by the OECD in 2006; second, an assessment of accreditation and evaluation practices has been commissioned to the European Network for Quality Assessment (ENQA); third, a voluntary system of institutional evaluations has been commissioned from the European University Association. The reorganisation of the higher education system is underway as these on-going international studies become available.

The December 2005 the Government also took steps to define the procedure and the timelines for the reform the State Laboratories in a joint course of action involving the respective ministry of each State Lab and the Ministry of Science, Technology and Higher Education. An international evaluation team has been appointed and will present recommendations for reform in May of this year.

3. Please identify major shifts or changes in priority among the approaches for strengthening public sector research, including efforts to: i) increase level of funding; ii) alter the structure of funding (e.g. institutional vs. project-based funding; public vs. private-sector funding), iii) reform the governance of public research organisations, iv) implement new structures for performing research (e.g., centres of excellence, multi-disciplinary centres), v) changing guidelines for ownership and management of IPR, and vi) implementing new evaluation procedures).

The Ministry of Science, Technology and Higher Education has identified the following initiatives studied to accomplish over the next two years:

- Reinforcing a system of higher education with autonomous institutions, facilitating the reform of the system governing institutions, making use of the following lines of action.
- Promoting conditions for the development of a logic of a system of higher education recognised internationally, improving the co-operation between institutions with different objectives and diversified functions and promoting their autonomy.
- Promoting the review of the laws regulating the autonomy of the universities and polytechnics within this new framework of assessment and accreditation.
- Reviewing the laws regulating academic careers, stimulating the entry of more qualified human resources, gathering diversified profiles for teachers, stimulating good performance in every dimension of the teaching profession and facilitating mobility between different profiles and institutions, between teaching and research careers and between academic careers and professional activities outside teaching.
- Optimising the regulation of the system of higher education and promoting a national quality assurance system, making use of the following lines of action.
- Giving priority to the reorganisation and consolidation of the system of higher education.
- Promoting the independent, transparent and rigorous assessment of the public and private, university and polytechnic systems of higher education, working with international standards to permit the necessary stream-lining and re-organisation of the present system in the light of challenges in the future.
- Creating a national accreditation agency and stimulating a national system for guaranteeing the quality of higher education, recognised internationally, which covers all of its institutions.
- Extending the assessment to the performance of institutions, focusing on criteria for assessment and clarifying the consequences of the assessment, both for the functioning of courses and schools, and for their financing, and guaranteeing the internationalisation of the assessment process, in the dimension of institutional assessment.
- Promoting the implementation by universities and polytechnics of their own systems for certified quality assurance.
- Clarifying the system of public financing for higher education, guaranteeing the full implementation of a formula of financing which ensures stability in the institutions and an element of trust between the institutions and the State.
- Promote access and equal opportunities, and the following lines of action should be considered.
- Admitting more working students, respecting their specific situations, and permitting them to sign of contracts with the schools for part-time study.
- Involving the institutions of higher education in the expansion of post-secondary secondary education, in the double perspective of co-operation between the secondary and higher levels of

education and accreditation, for the purposes of higher studies, from the training received in courses of post-graduate specialisation.

- Substituting ad-hoc examinations by more appropriate admission systems for adults, particularly through the recognition and accreditation of acquired competencies.
- Improving the efficiency of the system of social action, assessing the equity of its concrete procedures and dealing more closely with possible cases of exclusion.

The major shifts or changes involve the consolidation and growth of Portuguese science, technology and innovation in the European Research and Higher Education Area. This involves attributing priority and support for diversified research units, most of them with internationally recognised scientific quality. This also requires a considerable increase in qualified human resources and the rationalisation and reorganisation of the higher education sector. Institutional partnerships have been started at the international level with higher education institutions such as between universities to promote education, research and technology commercialization initiatives, which should be implemented in a way to extend the enterprise value chain in mature and emerging sectors by facilitating strategies for improving competence and capability.

The Government has defined the following as main policy actions:

- Giving priority to the reorganisation and consolidation of the system of higher education.
- Promoting the independent, transparent and rigorous assessment of the public and private, university and polytechnic systems of higher education (namely in close collaboration with OECD, with ENQA and with EAU), working with international standards to permit the necessary stream-lining and re-organisation of the present system in the light of challenges in the future.
- Clarifying the system of public financing for higher education, guaranteeing the full implementation of a funding methodology ensuring stability in the institutions and an element of trust between the institutions and the State.
- Improving the efficiency of the system of social action, assessing the equity of its concrete procedures and dealing more closely with possible cases of exclusion.
- Complementing current social support systems for students with a new system of public loans to students.

The Ministry of Science, Technology and Higher Education has defined a **new funding system** for higher education, approved with the 2006 budget, which includes two main quality factors, namely:

- **Qualification of teaching staff**, as measured by the fraction of PhD's in the total number of teachers of each institution.
- **Graduation rate**, as measured based on two indicators:
 - The number of graduates in terms of the first cycle.
 - The number of master and PhD degrees awarded.

In addition, the formula includes the following two institutional factors to answer to specific characteristics of each individual institution and training area:

- **Average personal cost for each institution**, to account for the specific characteristics of the teaching and non-teaching staff of each institution

- **Specific student/teacher ratio for each scientific area.**

First, the funding formula favours higher education institutions that show better teaching performance as measured by the number of students finishing with a bachelor's degree (universities or polytechnics) and by the number of masters and PhD degrees awarded in universities. Second, the formula rewards institutions which are hiring more qualified teachers. In general, the new policy is aimed to clarify the system of public financing for higher education, guaranteeing the full implementation of a funding methodology which ensures stability in the institutions and an element of trust between the institutions and the State.

4. Please describe any new or recent changes in policies adopted by government, public research funding bodies or public research institutions to improve access to data resulting from publicly funded research.

The main options for policy and lines of action in the area of the information society consist of widening the scope of State intervention and mobilising a social support base extended to every citizen, to state-run and private schools, and to companies and associations. It will be necessary to diversify public investment, directing it towards consolidating or reinforcing some current initiatives which have a great probability of success (*e.g.*, electronic transactions, digital cities and regions, digital content, university campuses), remedy shortcomings (*e.g.* access to the Internet in the schools; the sharing of democratic electronic knowledge) and promote the innovation and creation of new businesses in areas of strategic development (particularly in P2P *ad-hoc* networks, in distributed computation and the visualisation of information). The present distance between Portugal and the more developed countries may be significantly reduced if investments are re-orientated towards initiatives with a greater impact on the daily life of the Portuguese people, facilitating access to knowledge and experience of utilisation.

Opening the public telecommunications markets and guaranteeing the independence of the sector's regulatory entity are priority conditions for stimulating competition and permitting a more rapid and sustained development in this domain. However, options for policy also have to include actions to develop competencies, to stimulate employment and encourage the social appropriation of information and communication.

In this sense, political initiatives and lines of action to be implemented in the 2005-2006 period include:

- Continuously supporting city projects and digital regions, transforming them from a group of local and regional projects into a new dimension, "Digital Portugal", based on challenges common to the present digital cities and regions or those developing, particularly in applications with strong network economies, such as the inter-modal functioning of transport or tele-medicine.
- Stimulating the open development of the inter-municipal network with a connection with other public institutions, including schools, hospitals and local administration services, to demonstrate advanced services based on information as a way to stimulate demand for the same.
- Promoting greater competition for the supply of DSL and cable, to make broad band available to the final user under better conditions, and exploring complementary or alternative technology for wireless access and possibly the electricity network, by de-regulating the necessary spectrum and interconnection access.
- Regulating and clarifying electronic transactions, promoting their general use, and appropriately completing the legal provisions regulating electronic commerce.
- Assuring the general use of information and communication system in public administration and the public health services, guaranteeing the availability of totally interactive services with the

citizens, and integrated into the principle of the "one-stop shop" for the relationship of the State with citizens and companies, and with a fully functioning common citizen's charter.

- Developing a tele-medicine network (consultation, diagnosis and distance monitoring) on the broad band network of digital cities and regions, with special emphasis on connection to remote regions.
- Reinforcing digital projects, launching national initiatives in emerging domains (i.e., musical, artistic, animation) on new distribution platforms and with systems adapted to new reading equipment.
- Stimulating the development of *virtual campuses* in institutions of higher education, promoting the general involvement of teachers and pupils, and the development of tools for distant collaboration and bilingual education to encourage networking between national and international institutions.
- Promoting access to and the use of the Internet in all state-run and private basic and secondary schools, facilitating the training and general involvement of teachers and the development of content extended to every subject, particularly those beyond the technological areas, and promoting the general use of digitally supported activity portfolios.
- Developing the dissemination of tools for computer processing of the Portuguese language in public and private partnerships.
- Promoting the development and use of ICT for citizens with special needs.
- Reinforcing the dissemination of good practice and the system for monitoring the progress achieved in the social use of information and communication technologies in Portugal, and specifically for the international benchmarking required by the Lisbon Strategy, promoting the development and use of tools to extract, transform and visualise information.
- Promoting the independent, regular and transparent assessment of the information systems of administration and public services, particularly of the education and health systems, in order to improve them from the point of view of the user.
- Increasing the sharing of knowledge and adopting creative commons licences, to regulate the free circulation of authors' documents and texts.
- Promoting non-owned, *open sources*, operating systems whenever appropriate, combating fraud and reinforcing the privacy, security and reliability of the information and communication systems in public administration and in SMEs.
- Promoting the innovation and creation of new activities in areas of strategic development, particularly in distributed computation (GRID).

5. Looking to the future, what are the main challenges that the science system is expected to face and the main issues that policy makers will need to address? What future actions are anticipated?

These are challenging times for Portugal. Keeping the industrial status-quo, still heavily geared around a strategy of low-cost production, is not a sustainable option in the face of increasing global competition. Industry must transform and new and qualified employment must be promoted. Fortunately, the evidence provided by a range of emerging technology-based firms created in the mid 1990`s is demonstrating the usefulness of prior investments in the science base. But more progress is needed. This requires Portugal to learn from international experience and to be engaged with international leaders in

innovation systems and organizational transformation. National challenges are attracting international interest.

The performance of the Portuguese economy is a complex and multifaceted challenge. It is clear that fostering the science base and the growth of emerging technology based firms, as well as breaking the overall cycle of low productivity/low innovation is beyond the power of any single entity. Still, a focused initiative, building on the reputation and accomplishments of leading institutions worldwide in conjunction with Portuguese university, research centres and firms could go a long way in meeting three important challenges. First, there is a gap in qualified people and a relative small critical mass of scientific institutions and of innovative enterprises, which exhibit difficult access to new and dynamic markets. Second, there is a gap in understanding about the specific problems, and possible solutions, that affect the performance of the Portuguese economy. Third, there is a gap in the number and effectiveness of concrete initiatives devoted to taking steps to improve the current situation.

It is recognized that any development strategy for Portugal must be understood and enacted in a context of the country in an increasingly open and interconnected world. Several currently distinct disciplines must join efforts to provide new solutions to mobilize people, knowledge and ideas to help to catalyse the strong progress in different areas such as, for example, in engineering applications and management skills needed to secure Portugal's future.

Thus different programs need to be proposed to promote and develop new technological competencies to increase Portuguese innovative capacity. This will be accomplished through the development of research, education and technology commercialization initiatives, which should be implemented in a way to extend the enterprise value chain in mature and emerging sectors by facilitating strategies for improving competence and capability in two key areas for delivering innovation, namely: a) the new product development practices and related processes of larger, established enterprises and firms; and b) high technology entrepreneurship. In addition, the research programs should encompass activities oriented towards the public understanding of science and the social appropriation of the knowledge generated.

To that effect, the government has taken specific measures such as reintroducing the National Program for Teaching Experimental Science in Schools ("Concurso Nacional de Projectos para o Ensino Experimental das Ciências nas Escolas"), promoted summer activities in science, and establishing new science centers throughout the country, all initiatives of the Ciência Viva Agency.

Section C: Government support for private-sector R&D and innovation

1. Please describe major policy changes in the instruments used to support private sector R&D and innovation, including: tax treatment of business R&D (e.g., tax credits for R&D expenditure, changes in corporate tax regimes that could affect business R&D activities); direct public funding of business R&D and innovation (e.g., grants, contracts, loans, etc.); public procurement policies, new contractual guidelines, more competitive selection processes, etc.); changes in IPR regimes to create additional incentives for business investments in innovation, such as via new or strengthened mechanisms for enforcement of IPR (e.g. specialised courts); other forms of public support for innovation (e.g. consulting services and extension programmes):

In Portugal, most public funding is allocated to basic research undertaken in universities and research institutes, while the involvement of the business sector is negligible. Given the structure of Portuguese industry where most firms are small and often family owned, links between firms and with universities have generally been weak. Hence more efforts are needed to strengthen the links among the main players in innovation and science, *i.e.* business and public research. All higher education institutions are free to

contract with enterprises and there have been links with large companies abroad. International experience shows that partnerships can also be built between small innovative companies.

Supportive financial conditions are needed to ensure that even small and very small firms have access to financing for investment. Regarding bank loans, a major source of financing in Portugal, there are problems of access for smaller-size firms and those involved in innovative activity. In this context, the lack of experienced evaluators of innovative projects has been reported as a problem in Portugal (EC Enterprise DG). For smaller innovative firms which cannot obtain bank finance, venture capital is typically a major source of external financing. The availability of such funds has been very limited in Portugal.

The main Portuguese policy measures and public instruments to foster innovation are listed below.

Stimulating Business Intramural R&D

SIFIDE - Tax Incentives for Company Investments in R&D

This measure is aimed at stimulating business R&D as a tax credit granted to companies that performed or contracted R&D activities. In 2003, the OECD report 'Tax Incentives for Research and Development' classified SIFIDE as one of the best R&D tax provisions for the years 2001/2002, among three other countries (*e.g.* Spain, Australia and Canada). This measure started in 1997 and although suspended in 2004 and 2005, it will restart from the fiscal year of 2006 onwards with better incentives. The institution responsible for this measure is MCTES.

NITEC - Incentive System for Creating R&D Centres in Companies

This programme is aimed at enhancing business enterprises in-house competences, through the provision of financial support for the creation of R&D teams. It provides also support capacity to participate in R&D projects through the absorption of technological knowledge. The institution responsible for this measure is Agência de Inovação AdI.

Doctors and Masters in Companies and Technology Centres

This programme aims to encourage firms to recruit human resources holding a doctoral or a master degree, in order to strengthen company's R&D, technological innovation and competitiveness. The institution responsible for this measure is AdI.

SIME I&DT

This measure is aimed at supporting R&D activities related to new products, processes or systems, or significant improvements in current products, processes or systems. This measure also promotes University-Industry relations by encouraging sub-contracts to scientific institutions. The institution responsible for this measure is IAPMEI.

Reinforcing University-Industry relations

It is an important objective to create favourable conditions for researchers in Portugal. The share of researchers in total employment is only 3.5 per thousand, compared with 6 per thousand on average in EU-15. Increasing their number would help to promote links between university units or between university and companies or state laboratories (at the national and international levels). The development of scientific-based networks can help overcome difficulties resulting from the small size of research units and contribute to the diffusion of knowledge in small size enterprises. The Ministry of Science, technology and Higher Education intends to restructure the university faculty career system and create enough flexibility to allow merit advancement for young researchers, irrespective of vacancies. The objective would be to also introduce flexibility in the career system.

IDEIA Applied R&D in Companies

IDEIA is aimed at supporting cooperative R&D projects involving companies and S&T organisations, in order to develop new products, process or services. The programme gives special emphasis on product innovation. The institution responsible for this measure is AdI.

Centres of Excellence – Competence building making use of ICT

Centres of Excellence is a programme aimed at supporting networking of companies, research centres, Universities, Polytechnic Institutes, Public bodies and business associations. The institution responsible for this measure is AdI. The main goals are the following:

- Encouraging the linkages between companies, research centres, high education and universities to develop networks.
- Promote the development of new and better services and new technologies.
- Orientate sectoral and regional S&T development toward key areas.
- Contribute to improve education curricula.

Support to the Creation of New Technology Infrastructures

This measure aims to promote the technological infrastructure in private and public organizations, by strengthening their scientific potential. The scope of this measure was enlarged in 2005 to include the creation of new technology infrastructures (technology centres, technology transfer centres, new technology institutes, technology incubators and technology parks). Among these organizations are interface institutions linking University to industry. This measure also promotes new technology based companies. The institution responsible for this measure is AdI.

Supporting Participation of Portuguese Organisations in the EU Programmes

This programme is aimed at encouraging economic actors, in particular SMEs and S&T organizations, to apply for projects under the 6th Framework Programme. Support is provided for preparation of applications of research projects to be undertaken under the Framework Programme. The institution responsible for this measure is UMIC.

Promoting New Technology Based Companies

NEST - New Technology Based Companies

The objective of NEST is to provide financial support to the creation, launching and development of technology-based firms that have a close relationship with domestic S&T organisations and/or are expected to reach a high level of technological capacity. The institution responsible for this measure is AdI.

NEOTEC Initiative

The NEOTEC Initiative is concerned with the provision of seed capital for the creation of new technology-based firms, by supporting them in the different stages, from the identification of market potential to the commercialisation. The institution responsible for this measure is AdI and the initiative has the following objectives:

- Promoting the creation of new technology based firms.
- Encouraging an attitude change of NIS players, encouraging the carrying out of research activities and the exploitation of its results.
- Stimulating entrepreneurship and an innovation culture.

- Promoting the development and market launch of new products, processes and services.
- Other activities that complement the above-mentioned measures, include.
- Ideas Contests for new business: these activities are price-winning events aiming to promote new business ideas.
- Investment forums: these activities are brokerage events that gather entrepreneurs and venture capital, business angels, investors and managers, in order to stimulate seed investment in start-ups.

Enhancing R&D results

GAPI - Industrial Property Support Offices

The GAPI initiative is aimed at launching small units specialised on the provision of information and on the development of actions concerning the promotion of industrial property. The institutions responsible for this programme are INPI together with the host of the GAPI, namely Universities, Technological Centres, Employers Associations and S&T Parks.

OTIC - Technology and Knowledge Transfer Offices

OTIC is aimed at supporting the setting-up and development of activities of interface organisations to promote University-Industry technology transfer and the networking of these institutions. The institution responsible for this measure is AdI. More specifically, the objectives are:

- To enhance University-Industry cooperation through common technology transfer projects.
- To identify and disseminate information about University and Polytechnic Institutes technology supply.
- To identify company technology demands which may lead to the carrying out of cooperative R&D projects by Universities and Polytechnic Institutes

SIUPI - Industrial Property Use Incentive System

SIUPI is aimed at supporting domestic and international industrial property rights of Portuguese companies, namely patenting. In 2005 support was also extended to the expenditures incurred in connection with the introduction of pharmaceutical products in foreign markets. The institution responsible for this measure is INPI.

Promoting Human Resources

The main impediment to innovation activity in Portugal is probably the lack of highly qualified human resources. Despite some increase in the number of science and engineering graduates, the overall supply of such graduates continues to be low. Graduates (PhDs) in the fields of science and engineering generally find employment in higher education institutions in Portugal; only a small share is employed in private firms (less than 20% in 2000).

Existing programmes include:

Enterprise PhDs

This programme has the objective of promoting PhDs in a business environment, through university-company co-operation in areas of interest for the enterprise. The institution responsible for this measure is FCT.

Grants for Internships in International Science and Technology Organizations

The Programme offers grants for internships at international scientific organizations CERN, ESA or ESO in several scientific and technological areas, during a minimum of one year and the maximum of two years. The institution responsible for this measure is AdI.

CONTACTO INOV

The Programme promotes international internships in innovative companies and other international institutions. It is directed to graduates or mid-level professional graduates in the areas of economics, managing, marketing, engineering, science and technologies and design, as well as other critical areas for business innovation. The institution responsible is ICEP Portugal.

QUADROS Programme

The Programme is aimed at supporting SME development through the strengthening of its human resources, namely in the management and technological areas. The institution responsible for this measure is IAPME and IFT.

Dissimination of R&D

DEMTEC - Incentive System for Undertaking Pilot Projects Concerning Technologically Innovative Products and Processes

This programme is focussed on pilot projects of products, processes and Innovative technological systems, by promoting technology diffusion and gearing research to innovation. More specifically, the programme is concerned with the industrial validation of knowledge relating to the application of new technologies, as well as with the demonstration and diffusion of such applications. The institution responsible for this measure is AdI.

2. Please describe policy changes in programmes to support R&D and innovation in SMEs and new technology-based firms, e.g. via efforts to: establish and develop venture capital funds and /or second-stage financing for the support of new technology-based firms or spin-offs from public research organisations; provide additional R&D funding targeted to SMEs and new technology-based firms; encourage entrepreneurship through training, information services, or other means:

In the second half of the 1990's, the number of companies active in R&D doubled in Portugal. These companies no longer compete internationally with low salaries, but rather with qualified human resources, R&D and innovation, marketing, design, training and quality, co-operating with S&T institutions. The main objective is to make it possible for this emerging economic model, this new Innovative Portugal, to become the prevailing model from which a new cycle of economic growth will be sustained.

While Portugal has a large proportion of SMEs, entrepreneurial activity (i.e. the proportion of people engaged in new firm start-ups) is relatively low, and concentrates mostly on micro-firms (less than 10 employees) that are unable to grow significantly. It can be argued that either financial constraints or lack of entrepreneurial skills and incentives among scientists may be hampering industrial re-structuring and therefore limiting economic growth and job creation in Portugal, since R&D results are not being introduced in the market (hence generating innovations) in the proper amounts

Further important changes are in progress, particularly in terms of the endogenization of a “culture of monitoring and accountability”, as well as the international recognition of the enormous potential for expanding research activities and technological development.

3. Please identify major shifts or changes in the mix of instruments used to provide public support for private sector R&D and innovation, to include 1) direct financing of R&D; 2) R&D tax incentives; 3) support to entrepreneurship and SMEs and 4) IPR protection and other framework conditions. What shifts in the policy mix are anticipated in coming years?

Policy changes are underway to support private sector R&D and innovation. These include:

- Tax treatment of business R&D (*e.g.* tax credits for R&D expenditure, changes in corporate tax regimes that could affect business R&D activities).
- Direct public funding of business R&D and innovation (*e.g.* grants, contracts, loans, etc.).
- Public procurement policies, new contractual guidelines, more competitive selection processes, etc.
- Changes in IRP regimes to create additional incentives for business investments in innovation, such as via new or revised guidelines for specific types of inventions (*e.g.* genetic, software, business methods), or new or strengthened mechanisms for enforcement of IPR (*e.g.* specialised courts).
- Other forms of public support for innovation (*e.g.* consulting services and extension programmes).

4. Looking to the future, what are the main issues that policymakers will need to address regarding support to the business innovation system? Please describe any efforts that have been taken to identify or address them.

In early 2006 the government established a new framework for SME access to finance. The first initiative (FINICIA) aims at improving access to finance for small firms in the early stages of the business life cycle. The programme combines: *i*) a public counter-guarantee fund in partnership with mutual guarantee schemes, to improve the access of very small firms to bank loans; and *ii*) a public risk-sharing fund in partnership with venture capital, to provide small amounts of capital to start-up activities, and to innovative investment projects.

The main issues that can be addressed within the Ministry of Science, Technology and Higher Education have been identified in the answer to question C. 1. The Compromise with Science reinforces many of those initiatives.

Section D: Enhancing collaboration and networking among innovating and research organisations

1. Please describe major initiatives to promote collaboration and networking among innovating firms, *e.g.*, via joint R&D programmes, regional innovative clusters, international co-operation (attracting research labs of foreign firms or supporting access of domestic firms to foreign programmes).

A number of initiatives have begun to encourage networks and collaboration between research organisations at the national and international level.

At the national level this is carried out by:

- Restarting the renewal and reform of the State Laboratories, establishing guiding missions and contracts, particularly to support the State's regulatory and fiscal activities, as well as economic activity, and decision-making and risk minimisation.

- Restoring the financial autonomy of the State Laboratories and signing public service contracts with the Associated Laboratories, to support decision-making and the detection of risks and opportunities.

Further initiatives have been taken to promote public/ private partnerships in the area of computational biology, information technology and other fields through the signing of a specific protocol between research companies (for example, Siemens; Microsoft, Sun Micro systems).

At the international level, a number of institutional international partnerships are underway. International agreements with Spain, Poland, China and the United States have been further developed. A major endeavour between the governments of Spain and Portugal resulted in the creation of Portugal /Spain International Research Laboratory under joint responsibility, promoting public/private partnerships in a number of specific fields and promoting networking between universities and research centres. Among other area, the international lab will develop joint nanotechnology initiatives.

A number of international collaborations have recently been signed with major American universities (MIT, Carnegie Mellon, and University of Texas at Austin) and different Portuguese universities to strengthen the country's knowledge base, foster economic growth and enhance quality of life. Such collaboration seeks to promote and develop new technological competencies to increase Portuguese innovative capacity. This will be accomplished through the development of research, education and technology commercialization initiatives. By promoting advanced educational and research programmes at an international level Portugal promotes an attractive setting to study and perform research, to invest in technology-based ventures and reinforces the entrepreneurial capacity of students, scientists and engineers.

Furthermore, all outstanding debts to major international scientific organisations were paid and Portuguese quotas regularized.

2. Please describe major policy initiatives to promote stronger industry-science relationships, such as efforts to:

- The creation of spin-offs, take equity positions in technology-based firms emerging out of public research, etc.); enhance collaborative research (*e.g.*, through changes in regulations governing the types of agreements negotiated between public research organisations and businesses and their implications for access to and exploitation of research results).
- Increase the mobility of human resources between public and private sectors (*e.g.* by revising employment and financial rules governing public-sector researchers to allow them to more easily collaborate with industry, move between the public and private sectors, participate in set up new modes of public/private partnerships for research and innovation:

The aim of current policies is to support strategies for encouraging industry-science relationships and partnerships for innovation in general, which are considered crucial for Portugal's social and economic development and which will require incentives that take the following factors into account:

- Time: a relatively long-term perspective, with ongoing efforts to promote research and development.
- Scope: promoting international relationships and opening up cooperation in science and technology, particularly within Europe but also with a transatlantic dimension.
- Context: taking into consideration specific regional and sectoral aspects, thus promoting a diversified environment.

- Value: promoting market strategies and encouraging market-oriented technological cooperation, particularly through developing clusters in key sectors of the economy.

In particular the actions planned are designed to foster links between the science and technology system and the productive sector so as to promote the development of national skills in science and technology, while at the same time enabling the scientific base to be strengthened through institutional cooperation at various levels, particularly through alliances that develop the capacity of existing resources within a system of innovation.

Analysis has shown that there are two main, inter-linked sources of restrictions to the kind of financing R&D and innovative activities receive from the business sector in Portugal. The first of these sources has to do with the relatively low levels of in-house R&D done by most Portuguese industrial firms, which are particularly small in size, as well as with their concentration in activities that are mostly into mature stages of their life-cycles. The largest companies (namely in the energy, telecom, transports and construction sectors) invest a very small amount of resources in R&D. This means that, on one hand, firms' absorptive capacity for new innovations is limited. This leads to a second source of restrictions: since Portuguese firms are unable to absorb, and therefore finance the development of a large part of the R&D results generated by universities and research institutions, **new firm start-ups and technology-based entrepreneurship** need to assume a stronger role in introducing new innovations to the market, and creating jobs.

3. How has policy shifted in recent years in its support for different channels of industry-science linkages (e.g. collaboration, licensing, spin-outs, public/private partnerships). Please describe any anticipated shifts or changes in policy for strengthening industry-science linkages.

Based on the experience gained in many OECD countries, it is felt that the industry-science relationships and partnerships to be established should be directed towards the following challenges:

- **Increasing the degree of technology use in strategic sectors of Portuguese industry**, which involves developing the capacity to absorb new knowledge and improving the capacity to create new technology-based products and services;
- Promoting **inter-institutional mobility**, in particular between universities, research centers and firms, as well as the recruitment of young researchers;
- Promoting **research and development of public interest**, particularly in collaboration with state laboratories, so as to encourage the adoption of public policies of strategic importance for Portugal;
- Facilitating the development of **new technology-based firms** as potential promoters of innovation in the emerging societies;
- Strengthening the role of **technological infrastructures**, while ensuring diversification of its role in the promotion of innovation policies;
- Promoting the diffusion and dissemination of the **scientific culture**.

These challenges are considered in the context of Portugal's full integration into Europe, which among other aspects will require linkage to other structural policies, including attracting foreign investment.

In addition, it should be noted that tax incentives were first introduced in 1997 and significantly improved in 2001, giving rise to a considerable increase in private funding of R&D, although still with

small absolute values. The incentives were canceled in 2003, but have recently been re-introduced by the current Government starting to enter into effect in January 2006.

Section E: Globalisation

1. Please describe the most important policy issues and objectives with respect to the process of internationalisation of R&D:

The main options for policy and lines of action to be implemented with respect to the process of internationalisation of R&D include:

- Fostering institutional links between international partners, at university and corporate levels and by attracting direct foreign investments.
- Guaranteeing the regularity of tenders for public financing, with international and independent assessment and monitoring of projects, networks and institutions in every scientific domain.
- Developing a system of top international scientific assessment on a bi-annual basis, guaranteeing the improvement of the present system for the assessment of institutions, projects and individual careers.
- Participating fully in international organisations and in the setting of the scientific and technological policy within the European Union, supporting the reinforcement of resources, the de-bureaucratisation of procedures, better access for SMEs and the creation of a European Research Council.
- Systematically organising scientific and technical capacities to minimise and prevent major risks to the public, as well as to reinforce the regulatory and monitoring institutions through periodic international assessment.
- Stimulating the dissemination of R&D results: the creation of the label Inovação XXI, a programme of participation in important international fairs in the areas of technology in which the country has achieved results which contribute to changing the image of the country abroad when disseminated.

2. Please identify and describe changes in policies to attract R&D through foreign direct investment. This may concern: direct financial support; fiscal incentives (tax breaks; R&D tax credits; administrative support; provision of infrastructure; public procurement; active recruitment of foreign firms; advertising; other measures.

Policy measures to attract R&D to Portugal contemplate the following:

- Reinstating the system of tax incentives for entrepreneurial R&D, adjusted to their specifications, to emerging challenges and to the special characteristics of entrepreneurial R&D in Portugal.
- Reinforcing research in consortiums between research companies and institutes, conditions favouring new technology-based companies and the improvement of national engineering.
- Promoting the creation and development of thematic science and technology networks.
- Improving management and de-bureaucratising the system of financing, and creating conditions for its de-governmentalisation and for safer assessments and decisions.
- Promoting the competitive, progressive creation and filling of additional jobs in R&D in the public sector, to compensate for the cutting of other less qualified jobs in other sectors.

- Introducing mechanisms in the Universities and Laboratories which award the participation of researchers in results.
- Promoting projects directed towards the development and endogenisation of new emerging technologies in companies, creating the potential for the creation of laboratories and co-operative research networks and the reinforcement of our participation in the European Union R&D Framework Programme.
- Promoting R&D projects and programmes to support public sectoral policy in inter-ministerial co-operation.
- Promoting the creation of technology-based companies, making adjustments in existing programmes and making the most of opportunities brought by the SIFIDE (Sistema de Incentivos Fiscais em Investigação e Desenvolvimento Empresarial).
- Developing standards which promote the creation of markets for innovatory products.
- Stimulating scientific research in the Polytechnic Institutes, in thematic programmes in close articulation with opportunities for economic development and public policy at regional and/or national level.
- Reviewing the functioning of considerations for large-scale public spending, introducing the principle that at least 20% of considerations should be invested in the financing of R&D and Innovation.
- Promoting the participation of S&T in policies for the attraction of intensive IDE in technology.

3. Please describe any changes in the principles concerning the treatment of foreign firms (both non-domiciled firms and foreign-owned subsidiaries) or foreign research institutions in national R&D programmes (e.g., access to national R&D funding programmes, rules for co-operation with domestic research institutions, rules for co-operation in public private partnerships, public procurement, etc.).

The international institutional partnerships (described already) and the measures to attract foreign researchers (answer F.1) are some of the measures already described.

4. Please describe specific measures to support the internationalisation of domestic public research institutions (e.g., such as additional funding for projects with international partners, co-funding for project partners not located in-country, support for setting-up affiliates abroad).

The Portuguese S&T system has been concerned with the process of building a science community, as initiated during the second half of the nineties, through the consecutive international evaluations of S&T institutions that have imposed a dynamic of change within the research community and the fast increase in the presence of young doctorates and of Ph.D. students, as well as a high expression of international connections. The continuous increase in the number of doctorates, especially when considering European and international figures, was systematically referred to by the generality of the evaluation panels as a decisive factor to guarantee the critical mass essential for scientific development and innovation. Moreover, it is a policy to privilege the national and international mobility of researchers, in a context of effective need to promote the internationalization of the research community.

The Foundation for Science and Technology funds in-bound and out-bound international mobility. About half of the Portuguese PhD and one third of post-docs with a grant from the Foundation for Science and Technology go abroad. Of the 1600 grants attributed abroad in 2001, 76% went to other EU countries and 20% to the USA.

In 1998, the Foundation for Science and Technology began to attribute grants to foreign researcher without a previous one-year residence requirement. Within 3 years the numbers of foreign researcher grew considerably. In 2001, about 56% of post-docs and 11% of PhD grants were foreigner –born researchers. The country of origin of these post-docs varied considerably with about 40% from other EU countries, the USA or Canada; 20% from Eastern Europe; 20% from China; 11% from India and 7% from Brazil. In 2001 there were 300 foreign researchers in PhD and post-doc programs in Portugal. From 2000 to 2005 the total number of post-docs attributed was 1,982, of which 750 were granted to foreigners. This corresponds to 38% of the total number of grants attributed to post-docs. For the same period of time the total number of all grants attributed by the Foundation for Science and Technology was 8,919 and 1,271 were given to foreign researchers (14.3%). The policy of attracting foreign researchers and scholars to Portugal and of sending PhDs and post-docs abroad is an integral component of the internationalization of the science base and ensuring a dynamic scientific community.

It is also important to mention the increase of new PhD holders, with who is associated a high potential for the development of research activities. This fact reveals an increasing capability of Portuguese universities to offer PhD programs, but it also raises new challenges regarding the mechanisms that guarantee the quality of PhD programs, and the need to strengthen their internationalization and establish international scientific research networks, where PhD students can be fundamental links. It is, in fact, the capability to train and attract new PhD holders, fostering scientific employment that determines the full maturity of a scientific system, and it is also decisive to improve the scientific activity in networks to promote the institutional relationship, either between university units, or between these units, State Laboratories and companies.

5. Please describe measures to link domestic firms, in particular SMEs, to foreign sources of research and innovation, including international co-operation in R&D (e.g., additional/preferential funding for projects with international partners; co-funding for project partners not located in the country; and support to find international partners, etc.).

Through the EU Framework programme of research and technological development Portugal encourages SMEs to participate and establishes technological centres as well as the Innovation Agency to enhance this participation.

OTIC - Technology and Knowledge Transfer Offices support the setting-up and development of activities of interface organisations to promote University-Industry technology transfer and the networking of these institutions. The objectives are:

- To enhance University-Industry cooperation through common technology transfer projects.
- To identify and disseminate information about University and Polytechnic Institutes technology supply.

To identify company technology demands which may lead to the carrying out of cooperative R&D projects by Universities and Polytechnic Institutes

IDEIA - Applied R&D in Companies – aims to support cooperative R&D projects involving companies and S&T organisations, in order to develop new products, process or services. The programme gives special emphasis on product innovation.

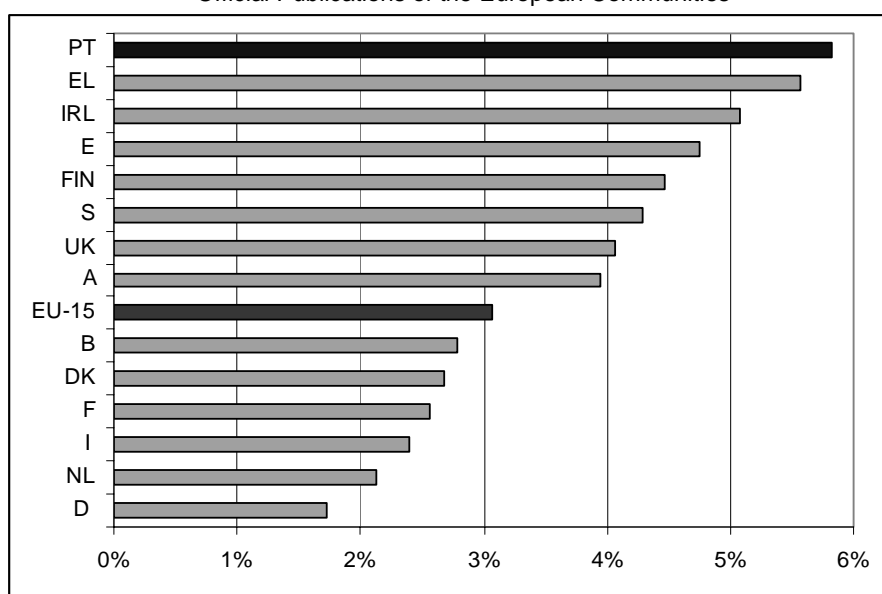
Section F: Human resources:

1. Please identify and describe recent efforts to improve supplies of university graduates with science and engineering degrees (both quantity and quality).

The rapid increase in the number of researchers in Portugal has been recent. It is linked to the implementation of the CIÊNCIA programme in the beginning of the nineties and later on to the programme of advanced training scholarships sponsored by the Science and Technology Foundation that allowed the number of PhD holders and researchers to increase sharply in all scientific domains.

Compound annual growth rate of the number of students enrolled in tertiary education (ISCED 5 and 6), 1975/76 – 2000/01

Source: Source: Eurydice, (2005), Key data on Education in Europe 2005, Luxembourg, Luxembourg: Office for Official Publications of the European Communities



In spite of the increase Portugal needs to significantly increase the number of graduates and the academic and professional qualifications of the Portuguese society continue to be an essential factor for our economic, social and technological modernization. The Government aims to:

- Produce an increase of 50% in human resources and R&D and in internationally recognised scientific production.
- Increase to 1500 PhDs per year in Portugal and abroad.

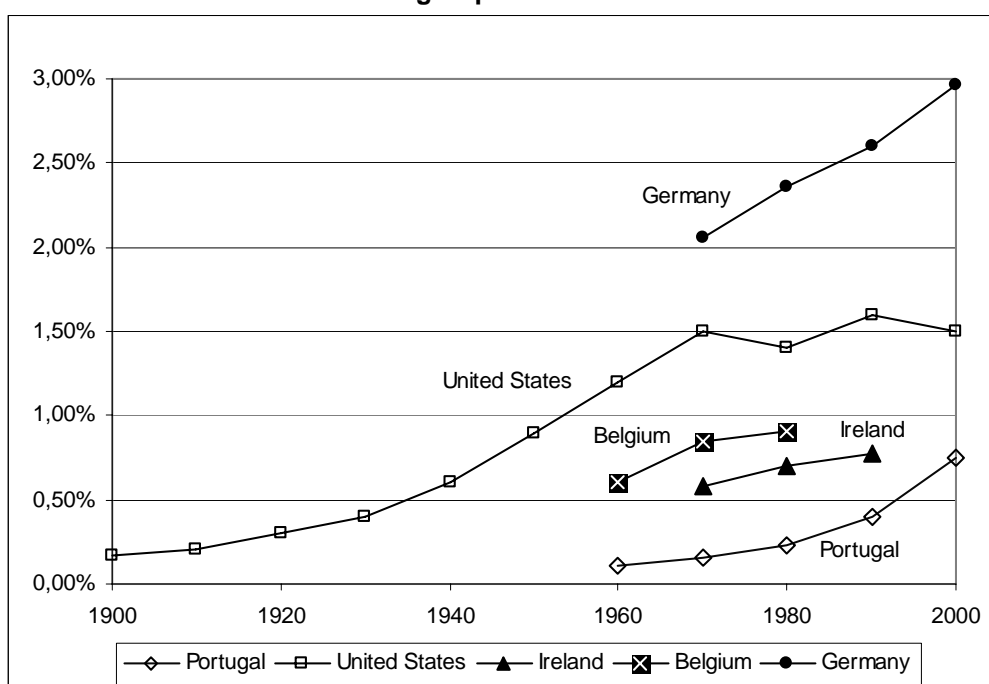
An increase in the number of doctorates, especially when considering European and international figures, is seen as a decisive factor to guarantee the critical mass essential for scientific development. However, in 2003, the number of researchers in terms of the active population represented still about 1/2 of the European average (2.9 and 4.9, respectively for every thousand inhabitants) and clearly structural actions are needed to:

- Reinforce infra-structural aspects, including the support to libraries and the widespread electronic access to documentation centers, and fast and efficient access to the Internet.

- Intensify the technical and administrative support, that continued to be particularly below the European average when analyzed in terms of the personnel per researcher (respectively, 3.9 and 9.5 for every thousand inhabitants), but also because of its reduced quality in most cases.

The qualification level growth of the young Portuguese population is associated with the fact that the Portuguese higher education system has rapidly grown and was opened to young people of all social classes, evolving from 30.000 students in the sixties, to nearly 400.000 students by the end of the century. This rapid increase in the student population, comparatively to the development in other European countries during the same period raises a series of new challenges for the higher education system in the national context, namely in terms of the need to strengthen the R&D activities in order to differentiate its supply on a national scale.

Percentage of graduated engineers in active population aged between 25 and 64 years old in a selected group of OECD countries



Sources: Conceição and Heitor (2004). Primary data from: Germany - Bundesanstalt für Arbeit/German Federal Statistics Office/International Labour Organization; USA - U.S. Department of Labor, Department of Labor Statistics, Digest of Education Statistics, 2001, U.S. Education Department/International Labour Organization; BE - Statistics Belgium/ International Labour Organization; Ireland - Central Statistics Office/International Labour Organization; Portugal - Instituto Nacional de Estatística/DAPP/DGES/ International Labour Organization.

It should be noted that the improvement of the S&T system over the last few years has been associated with a critical challenge related to the need to restructure the university faculty career's system. This includes understanding forms of merit enhancement devoted to young researchers, regardless of the existence of vacancies in the university faculty staff derived from the number of undergraduate students. Indeed, the progressive saturation of these vacancies, at least in older universities, has stalled the attractiveness of scientific careers, which requires the change of university recruiting systems to schemes such as those in force in more developed S&T systems.

It is also worthwhile mentioning that, since 1998, there is a visible absorption of PhD holders by the private higher education and by the polytechnic higher education systems. This fact corresponds to a new

situation that Portugal is facing¹, which needs to be duly analyzed and dealt with, in particular by revising the faculty career statute in polytechnic institutes. These aspects need a more detailed discussion about the institutional context in force, in particular the University Faculty Career (ECDU).

In terms of scientific employment, the information on the employability of Portuguese PhD holders since 1998 also shows that the importance of higher education in scientific employment has decreased. There has simultaneously been a slight growth of former scholarship holders working abroad, namely in universities or in research centers. Different surveys reflect a possible brain drain trend in Portugal, with the increasing permanence of Portuguese scientists abroad, unless short-term measures for the promotion of scientific employment are taken.

It is also known that only a small percentage of PhD holders in Portugal develop their activity in companies. Moreover, some success cases of new technology-based firms created by young PhD holders are noteworthy in particular in the areas of information technologies, biotechnology and, more recently, space technologies. In the period 1997-2003, FCT helped to integrate 77 PhD holders and 63 Masters in nearly 50 firms, through the support of the Innovation Agency, whose public funding totaled around 1.2 million Euros in 2001. Once again, the continuity of this process goes beyond the public effort and requires the establishment of effective networks with universities, namely through R&D units, that are in a particularly privileged position to facilitate and develop close relationships with new technology-based firms.

To encourage young people to follow science and technology courses it is often necessary to start to develop this interest at the basic and secondary school level. The **technological plan** specifically refers to the following objectives to encourage interest in science and technology:

- Make experimental practice in science subjects in Basic and Secondary Education compulsory.
- Reinforce the Agência Ciência Viva [Live Science Agency] as a non-governmental institution of international excellence, capable of mobilising the efforts of scientists, teachers and pupils, local authorities and companies, to promote scientific and technological culture.

To that effect, in October 2005, the Ciência Viva programme re-initiated its support to experimental science teaching in schools. After a 4 year drift the Ciência Viva project began to support science experiments in basic and secondary schools throughout the country again. Between 1997 and 2001 this programme has involved 7000 teachers and 500,000 students in 3000 science projects in all schools. It brings together researchers, schools, students, local authorities, science centres and science museums with universities, polytechnics and research laboratories in an initiative that supports science education and culture in young people.

2. Please describe recent changes to enhance the international mobility of scientific and high-skilled personnel, including programmes to attract foreign (and expatriate) talent and encourage students / workers to gain international experience. Consider such policies as: changes in immigration legislation; funding of scholarships, grants for international mobility of students /scholars; creation of special positions at universities or public research centres; fiscal incentives (e.g., income tax breaks) for foreign workers; programmes to promote return migration of expatriate students and engineers, other measures.

There is an intention to entrust the different types of institutions with similar degree of institutional autonomy (universities and polytechnics, public and private) while increasing their level of accountability.

¹ See the FCT's quinquennial Report (2002): FCT 1997-2001 – 5 years Report, Portuguese Science and Technology Foundation

It is also necessary to provide a less prescriptive legal framework allowing each institution to create its own tailor-made system of governance, both at institutional level and at the level of their units. Opening institutions to the outside society by allowing greater participation of external stakeholders in the governance bodies is also an objective. The goal pursued by the current Government is to strengthen institutional autonomy, by reinforcing a system of higher education with autonomous institutions, facilitating the reform of the system governing institutions. Under these conditions all levels and types of mobility will be enhanced.

The Foundation for Science and Technology has a policy to attract foreign researcher to Portugal that is described above. Further measures of attracting researchers to Portugal have recently been announced.

3. Please describe recent policy efforts to foster development of specific skills other than S&T skills needed to foster innovation in a knowledge-based economy (e.g., management, communication, legal), notably as relates to the service sector.

It is recognized that the population's lack of qualifications is one of the factors that most contributes to the low Portuguese productivity in comparison with other OECD's countries. Despite the considerable increase in the education level of the active Portuguese population, over the last ten years there are still levels similar to those of developing countries, such as Mexico or Turkey. Furthermore, the workforce is characterised by having nearly half of the graduates, comparatively to the OECD country's average (10% and 20%, respectively, in 1996). The deficit in qualifications, especially at the level of secondary education, continues to be an obstacle to the adoption of organisational structures that would allow greater labour flexibility and adaptation, associated with increasingly competitive markets, and scientific development.

The government has introduced measures to facilitate and improve access to new forms of learning at different levels thereby introducing greater flexibility into the learning and qualification process. Two specific measures to address this question were recently approved. New legislation was introduced to expand specialised courses in technology (CET – Cursos de Especialização Tecnológica), facilitating professional training at level 4 and permitting new publics to benefit from these courses. Consequently, 70 new CET courses have already been financed. Another new legislation was introduced to facilitate entry to higher education of people over 23 years of age. Both measures aim to improve the knowledge base and promote more qualified human resources.

4. Please describe any major shifts or changes in the priorities and mix of instruments used for developing human resources for innovation, e.g., between development of domestic talent versus attraction of foreign talent; between development of S&T skills and non-S&T skills; between stimulation of demand and development of supplies; between support for teaching and support for research; etc.

The answer to this question has been provided in the answer to question 1 and 2.

5. Looking to the future, what are the main changes anticipated in the supply and demand of human resources, and what are the main policy challenges that policy makers will need to address? Please describe any efforts being made to identify future challenges of develop future policy directions?

These challenges have already been defined in A. 1. These are concretely:

- Produce a growth of 50% in human resources and R&D and in internationally recognized scientific production.

- **Increase the number of new PhDs per year in Portugal and abroad from about 1000 to 1500;**

Further, attention is being paid to retention, drop-out and early leaves from the secondary and higher education system. Measures have been introduced to widen education to new publics (the CET courses and the lowering of the age for adult entrance into higher education).

Section G: Policy Evaluation

1. Please describe recent changes in policies regarding ex-ante or ex-post evaluation policies and programmes, including new legislation or regulation, methodologies employed, criteria considered and the organisation b/institutions that perform the evaluations.

Major evaluations processes are underway. These are:

- The OECD, ENQA and EUA are all involved in evaluations during the current year with regard to the higher education sector. Reorganisation of accreditation and quality assurance is underway.
- An external evaluation by an international panel is also underway for the State Laboratories.
- All research centres are also periodically evaluated by international peer review panels under the Pluri-annual Programme. (All these have been described above.)

2. Please describe recent changes in policies regarding the evaluation of public research organisations, including legislation or regulations requiring evaluation, methodologies employed, criteria considered and the organisations/ institutions that perform the evaluation.

Several recent changes regarding evaluation of public research organisations or higher education institutions have occurred or are currently underway. These are:

- Administrative and financial autonomy was reinstated in the State laboratories.
- Evaluation of State Labs underway by international panel of experts.
- Legislation was introduced with regard to the revision of the Basic Law of the Education so as to create the legal conditions for the implementation of the Bologna Process in the reform of the higher education system.
- International evaluation process of the higher educations system by the OECD is currently underway.
- Institutional evaluation by the European Association of Universities is supported at a rate of ten per year.
- Evaluation of accreditation and quality review is underway by the European Network of Quality Assurance.
- Establishment of a system of evaluation of research institutions and projects.

3. Please describe any significant changes in the priority given to evaluations in innovation policy, including the motivations for such changes and anticipated effects. Please include information about additional resources being invested in evaluation and approaches used to ensure that results of evaluation feed-back into policy making.

The development of the Portuguese science and technology system has been particularly stimulated over the second half of the nineties through wide-ranging reform of the evaluation system for research and

development institutions, ensuring the independence and effectiveness of assessments, the publication of the methodologies used and the results, and the exercise of the right of appeal. The assessment procedure included state laboratories and the research units funded by the Portuguese Science and Technology Foundation (FCT), with current programs designed to help increase employment opportunities in scientific areas and to promote the rejuvenation and mobility of human resources, particularly Portuguese PhDs.

Several research units include specialists who are well known at the international level, a fact which is also reflected in the number and quality of publications, strong involvement in European consortia, and the large number of international conferences and other events held in Portugal. In particular, various panels of evaluators found a dynamic for change and considerable enthusiasm, no doubt the result of the high proportion of young PhDs and doctoral students, together with a high level of international links.

The **continued increase in the number of PhDs**, particularly when considered in European and international terms, was consistently mentioned by all the evaluation panels as a **crucial factor** in achieving the critical mass essential for scientific development, despite the fact that in 2005 overall values for number of researchers as a proportion of the economically active population was around **half the European average**. In general terms, and besides the question of the size of the science and technology system, the various panels' reports published in the last years pointed to the need to implement a series of actions, including:

- **To strengthen current public funding lines for R&D** (which include support for discipline-based projects, scholarships, and infrastructure, as well as pluriannual funding), and to complement existing funding lines with thematic program of a multidisciplinary nature. These program should be linked to major national priorities, especially those related to large-scale public investment in the coming years, in areas that include the promotion of the information society, telecommunications, and transport and communications, as well as public health and safety issues such as earthquake protection, food products and environmental and social questions. It is important to stress the structural role of this type of program in promoting links between the scientific community and civil society.
- **To promote scientific networks** that foster institutional relations, both between university research centers and between these centers and state laboratories. Besides lessening the effects of the small size of the units, developing such science-based networks will certainly encourage the creation and transmission of new knowledge and stimulate scientific development in the context of continuous change and increasing internationalization of the scientific base.
- To encourage the national and international **mobility** of researchers, particularly within Europe, in the face of a real need to promote the internationalization of units.
- To strengthen research **infrastructures**, including support for libraries and electronic access for all documentation centers, together with rapid and efficient access to the Internet.
- To improve technical and administrative **support**, an area which continued to be found wanting and was repeatedly criticized by the evaluators, both for the fact that Portugal remains significantly below the European average measured in terms of number of support personnel for researchers (3.9 and 9.5 per thousand population respectively), and for their low qualifications in the majority of cases.
- To implement comprehensive mechanisms for the **protection of intellectual property** as a means of increasing its scientific impact, as well as preserving institutional integrity, given the increasing importance of innovation as a critical factor for economic development.

- To develop appropriate **skills for the management of technology**, as well as strengthening strategies that foster links with firms and encourage the creation of new technology-based companies.

While many of these actions could be considered the sole responsibility of the Ministry of Science, Technology and Higher Education, the various evaluation reports published since 1996² make it clear that their implementation, and scientific and technological development in Portugal in general, is affected to a large extent by **structural deficiencies in the organisation and constitution of the majority of the research units, especially in terms of their relationship with universities**, including:

- Inadequate linkage between education and research, which will certainly require a better division of workloads for both teachers and students, particularly in the distribution of academic timetables, but above all greater emphasis to be placed on research activities within the structure and organization of universities. On this point, the Evaluation Panel for Health Sciences in 2000 stated: “the visitors fully understand and support the autonomy of universities; however, we also expect the leadership of the universities to emphasize the importance of research”;
- Relative ageing of teaching staff, which requires the adoption of policies designed to bring younger teachers onto the staff and to establish a career structure for research staff so as to provide for career development, the achievement of justifiable aspirations for promotion among younger teachers and researchers, the recruitment of new PhDs into universities, and the encouragement of a dynamic of international collaboration with centres of excellence throughout the world;
- Inadequate support structures, which requires an increase in the number of technical and administrative support staff, and the adoption of strategies to develop the internal functioning of universities and make it more flexible.

Still on the question of the relationship between research units and host universities, many evaluation panels, notably those for Mathematics, Economics and Management, Health Sciences, Earth and Space Sciences, Electrical and Computer Engineering, and Psychology, referred in 2000 to the need to promote mobility of researchers and teachers by limiting universities’ recruitment of their own postgraduate students (‘inbreeding’), which in turn led to various comments on the need in Portugal to rethink the structure of doctoral programs and postgraduate studies in general. Indeed, the need to widen the recruitment base and to facilitate study placements and postgraduate and post-doctoral programs abroad, and in general to promote the effective internationalization of the scientific community, was repeatedly emphasized by the evaluators, even in rapidly expanding areas such as Mathematics.

It should be noted that many evaluation panels that visited Portugal in the last years concluded that since **direct funding from industry was on a small scale, it had had no significant impact** on the quality of research and had been used almost exclusively for short-term goals and for technological development. Examples of actions suggested by the evaluation panels include the establishment of: i) monitoring committees for research centers and state laboratories, to include representatives from the business world; ii) cooperation networks, supported by public funding; iii) exchange mechanisms for teachers, researchers and students.

² See, for example, Heitor, M. V. (2000). *Evaluation of Research Units, 1999/2000—Final Report*. Lisbon: Observatory for Science and Technology, Portuguese Ministry of Science and Technology.

4. Please provide information or web-links, if available, about the outcomes of recent evaluations of R&D or innovation policies.

The web page of the Foundation for Science and Technology carries the outcomes of recent evaluations of research centres. <http://www.fct.mct.pt>

Data on the R&D&I system can be found in: <http://www.oces.mctes.pt>

Data and information on the higher education system can be found: <http://www.dges.mctes.pt>