Ministry of Science, Technology and Higher Education, Portugal

A new landscape for Science, Technology and Tertiary Education in Portugal

Sample Background Information

June 2010

This brief note is aimed to provide sample background information about the increasingly relevant capacity for science and technology in Portugal and to introduce main issues for discussion about the challenges the country is facing to sustain the growth of science and technology and actively participate in international knowledge networks and flows.

Portugal has recently overcome its traditional gap in scientific and technological development and achieved the average OECD level in terms of the number of researchers per thousand workforce (i.e., 7.2 full time researchers per thousand workforce in 2008, while it was 3.5 in 2005 and only 1.5 in the late 80´s). Overall R&D expenditure more than doubled over the last five years (it was 1.55% of GDP in 2008, while 0.81% in 2005, and only 0.4% in the late 80´s). At the same time, the system of higher education has been reformed, the social basis for recruitment of students was enlarged and industry-science links were reinforced, together with business expenditure in R&D (which represented 0.78% of GDP in 2008, while 0.31% in 2005 and less than 0.20% until some ten years ago).

Opportunities around emerging themes for knowledge exploration and discovery, as well as for advanced training, represent continuous challenges for small and medium size countries and Portugal has experienced such opportunities through strategic partnerships with leading partner worldwide, in a way requiring further emphasis across a diversified set of areas, from deep sea biotechnology in the North Atlantic, to the internet of the future, and involving building further competencies in the nano- and bio-sciences, as well as in engineering systems, advanced computing and system complexity.

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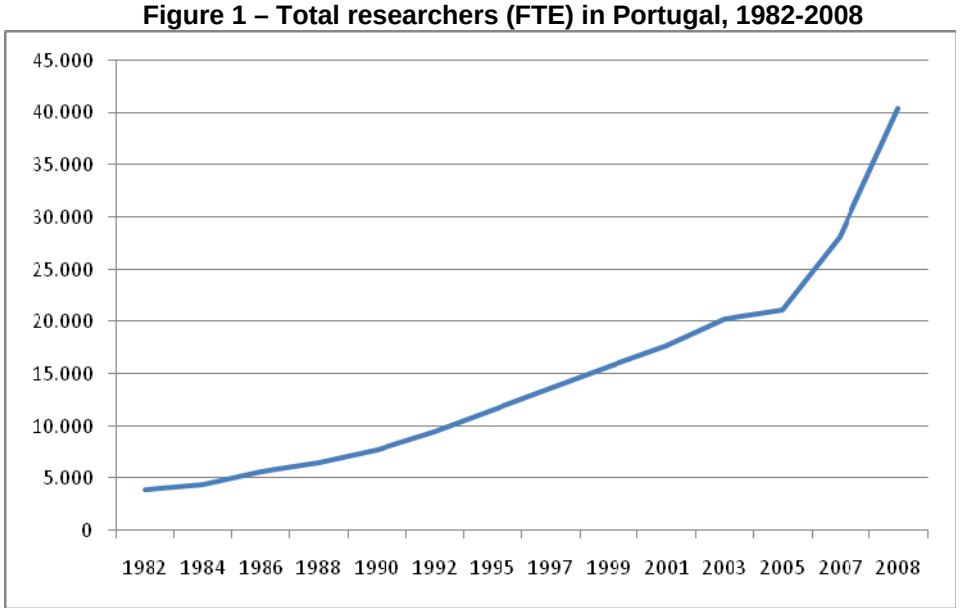
People, skills and competence building

1. **Researchers - overall**: The number of researchers in Portugal has recently reached, in 2008, about 7.2 per thousand workforce (i.e., above 40.000 FTE researchers, with ¼ in the business sector)[1]. It is thus nowadays similar (and even higher in some cases) to the levels of Spain, Ireland, Italy, Germany, the Netherlands, and the UK. Analysis also shows:

   - In recent years Portugal had the second highest percentage growth rate in Europe in terms of the total number of researchers (measured in full time equivalent, FTE) per thousand workforce (about 34%), well above the European average (which only grew by 5.4% from 2003 to 2006), Spain (13%) and Ireland (7%);
   - The total number of researchers increase about 8 times since the early 80s, from 0.9 researchers per thousand workforce in 1982 (i.e., about 5000 researchers FTE) to 3.5 in 2002 and 7.2 in 2008.
   - An increase of 25% in the last two years of the number of researchers working in academic R&D centers (12,000 FTE doctorate researchers) and a doubling of the number of doctorate researchers since 2000.

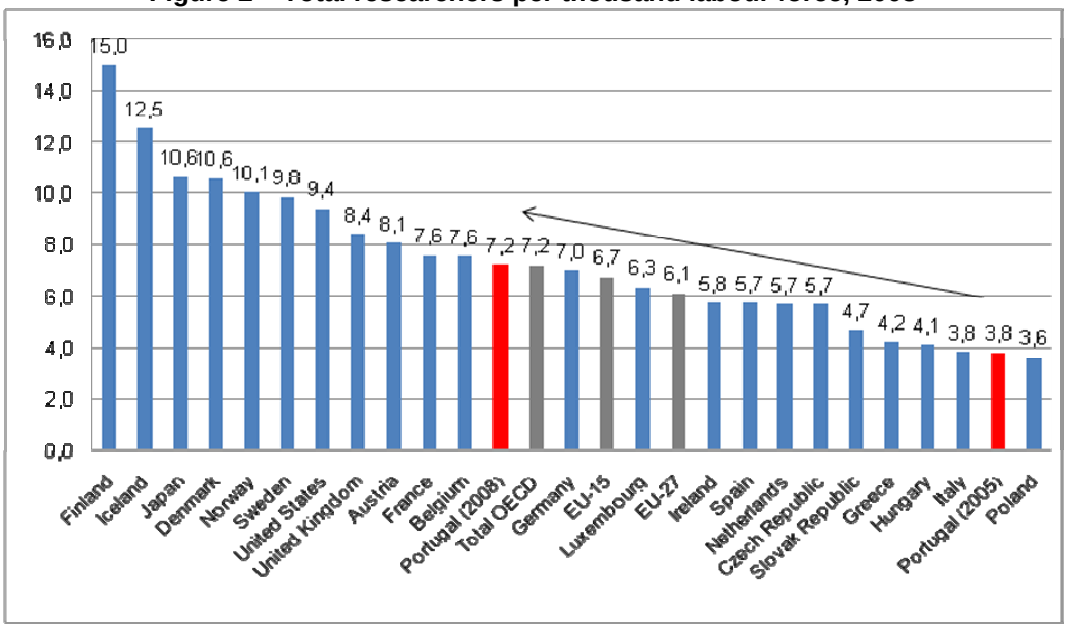
Figure 1 – Total researchers (FTE) in Portugal, 1982-2008



Source: GPEARI / MCTES

[1] For details, see M. Heitor and M. Bravo (2010), "Portugal on the crosstalk of change, facing the shock of the new: People, knowledge and ideas fostering the social fabric to facilitate the concentration of knowledge integrated communities", *Technological Forecasting and Social Change*, 77, pp. 218-247.

Figure 2 – Total researchers per thousand labour force, 2008

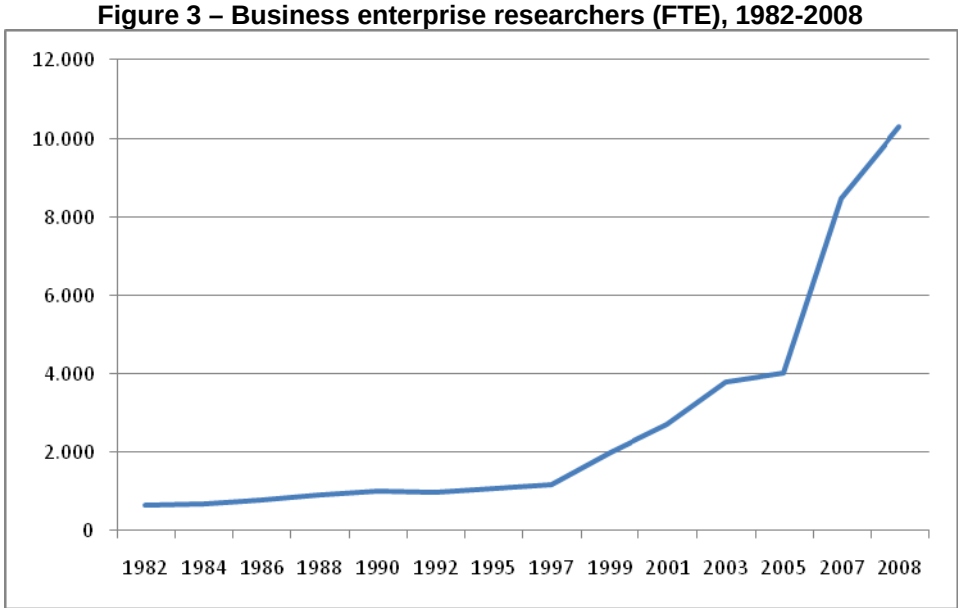


Note: France, Germany, Greece, Hungary,Ireland, Japan, México, EU-27, EU-15: 2007; US, OECD total: 2006; Source: OECD, Main Science and Technology Indicators

2. **Researchers – business sector**: Although the large increases in the values given are also associated with an attempt of the R&D statistics system in Portugal to bring the figures closer to reality by accounting more rigorously the statistical inputs from particular areas of business, the data also show that the increase in overall research personnel has been matched by a significant increase in the total R&D personnel in the business sector, which more than doubled between 2005 and 2007, and increased from 4,014 to 10,315 FTE researchers between 2005 and 2008,. Analysis also shows:

   - This evolution was particularly observed in knowledge intensive sectors where the growth in human resources was especially significant.
   - The human resources in the ICT sector grew from 650 FTE in 2005 to 3,100 FTE in 2007. The financial services have also tripled their human resources in R&D, and the automobile sector had a five-fold increase between 2005 and 2007.

Figure 3 – Business enterprise researchers (FTE), 1982-2008



Source:GPEARI/MCTES

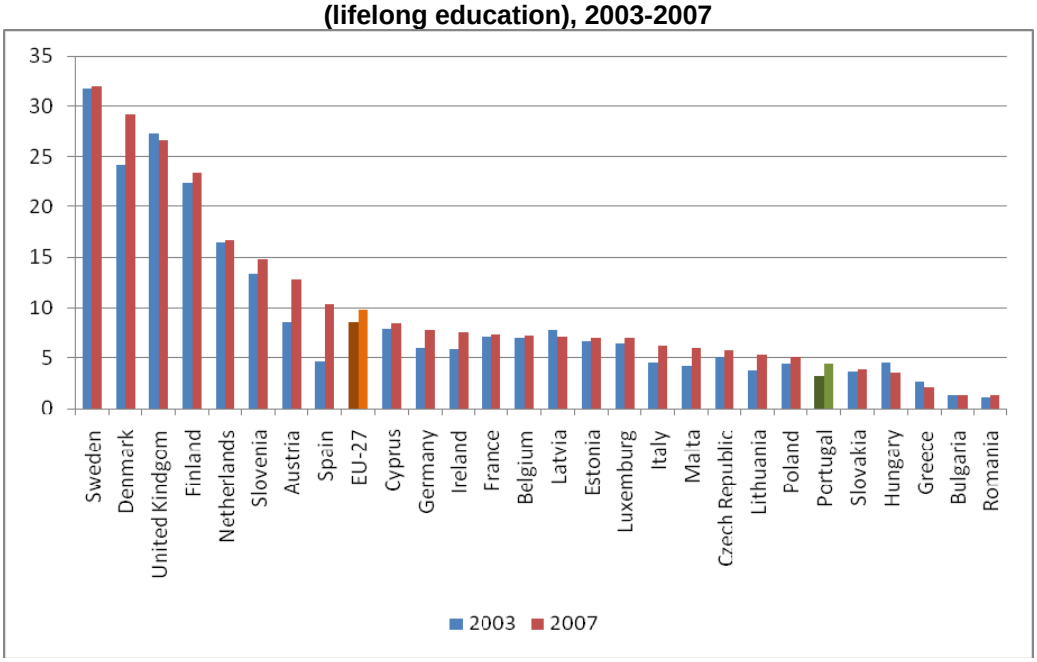
3. **Women in science**: The latest available data show that Portugal has achieved a remarkably high rate of women researchers, particularly in academic research, with their share of the total number of researchers increasing from about 41% in 1997 to 44% in 2007.

4. **Immigration of qualified people**: According to the Ministry of Foreign Affairs, in 2008 Portugal attracted over 500 highly qualified foreigners of more than 40 nationalities outside the European region, more than double the number in 2007. Of the total of 533 highly skilled foreigners pursuing their professions in Portugal in 2008, 88 were researchers, while 132 were academics and the remaining 313 were mostly business professionals, medical and paramedical practitioners, computing experts, electrical engineers, chemical specialists, legal specialists, liberal professionals, and other highly trained personnel.

5. **Lifelong education**: The figures above contrast with the typical participation of the Portuguese population in lifelong education, which is still below the EU average. For example, in 2007 Portugal had only 4.4% of its population aged 25-64 years old engaged in formal lifelong education and training, while that figure for the EU-27 average was 9.7%[2]. This has motivated the program "Novas Oportunidades" (New Opportunities), launched in 2005, to foster new training opportunities and formal competence acquisition for the least qualified population. In 2009, 455 "new opportunities centers" were functioning and more than one million people were enrolled. About 250.000 new certifications were granted. In addition, recent analysis has shown that:

    - According to the UNESCO's Global Monitoring Report 2010, the adult literacy rate (15 years and older) in Portugal was 95% in 2007, when it was only 88% in 1994;
    - In 2008, 5.3% of the Portuguese population aged 25-64 is involved in education and training activities (9.5% for the EU 27 average), which represents a growth of 89.3% since 2000;
    - In 2008, 54.3% of the Portuguese population completed at least secondary education (79% for the EU27 average), which represents the second largest growth in the EU area since 2000 (Portugal growth rate was 26%, while the EU growth rate was 2.5%).

Figure 4 - Percentage of the population aged 25 to 64 participating in education and training (lifelong education), 2003-2007

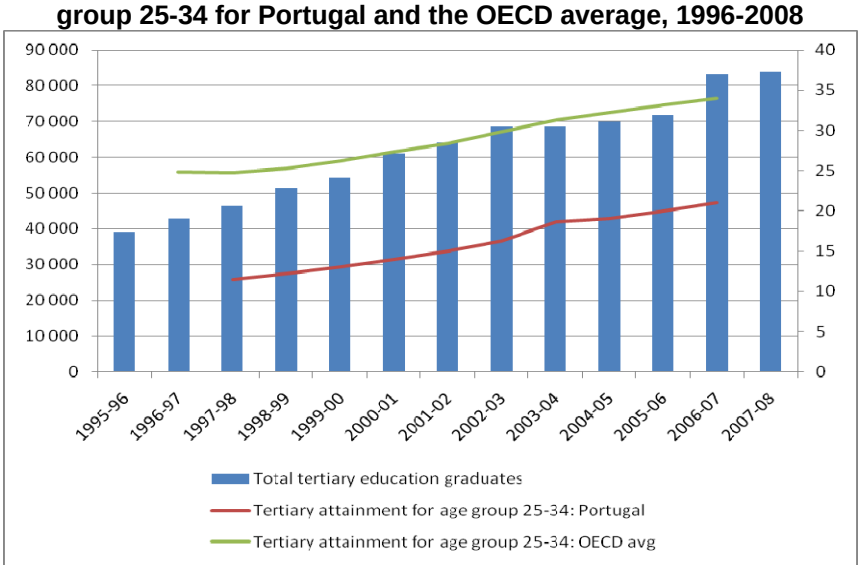


Source: Eurostat

[2] Source: EUROSTAT, www.ec.europa.eu/eurostat, accessed on 29 March 2010

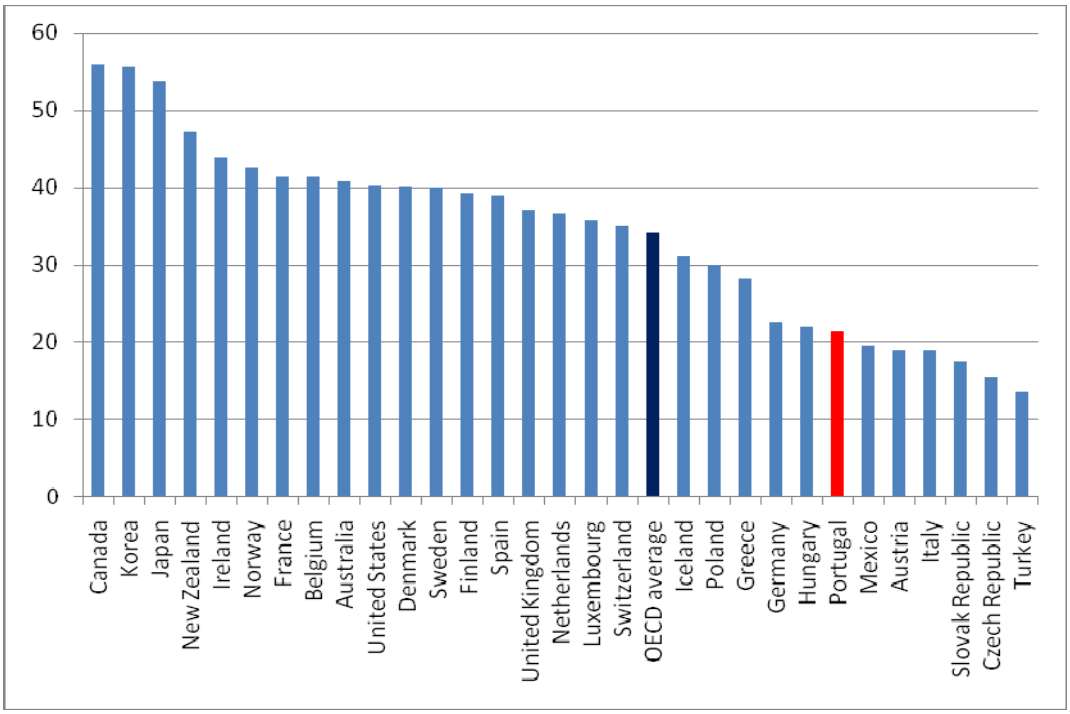
6. **Student enrollment in tertiary education**: Portugal follows the OECD average about students enrolled in tertiary education as a percentage of the total population (i.e., about 4% in 2005, corresponding to about 375.000 students). The number of students currently in tertiary education is important because it determines, in part, a region's future competitiveness in terms of its ability to promote and use innovation. It is obvious that the rise in qualification level of the young Portuguese population is associated with the fact that the Portuguese higher education system grew rapidly in the 1980s and 1990s and opened up to young people of all social classes, rising from 30,000 students in the 1960s, to over 370,000 students since the late 1990s. After a period of relative stagnation, the following figures quantify the current trend associated with the recent reform of tertiary education:
    - Total enrolment in tertiary education of 20-year-olds has increased by 15% over the last three years (2005-2009), reaching about 35% of this age-group (compared to 30% in 2005). In other words, one in three 20-year-olds in Portugal is enrolled in tertiary education. This is similar to the European average, although still lower than that for most industrialized regions. It has resulted mainly from an increase in non-university higher education, which grew at a considerably higher rate than that of university education;
    - Enrolment in tertiary education of adults aged 30-34 has increased by about 20% over the last three years (2005-2009), but it was still relatively low in 2009 and about 4.1% of the corresponding age-group (compared to 3.6% in 2005);
    - Adult enrollment in tertiary education for the 35-49 year old cohort was as low as 2% in 2009 (although with a 39% growth rate between 2005 and 2009).
7. **Higher education graduates**: The total number of graduates per year increased by about 20% over the period 2005-2008, with graduates in S&T rising in recent years to about 18 per thousand population aged 20-29 years (well above the EU average):
    - The fraction of total graduates aged 25-34 was about 21% of the corresponding population in 2007 and this is still low as compared to the current European average (31%) and targets (i.e., 40% for 2020). The OECD average was 34% in 2007;
    - The tertiary qualifications of the Portuguese population aged 25-64 are still below the OECD average. While 21% of the Portuguese population aged 25-34 had a tertiary degree, the related OECD average was 34% in 2007. For the same year, 14% of Portuguese population aged between 25-64 years old had a tertiary degree, while the OECD average was 28%;

Figure 5 - Total tertiary education new graduates in Portugal and tertiary attainment for age group 25-34 for Portugal and the OECD average, 1996-2008

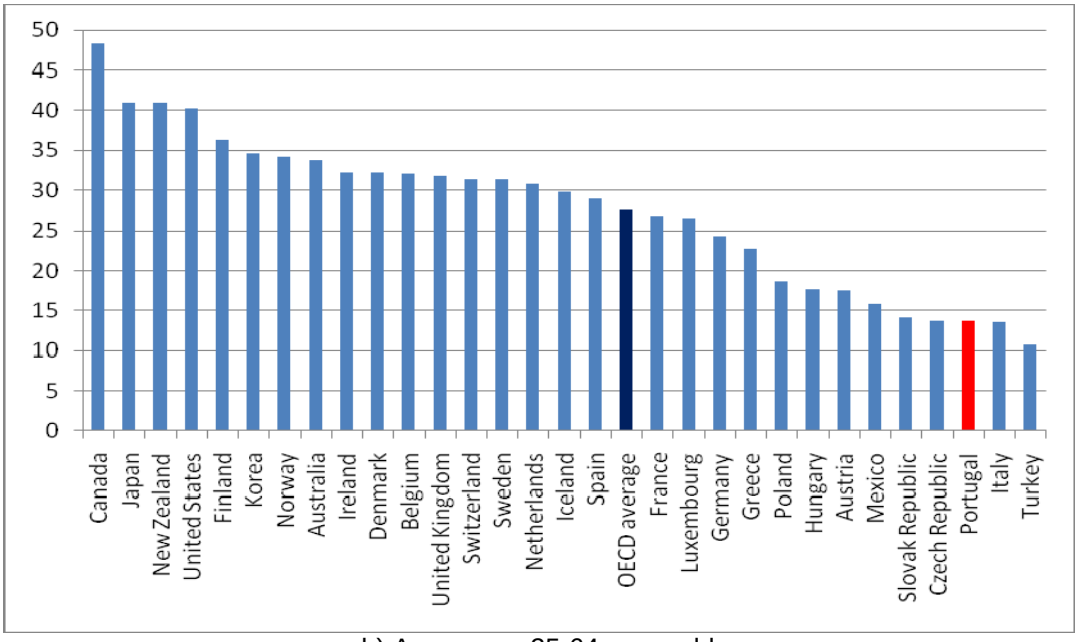


Source: GPEARI/MCTES; OECD Factbook 2009: Economic, Environmental and Social Statistics

Figure 6 - Percentage of the population that has attained tertiary-education, by age group, 2007



a) Age group: 25-34 years old



b) Age group: 25-64 years old

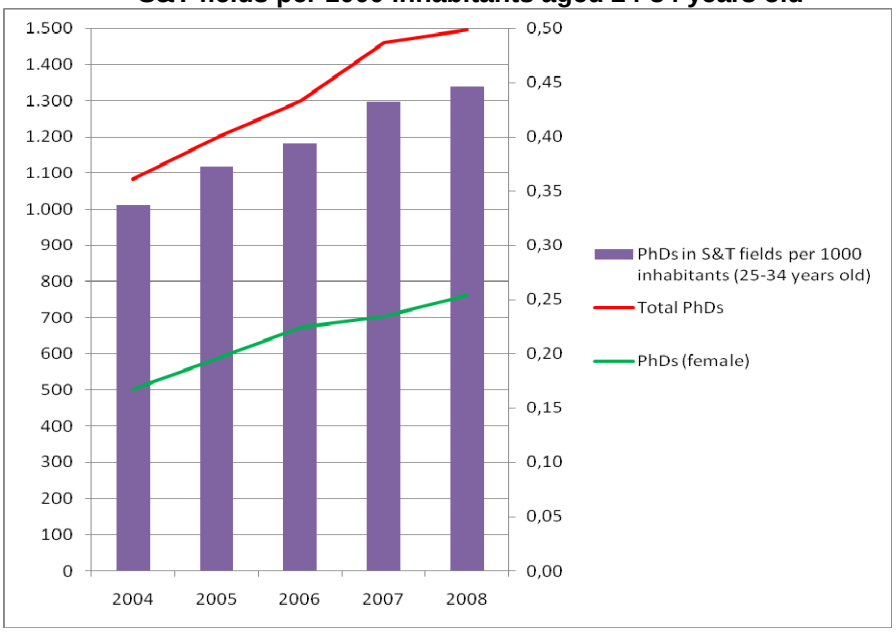
Source: OECD, Education at a Glance 2009

8. **Higher education graduates in Mathematics, Science and Technology (MST)**: The growth of graduates in Mathematics, Science and Technology (MST) in Portugal between 2000 and 2007 was the largest of the EU-27 (14.9% growth in MST graduates per year), with 18.1 MST graduates per 1000 inhabitants aged 20-29 (while 13.4 from the EU-27).

9. Doctorate graduates: the number of doctorates graduates increased over 50% in the last 5 years:

- The number of new PhDs increased to about 1500 in 2008. About 51% of these new PhDs were performed by women;
- At the same time, the number of new PhDs in science and engineering (S&E) per thousand population aged 25-34 increased to 0.45 in 2008, compared to only about 0.3 in 2001.

Figure 7 – Total Portuguese doctorates, female doctorates and percentage of PhDs in S&T fields per 1000 inhabitants aged 24-34 years old



Source: GPEARI/MCTES

10. **Promoting science and technology culture and education**: The systematic development and promotion of activities to foster science awareness, science education and the role of science in the daily life of citizens has been implemented through the National Agency for Scientific and Technological Culture, "Ciência Viva", including:

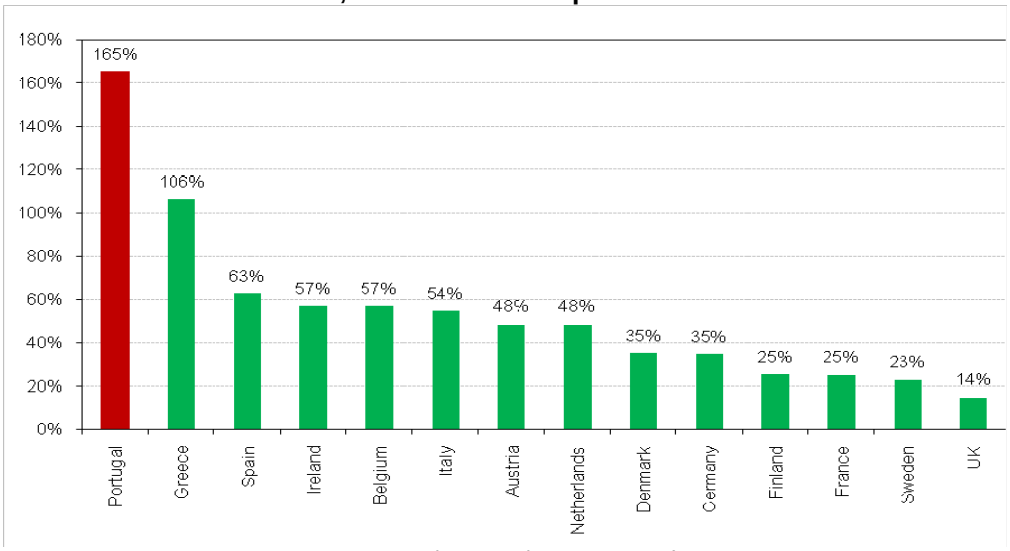
- An integrated network of 18 science centers throughout the country (as launched in 1999, and extended initially to 10 centers in 2005), which will be further expended next year with 3 additional science centers;
- Science awareness, including a large annual program of "science in the summer", which has involved last year more than 17.000 people and over 140 research institutions;
- Science projects in schools, which involved more than 1.000 projects throughout the country in the past two years.
- Science internships for secondary school students, which has involved more that 7000 youngsters (15 to 18 years old) over the last decade.

Knowledge and Ideas

11. **Scientific Production – publications in the Science Citation Index Expanded (SCI)**: The scientific output of Portuguese research institutions, as measured by the number of internationally refereed scientific publications in SCI (which relate to scientific publications in the fields of exact, natural, and health sciences, as well as agriculture and engineering) reached 7.470 articles, letters, notes and reviews in 2009, from 2.702 article, letters, notes and reviews in 2000. Analysis also shows:

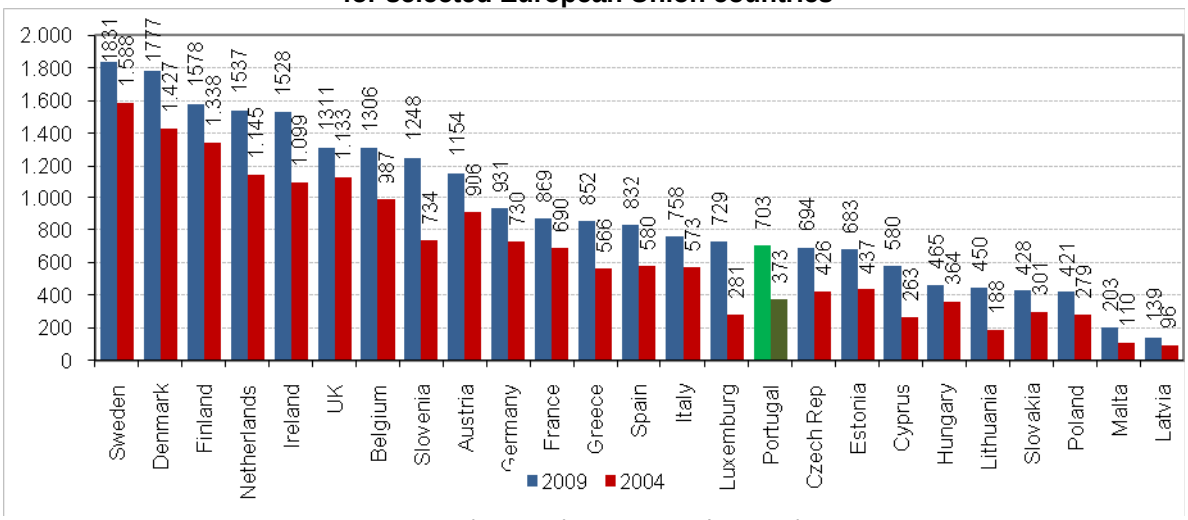
    - Internationally refereed Portuguese scientific articles, letters, notes and reviews in the exact sciences, natural sciences, health sciences, agriculture and engineering increased nearly 2.8 times since 2000;
    - This growth is also perceived by the number of publications by total population which reached 703 articles by million inhabitants in 2009, from 373 in 2004;
    - The number of articles by the total population is now 77% of the EU-27 average when it was only 51% in 2004, suggesting that Portugal's science base in the STEM fields is becoming internationally competitive, although still lacking critical mass.

Figure 8 - Growth rate of articles per million inhabitant (2000-2009) registered in the Science Citation Index, for selected European Union countries



Source: GPEARI/MCTES/Reuters ISI Thomson

Figure 9 – Number of articles in the Science Citaion Index per million inhabitant (2004-2009), for selected European Union countries



Source: GPEARI/MCTES/Reuters ISI Thomson/Eurostat

12. **Scientific Production - Internationalization**: A relevant factor concerning the increasing Portuguese scientific production measured through international refereed publications is related to international collaboration trends. In 2009, nearly half of all publications were published in co-authorship with scientists and engineers based abroad, while this share in 1990 was merely 39%. In this context, it should be noted that the volume of internationally co-authored publications rose from 375 in 1990 to 4886 in 2009, suggesting a rather strong internationalization of the Portuguese science.

13. **Scientific Production - Impact**: The quality of the Portuguese publications in international refereed journals as measured by the number of citations has also shown an impressive growth:

    - In the 2003-2007 period Portuguese publications received nearly 108,000 citations from about 59,000 citations received in the 1999-2003 period. However, the current number of citations is much more impressive when compared with the number of citations received during 1986-1990, which refers to the period right after Portugal joined the EU. Then, Portuguese authored publications refereed internationally only received 5.662 citations. This evolution suggest an increased "quality" of the Portuguese scientific output and indicate that Portuguese publications are achieving greater relevance internationally;

    - While for 1986-1990, only 45% of the Portuguese publications were cited, in 1999-2003, this value reached 60% attaining the mark of 64% in the 2003-2007 period (the same value of the EU-27 average).

    - Regarding the impact that some scientific areas achieved, 19 out of 22 scientific areas considered by the ISI Thomson Reuters increased their impact *vis a vis* the world average from the 1998-2002 period to the 2003-2007 period. In the latter period, the impact of the Portuguese scientific publications in physics, space science, clinical medicine and agriculture were superior to the world average impact.

14. **Overall Scientific Production**: The scientific output of Portuguese research institutions in all scientific fields, as measured through the Science Citation Index Expanded (SCI) together with other data bases such as Social Science Citation Index – SSCI, and Arts & Humanities Citation Index - AHCI, and using the fractional counting method, reached 10.081 publications in 2009, from 3.792 publications in 2000, and just 970 publications in 1990. Analysis also shows:

    - The natural sciences and agriculture reached 2798 publications in 2009, from 889 publications in 2000, and just 218 publications in 1990.

    - The number of publications in the exact sciences reached 2.486 publications in 2009, almost doubling from the 1.279 publications attained in 2000. The publications in the engineering fields also evolved from 621 publications in 2000 to 1.472 publications in 2009.

    - The health sciences and medicine grew from 205 publications in 1990, to 782 in 2000, and 2.668 in 2009

    - The social and human sciences evolved from less than 40 publications in 1990, to 216 publications in 2000 and 581 publications in 2009.

15. **Research capacity for doctorate training**: Analysis about doctorate training shows that:

    - Around 20% of all new PhDs awarded since 1990 have been awarded or recognized in Portugal in the last two years. This reveals the increasing capability of Portuguese universities in offering PhD programs, but it also poses new challenges regarding the mechanisms that guarantee the quality of PhD programs, and the need to strengthen their internationalization and to establish international scientific research networks.

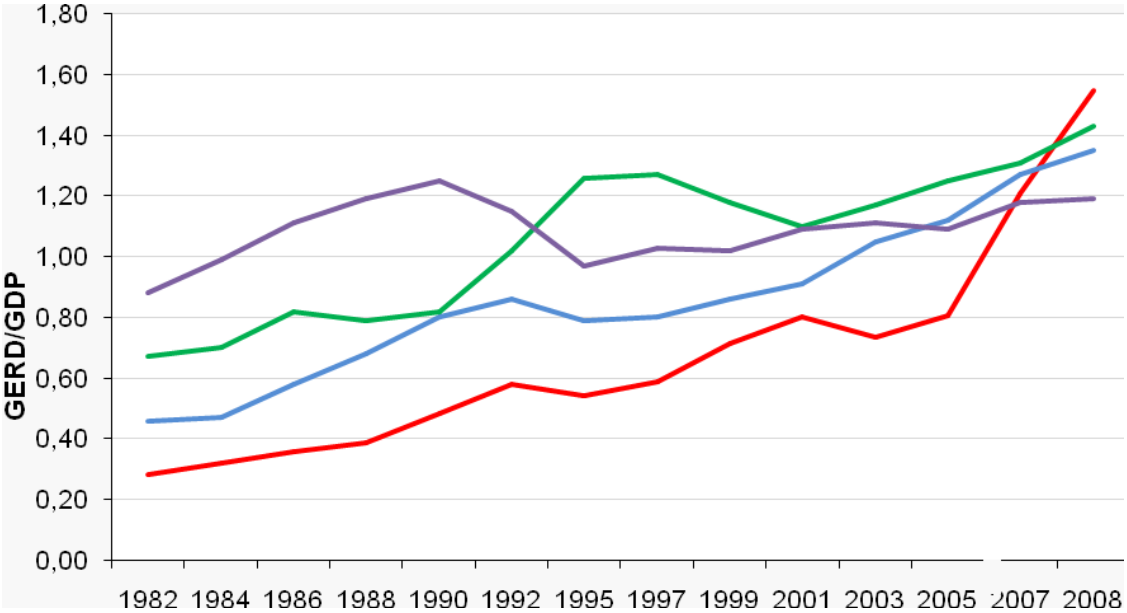
    - The percentage of international students pursuing a PhD in Portugal increased considerably in the last ten years. In 1998-1999, there were only 172 foreign PhD students registered at Portuguese universities, representing 7% of all enrolled PhD students (of these 140 were from countries outside the EU). In 2008-2009, there were 1581 foreign PhD students in Portuguese universities, representing 13% of the total PhDs students enrolled at Portuguese universities (1265 are from countries outside the EU).

16. **Scientific employment**: The rise in PhD holders has been promoted in recent years, together with scientific employment, through a new program launched in 2007 to support contractual arrangements for researchers. Nearly 1200 new PhD researchers were hired by the summer 2009 (of which 41% were foreigners), based at 264 R&D different institutions (mostly in the scientific areas of natural and exact sciences, 43%, and engineering and technology, 24%).

This program is stimulating major changes in the academic community and facilitating the renewal of teaching and research staff. It has double the number of foreign researchers/teachers in Portuguese Universities (Which was only about 3% in 2004).

17. **Gross expenditure in R&D**: The evolution documented in the previous paragraphs is the result of investments: in 2008 the total R&D expenditure in Portugal attained 1.55% of GDP (while it was 0.81% in 2007 and only 0.4% in the late 80´s):
    - It has surpassed that of Spain (1.22%) and that of Ireland (1.31%);
    - Portugal had the highest growth rate of any European country in terms of total R&D expenditure in the period 2005-2007 (about 46% as a percentage of GDP), well above the EU-15 average (only 1%), Spain (9%), and Ireland (5%);
    - Again, we should note that the values given may have been given a positive bias by the efforts of those processing R&D statistics in Portugal to bring the figures closer to reality. Nevertheless, this should not be considered as a methodological change but rather as an attempt to uncover hidden and/or underestimated R&D efforts within a stable methodology. In fact, the total public budget for R&D grew at 11% per year from 2004 to 2009, while it had grown at 10% a year from 1995 to 2002, among the highest figures in Europe.

Figure 10 – GERD as a percentage of GDP for Portugal, Spain, Ireland, Italy, 1982-2008



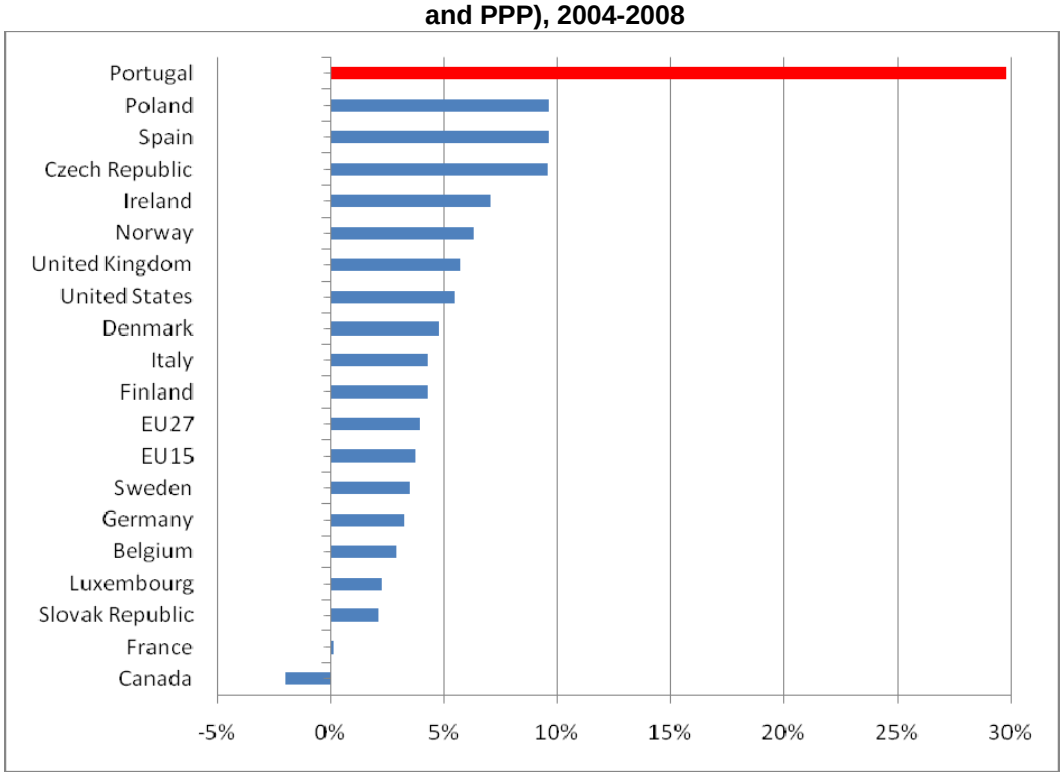
Source: GPEARI/IPCTN 2008; OECD, Main Science and Technology Indicators

18. **Business expenditure in R&D**: The increase in public investment in R&D in recent years in Portugal is matched by a steep rise in companies' investment in R&D, which represented 0.78% of GDP in 2008, while 0.31% in 2005 and less than 0.20% until some ten years ago:
    - The businesses' share of the gross expenditure on R&D (BERD) grew by 71% from 1995 to 2005, a figure unmatched in Europe. But it was only from 2005 onwards that business expenditure on R&D exceeded that of higher education institutions, with overall figures exceeding 1 billion Euros from 2007 onwards;
    - These changes coincided with a review of the tax system for corporate R&D in 2005, in a way that has fostered business expenditure on R&D, as well the employment of research personnel in private corporations. For example, the number of firms applying to this tax incentive has been steadily increasing, from less than 300 firms until 2003, to more than 1000 firms in 2009. The system (SIFIDE) has been considered one of the most attractive tax systems in Europe. It allows for a fiscal deduction of 32.5% in relation to the total R&D

expense, to which can be added a further deduction of 50% associated with the increase of the expenditure in R&D in relation to the previous two years (until a maximum of 1.5 million euros). Consequently, the total tax deduction can reach 82.5% of the total investment in R&D. In addition, the system was recently updated and for 2010 the employment of doctorate researchers can be totally deducted in the first year. The overall tax credit considered in the State Budget for 2010 is about 50 million Euros (it was 27 million Euros in 2008).

- The number of patents applications in the EPO increased by 2.3 times (86 patents in 2008) and the number of granted patents in the USPTO more than tripled between 2005 and 2008 (27 patents in 2008).

Figure 11 – BERD – compound annual growth rate (million dollars 2000, constant prices and PPP), 2004-2008



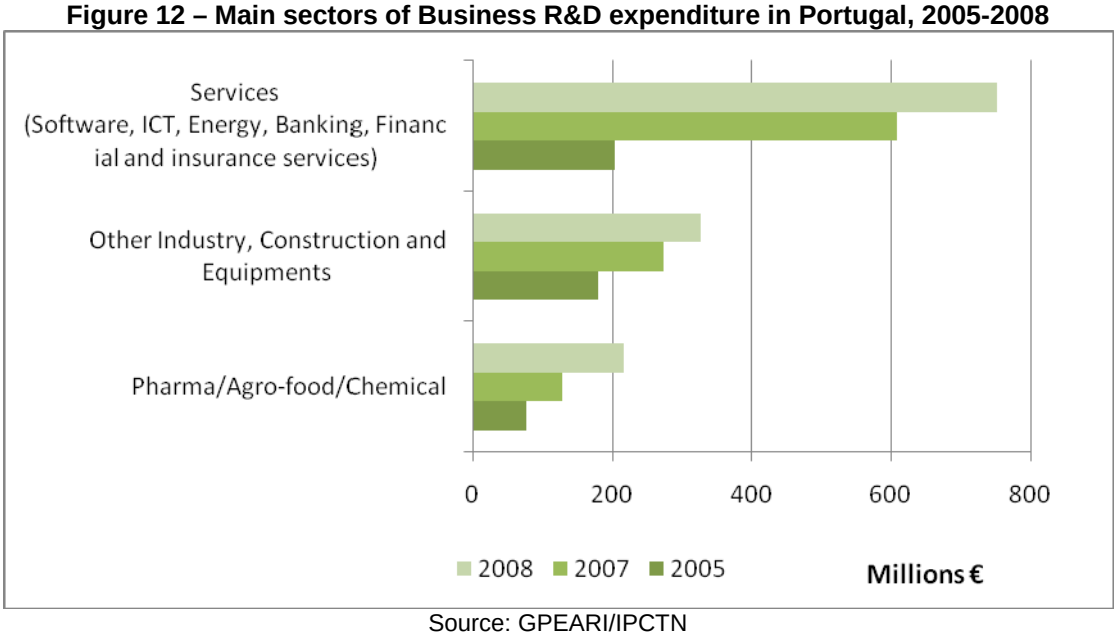
Source: OECD, Main Science and Technology Indicators

19. **Specialization of business R&D**: Knowledge-intensive services, including computing services, communications, financial services and insurance, are the sectors with the highest investments in R&D, and simultaneously those with the highest growth between 2005 and 2008, along with the energy sector (highest growth during that period) and the automotive industry:

    - R&D investment in knowledge intensive sectors has quadruplicated since 2005, of which the financial services and insurance are responsible for the highest increase (nine-fold), while communications registered an eight-fold, followed by computing activities (six-fold).

    - Private expenditure in the energy sector has increased 80-fold, while that in the automotive sector increased seven times. During the same period, R&D investment in the food industry sector increased 3.5 times and the pharmaceutical industry by only 1.5. On the other hand, R&D expenditure decreased during the period 2005-2007 for the electrical appliance and construction sectors, although with a relatively low absolute level overall. This is partly due to methodological issues affecting the classification of companies in the various sectors listed and also to market-related adjustments in these two sectors, which are particularly affected by the demand for construction (especially public infrastructure).

Figure 12 – Main sectors of Business R&D expenditure in Portugal, 2005-2008



Source: GPEARI/IPCTN

20. **Sustainable Business R&D**: The sustainability of the recent increase of the businesses' share of the gross expenditure on R&D (BERD) has been discussed on the basis of the relative spread of the number of companies investing in R&D, which has grown at a considerable speed. For 2008 the analysis shows that:

    - The top 5 most intensive companies in R&D represent 30% of BERD
    - The top 20 most intensive companies in R&D represent 59% of BERD
    - The top 100 most intensive companies in R&D represent 80% of BERD

    These figures suggest that business R&D is not dependent on a few large companies and this is a positive signal towards the goal of continuing increasing the participation of the private sector in the overall national effort to increase the technological intensity of the country. On the other hand, they also suggest that large companies do need to significantly increase their R&D investment in order to foster routines of scientific employment in the private sector, together with the specialization of capacities in emerging areas. In particular, consortia of technology leading companies with scientific institutions can be oriented towards increasing Portuguese exports and as a specific way to better facilitate the penetration of Portuguese companies in emerging markets worldwide.

21. **Technology balance of payments**: The trend shown in the above paragraphs can be further documented through the evolution of the technological balance of payments, which is positive since 2007 for the first time in Portugal. The technology balance of payments records commercial transactions related to international technology and know-how transfers. It consists of money paid or received for the use of patents, licenses, know-how, trademarks, patterns, designs, technical services (including technical assistance) and for industrial research and development (R&D) carried out abroad. Unlike R&D expenditure, these are payments for production-ready technologies.

    The positive evolution of the Portuguese technological balance of payments is associated with the growth of credit (income) from a broad range of markets, including those in the US, the UK and France. The credit analysis of the Portuguese technological balance of payments in 2009 indicates a diversified market portfolio, from which the main features are:

    - The country with the largest market share (in terms of credit) is the UK (15%), followed by Germany (12%), Spain (11%) and the US (9%);

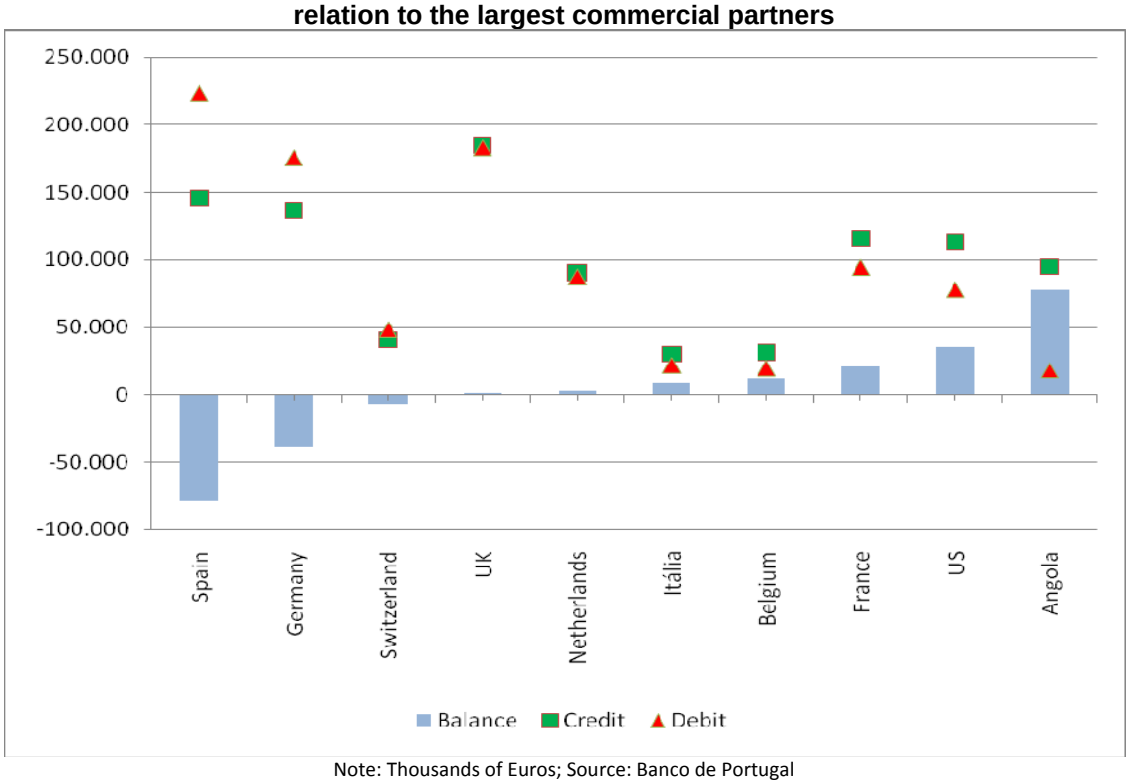
- Spain is the country to which Portugal most acquires technology based services and products (19%). The UK (16%) and Germany (15%) are the other markets where Portugal most acquires such services and products.
- The most positive balance refers to the emerging market of Angola. However, Angola represents only 8% of the total credit and 2% of the total debit in 2009.

Table 1 – Technology Balance of Payments of Portugal, 1999-2009

	Sale, licensing, franchising of designs, trademarks and patterns	Services with a technical content, including technical and engineering studies, as well as technical assistance	R&D services	Other technical services	Balance
1999	**-252.175**	**-120.107**	**-3.160**	**-106.564**	**-482.005**
2000	**-227.406**	**-111.680**	**180**	**-78.090**	**-416.996**
2001	**-232.422**	**-41.113**	**6.040**	**-66.209**	**-333.704**
2002	**-294.419**	**-1.678**	**21.427**	**-81.248**	**-355.918**
2003	**-222.314**	**-32.598**	**3.144**	**-52.830**	**-304.598**
2004	**-259.498**	**-32.744**	**10.037**	**1.753**	**-280.451**
2005	**-221.112**	**-35.700**	**5.276**	**-38.947**	**-290.483**
2006	**-240.867**	**13.791**	**21.306**	**32.785**	**-172.984**
2007	**-129.265**	**149.149**	**13.542**	**88.695**	**122.121**
2008	**-194.294**	**169.698**	**10.359**	**75.601**	**61.365**
2009	**-220.011**	**229.052**	**15.200**	**62.777**	**87.018**

Note: Million of Euros; Source: Bank of Portugal

Figure 13 - Technology Balance of Payments of Portugal (balance, credit e debit), 2009, in relation to the largest commercial partners



Note: Thousands of Euros; Source: Banco de Portugal

A longitudinal analysis of the balance of the Portuguese Technology balance of payments in relation to the markets is highlights a greater competitiveness of Portuguese firms in highly competitive markets:

- The balance of the Portuguese Technology of payments kept a positive trend from 1999 to 2009 in the following countries: Angola (where the positive balance grew substantially from 2006 onwards) and Italy (except on 2002 and 2003);
- The balance of the Portuguese Technology of payments kept a negative trend from 1999 to 2009 in the following countries: Germany, Spain (except in 2007: the balance of payments is positive) and Switzerland (except in 2003 and 2004: the balance of payments was positive).
- The balance of the Portuguese Technology of payments became positive in the last two to three years in the following countries: Netherlands (since 2008), France (since 2007), UK (since 2009) and US (since 2007)

22. **Technology-based start-ups**: An assessment on national inventors, entrepreneurs and companies carried out in Portugal over the last year by the recently formed University Technology Enterprise Network (UTEN), shows: (1) an emerging technological capacity located in Portugal; (2) an increasingly effective university-research connection; (3) a clear commercialization interest and potential. Analysis also shows:
    - Indicators of economic activity show that the proportion of knowledge based firms in Portugal grew from 6.4% in 1991 to 9.8% in 2003, corresponding to a 3% growth in the number of firms involved in knowledge related activities. Many new firms have been funded in this time period, having tripled the number of new firms in knowledge-intensive sectors.
    - This growth is mostly based on business services, were high-tech services (including communications and computer activities) represent 10% of the total number of new firms, and 70% of all new firms in high-tech sectors. Other relevant sectors accounting for new start-ups are the medical devices sector, responsible for 6% of all new firms in the period 2002-2007, followed by the pharmaceutical (2.5%), the industrial equipment (2%), and the fabrication of electronic components (1.5%). These firms represent the high-growth activities, also with higher survival rates.
    - Individuals starting these new high-tech firms vary in their education background: 27% of the entrepreneurs are graduated in engineering, 18% in medical sciences, 9% of the entrepreneurs are graduated in administration and commercial trade, and 9% in humanities. In addition, firms in these sectors have a higher proportion of graduates, and the total workforce of firms in knowledge intensive sectors has on average 9.9 years of schooling.

<u>Institutional Development - 1: Steering and Funding of R&D</u>

23. **R&D landscape - Instruments**: Science policy has evolved over the last decade on the basis of the following main instruments and funding levels:
    - Advanced training of human resources, including a competitive program of PhD fellowships, which was considerably enlarged since 2006 to about 2000 new fellowships per year (it was about 1000/year in 2005) and a Program of Post-doctoral fellowships, also in a competitive basis (about 500 new fellowships per year). By the end of 2009, over 7.000 fellowships were actively funded (they were about 4.500 in 2005), with an overall public expenditure above 140 million Euros;
    - Scientific employment, through a new program launched in 2007 to contract post-doctoral researchers in a competitive basis (5 years contracts), which involves over 1200 new contracts by Portuguese Universities and Research establishments by the end of 2009, with 41% of foreigners, with an overall public expenditure above 60 million Euros;
    - Institutional development, through a program to seed-funding of research centers throughout the country (in universities and related private, non-for profit institutions), based upon their periodic evaluation, which involved over 80 million Euros in 2009;

- Fostering competitive activities, through the systematic opening of national competitions for funding R&D projects in all scientific areas, involving over 3300 active projects by the end of 2009, with an overall public expenditure about 80 million Euros;
- Promoting scientific and technological culture, through the systematic development and promotion of activities to foster science awareness, science education and the role of science in the daily life of citizens, as implemented through the National Agency for Scientific and Technological Culture, "Ciência Viva", with an overall public expenditure over 15 million Euros in 2009;
- Promoting internationalization, through the systematic participation in large international organizations (CERN, EMBL, ESO; ESA; among others), the development of bilateral cooperation in S&T and the promotion of strategic international partnerships. Overall public expenditure has been about 50 million Euros in 2009;
- Promoting scientific infrastructures, which has involved funding a diversified network of physical installations and equipments, with an overall public expenditure over 90 million Euros during the last five years;
- Maintaining the National Science and Education Network (NREN) of information and communications as a fully fledged "Next Generation Network" with advanced services connecting all research establishments and higher education institutions with very high speed broadband and reaching 80% of all the national scientific and higher education system with fiber infrastructure operated at 10 Gbps and owned by the Portuguese NREN, providing online free access to about 17,000 scientific journals subscribed by a "big deal" at national level, developing the Open Access Scientific Repository of Portugal which involves 25 institutional repositories including all public universities and from its creation in the end of 2008 grew fourfold to reach 40.000 documents, assuring low-cost voice communications to facilitate collaborative work by adopting VoIP for the whole public higher education system and developing and associated free video- and tele- conferencing system easily available at each researcher's desk, as well as other "e-science" related activities, with an overall public expenditure over 25 million Euros in 2009.

24. **R&D landscape – strengthening institutions**: Over the last decade, institutional development in S&T has been based on two main pillars:
    - Strengthening and restructuring the network of research centers throughout the country (in universities and related private, non-for profit institutions) through a systematic international evaluation every three years, with direct impact on their funding levels, which has been consistently implemented in Portugal since 1996;
    - Promoting critical mass across all scientific disciplines by establishing a network of selected "Associate Laboratories" in the form of relatively large research consortia oriented towards thematic networks in a number of selected institutions after an international assessment.

    By 2009, the network of scientific institutions included 510 research centers (257 after the 1996 evaluation) and 25 Associate Laboratories (with the first three launched in 2001), with an overall level of institutional funding about 80 million Euros in 2009 (25 million Euros in 1999).

25. **Fostering research networks, through international partnerships**: It is in this context that a revised approach to institutional development has recently been launched, with particular emphasis on institutional cooperation at national and international levels, as a way of encouraging scientific activity in networks that promote inter-institutional relations. As well as helping to overcome the effects of the limited size of some research units, developing such science-based networks is intended to encourage the creation and dissemination of new knowledge and stimulate scientific development in a climate of constant change and growing internationalization of the scientific base. Under this broad scope, the following actions deserve special mention:
    - A strategic program of international partnerships in science, technology and higher education was initiated in 2006 and by September 2007 the first doctoral and advanced studies programs were officially launched, bringing together several Portuguese universities and leading universities worldwide, including MIT, Carnegie Mellon University

and the University of Texas at Austin. Unprecedented in Portugal, these programs facilitated the creation in 2007 of effective thematic networks involving a large number of Portuguese institutions with the objective of stimulating their internationalization through advanced studies projects and sustainable schemes to stimulate new knowledge and exploit new ideas in collaboration with companies and internationally renowned institutions, as follows:

- The MIT-Portugal Program, http://www.mitportugal.org/, launched on October 2006 in the field of "engineering systems", attributing special emphasis to the complex processes associated with industrial production, sustainable energy, bio-engineering and transport systems, in which Portuguese and MIT faculty and researchers identified three main thematic areas for research and development in close cooperation with an industrial affiliation program. They include sustainable energy and transportation systems, stem cell engineering for novel therapies in regenerative medicine, and materials and design-inspired products with specific applications in electric mobility and new medical devices. Overall, the program involved over 340 master and doctorate students at the beginning of its third year in September 2009.
- The MIT-Portugal Program was recently strengthened and opened to additional partners through three thematic research networks, namely on: 1) The Sustainable Cities Forum and Research Network; 2) Sustainable Energy Systems and Electric Mobility Research Platform and Network, or the "E2 Research Net"; and 3) Stem Cell Engineering and Clinical Research net, or "StemCellnet".
- Through the joint program with MIT, co-operation with the Sloan School of Management was strengthened through an international MBA program, "Lisbon MBA". This involves co-funding from seven major Portuguese companies and banks in a way that will stimulate new research and the quality of education in management sciences in Portugal.
- The Carnegie Mellon Portugal Program, http://www.cmuportugal.org/, was launched in October 2006 with emphasis on information and communication technologies, in particular the so called Future Internet technologies and services, and involving dual professional masters and PhD programs by Portuguese institutions and Carnegie Mellon University. The areas covered include new generation networks, software engineering, cyber-physical systems for ambient intelligence, human-centric computing (including language technology), public policy and entrepreneurship research, and applied mathematics. Overall, the program involved about 170 master and doctorate students at the start of its third year in September 2009.
- The Carnegie Mellon Portugal program launched three new innovation networks, whose goal is to consolidate and expand the successful cooperation among all partner institutions and industrial affiliates: 1) Security and Critical Infrastructure Protection (NET-SCIP); 2) Future Internet Services and Technologies (NET- FIT); and 3) Services and Technologies for Interactive Media (NET-STIM).
- Under the University of Texas in Austin-Portugal program, a "Collaboratory for Emerging Technologies, CoLab" was launched in March 2007, http://www.utaustinportugal.org/, focusing on collaborative research in advanced interactive digital media and integrating advanced computing and applied mathematics. Overall, the program involved about 70 doctorate students at the start of its third year in September 2009.
- Also under the joint collaboration with the University of Texas in Austin, a "University Technology Enterprise Network, UTEN" was established in 2007 and oriented towards international technology commercialization and the professionalization of university technology managers.
- The Harvard Medical School-Portugal Program on translational research and information, http://www.hmsportugal.org/ , which has established a new collaborative framework, launched in May 2009, to foster translational and clinical research programs and the development of a new infrastructure for delivering medical information produced by medical schools to medical students across the academic institutions, to health practitioners and to the general public, thus contributing to strengthen the relationships of medical schools and health science institutions with their main constituencies.

- The launching of Portuguese-Spanish networks oriented towards new developments and applications of nanosciences, within a boarder framework associated with the establishment of the International Iberian Nanotechnology Laboratory (INL). This Laboratory was created by an international treaty between Portugal and Spain signed at the end of 2006 which is at the final stage of installation in Braga (Northern Portugal). It is the first research laboratory set up under international law in the Iberian Peninsula and it is the first such institution worldwide explicitly focused in nanotechnology. It is expected to achieve a reputation as an international institution of excellence in application areas of food and water quality, environmental monitoring and nanomedicine, conceived for about 200 researchers from all over the world, a total of 400 people, and an annual investment and operational budget of around 30 million Euros that is being funded equally by both countries. It is expected that this Laboratory will develop strong links with industry and will attract the membership of more European countries and countries of other continents.
- Co-operation with the Fraunhofer Gesellschaft for the establishment in Portugal of the first Fraunhofer Institute in Europe outside Germany through the recently established Fraunhofer Portugal Research Association. This is an ambitious project focusing on emerging information and communication technologies, such as "Ambient Assisted Living", to be complemented by the establishment of R&D consortia and co-operative projects involving several Portuguese institutions and Fraunhofer institutes in Germany.

Strengthening the internationalization of higher education and S&T is recognized as a way to stimulate the integration of national institutions in emerging scientific networks at an international level. In general, internationalization should be a full component of all higher education institutions, stimulating the mobility of students and academic staff and strengthening scientific and academic activities in networks.

Projects of interest to Portuguese industry have been launched, and this synergy has been extended by industrial affiliation programs, especially in stem cell engineering for regenerative medicine, automotive engineering, low-energy systems (via the MIT-Portugal Program), telecommunications and information systems (via the CMU-Portugal and Fraunhofer-Portugal Programs) and interactive digital media (via the UT Austin-Portugal Program). A network of technology transfer offices to support the development and internationalization of technology-based entrepreneurial projects has also been developed under the scope of the University Technology Enterprise Network (UTEN).

Institutional Development - 2: Reforming Tertiary Education[3]

26. **Reforming degrees and diplomas - The Process**. The implementation of the full regulation designed to bring higher education in Portugal in line with the Bologna process was carried out very successfully and at the same time as part of a profound legal reform of the higher education system. This overall reform process was launched in autumn 2005 through an international assessment of the higher education system and its institutions, involving organisations of recognised experience and standing such as the Organisation for Economic Co-operation and Development (OECD)[4], the European Network for Quality Assurance (ENQA)[5] and the European University Association (EUA)[6]. At the end of 2006 the OECD presented an overall evaluation of the higher education system, while ENQA presented an evaluation of the system of quality assurance of higher education and accreditation practices. A voluntary programme of institutional assessment has also been conducted by EUA.

    The first step in the reform was an Act amending the Basic Law of the Education System, passed by Parliament in order to provide the legal basis for implementing the Bologna Process of higher education reform. This was followed by the regulatory Decree-Laws passed by the

[3] See, for example, M. Heitor (2008). "A system approach to tertiary education institutions: towards knowledge networks and enhanced societal trust". *Science and Public Policy*, 35 (8), pp. 607-617.

[4] OECD (2007) Reviews of National Policies for Education: Tertiary Education in Portugal, OECD, Paris.

[5] ENQA (2006), Quality Assurance of Higher Education in Portugal: An assessment of tehe xisting system and recommendations for a future system", European Network for Quality Assurance (ENQA), Helsinki, Finland.

[6] For details, see www.dges.mctes.gov.pt

Cabinet, in particular the Legal Framework of Higher Education Degrees and Diplomas (i.e., Decree-Law no. 74/2006), establishing the general principles for the organization of degree programs and their accreditation, and establishing transition rules for the reorganization of existing degree programs and the creation of new ones. This has had a significant mobilizing effect throughout the higher education system and full institutional adaptation to Bologna has been achieved in the current academic year (it was about 90% in 2007/08). The following developments have also taken place:

- New legislation was passed, regulating the creation of post-secondary education programs (i.e., Technological Specialization Courses, CETs, by Decree-Law no.88/2006), aiming at increasing the availability of technical and vocational education and widening access to such programs for new publics. This process has brought a new dynamism to post-secondary education in Portugal, in particular at polytechnic institutes. About 5000 students were enrolled in these programs every year since 2007/08 (compared to around 1000 students in 2005), which represents a significant opening up of higher education in Portugal.
- New legislation was passed, providing greater flexibility in admissions and access to higher education, in particular for students aged over 23 and those meeting certain specific educational qualification criteria, thereby widening the recruitment pool and making it possible to reverse the decline in student numbers in higher education observed in recent years. Above 10.000 new students were enrolled in higher education through this type of mechanism since 2007/08 (up from around only 900 adults who started higher education in the 2005-06 academic year), representing another significant opening up of higher education in Portugal.
- The implementation of a mechanism to ensure compliance with the Bologna Process, by creating follow-up methods to monitor the transition from an education system based on knowledge transmission to a system based on development of students' skills, in which experimental and project work components, among others, and the acquisition of key skills will play a decisive role.
- The implementation of easier and more flexible procedures for access to higher education. This includes the possibility for anyone interested to attend individual curricular units/courses, with a guarantee of certification and accreditation in the case of successful completion, when they enter a program which includes those curricular units/courses; the opportunity for students on a given higher education program to attend curricular units/courses not included in their cycle of studies and provided in any higher education establishment, with a guarantee, in the case of successful completion, of certification and inclusion in the diploma supplement; and the opportunity to attend a higher education program on a part-time basis.

27. **Reforming the legal framework - The Process**. Following the OECD report of December 2006, the reform of the legal frameworks for the higher education system and the higher education quality assessment system were passed by Parliament and published in the second half of 2007. It brings about significant changes in the internal governance system of higher education institutions (including their management structure), as well as in their relations with society (including internationalisation, research partnerships and business links, as well as external assessment and accountability). The following points should be noted:

    - The new Legal Regime of Higher Education Institutions (RJIES; Law no. 62/2007, of 10th September), establishes the organizational principles of the higher education system, defining the autonomy and accountability of institutions, establishing governing Boards with external participation, allowing for diversity of organization and of legal status of public institutions (these can become public foundations under private law), allowing for the establishment of consortia, and recognizing research centers as part of the university management framework.
    - The new legal framework for the assessment of higher education (Law no. 38/2007, of 16th August) and the creation of the Higher Education Evaluation and Accreditation Agency (Decree-Law no. 369/2007, of 5th November), both designed to ensure the quality of higher education through the assessment and accreditation of higher education institutions and their cycles of studies, according to best international practices, in which independent external assessment is mandatory.

- The introduction in autumn 2007 of an innovative system of student loans with mutual guarantee underwritten by the State, which complements the system of public grants, thereby improving access to higher education for all students. About 11.000 loans had been contracted up to December 2009 through the banking system; this represents an important new achievement for Portugal and Portuguese families, which follows current practices in modern societies at the OECD level.
- The creation of a National Qualifications System (Decree-Law no. 396/2007, of 31st December) and the establishment of the National Qualifications Agency (Decree-Law no. 276-C/2007, of 31st July), which has specific functions to regulate, accredit and control the quality of vocational and professional education, establishing the necessary conditions to foster access to tertiary education.

It should be noted that each of the legal documents described above and part of the legal reform of higher education was implemented after a wide-ranging consultation process with diverse higher education stakeholders, notably the Council of Portuguese University Rectors, the Coordinating Council of Polytechnic Institutes, the Portuguese Association of Private Higher Education, students' associations, and professional associations.

28. **Reforming the legal framework – The new "University Foundations"**. Following the OECD Review, the new legislation approved (RJIES; Law no. 62/2007, of 10th September) allows public institutions (universities and polytechnics), on a voluntary basis, to acquire independent legal status in the form of public foundations governed by private law. Granting independent legal status to institutions of tertiary education is one means of giving them greater autonomy:
    - By then end of 2009, three universities have acquired this status, namely: i) The University of Porto, the largest Portuguese public University, with about 30.000 students, that brought together into de Foundation four large non-for profit research organizations created over the last two decades by several research groups associated with University of Porto; ii) The University of Aveiro, a medium-size public University, with about 13.000 students; and iii) ISCTE – The Lisbon University Institute, one of the smallest public Universities, with about 6.000 students, integrating a business school and two large non-for profit research organizations created over the last two decades by several research groups associated with ISCTE;
    - A university foundation has typically four main defining features[7]: (i) it is an independent legal entity; (ii) it has a mission (or charter or mandate) to serve defined public (or national or societal) interest in tertiary education and research; (iii) as a not-for-profit public interest legal entity, has favorable tax treatment on its incomes, assets and trading activities undertaken in the pursuit of its foundation goals; and (iv) it has the autonomy to raise funds and manage its assets in pursuit of the foundation goals. In its more extensive form, it may grant the rights to: borrow and raise funds; own building, equipment and other financial assets; fully control budgets to achieve objectives; set internal administrative and management procedures; set academic courses and evaluation procedures; employ and dismiss academic and other staff; set salaries and reward systems; set criteria and size of student enrolment; and set the level of tuition fees;
    - University foundations may have a number of advantages. First, institutional leadership has the maximum autonomy to pursue its goals with little external constraint. Second, institutional leadership can plan with a long term view without being subjected to changes in government's budgetary policies. Third, there are new opportunities for generating additional resources. Finally, accountability is placed on the shoulders where responsibility rests. There are also a number of potential shortcomings. For example, running a foundation requires a new set of skills that the institutional leadership may consider difficult to acquire. In addition, staff may see the transition from a public service status to a university employee status filled with risks and uncertainties. There are also concerns about the feasibility of foundations, for example as a result of not high enough scale or sufficient expertise to run foundations.

[7] A. Hasan (2007), Independent Legal Status and Universities as Foundations, a paper prepared for the Ministry of Science, Technology and Higher Education of Portugal.

29. **Reforming the legal framework - The new Accreditation and Evaluation Agency**. Following the ENQA report of November 2006, the new Legal Framework for the Evaluation of Higher Education has been introduced (Law no. 38/2007, of 16th August) and a new Higher Education Evaluation and Accreditation Agency ('A3ES') is being implemented (Decree-Law no. 369/2007, of 5th November), which is fully operational since July 2009.

Following similar practices in Europe, auditors and reviewers appointed independently will look at how institutions align the academic standards of their degrees. They will also ascertain whether institutions have means of ensuring that degrees and qualifications are of an academic standard consistent with European standards.

Table 1 identifies the different levels of higher education qualifications in Portugal. Each level is illustrated by, and each degree determined by reference to, a qualification descriptor. The qualification descriptors reflect the distinct levels of intellectual achievements associated with the typical qualifications awarded by higher education institutions in Portugal in accordance with their degree-awarding powers. Typically, programmes leading to higher education qualifications, particularly those taken over a number of years, include learning that is progressively more challenging. For the award of a higher education qualification at a particular level, the outcomes of this learning must, in overall terms, reflect the qualification descriptor for that level.

Table 1: Higher education qualifications in Portugal and the corresponding level of EQF and cycle of the FQ-EHEA

<table>
<tr><th>Higher education qualifications in Portugal</th><th>Corresponding FQ-EHEA cycle</th><th>EQF levels</th></tr>
<tr><td>Doctoral degrees</td><td>Third cycle qualifications</td><td>8</td></tr>
<tr><td>Doctoral course diplomas</td><td>-</td><td>-</td></tr>
<tr><td>Master's degrees</td><td rowspan="2">Second cycle qualifications</td><td rowspan="2">7</td></tr>
<tr><td>Integrated Master's degrees</td></tr>
<tr><td>Master's course diplomas</td><td>-</td><td>-</td></tr>
<tr><td>Licenciatura degrees</td><td>First cycle qualifications</td><td>6</td></tr>
<tr><td>Higher education short cycle diplomas</td><td>Short cycle qualifications (within or linked to the first cycle)</td><td rowspan="2">5</td></tr>
<tr><td>Technological Specialisation Diplomas</td><td>Short cycle qualifications (within or linked to the first cycle)</td></tr>
</table>

Within the Framework for Qualifications in the European Higher Education Area (FQ-EHEA), the term 'cycle' is used to describe the three sequential levels identified by the Bologna Process (first cycle, which can include short cycle qualifications, second cycle and third cycle) within which all European higher education qualifications are located. In broad terms, the first cycle corresponds to undergraduate degrees (i.e., Licenciatura degrees), and the second cycle and third cycles to postgraduate degrees (i.e., master's degrees and doctoral degrees, respectively). Similarly to several National Frameworks of Qualifications in Europe, including Portugal, the FQ-EHEA has generic qualification descriptors for each cycle, called the 'Dublin descriptors'. These illustrate the typical abilities and achievements associated with qualifications that signify the completion of each cycle.

In many other European countries, as in Portugal, some higher education qualifications are available to students who have undertaken a programme of study within the FQ-EHEA first

cycle, but which do not represent the full extent of achievement for this cycle. These qualifications are referred to as higher education short cycle diplomas (within or linked to the first cycle) and may prepare students for employment (also providing preparation for the subsequent completion of the first cycle).

At a post-secondary level, higher education institutions can also provide qualifications associated with Technological Specialisation Courses (CETs), leading to a Technological Specialisation Diploma. By their nature and objectives, these qualifications are short cycle programmes, with the main goal of preparing students for employment, but also providing preparation for, and access to, the first cycle.

Table 1 also indicates the relationship between the levels of the FHEQ-Portugal, the levels of European Qualifications Framework for Life-long Learning (EQF), and the cycles of the FQ-EHEA. When positioning higher education qualifications within the FHEQ-Portugal, higher education institutions should ensure that the achievements represented by qualifications are appropriate and represented consistently. Higher education institutions are responsible for demonstrating that each of their qualifications is allocated to the appropriate level of the FHEQ-Portugal.

30. **A new framework fostering student mobility**: The reform of the higher education system in Portugal has included the implementation of a series of measures which seek to ensure the effective and less bureaucratised national and international mobility of students and graduates, aimed at attracting and encouraging the settlement in Portugal of qualified human resources, both Portuguese and foreign. Mobility of students and graduates depends on the recognition of their prior learning and qualifications, which is required when they move between qualifications or cycles in order to access more advanced programmes.

    - First, new regulations were introduced for mobility of students between national higher education institutions, from the same or different subsystems, as well as between national and foreign higher education institutions, based on application of the European Credit Transfer and Accumulation System (ECTS). These regulations are based on the principle of mutual recognition of the value of training undertaken and competences acquired. This purpose was specifically set out in the Legal Framework for Degrees and Diplomas (Article 45 of Decree-Law no. 74/2006, of 24th March) which establishes that higher education institutions will take into account the level of credits and the academic area in which they were obtained and will: i) credit within their cycles of studies training undertaken within the scope of other higher education cycles in national or foreign higher education institutions; ii) credit within their cycles of studies training undertaken within the scope of Technological Specialization Courses (CETs) under the terms fixed by the respective statute; and iii) recognise, through the award of credits, professional experience and post-secondary training.
    - Second, new regulations were implemented for re-entering higher education, changing programmes and transferring between higher education institutions (Ministerial Order no. 401/2007, of 5th April), by means of which all obstacles are removed to re-entry for those who have interrupted their higher education studies, and the procedures for transfer or change of course are altered, integrating students coming from both national and foreign institutions into a single system, extending limits to admission and simplifying procedures.
    - Third, a new regime was implemented for the recognition of foreign academic degrees of the same level and nature (and with the same objectives) as Licenciatura, master's and doctoral degrees awarded by Portuguese higher education institutions, entitling holders to all the rights associated with these academic degrees (Decree-Law no.40/2007, of 20th February):
        - This new regime is based on the extension to Licenciatura and master's degrees of the system established for doctoral degrees in 1997 (Decree-Law no. 216/97, of 18th August). It is based on the principle of reciprocal trust that should be adopted by the international academic community, replacing, in all cases where applicable, the process of equivalence based on the academic re-assessment of work carried out with the aim of obtaining a foreign degree.
        - The simplified mechanism for the recognition of foreign degrees is entrusted to a committee, presided over by the Director-General of Higher Education, and including

one representative each of the bodies representing higher education institutions (the Council of Portuguese University Rectors, the Coordinating Council of Polytechnic Institutes and the Portuguese Association of Private Higher Education), and a fifth member, co-opted by the others.

- For the purposes of the simplified recognition process, a number of foreign degrees are recognised after consultation with the above-mentioned committee, and this group is then constantly updated and extended. The recognition process includes (i) academic degrees awarded by foreign higher education institutions of a state signatory to the Bologna Process, following a first, second or third cycle organized in accordance with the Bologna Process and accredited by an accreditation body recognized within the scope of that process, and (ii) all academic degrees awarded by foreign higher education institutions which, through a decision from the above-mentioned committee, are classified as such. The recognition mechanism also includes a simplified mechanism for recognizing the final classification.
- This has removed a serious obstacle to the free circulation of diploma holders who wish to study in Portugal after obtaining their academic degree abroad, and are now welcomed without the bureaucratic impediments and delays that hitherto existed.

o Fourth, with the aim of ensuring greater flexibility in accessing and attending higher education, new norms were introduced (Decree-Law no. 107/2008, of 25th June), in order (i) to enable any interested citizen to enroll in individual curricular units, with a guarantee of both certification and accreditation in the case of successful completion and when they enroll in a cycle of studies that includes it; and (ii) to enable students enrolled in a higher education cycle of studies to enroll in curricular units which are not part of their cycle of studies and in any higher education institution, with a guarantee of certification in the case of successful completion, and inclusion in the diploma supplement.

o Finally, similarly to the practices in other countries, particularly in the USA, and to promote diversity of academic and educational backgrounds for candidates applying for higher education programs in Medicine, a new regime for access to Licenciatura degrees in this area was created (Decree-Law no. 40/2007, of 20th February) specifically designed for undergraduates with a diploma in a related scientific field (such as biology, physics, or chemistry), thus broadening the areas of training which will permit people to be admitted into a course of Medicine, although guaranteeing an appropriate level of knowledge in the core subjects which are an enrolment condition.

31. **Early outcomes of the Tertiary Education reform**: Overall, the success of the reform is demonstrated by a significant increase in the number of students enrolled in higher education. In fact, the decline in new students entering higher education observed in the OECD Review Report of December 2006 was reversed in the academic year 2006-2007 (95 431 in 2006-2007, compared to 84 363 in 2004-2005 and 82 720 in 2005-2006). This trend accelerated in recent years with an increase of new enrolments in public higher education, with particular impact on polytechnic education:

    o Total enrolments in higher education of 20-year-olds have increased by 15% over the last three years (2005-2008), reaching about 35% of this age-group (compared to 30% in 2005). In other words, one in three of all 20-year-olds in Portugal are enrolled in higher education. This is similar to the European average, although still lower than for most industrialized countries and regions.

    o Total enrolments in higher education of adults aged 30-34 years have increased by about 20% over the last three years (2005-2008), reaching about 4.1% of this age-group (compared to 3.5% in 2005).

    o The total number of graduates per year increased by about 19% over the period 2005-2007, with graduates in science and technology rising in recent years to a figure of 18.1 per thousand population aged 20-29 years (well above the EU average). At the same time, the number of new PhDs in science and engineering per thousand population aged 25-34 increased to 0.42 in 2007, compared to only about 0.3 in 2001.

    These success indicators do not stem solely from the legal reform of higher education; they also reflect the current European movement to modernise higher education, and have been driven by policies designed to extend the recruitment base and the number of students in higher

education; to reinforce the upper ranks of the system, by fostering the internationalisation of research universities and their specialisation; and to promote the binary system, with polytechnic education concentrating on professionally-oriented and vocational training, while university education concentrates further on postgraduate education.

32. **A national contract for the development of Higher Education**: In January 2010 a national contract for the development of Higher Education has been collectively signed between the government and all public universities and polytechnics. This contract entails an increase of public investment in higher education underlining the commitment of the Portuguese government and higher education institutions to increase the qualification of the Portuguese population by setting the goal of graduating 100.000 people in addition to the current graduation levels by 2013.

Annex 1: Sample Science and Technology Indicators for Portugal

indicator	Source	2003	2005	2007	2008	2009
A - EXPENDITURE						
Total Government Budget Appropriations or Outlays for R&D (GBAORD) as a percentage of GDP	**(1)**	**0,61**	**0,73**	**0,78**	**1,01**	**1,09**
GERD as a percentage of GDP	**(1)**	**0,74**	**0,81**	**1,21**	**1,55**	-
Gross Domestic Expenditure on R&D -- GERD (M Euros)	**(1)**	**1.020**	**1.201**	**1.972**	**2,585**	-
BERD as a percentage of GDP	**(1)**	**0,24**	**0,31**	**0,62**	**0,78**	-
Business Enterprise Expenditure on R&D -- BERD (M Euros)	**(1)**	**338**	**462**	**1.010**	-	-
Percentage of GERD performed by the Business Enterprise sector	**(1)**	**33%**	**38%**	**51%**	-	-
Percentage of BERD financed by industry	**(1)**	**89%**	**91%**	**89%**	-	-
Percentage of BERD financed by government	**(1)**	**5%**	**4%**	**4%**	-	-
Percentage of BERD financed by abroad	**(1)**	**6%**	**5%**	**7%**	-	-
R&D expenditure by S&T institutions as a percentage of GDP	**(1)**	**0,49**	**0,5**	**0,59**	**0.78**	-
R&D expenditure by S&T institutions (M Euros)	**(1)**	**682**	**739**	**962**	-	-
S&T institutions expenditure as a percentage of total expenditure	**(1)**	**67%**	**62%**	**49%**	-	-
GERD -- Compound annual growth rate (as a percentage of GDP)	**(1)**	**-8%**	**9%**	**49%**	-	-
BERD -- Compound annual growth rate	**(1)**	**-8%**	**29%**	**100%**	-	-
S&T institutions funding by FCT (expenditure in M Euros)	**(1)**	**56.478 (2004)**	**56.074**	-	**89.031p**	-
R&D projects funding by FCT (expenditure in M Euros)	**(1)**	**25.035 (2004)**	**29.040**	-	**61.870p**	-
R&D projects funding by FCT (number of projects)	**(1)**	-	**2.078**	-	**3.310p**	-
Research and advanced training fellowship directly funded by FCT (expenditure in M Euros)	**(1)**	-	**85.286**	**110.114**	**126.523**	**146.702**
National Science and Education Network infrastructure and services funding from the Knowledge Society Agency (UMIC) to theFCCN – Foundation for national Scientific Computing (expenditure in M Euros)	**(7)**	**6.2**	**18.2**	**23.8**	-	-

indicator	Source	2003	2005	2007	2008	2009
B - HUMAN RESOURCES						
Total researchers (FTE)	(1)	20.242	21.126	28.176	40,411	-
Total researchers per thousand labour force	(1)	3,7	3,8	5,0	7,2	-
Total researchers per thousand labour force - compound annual growth rate	(1)	-	2%	31%	-	-
Higher Education researchers (FTE)	(1)	10.062	10.956	13.114	-	-
Higher Education researchers as a percentage of total researchers	(1)	50%	52%	47%	-	-
Total number of PhDs at public universities	(2)	-	6.177	9.217	-	-
Percentage of faculty holding a PhD at public universities	(2)	52,1%	57,0%	60,1%	63,9%	-
Total number of PhDs at private universities	(2)	-	1.624	1.968	-	-
Percentage of faculty holding a PhD at private universities	(2)	23,2%	26,1%	28,5%	30,9%	-
Total number of PhDs at public polytechnics	(2)	-	968	1.496	-	-
Percentage of faculty holding a PhD at public polytechnics	(2)	8,9%	11,1%	13,1%	14,9%	-
Business Enterprise researchers (FTE)	(1)	3.794	4.014	8.477	10,315	-
Business Enterprise Sector researchers as a percentage of total researchers	(1)	19%	19%	30%	-	-
Total PhDs in firms	(1)	-	-	361	-	-
Total Business Enterprise R&D personnel (FTE)	(1)	6.124	6.133	12.784	-	-
Number of yearly new PhD	(1)	1.027	1.199	1.461	1.496	-
Number of yearly new PhD in 25-34 population	(1)	0,33	0,37	0,43	-	-
Number of yearly new PhD (females)	(1)	46%	49%	48%	51%	-
New PhD fellowships sponsored by FCT	(1)	670	1.172	2.078	1.958p	-
New postdoctoral fellowships sponsored by FCT	(1)		637	998	598p	-
New PhD contracts sponsored by FCT	(1)	-	-	620	589p	-
PhD fellowships sponsored by FCT (in execution - April)	(1)	-	3.232	4.301	4.905	5.310
postdoctoral fellowships sponsored by FCT (in execution - April)	(1)	-	826	1.190	1.345	1.342
PhD contracts sponsored by FCT (in execution - June)	(1)	0	0	0	620	1.209
C - OUTPUT						
Number of Portuguese patent applications to the EPO	(6)	25 (2004)	71	83	107	-
Number of Portuguese patents granted by the USPTO	(6)	7 (2004)	8	14	-	-
Number of higher education institution's patents granted by INPI	(6)	34 (2004)	55	108	-	-
Scientific publications	(3)	3.906 (2004)	5.514	6.758	7.470	-

Note: p – provisory data; Sources: (1) GPEARI/MCTES; (2) Fundação para a Ciência e Tecnologia, FCT; (3) GPEARI/MCTES, ISI Thomson Reuters SCI Portugal; (4) European Patent Office EPO; (5) US patent and Trademark Office USPTO; (6) Instituto Nacional da Propriedade Industrial INPI; (7) Knowledge Society Agency (UMIC).

Annex 2: Sample Tertiary Education Indicators for Portugal

Indicator	Source	2003	2004	2005	2006	2007	2008	2009
A – ENROLLED STUDENTS AND GRADUATES								
Enrolled students (first time, first year)	(7)	94.446	89.269	84.363	82.720	95.341	114.114	115.372
Total students enrolled	(7)	400.831	395.063	380.937	367.312	366.729	376.917	373.002
Enrolled in tertiary education in relation to the same age group population								
18 years	(7)	19,0%	18,9%	18,9%	19,9%	19,2%	21,9%	26,0%
19 years	(7)	26,0%	26,5%	25,8%	26,6%	27,3%	30,7%	32,9%
20 years	(7)	29,8%	30,0%	30,2%	29,6%	30,5%	33,0%	35,7%
30-34 years	(7)	3,6%	3,6%	3,5%	3,5%	3,8%	4,1%	4,1%
35-39 years	(7)	2,1%	1,9%	1,9%	1,9%	2,1%	2,4%	2,5%
40-44 years	(7)	1,3%	1,3%	1,2%	1,2%	1,4%	1,6%	1,7%
Enrolled students in Technological Specialisation Courses (CETs)	(7)	-	-	294	1 259	2 253	4 811	5 832
Erasmus students (outward mobility)	(8)	3 642	3 845	4 312	4 424	4 753	-	-
Erasmus students (inward mobility)	(8)	3 397	4 356	4 786	5 021	-	-	-
Tertiary education graduates	(7)	-	-	69 987	71 828	83 276	84 009	-
New graduates in S&T per 1000 population aged 20-29	(7)	-	-	12,0	12,6	18,1	-	-
Student Financial Aid (Number of grants)	(9)	-	-	-	-	70603	73493	73063
% of tertiary education students supported by grants	(9)	-	-	-	-	19,3%	19,5%	19,6%
Student loads (*Garantia Mútua*), acummulated	(9)	0	0	0	0	800	3 150	6 500
B - FUNDING								
Income, excluding PIDDAC (A)	(7)	-	-	1 712	1 790	1 806	1 871	-
Income, including PIDDAC (B)	(7)	-	-	1 807	1 862	1 867	1 935	-
Income as a % of GDP (A)	(7)	-	-	1,15%	1,15%	1,11%	1,13%	-
Income as a % of GDP (B)	(7)	-	-	1,21%	1,20%	1,14%	1,16%	-
Expenditure on tertiary educational institutions as a percentage of GDP	(10)							
Portugal	(10)	-	-	-	1,4%	-	-	-
OCDE	(10)	-	-	-	1,4%	-	-	-
Tuition fees (M Euros)	(7)	-	-	184	207	231	254	-
% tuition fees income in relation to total income	(7)	-	-	10,7%	11,5%	12,8%	13,6%	-

Sources: (7) GPEARI / MCTES; (8) Agência Nacional para o Programa Aprendizagem ao Longo da Vida; (9) Direcção Geral do Ensino Superior (DGES); (10) OCDE, Education at a Glance.