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Democratizing Higher Education and Access to Science: The Portuguese Reform 2006–2010

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The democratization of higher education through strategically driven science policies and higher education reforms is documented in this paper. These represent complementary policy actions oriented towards strengthening social, cultural and economic dimensions that allow higher education institutions (HEIs) to grow and to train graduates able to adapt to increasingly uncertain job markets. Drawing from the main achievements in Portugal during the period 2006–2010, our central argument focuses on the need to open higher education to all as a means to sustain a strong and specialized knowledge base. The results are related to the role of HEIs in fostering socially robust knowledge and supplying talented people and researchers to society in globalized socio-economic contexts.
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Introduction

It is well known that higher education systems are under mounting pressure to meet the demands imposed by a globalized knowledge society without compromising quality. But the pressure to respond to these demands and to change is increasing and taking new shapes (Barnett, 2000; 2003). Students face increasingly competitive labour markets and will tend to select higher education institutions (HEIs) that give them guarantees of employability. Industry and students alike also demand broader skill sets to be incorporated in learning processes (Papayannakis *et al.*, 2008). Concurrently, governments worldwide are frequently divided, with Treasuries and Finance Ministries, more often than not, adopting supervisory policies focused on quantitative and financial performance measures, and enforcing general financial constraints and other control processes in higher education (e.g., Tolofari, 2005).

In many parts of the world, it has been acknowledged for many years that changes are needed in the ways HEIs are internally organized and how they structure incentives and establish links with society, but action has been continuously hampered or delayed (Enders and De Boer, 2009). Most often, HEIs leaders demand

public funding, but usually not autonomy; they do not know how to effectively use their potential institutional freedom and autonomy. This is a common phenomenon even in developed countries, where organizational inertia, entrenched cultures and informal institutions stall the implementation of change, with the result that institutions often end up being merely reactive (Leišytė, 2011). Nonetheless, the pressing need for change has led to reforms in higher education, implemented more or less directly by governments worldwide (Huisman, 2009). Portugal is no exception to these mounting pressures and a reform was effectively introduced through governmental action in the period 2006–2010 (Gago and Heitor, 2007; MCTES, 2011).

In order to understand and contextualize this reform, we start with a brief overview of its main rationale and content, followed by a critical assessment of its immediate impact, as reported by the Portuguese Ministry of Science, Technology and Higher Education to the Organization for Economic Co-operation and Development (OECD) in mid-2011 (MCTES, 2011). In this process, two features are critical: substantial autonomy was granted to HEIs, while the social basis for the recruitment of students was widened. These actions have facilitated further opportunities for learning, linked to emerging themes for knowledge exploration and discovery, as well as for advanced training. Both represent constant challenges for developing and emerging economies (Kim, 2008). Therefore, this paper is not intended to be an article about Portugal (for a comprehensive analysis of the Portuguese case, see Neave and Amaral, 2012), but on how the integration of science and higher education policies can be understood as a lesson to other world regions.

It may be that the present economic and financial difficulties in Europe (and in the world) will act as a barrier to the continued impact of most of the reforms discussed in this paper, which focuses on the period 2006–2010. Still, we argue that these reforms have enhanced the resilience of Portuguese HEIs, enabling them to better prepare young generations for a heavily globalized society, in order to face the financial and social constraints increasingly imposed on many peripheries of Europe and other regions worldwide.

Brief Overview of the Higher Education Reform in Portugal, 2006–2010

The policy measures undertaken in the period considered in this paper are presented below, focusing on two main dimensions: access and specialization.

Fostering student access and social equity in higher education

After an assessment of the higher education system by the OECD, the European Association for Quality Assurance in Higher Education and the European University Association, the reform of degrees and diplomas started with an Act amending the

Basic Law of the Education System, to provide the legal basis for implementation of the Bologna Process. This was followed by the Legal Framework of Higher Education Degrees and Diplomas (Decree-Law 74/2006), establishing general principles for the organization of degree programmes and their accreditation, and establishing rules for the reorganization of existing degree programmes and the creation of new ones. The creation of post-secondary Technological Specialization Courses was also regulated (Decree-Law 88/2006) to increase the availability of technical and vocational education, widening access to new publics. This is particularly relevant as studies demonstrate that technological and vocational courses reduce retention and dropouts, and are essential to economic growth (OECD, 2010).

Associated legislation enabled greater flexibility in admissions and broader access to higher education (OECD, 2010). New regulations facilitated access (particularly for students aged over 23), the return of students to higher education, changes of programmes and transfers between institutions (Ministerial Order 401/2007). To ensure greater flexibility in accessing and attending higher education, Decree-Law 107/2008 enabled students to enrol in individual curricular units, with a guarantee of both certification and accreditation in the event of successful completion. This also permitted students to enrol in any HEI and in curricular units which are not part of their cycle of studies.

In addition, the level of direct social support for less-favoured students was considerably increased and the number of students benefiting from it rose from 63,000 in 2004 to 75,000 in 2010 (see discussion on related impact below). This was implemented together with a system of student loans with mutual guarantee underwritten by the State, as introduced in 2007 under the scheme schematically represented in Figure 1. This scheme supplemented existing grants rather than replacing them, extending students' options. It has no blanket interest subsidy, but an innovative element of mutuality, which is the key that makes it possible for the scheme to make use of private funding sources.

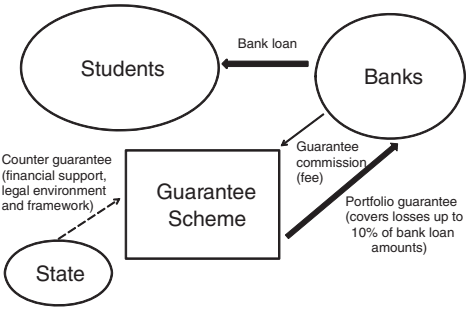

Figure 1. Triangular relationships related to extended guarantees to include the new scheme for student loans implemented in Portugal in 2007.

This solution was designed in times of financial restraints in both public and banking sectors, facilitating a risk-sharing mechanism, which was driven by a public-private partnership supported by a Mutual Counter-Guarantee Fund (FCGM). The specific conditions that were established include universal and highly simplified access, reduced interest rates with additional reductions depending on students' success, a one-year grace period and long repayment periods. It is important to stress that this system was launched with very little infrastructure requirements or organizational changes, and little public investment (including minimal governmental intervention), with only the investment necessary to assure the operation of the guarantee scheme. It gave all students the opportunity for improved access to higher education, and over 14,000 loans had been contracted by December 2010.

It should be noted that in the context of the global trend towards wider access to higher education, it is now recognized that part of the benefit of participation in higher education is private (i.e., private returns to education), particularly through the existence of an additional wage premium and a lower risk of unemployment for job seekers, which justifies the idea of sharing the cost of education between graduates (not students) and taxpayers (see Barr, 2004).

The result is that student loan systems, based on lending funds to students to cover the direct cost of education (such as tuition fees and educational materials) and living expenses until graduation (recognizing that while students cannot easily afford to pay more, graduates in principle can), have been implemented in almost every country in the OECD, although using a mix of different systems and accommodating different features. These student support systems coexist in many countries with scholarships and grants (public subsidies) specifically oriented to low-income students.

Although income-contingent loan systems are becoming common worldwide, as clearly acknowledged by the OECD, it should be noted that their applicability is particularly dependent on the characteristics of the tax system (Barr, 2009). This is why the new Portuguese system was designed to make use of an element of mutuality underwritten by the State, which facilitates a risk-sharing scheme with private finance in a way that complements the system of public grants and helps to improve access to tertiary education with minimal governmental intervention. Recent analyses indicate how this policy mix has positively affected the enlargement of the recruitment basis for higher education (see Costa *et al.*, 2009).

Institutional development and specialization: Science and higher education

The new legal framework for the assessment of higher education (Law 38/2007) and the creation of the Higher Education Evaluation and Accreditation Agency (Decree-Law 369/2007) were both designed to ensure the quality of higher education according to best international practices (Sin, 2012). A National Qualifications System was also created (Decree-Law 396/2007) and the National Qualifications

Agency was established (Decree-Law 276-C/2007), with specific functions to regulate, accredit and control the quality of vocational and professional education.

A new Legal Regime of Higher Education Institutions (Law 62/2007) established 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 legal status of public institutions, establishing consortia, and recognizing research centres as part of the university management framework.

Law 62/2007 promotes the institutional autonomy of higher education, mainly in issues of independent accountability and flexible operation beyond traditional public administration. In addition, it allows HEIs, on a voluntary basis, to be granted independent legal status, in the form of a 'University Foundation'. This means giving HEIs greater autonomy (Hasan, 2007), as follows. First, institutional leadership has the autonomy to pursue its goals with fewer external constraints. Second, there is less vulnerability to changes in the government's budgetary policies. Third, new opportunities for generating additional resources emerge. Fourth, the strategic influence wielded by curators may lead to closer collaborations with external stakeholders. Finally, accountability is placed on the shoulders of those in whom responsibility rests.

Although it is still too soon to assess the full benefits and shortcomings of university foundations in Portugal, by the end of 2010 three universities had acquired this status. Potential shortcomings can be identified, as in other international experiences with the development of university foundations, including potential lack of managerial skills to run them. In addition, staff might perceive the transition from public servant to foundation employee as fraught with uncertainties. However, the expectation remains that HEIs that opt for independent legal status will become more flexible in financial and recruitment strategies, more adaptable to the demands of society, and more alert to structural problems affecting research proficiency and productivity.

In terms of strengthening the role of science and developing the science system together with higher education, government action was critical in giving priority to increasing public expenditure on R&D, including doubling the budget of the Portuguese Science and Technology Foundation between 2005 and 2010, as discussed below. Specific policy actions have focused on two major pillars of institutional building and development of R&D, as implemented since the mid-1990s, namely strengthening the impact of national research assessments and promoting large research institutions in the form of Associate Laboratories (see Heitor *et al.*, 2013). In addition, increasing the internationalization of the knowledge base and establishing international partnerships with leading American research universities in 2006 represent a complementary strategy to develop both the scientific and higher education systems. These initiatives, unprecedented in Portugal, brought together several Portuguese universities and the Massachusetts Institute of Technology, Carnegie Mellon University, Harvard Medical School and the University of

Texas at Austin, opening the way to set up a number of thematic industry-university networks, seeding change in research and advanced training at Portuguese universities (see Pfotenhauer *et al.*, 2013).

Assessing Impacts of the Portuguese Reform of Higher Education, 2006–2010

Six main areas in which the reform of higher education in Portugal have had impacts are discussed as follows: (i) student engagement and graduation levels; (ii) system specialization; (iii) qualification of academic staff; (iv) strengthening the research landscape; (v) internationalization and (vi) securing funding conditions. They underline the need to foster resilience in higher education, through institutional autonomy, systemic diversity, broader access, and quality in the development of modern, democratic and open higher education systems. The impact of this reform is ever more relevant given the current worldwide economic and financial difficulties. It opens up the possibility of making higher education a significant political and social player in driving societies forward in times of financial constraints and political shifts.

Increasing student engagement and graduation levels

Total enrolment in higher education of 20-year-olds reached 37% of this age group in 2010 compared with 30% in 2005. The number of students currently in higher education is important because to some extent it determines the resilience of any region, including its future competitiveness in terms of the ability to promote technological change and create value (Damian and Danciu, 2011). The rise in the level of qualifications of the young population is associated with the mass expansion of the Portuguese higher education system, which had been stagnant or declining since the mid-1990s, after a period of opening up to young people of all social classes, from 30,000 students in the 1960s to about 400,000 students by the mid-1990s.

The period of relative decline in higher education enrolment before the reform documented in this paper is reported in Amaral and Magalhães (2008). In 2006, before the Bologna process was implemented, about 82,720 students enrolled in higher education in the first year for the first time. The following year, when the Bologna process was implemented, this figure rose to 95,341 and in the following year to 114,114, but 6 years after the implementation of the Bologna process this number had continued to rise, to 131,508 in 2011.

In assessing the impact on higher education of the current financial crisis and related political shifts, it should be noted that the above figure only declined in 2012 to a number of entrants close to that in 2007, after direct social support for student expenditure decreased from 163 million euros in 2010 to 131 million euros in 2011[1] (as compared with about 90 million euros in 2005). These figures demonstrate the

importance of social support in increasing student participation in higher education, but also suggest how vulnerable it is to changes in public expenditure and policy. Student loans have certainly helped to cushion further negative impacts on student enrolment, but the evidence is that they do not replace the role played by direct social support schemes, especially in times of increasing unemployment.

In parallel with the figures above, it should also be noted that the total number of graduates increased by about 16% over the period 2005–2010, with graduates in science and technology rising in recent years to 15 per thousand population aged 20–29 years, above the EU average. The number of graduates in mathematics, science and technology (MST) also rose by 64% compared with 2004, with Portugal, Slovakia and the Czech Republic being the best performers in Europe in terms of growth rate of MST graduates (European Commission, 2011). These trends are to be expected, as other studies show that public support for higher education also positively impacts graduation rates (Zhang, 2009). Again, we argue that student loans and social support that foster student participation help to build resilience and are important factors in the ability of higher education to decrease the vulnerability of countries to financial crises, although they cannot by themselves prevent such crises.

Promoting system specialization

Promoting resilience in higher education requires policies that widen the scope of its diversity and institutional autonomy, while ensuring effective accountability (Estermann *et al.*, 2011). A diversified higher education system can be expected to respond effectively to different demands, given the comprehensive nature of research and training (van Vught, 2008). A greater institutional diversity in the Portuguese higher education system was envisioned under the reform process, with polytechnics concentrating on professional/vocational training and the first cycle of higher education, while most universities were expected to concentrate their growth in master's and doctoral programmes. For example, the proportion of students enrolled in vocational short-term cycles in polytechnics increased from 40% in 2005/2006 to more than 80% by 2010/2011. Still, these short-term cycles only account for 3.5% of all polytechnic students (below 0.05% in 2005/2006), suggesting that there is a large potential for growth in vocational training, and that the time frame for the full goals of the reform to be achieved is a long one.

On the other hand, universities, as the only institutions conferring Ph.D.s, have seen the proportion of students enrolled in Ph.D. programmes increase from 3% in 2005/2006 to 7% in 2010/2011. But, most importantly, a focus on doctoral education at universities, together with increased investment in research, has led to considerable growth in the number of doctorates, which increased by 39% in the period discussed in this paper. In 2010, Portuguese universities graduated 1,666 new Ph.D.s, as compared with 1,198 in 2005 and only 337 in 1990. This shows the increasing capacity of Portuguese universities to offer Ph.D. programmes, but also poses new

challenges regarding the need to strengthen their research-based orientation and to integrate post-doctoral activities, together with the specialization of academic staff, as well as to engage in international research networks.

Improving qualifications of teaching staff

The percentage of academic staff holding Ph.D.s in public universities reached 68% in 2010/2011, up from 57% in 2005/2006, and from 48% in 2001/2002. A similar trend is seen in private universities, where the percentage of academic staff holding a Ph.D. reached 42% (26% in 2005/2006). In the polytechnic higher education sector, the figure is 22% in both public and private polytechnics in 2010/2011 (up from about 11% in 2005). This change in the nature of qualification levels of academic staff in all higher education sub-sectors is a long-term process that was stimulated in the period discussed in this paper (Figure 2), although the percentage of academic staff holding a Ph.D. is still low by international standards and varies across disciplinary fields.

The evolution in qualification levels of academic staff is to a large extent the result of continuous advanced training programmes funded through the research budget. From the mid-1990s until 2010, about 19,000 fellowships were awarded by the Portuguese Science and Technology Foundation (FCT) to Portuguese and foreign nationals to pursue doctoral programmes. About half of these Ph.D. fellowships were awarded during the period discussed in this paper, revealing the impact of the greater

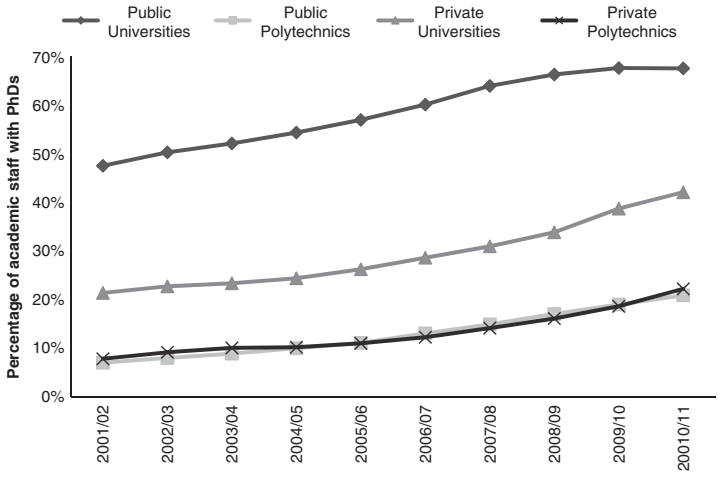

Figure 2. Changes in academic staff with Ph.D.s in the Portuguese higher education system, 2001–2009.
Source: Statistics office, MCTES.

investment in science on both the qualifications of academic staff and research-based doctoral education.

In the context of this paper it is important to note that concentrating science policy on the advanced qualification of human resources as a way to foster the development of the knowledge base supporting Portuguese universities was accompanied by integrating post-doctoral activities in research centres. A public programme to fund the recruitment of doctoral researchers in all fields of knowledge, launched in 2007, had by 2009 enabled about 1,200 Ph.D. researchers (of whom 41% were foreigners) to be competitively hired on 5-year contracts. This programme promoted a research-based orientation in academia and aimed to facilitate the renewal of teaching and research staff in HEIs (MCTES, 2011). The continued success of this programme, also, is vulnerable to changes in public expenditure and policy, and its future impact remains to be assessed in the years to come.

However, the impact of the growth in public expenditure on R&D in association with the reform of higher education can be assessed through the findings of an in-depth nominal study focused on flows of doctorates in and out of the country over the period 1970–2010 (GPEARI, 2011a; also, Heitor *et al.*, 2013). It shows a notable process of brain gain by the end of the period. Of a total of 19,876 Ph.D. holders working in Portugal in 2009 and/or graduating since 1970, only 667 were found to be working abroad, while 1,836 foreign Ph.D.s were working in Portugal, at least during the last 5 years.

In higher education policy terms, a central finding is that public investment in science associated with policies that facilitate the co-evolution of human capital formation and institutional capacity building can lead to a situation of brain gain of doctorates. In the Portuguese case, it took almost four decades to achieve reasonable international levels of investment in science and technology and to overcome the perpetual lagging behind other countries. This is shown to be associated with patterns of relatively sluggish or fluctuating investments in R&D for many years, reaching unprecedented levels of development only by 2009 and 2010. We argue that other regions worldwide may accelerate this process, if appropriate policy measures are systematically taken to facilitate the co-evolution identified in this paper. In the Portuguese case, the number of researchers grew with relatively low levels of R&D funding per researcher, but at a sufficiently attractive level to foster brain gain.

Strengthening the research landscape

According to data from Thomson/Reuters, the scientific output of Portuguese research institutions in all scientific fields, as measured by the Science Citation Index Expanded, Social Science Citation Index and the Arts & Humanities Citation Index using the fractional counting method, reached 12,865 internationally refereed scientific publications in 2010, up from 7,407 publications in 2005. From another perspective, the number of publications in the SCI reached 832 articles, letters, notes

and reviews per million total population in 2010, up from 483 in 2004 (GPEARI, 2011b). The number of articles by total population is now 81% of the EU-27 average, compared with only 57% in 2004. This suggests that Portugal's science base is gradually becoming internationally competitive, a result of the accumulation of investment in people and institutions (Figure 3).

So far, doctorates have been absorbed mainly by HEIs, including for post-doctoral research under public funding (85% according to the OECD's 'Careers of Doctorate Holders' 2009; see also GPEARI, 2011a). In Portugal, the employment rate of doctorates is 98%, with only 0.4% unemployed, and 1.5% inactive. Along with Lithuania, the country has the lowest unemployment rate of doctorates among the 21 countries surveyed by the OECD, suggesting potential for growth.

Still, our analysis shows the importance of public policies in facilitating a research career path in universities, independent of traditional faculty careers, in a way that promotes the continuous recruitment of young researchers by academic research units following best international practices, but independent of internal university procedures. It is clear that the relatively temporary and precarious nature of that research career path leads to the need for integrative measures that will facilitate gradual recruitment policies by the public and private labour markets. In Portugal, 33% of doctorates are employed on temporary contracts (the second highest in the OECD countries surveyed), highlighting the need to grant greater autonomy to HEIs, together with sufficient funding to promote academic employment, and further qualifying academic staff (this is expected to be an effect of the establishment of University Foundations).

It should also be noted that in assessing the impact of the reform discussed in this paper on the nature of the research landscape, the number of new Ph.D.s per 10,000 workforce in Portugal remains relatively low compared with other EU countries and

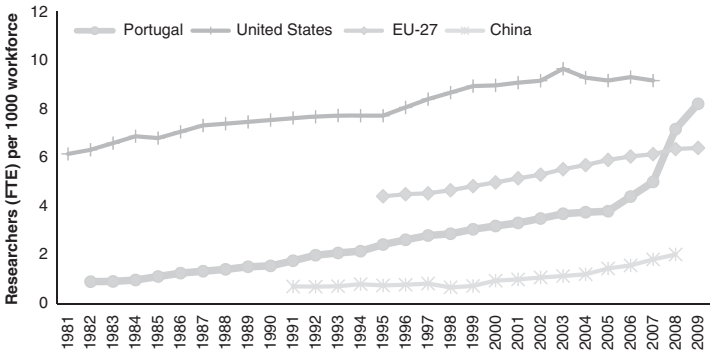

Figure 3. Changes in total researchers per thousand workforce, comparing Portugal with averages of major scientific powerhouses, 1981–2009.
Source: OECD, MSTI.

selected US states (Figure 4). Even so, Portugal produces more doctorates per year than the US states of Florida or New Jersey, having reached that position from a very weak level (0.68 new Ph.D.s per 10,000 workforce in 1990).

Looking at lessons learned, our analysis shows that the above figures can only be understood as part of a broader and long-lasting process of involving young people in scientific activities. This has required specific actions aimed at trust-building between science and society promoted in Portugal since the mid-1990s (Delicado, 2009). The systematic development of activities to foster science awareness and education and promotion of the role of science in the daily life of citizens has been implemented primarily through the National Agency for Scientific and Technological Culture's *Ciência Viva* agency. This agency oversees an integrated network of 21 science centres running science awareness initiatives, including a large annual programme called 'Science in the Summer', which involved more than 17,000 people and over 140 research institutions in 2009. It has also supported more than 1,000 science projects in schools and 7,000 internships of youngsters (aged 15 to 18) in university-based research centres over the last decade.

Promoting internationalization

The internationalization of the Portuguese academic community can be best understood through trends in collaboration in international peer-reviewed journals. In 2010, 43% of all publications by Portuguese researchers were published in co-authorship with others based abroad, compared with 39% in 1990 (GPEARI, 2011b).

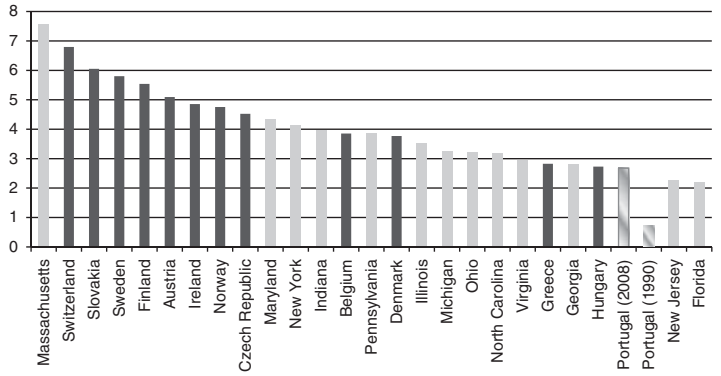

Figure 4. Number of new Ph.D.s per 10,000 workforce in selected US states and European countries, 2008.

Note: US workforce refers to the civilian workforce; the countries and US states have a small-medium-sized workforce comprising between 2 and 9.5 million individuals. Data refer to headcounts.

Source: NSF/NIH/USED/USDA/NEH/NASA, 2008 Survey of Earned Doctorates; Eurostat; GPEARI/MCTES.

In this context, the volume of internationally co-authored publications rose from 375 in 1990 to 5,550 in 2010, suggesting a significant and relatively recent internationalization of Portuguese science (also identified in Horta, 2010).

It is worth noting that this trend is different from the typical internationalization paths based on recruiting foreign students, which has been the most common pattern in developed countries and their well-established universities (Bhandari and Blumenthal, 2011). By contrast, the internationalization of the academic community in Portugal is typical of a small developing region, resulting from a long-term trend of supporting Ph.D. fellowships abroad since the late 1970s (Horta, 2010). Although in those years new doctorates abroad represented almost half of the total number of new doctorates per year, this figure has been significantly reduced, while the capacity of Portuguese universities has been strengthened. Nevertheless, it should be noted that the proportion of fellowships for new Ph.D.s concluded abroad was maintained at about 10% of the total number of fellowships awarded, to sustain a strong network of international relations.

In the context of our assessment, it should be pointed out that other indicators show that the internationalization of higher education has been slow. Science policies and the higher education reform barely impacted the number of foreign faculty in HEIs, who increased from 1,243 in 2005/2006 to 1,543 in 2010/2011. In relative terms, the proportion of foreign faculty at Portuguese HEIs is still as low as 4%, barely changing from the 3% observed in 2005/2006. A similar evolution can be observed in the science and technology system, where the number of foreign researchers rose from nearly 1,900 in 2005 to about 3,800 in 2008, but still only representing 7% of the total number of researchers.

However, an important new element driving the internationalization of the university landscape is the strategically oriented international partnerships launched in 2006, which bring together Portuguese universities and research centres and world-leading research universities (Heitor and Horta, 2011). By September 2007, the first doctoral and advanced study programmes within these partnerships were operational (in some cases offering dual degrees between US and Portuguese universities). These international partnerships brought together a large number of Portuguese research and academic institutions and private sector companies through collaborative research projects to stimulate new knowledge and ideas (Pfotenhauer *et al.*, 2013).

Securing funding conditions

The evolution of the results of the 2006–2010 reforms is analysed in terms of funding in two complementary areas: (i) block funding of HEIs and (ii) competitive research funding.

Starting with block funding of HEIs, it should be noted that funding levels for higher education are asymmetric worldwide, with comparatively higher values in

well-developed and industrialized regions and countries (UNESCO, 2009). It is the accumulation of this funding over decades that has been able to drive systems and universities to attain excellence in many of these regions. In this context, it is important to note the relatively low levels of funding in Portugal in international terms, but also their growth in the period reported in this paper. With regard to the funding of higher education, we focus on total expenditure and direct and indirect public funding to students through social support systems.

Total expenditure on public and private higher education measured as a percentage of gross domestic product (GDP) grew steadily over the period 2006–2010. Total expenditure on public and private higher education represented about 1.7% of GDP in 2010, compared with about 1.5% in 2005, slightly above the current OECD average of 1.5%, but still lower than that of most industrialized regions of the world.

Considering total expenditure on public and private higher education, funding per student (normalized by purchasing power parity), although still lower than in most industrialized countries, increased by over 30% in the period 2005–2010. In this funding, social support to students is critical in countries that have a population with a deficit of qualifications, and relatively few resources to invest in the education of their children (Woodhall, 2007). This is the case of Portugal and of many emerging and developing nations around the world. The widened recruitment of students in higher education was supported by strengthening the social support system for students from low-income families, through procedures aimed to assure equity in access and enrolment.

Two figures are of particular importance: the number of social grants for students has increased by 6% since 2006, and now covers about 20% of all students in higher education; and public expenditure on direct support of student grants increased by 68% between 2005 and 2010. The direct student social support system was reformed in 2010 to foster social equity in access to higher education, and to further concentrate direct social support on low-income families, as well as to ensure appropriate allocation of social support grants in times of increasing financial constraints (MCTES, 2011).

Turning now to the analysis of competitive R&D funding levels, the public budget for R&D in Portugal (i.e., Government Budget Appropriations or Outlays for Research and Development, GBAORD, in the OECD's nomenclature) reached 1,820 million euros by 2011, up 70% from 2005, and doubling since 2001 (when it was 778 million euros). In 2010, the Portuguese GBAORD exceeded 1% of GDP, representing about 2.85% of the overall public budget in 2011. From 2005 to 2011, it grew by 32% in relation to GDP and by 11% in relation to the overall state budget (Table 1).

Moving from budgets to expenditure, Portugal's gross domestic expenditure on R&D (GERD) exceeded 2,747 million euros in 2010, that is, about 1.59% of GDP. This is more than double the 2005 figure (as a percentage of GDP), bringing Portugal closer to the current EU average of R&D intensity (1.9% of GDP). The effective expenditure of the Portuguese Science and Technology Foundation, as the main R&D funding agency in Portugal, almost doubled from 2006 to 2010, reaching

Table 1 Government budget outlays or appropriations for research and development (GBOARD) in relation to GDP and the overall State budget in Portugal, 2003–2011

	2003 (%)	*2004 (%)*	*2005 (%)*	*2006 (%)*	*2007 (%)*	*2008 (%)*	*2009 (%)*	*2010 (%)*	*2011 (%)*
GBOARD/GDP	0.61	0.67	0.78	0.83	0.78	0.89	0.92	1.02	1.05
GBOARD/State budget	2.31	2.51	2.53	2.59	2.57	2.90	2.79	2.79	2.85

Source: MCTES/Statistics Office; Eurostat.

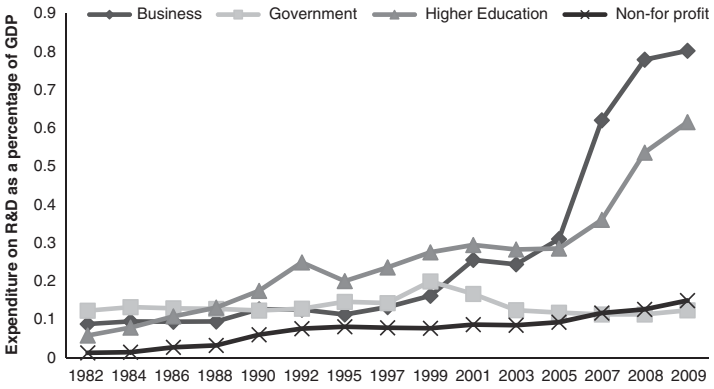

Figure 5. Expenditure on R&D as a percentage of GDP in Portugal by performance sector, 1982–2009. *Source*: MCTES statistics office.

nearly 450 million euros in the latter year. Importantly, the strong and continued public investment in R&D leveraged investment in R&D by the business sector, which recently became the sector with the greatest expenditure on R&D (Figure 5).

The level of public investment has helped to prepare our young generations for a globalized society. However, this investment is fraught with uncertainty due to the instability brought about by the financial crisis and the need to constrain public budgets, even when research intensity, measured through either research funding available per researcher or research expenditure per inhabitant, is still relatively low compared with the majority of industrialized countries.

In 2009, the total funding available per university researcher in Portugal was only 46% of the EU-27 average, but the average funding available for a university researcher in Europe was 80% of that for a Japanese researcher and 31% of that for a US researcher. Also, the GERD per inhabitant in Portugal in 2009 was about 65% of the average for EU-27, suggesting that the contribution of the Portuguese population to science is still low compared with that of other OECD countries. The average

contribution of each Portuguese citizen to science is lower than countries that Portugal has surpassed in terms of researchers per thousand workforce. The funding analysis shows that considerable public investment is needed to boost the scientific and higher education system, but this needs to be maintained to preserve these gains even in subsequent periods of financial crisis (as recommended by the Chairman of the US Federal Reserve, Ben Bernanke) (see http://www.federalreserve.gov/newsevents/speech/bernanke20110516a.pdf).

Discussion and Concluding Notes

The results presented in this paper emphasize the role of mixed and intertwined policies to strengthen links between science and higher education and to foster inclusive and diversified higher education systems. They are a call for a modernizing agenda for higher education in emerging and developing regions and countries worldwide, framed in the context of knowledge-based societies (Välimaa and Hoffman, 2008). The findings underline the need to establish a legal framework to promote the institutional development of HEIs, granting them the opportunity to become more autonomous and adaptable, and to assume independent legal status. In this context, we argue that public policies to create opportunities for change require public investment in knowledge activities. The Portuguese higher education reform was implemented alongside a substantial increase in overall public funding, including a diverse set of policies aimed at supporting the enrolment of students from poorer backgrounds.

In countries with poorly qualified populations and workforces, higher education framed as a global public good is the soundest grounding for their development (Marginson, 2011). Policies aimed at institutional development and specialization should be supported by public investment in science and research across different fields of knowledge. The evidence provided through our research is that two lines of action can be implemented together as complementary policies that need to be integrated if resilience is to be built through higher education: first, by opening up access to broaden the knowledge base; and second, by facilitating the specialization of that knowledge base.

These research findings have several implications. We have identified three main issues of relevance to many parts of the world, including emerging and developing regions and countries, as follows.

First, it is well known from the literature that students can profit in the future from skills learned during higher education, and in some cases with substantial private returns (Goetz and Rupasingha, 2003). HEIs may therefore be tempted to increase the direct price of students' education, as a way of increasing their income, especially those with scarce resources and in times of financial constraints (Sanyal and Johnstone, 2011). This path is not without its dangers for higher education systems and society as a whole.

Second, such a policy can also jeopardize the institutional integrity of HEIs, if the tendency to decrease public funding in many countries persists. Incentives for the production of public ideas come from a complex system of reward and prestige within the academic community, which draws on credibility and peer recognition, not on monetary or private gains (Moses, 1986; Melguizo and Strober, 2007). To disrupt this incentive system is to threaten the legitimacy of HEIs as societal institutions (Lieberwitz, 2005).

Third, public funding for science is critical to maintain the generation of academic ideas of a public nature, a mechanism to foster the knowledge base and to promote the diversification of higher education at a system level. In the Portuguese case, the legal reforms emphasizing vocational and professional training as the realm of polytechnics and doctoral education in the realm of universities were complemented with science funding as a major policy instrument to further diversify higher education.

In addition to the above points, it is also important to note that our analysis suggests that democratizing higher education and widening access to science drives socio-economic resilience by fostering the learning capacity of young generations. Following Conceição and Heitor (1999), this is achieved through three main processes: research and development (R&D), research and teaching (R&T), and research and learning (R&L).

R&D aims at the accumulation of ideas associated with processes of codification of knowledge. This has become the commonest form of research in the context of economic development and university-industry collaborations. R&T is geared towards training academic staff, improving teaching skills and developing teaching materials. R&L values the development of skills that enhance opportunities for learning. It is associated with processes of interpretation, and can play a critical role in building pedagogies to train undergraduate students in research-oriented environments.

Although the various processes listed above are closely linked, R&D and R&T are more to do with the creation of ideas and are particularly associated with graduate education and post-doctoral activities. In this context, careful selection of individuals with suitable skills for these types of activity is required. In turn, R&L is associated with learning processes, seeking to develop learning skills among students through the experience of doing research. In these circumstances diversified higher education systems are more likely to be able to respond effectively to the different demands made of them in global knowledge societies, by being selective in R&D and R&T, and all-inclusive in R&L. In particular, the comprehensive nature of R&T should cover the whole education system, as a way of promoting learning skills.

In this approach, lessons learned from the Portuguese reform with relevance for emerging economies include the range of reforms required to create synergies between the various learning processes, while at the same time meeting the specific requirements of each. Figure 6 is a schematic representation of such an integrative approach.

The combined development of R&D and R&T requires sustained public investment associated with policies that foster the advanced training of human resources

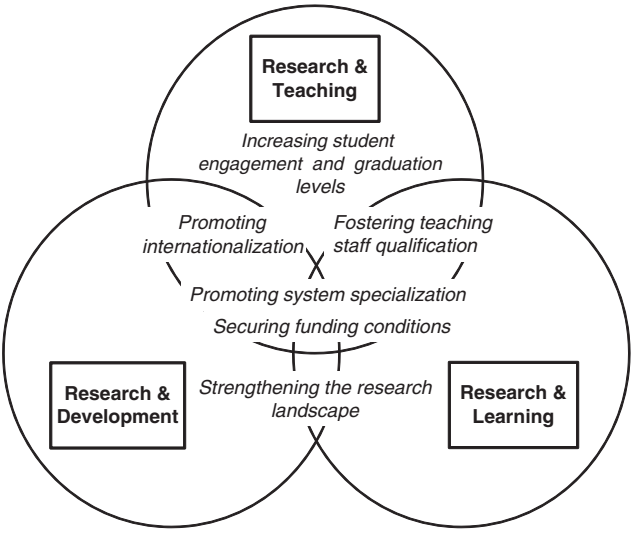

Figure 6. Schematic representation of learning processes and key items in the Portuguese higher education reform, 2006–2010.

and research-intensive academic environments to enhance the production of explicit knowledge and to train the next generation of researchers and academics. The resulting pattern of knowledge accumulation can be assessed through increases in scientific production and better-qualified academic staff.

In conclusion, our analysis of Portugal's higher education reform, its related impact on developing the nation's knowledge base, and its contribution to a more democratic and modern higher education system highlights three main points that we believe are of importance to any reform effort: (i) scale of funding, related to the need for continued public support for the advanced training of human resources through science funding, to attract research staff and personnel engaged in research and teaching activities, and to foster quality in knowledge outcomes; (ii) diversity, linked to the need to differentiate the role of public and private funding for science and higher education, preserving the integrity of institutions and freedom of thought, in the process increasing access and opportunities for all to learn; and (iii) time, reflecting a basic truth, that evolution in the academic system is a continuous process, as is its contribution to the social and economic development of countries. It requires both stability and the ongoing engagement of public policies, institutions and people.

Note

1 Data sourced by DGES and GPEARI, and provided by PORDATA: http://www.pordata.pt.

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