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BUSINESS R&D POLICY IN SPAIN AND PORTUGAL: OBJECTIVES, INCENTIVES AND OUTCOMES

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Abstract

Spain and Portugal are two EU countries of different size but similar structural problems of science and technology (S&T) to address. Over recent years, the R&D policy of both countries has been designed to tackle analogous R&D structural problems and challenges aiming to increase the historical low-level expenditures on R&D (GERD), business R&D expenditures (BERD), and BERD/GERD ratio. This paper compares and discusses the R&D policy strategy of Spain and Portugal to promote R&D, with particular attention to R&D objectives and business R&D incentives. In this sense, the paper focuses on the characteristics and differences of the two main tools used by governments to stimulate business R&D: *direct funding* (subsidies and loans) and *indirect support* (fiscal incentives for R&D). The scope and design of these instruments are likely to condition the firms' decision on how and when to invest in R&D and be able to partly reduce the problems with business underinvestment in R&D. The paper shows the differences and similarities of these tools in Portugal and Spain. Paradoxically, these countries have two of the most generous fiscal systems for R&D of the OECD but their S&T indicators of remain comparatively low. Despite the governments' efforts, the increasing generosity of the public incentives and the general tendency to reduce the gap with the EU average, none of the main R&D policy objectives has yet been achieved. Perhaps not expected, it is a fact that the BERD to GDP ratio in Portugal has grown at higher rates than that of Spain, leading to a faster approach of Portugal to Spain and the EU average, especially after 2005. On the contrary, the R&D growth rate in Spain has slowed down and began to decrease after 2008, coinciding with the implementation of a tax reform that reduced progressively the percentage of the tax credit in

the tax payable until its total elimination after 2011. There may be lessons to be learned by Spain from this rapid growth of BERD in Portugal and its connection with the financial support R&D policies.

Resumen

España y Portugal son dos Estados Miembros de la UE con problemas estructurales similares de ciencia y tecnología (C&T). En los últimos años, se han diseñado políticas para hacer frente a estos problemas con el objetivo de incrementar los bajos niveles de gasto total en I+D, gasto empresarial en I+D, y ratio gasto empresarial en I+D/gasto total en I+D. Este trabajo compara y discute las políticas de ayudas públicas a la I+D en Portugal y España, prestando una especial atención a los objetivos de I+D y la I+D desarrollada por las empresas. Centramos la atención en dos de los principales instrumentos usados para estimular el gasto en I+D empresarial: las ayudas públicas directas (subvenciones, créditos, etc.) y las ayudas públicas indirectas (incentivos fiscales). Su diseño y magnitud pueden condicionar la decisión de las empresas de en qué, cuándo y cuánto invertir y pueden, en parte, reducir los problemas asociados a la inversión subóptima en I+D. Se comparan las similitudes y diferencias de éstas ayudas públicas en los dos países. Como resultados, se observa que los indicadores de C&T se han mantenido comparativamente bajos, incluso a pesar de disponer de los incentivos fiscales a la I+D más generosos de la OCDE. A pesar del esfuerzo de los gobiernos (en particular durante la última década), el aumento progresivo de la generosidad de las ayudas públicas, y la tendencia general de reducir la distancia con la media de la UE, ninguno de los principales objetivos de I+D se han alcanzado. Es interesante destacar, no obstante, el hecho de que, especialmente desde 2005, el gasto empresarial en I+D sobre PIB en Portugal ha crecido, relativamente, a tasas más elevadas que en España, alcanzando una mayor aproximación a las medias de España y la UE. Por el contrario, el crecimiento en España ha sido más lento y comienza a decrecer desde 2008, coincidiendo con la implementación de la reforma que pretendió eliminar progresivamente las deducciones fiscales a la I+D en el impuesto hasta su eliminación total a partir de 2011. Como reflexión, España debería aprender del rápido crecimiento de Portugal y de su relación con las políticas públicas de apoyo a la I+D.

1. INTRODUCTION

Spain and Portugal are two EU Member States of different size but similar structural problems of science and technology (S&T) to address. Over recent years, the R&D policy of both countries has been designed to tackle analogous R&D structural problems and challenges aiming to increase the historical low-level expenditures on R&D (GERD) and business R&D expenditures (BERD). In particular, to increase BERD to about two thirds of GERD, and to increase the number of full-time equivalent (FTE) researchers to the level of the OECD or European Union (EU) averages. Both governments have made great efforts to catch up with the EU average level of R&D spending and currently these countries have two of the most generous tax incentives systems in the OECD area to promote private R&D expenditures. These countries fit perfectly in the current trend of competition between countries to attract international R&D investment through greater levels of generosity of the incentives schemes (OECD, 2008; Carvalho, 2012).

It is common for a EU country to compare and measure the evolution of its S&T indicators against the EU average and, regarding R&D spending, to compare against the EU objectives for 2020. Most catching-up countries, like Spain and Portugal, implement S&T policies with this framework in mind and measure the success according to the reduction of the gap-size from the EU average S&T indicators. Although not so common, it is also important to set objectives against other country's S&T indicators. There are advantages in comparing policies, instruments, incentives and outcomes of two countries with similar characteristics and structural problems to address. Including the opportunity to conceive common S&T policies.[1]

To our knowledge, prior research comparing the R&D policy of Spain and Portugal, in particular R&D policies to stimulate private R&D expenditures, is very scarce indeed. There is little scientific research done on this matter and little insight to assist policy makers of both countries in designing and implementing better business R&D policies. There is, however, a latent need of that knowledge because a country's S&T plan normally includes an *ad hoc* report on the evolution and international comparative analysis of the relevant S&T indicators that helps to justify and support the government's policy choices and policy instruments. Under the European 2020 Strategy, all the EU countries have set specific R&D goals in their National Reform Programmes as a beacon to guide their R&D policy strategy in the medium to long term. As former sailors, the Spanish and the Portuguese know that learning with each other experiences might be important to successfully navigate through these difficult waters.

This paper compares and discusses the R&D policy strategy of Spain and Portugal to promote business R&D expenditures over recent years, with particular attention to the issues of R&D objectives and business R&D incentives. The contribution of this work lies on the opportunity it offers to both countries to begin to assess the performance of their R&D policies as a function of each other's performance, rather than doing so only in the light of their own objectives or the EU average S&T indicators. It begins by referring to the similar structural problems of the S&T systems that both countries traditionally face. Following a general trend, goals-based poli-

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[1] Portugal and Spain have promoted a common R&D institute called "International Iberian Nanotechnology Laboratory" (http://www.english.umic.pt/).

cies have been set up in both countries over the last years, harder in Spain than in Portugal, in an attempt to increase GERD and BERD to levels closer to the EU average. It is generally accepted that R&D is a fundamental input of innovation and, thus, by stimulating business R&D spending these policies are ultimately promoting innovation. In this sense, this paper focuses its attention on the characteristics and differences of two main tools to stimulate business R&D expenditures: direct funding (subsidies and loans) and indirect support (fiscal incentives for R&D). The magnitude and design of these incentives are likely to condition the firms' decision on how and when to invest in R&D, and in this way be able to partly reduce the problems associated with the business underinvestment in R&D. Finally, we compare these instruments in Portugal and Spain and show their differences and similarities. It is noticeable that both countries have a generous fiscal system for R&D but their S&T indicators are rather low. This fact needs to be analysed in light of the effectiveness of these instruments in Spain and Portugal, something to be considered in the next research stage. In this sense, it is in the spirit of the authors to initiate a regular analysis of the R&D policy of both countries to produce a steady flow of information and knowledge that can be useful to assist policy makers in designing, implementing and assessing R&D policies to foster private R&D. This might also be useful should the governments decide to deepen cooperation between countries and implement common R&D policies to stimulate business R&D.

The structure of the paper is as follows. Chapter 2 provides a general view of the S&T policy in Portugal and Spain over recent decades and makes a theoretical framework on relevant topics linking business R&D and public policy. Chapters 3, 4 and 5 compare three important issues of the R&D policy in both countries related to setting and achieving quantified R&D goals, direct and indirect incentives to business R&D, and the evolution of the business R&D expenditures in comparison with the EU average. Some concluding remarks and policy implications end the paper.

2. STRUCTURAL AND POLICY CHALLENGES

Spain and Portugal share three major structural problems related to R&D that have been guiding the R&D policy of both countries over the last two decades. On an international comparison, these problems manifest themselves in two dimensions: the size of the R&D variables and the relative weight of each sector of performance. First, the amount of R&D expenditures (GERD) is historically low, well below the EU and OECD average R&D spending. Second, the weight of the business sector on GERD is historically smaller than that of the institutional sector (HES+GOVERD+PNP), it is far from the EU average and the EU's objective of two thirds of GERD. Third, the number of full-time equivalent (FTE) researchers per one thousand workers is historically well below the OECD average. Contrary to many other OECD countries, the number of FTE researchers in higher education in Spain and Portugal is proportionally bigger than that of the business sector.

Spain has traditionally had a weak S&T system which worsened after the Spanish Civil War due to the international isolation and the dismantling of scientific institutions. At that time, the industrial policy was developed essentially on the basis of imported technology. The economic development during the 1960s increased the demand for technologic inputs. However, the Spanish innovation system could not attend that demand until the arrival of the democracy in the 1970s and 1980s. Important changes have taken place at that time such as the *Law of Science, Tech-*

nology and Innovation (Law 13/1986, 14 April) that set up a multiannual S&T framework, the inclusion of budget previsions and the identification of thematic priorities through the *Annual Plans of R&D*, the creation of CICYT[2] that became committed for the coordination, planning and control of the Annual Plans, and the beginning of financial support for business R&D by CDTI[3]. This has characterised the Spanish innovation system from the 1990s until now. The new *Law of S&T&I* (Law 14/2011, 12 May) gathered the consensus and contributions of the different stakeholders and agents of the Spanish innovation system. It defines the Spanish S&T&I system as integrating the Central government system and all regional systems, including the agents of coordination, financing and execution. The coordination is established over the *Spanish S&T Strategy* and the *Spanish Innovation Strategy* as the multiannual framework to achieve the objectives shared by all the regional administrations, the *Science, Technology and Innovation Council*, the *Science, Technology and Innovation Advisory Council* (representing the social and economic agents), and th*e Spanish Committee for Research Ethics.* As the main novelties, the Law encourages the mobility between the private and public sector, the creation of specific labour contracts and the assessment of researchers in the public research centers. Finally, the Law regulates the instruments to promote research and innovation, establishes some measures to guarantee the correct knowledge transfer and emphasizes the importance of research in internationalization and development cooperation. The *Spanish S&T&I Strategy 2013-2020* and the *Annual Plan of R&D 2013-2016* have recently been approved.

Despite these advances in S&T, Spain has yet a long way to reach the average levels of the OECD and EU S&T indicators. Although having increased the GERD to GDP ratio from 0,91% to 1,39% in the period 2000-2010, the INE[4] reports indicate that in 2011 this indicator has decreased to 1,33% which is still far from the Barcelona's 3% objective for 2010. Other structural problem of the Spanish S&T system is the existence of important differences between regions (COTEC, 2012). In 2009 the R&D spending over regional GDP (in %) varied between 2,07% in the Community of Madrid and 0,42% in Baleares Islands. Only four Autonomous Communities outweigh the Spanish average (1,39%): Madrid (2,07%), Basque Country (2,03%), Navarra (2,02%) and Catalonia (1,65%). Another important problem is the reduced participation of firms in R&D expenditures: in 2010, the Spanish BERD represented 52,1% of GERD and 0,7% of GDP (INE), with an important gap from the EU (63,3%) and OECD (67,7%) averages.

In Portugal, the creation of JNICT[5] in 1967, an institution that sought to stimulate the domestic technology base, signaled the birth of the S&T policy (Caraça, 1999). Only in the 1980s, after the end of the dictatorship, Portugal started to build the foundations of its S&T system with the creation of the basic infrastructures, the launching of mobilizing programmes and the creation of a legal framework. The first national statistics on R&D expenditures date back to 1982. In 1986 Portugal entered the CEE and in 1988 created the first law on scientific research and technological development which addressed all aspects of a S&T policy, including objectives, priorities, planning, evaluation, mobility of researchers, articulation with the

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[2] CICYT - Comisión Interministerial de Ciencia y Tecnología.
[3] CDTI - Centro para el Desarrollo Tecnológico e Industrial.
[4] INE - Instituto Nacional de Estadística.
[5] JNICT - Junta Nacional de Investigação Científica e Tecnológica.

innovation policy, etc. (Caraça, 1999). In the 1990s, the CIENCIA and PEDIP programmes were the main policy instruments designed to create the infrastructures for science, research and development. The "Technological Plan" in 2005 along with a stronger political determination in developing science, technology and innovation were two political facts that had a great impact on the Portuguese S&T indicators. Indeed, Portugal always had and still has comparatively poor S&T and innovation indicators, namely concerning R&D expenditures, but a lot has changed in recent years.

2.1. PUBLIC FUNDING INSTRUMENTS FOR R&D

Goal-based R&D policies are designed to stimulate R&D expenditures in general and private R&D expenditures in particular. In the latter case, the public action is justified because private firms tend to spend less in R&D in the presence of externalities, which tends to create a gap between private and public profitability (Arrow, 1962; Nelson, 1959). This produces *market failures* that make the amount of private R&D expenditures lower than the socially optimal. First, there are failures in the *goods markets* due to the presence of externalities that prevent firms from appropriating all the benefits derived from the innovation. Social profitability of innovation can be five times (Salter *et al.,* 2010) or 18 p.p. (Bloom *et al.*, 2001) higher than the private one. Second, innovation always generates technical, competitive and market uncertainty that makes inefficiencies in the *capital markets* which contributes to generate *financial restrictions.* This problem affects especially SMEs and start-ups (Hall, 1992, 2005; Lerner, 1999; Hubbard, 1998; Höfer, 2002; Hall *et al.*, 2009). Third, there are failures in the *labour markets* because R&D projects require high qualified employees thus originating high costs to the firms. Finally, innovation presents *indivisibilities, high costs* and *scale economies* that are incompatible with the competitive function of the markets.

Market failures is the traditional economic justification for the public funding of private R&D, but it is no longer enough to explain the public intervention in the context of goals-based R&D policies aiming primarily at raising the amount of R&D expenditures and in the context of competition between countries for international R&D investment. Governments' R&D policies are no longer based solely or even primarily on market failures. Thus, Carvalho (2012) adds two additional reasons for the public funding of private R&D: innovation and economic growth; and, competition for R&D investment and researchers. Being R&D a fundamental input of the innovation system, governments promote business R&D expenditures to promote innovation not just within the firm that carries out the R&D projects, but ultimately across the whole system of innovation. All EU countries have public funding for private R&D, even for firms and sectors not showing evidence of market failures.

The main types of public support for private R&D are *direct funding* (subsidies, grants, loans) and *indirect support* (fiscal incentives). The effectiveness of these instruments depends on each country's fiscal system and the aims of its programmes (European Commission, 2003b). Tax incentives and direct support are part of a portfolio of tools that includes intellectual property rights (IPRs), public funding of basic research and public provision of venture capital. While IPRs and direct funding of private R&D have a long tradition in many countries, tax incentives have gradually become a popular policy instrument to increase business R&D, especially over the past decade. In 2011, 26 OECD countries provided tax incentives for R&D, up from 18 in 2004 and 12 in 1995 (OCDE, 2011).

Figure 1 shows OECD estimates of the relative weight of each instrument as a percentage of GDP in 2009 by country. Canada, The Netherlands and Japan rely mostly on tax incentives, while direct funding is still preferred in Sweden, Finland or Germany. France, Denmark, Spain, the United Kingdom, Portugal and the United States use both instruments. The amount of public incentives in Spain and Portugal reached 0,15% and 0,13% of GDP, respectively, but the structure of the public incentives is completely opposite. While in Spain direct funding represented about 80% of the whole amount of public incentives in 2007, in Portugal tax incentives represented about 80% of the public incentives in 2008.
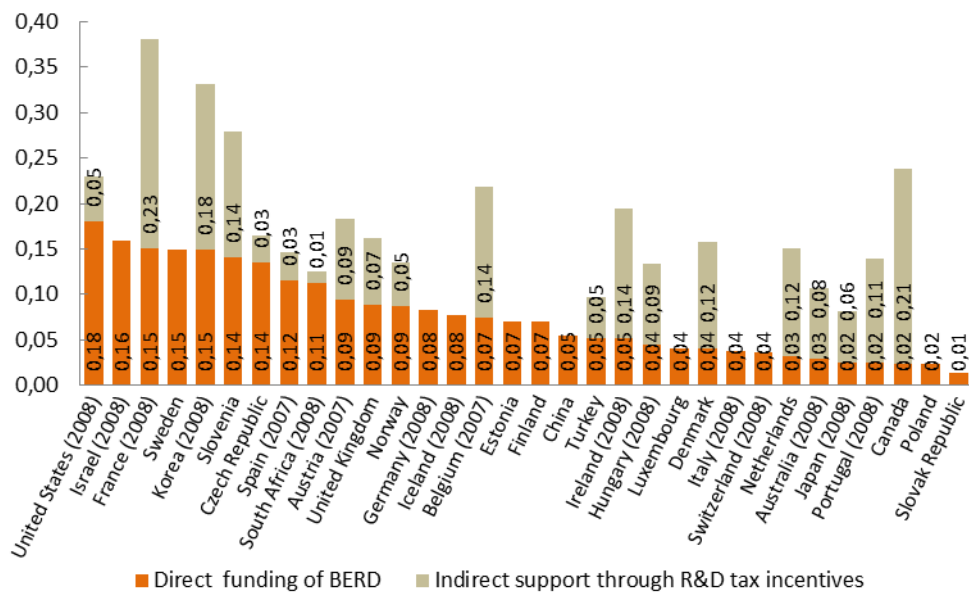
Figure 1. Direct government funding and tax incentives for R&D, 2009 (% of GDP)
Source: OECD (2011).

In general, *direct funding* is obtained only if the firm presents an application to the public agency and gets approval after the screening of the proposals. There may be important differences across countries in the specific design of direct support but the requirements set by the public agencies are usually related to the innovative content of the project, the technical ability of the firm to carry it out, and the market potential. The agency may rate projects along several dimensions, such as potential for generating additional social value, collaboration with public research labs or with universities, and financing constraints. If the agency has good information and is able to assess the potential for spillovers or the financing constraints faced by the firm, it can tailor the magnitude and duration of direct support to the particular features of the project, although a maximum subsidy rate is often set in practice. The firm runs the project once funding has been approved and usually the agency provides a down-payment to start it.

R&D tax incentives do not require the approval of a specific project by a government agency. Provided as tax credits (a deduction from the firm's tax liability) or as

tax allowances (a deduction from taxable income), they target all potential R&D performers irrespective of the features and quality of the R&D projects. A firm may claim a tax credit on any R&D expense considered deductible in the tax code. Tax credits applied to the corporate tax liability can be considered as an ex-post prize for performing research successfully, while when applied to the corporate wage and social contribution tax they act as a subsidy to R&D effort, regardless of the outcome. This difference is important since in the former the ability to claim the benefit depends on the firm's tax condition but not in the latter. To get the benefit the firm must have a positive tax liability, unless a refund system is established. The reduction of a firm's tax burden depends on the volume of R&D expenditures of the year and/or the incremental rate over past years. In general, it is rather simple to implement through the corporate taxation, implies low administrative costs to both the public administration and the firm, and claiming tax credits involves smaller costs than applying for subsidies. R&D tax incentives are neutral with regard to the research and type of firm being funded, are flexible and serve different policy objectives. They may vary according to firm size, region, sector and type of R&D activities. In some countries, R&D tax incentives can be effective also for firms with no payable taxes in a certain fiscal year using carry-forward or cash refund options. Tax incentives may be designed either as an allowance or a tax credit or may be used in other taxes such a withholding tax on wages. Fiscal incentives are potentially costly for the government since costs are difficult to determine in advance, but governments may limit the costs through an incremental tax incentive scheme or by applying a cap per firm, for example.

2.2. FEATURES OF DIRECT AND INDIRECT SUPPORT

Many questions can be discussed regarding the policy instruments to increase private R&D. Who applies for each type of R&D support and who is selected? Do appropriability and financing constraints play a role in either side's decisions, in both types of support? Differences in the design and timing of direct funding and tax incentives may have an impact on who benefits from each as well as on innovation decisions and outcomes. Here, we address relevant differences between both tools in three respects: eligibility requirements, magnitude and certainty of support, and timing of support.

Eligibility requirements. While all privately R&D projects qualify for a tax credit, only a part of them qualify for a subsidy, and some projects may qualify for both types of benefits. Subsidies may be awarded to projects that would not otherwise generate private profits and hence would not lead to a positive or significant deduction.

Certainty of support. Although both tax incentives and subsidies reduce the cost of R&D, subsidies have a higher degree of certainty on the extent of this reduction. If awarded, the firm knows the amount of the benefit it will get before it starts the project, whereas in the case of tax incentives effective support depends on the firm's ex-post tax position, which may be difficult to predict especially for truly innovative projects or for SMEs. The actual tax liability may turn out to be smaller than the tax credit. In addition, subsidies may be tailored to specific features of the project, i.e., whether it generates spillovers (with grants), or faces financing constraints (with loans), or both. Tax credits instead will be higher when there are few or no spillovers and financing constraints are mild.

Timing of support. Subsidies usually provide upfront funding for R&D projects,

while tax incentives provide a compensation after the research has been carried out. To benefit from a tax credit, and independently of whether it is applied to the corporate tax or to the wage or social security contribution taxes for R&D employees, the firm must be able to fund the project in advance. Young firms and SMEs may be less able to start a R&D project due to lack of funding, and therefore be unable to benefit from this instrument.[6] Unlike tax credits, R&D subsidies provide up-front funding for R&D and "certify" the project's quality to potential private investors (Takalo and Tanayama, 2010), which may be vital to young firms and SMEs.

With regard to the field of research, only recently have been developed structural models of firm and agency behaviour to explain and evaluate direct support. In Takalo and Tanayama (2010), firms face constraints to finance their R&D projects, some of which are high quality and others are low quality. The role of the public agency is to screen projects and provide a subsidy. The model predicts that firms with high quality projects will always apply for funding, firms with low quality projects will apply with some probability, and that subsidies will increase private effort by reducing the amount of market based capital needed and are a signal of quality for private external funding (both reduce the cost of projects).[7] Takalo *et al.* (2011) develop a model of firm application and agency granting decisions with fixed application costs. They estimate a set of equations, an agency decision rule among them, and find that technical challenge and risk affect these decisions, but financial constraints or spillover indicators are not explicitly included.

Keuschnigg and Ribi (2010) discuss how business taxation may affect financially constrained innovative firms, and predict that R&D tax credits will not only encourage innovation but also relax finance constraints and help innovative firms to exploit investment opportunities to a larger extent. From this work it seems that both types of support might be equivalent in addressing financing constraints. Busom *et al.* (2012) analysed the access by Spanish firms to R&D tax incentives and to grants or loans by taking into account the differences mentioned above. They examine the potential correlation between two sources of underinvestment in R&D and firm's access to these policy instruments, and find that firms facing financial constraints and newly created firms are less likely to use R&D tax credits and more likely to apply for direct public funding. With regard to appropriability, the estimates show that large firms using legal methods to protect their intellectual property are more likely to apply and obtain direct support, while SMEs are more likely to use tax incentives. For the Spanish firms, they conclude that direct funding and tax credits do not have the same ability to address the two types of failure associated with R&D, and these tools are complements rather than substitutes.

2.3. EFFECTIVENESS OF DIRECT AND INDIRECT SUPPORT

Although the case for policy action seems well grounded, policy instruments designed to address these market failures may have drawbacks. Direct public funding through subsidies or grants reduces the private costs of investing in R&D, but places high information requirements for the public agency awarding them. Tax credits and allowances may appear to be a neutral, simple and non-interfering tool, but the specific design is important as they may be easily claimed for R&D projects that

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[6] Hajivassiliou and Savignac's (2008) evidence suggests that constrained firms are less likely to start innovative projects.
[7] The certification or halo effect was pointed out by Lerner (1999).

yield high private returns and would have been carried out anyway (Carvalho, 2012). Empirical evidence evaluating the impact of both tools becomes therefore very valuable for their design and application.

A significant volume of research has been produced over the last decades to assess the impact of direct support on the level of private R&D investment. The main concern of most of this research has been testing for the presence of full crowding out effects, which would imply a waste of public resources. The impact on a firm's outcomes such as patents, productivity or sales of new products has also been analysed. Recently, parametric approaches have been combined with nonparametric ones in the evaluation of public policies. This approach has been widely used to determine whether R&D subsidies complement or crowd out private spending on R&D. In these studies, the recent concern about endogeneity and selection problems has led researchers to identify patterns in the distribution of public support and to estimate counterfactual status (Herrera and Heijs, 2006).

Using a matching approach, the studies of Czarnitzki (2001), Fier (2002), Czarnitzki and Fier (2002) and Almus and Czarnitzki (2003) in Germay; Duguet (2004) in France; Lööf and Hesmati (2005) in Sweden, and Czarnitzki and Ebersberger (2006) in Finland sustain that, on average, R&D subsidies do not fully crowd out private financing because innovation inputs increase with the receiving of public subsidies. In Spain, Herrera and Heijs (2006) and González and Pazó (2008) reject either full or partial crowding out of private financing by R&D subsidies although the latter concludes that some firms (especially SMEs and firms with medium-low technological intensity) would have not developed R&D activities in the absence of R&D subsidies.

Other studies combine parametric and nonparametric techniques to evaluate public funding policy as Kaiser (2004) who uses Heckman's two-step selection model and nearest neighbour matching estimator, Görg and Strolb (2005) who work with a sample of Irish plants and use parametric (DID) and nonparametric estimations (with Caliper matching estimator), Aerts and Czarnitzki (2005) who combine matching estimators and instrumental variables and Duch *et al.* (2007), in Spain, who use the matching and OLS approach to analyse the impact of various types of R&D subsidies received by Catalonian manufacturing and service sector firms. All of them reject the existence of a crowding-out effect as well.

Similar conclusions have been obtained in studies that have used only parametric methods of estimation to evaluate the relationship between R&D subsidies and firms' R&D activities as the Hussinger's (2006) study on German firms; Lach (2002) (Israel); Hanel (2003) (Canada); Ali-Yrkkö (2005a,b) (Finland); González *et al.* (2005) and Gelabert *et al.* (2009) (Spain).

Studies on tax incentives aim mainly at measuring the additional private R&D spending and the cost-effectiveness of the incentives, that is, whether the additional R&D spending is greater than the government's tax revenue losses. Most studies have used a micro-econometric framework and have focused on the American and Canadian economies (Hall and Van Reenen, 2000). But there are also studies that focused on other countries.[8] Studies using a macro-econometric framework are scarce but not irrelevant since macro-data allow the capturing of the indirect

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[8] Some examples: Lattimore (1997) in Australia, Asmussen and Berriot (1993) in France, van Pottlesberghe *et al.* (2003) in Belgium, and Parisi and Sembenelli (2003) in Italy.

effects caused by the incentives. For example, the spillover effects of innovation between countries (Guellec and van Pottlesberghe, 2003; Falk, 2004) or other macro-economic factors that affect R&D decisions as the culture of innovation, the fiscal system, etc. (Bloom *et al.*, 2002).

The methodology used in the literature on R&D fiscal incentives combines event studies comparing behaviour before and after a change in the policy (Collins, 1983); questionnaire surveys and interviews attempting to determine how individual firms respond to a policy change (Mansfield, 1986); and econometric estimation using two types of parametric methods: impact models (Berger, 1993) in which a binary variable shows the impact of the tax incentive, and demand models (Hall, 1993) that directly obtain the price-elasticity of R&D investment. Although results are mixed, recent studies confirm the effectiveness (Hall and van Reenen, 2000)[9] and cost-effectiveness (Finance Department of Canada, 1998) of tax incentives for private R&D. In Spain, there is little evidence of the impact of this tax policy, except for studies by Marra (2004), who concludes that tax incentives affect the firm cost structure and improves the private demand for R&D, and Corchuelo (2006) who finds that incentives increase the prospect of innovation and R&D effort.

In contrast, there are few papers that have analysed the effects of tax incentives on R&D using a nonparametric approach. In Canada, Czarnitzki *et al.* (2004), using data for 1999, show that tax credits increase a firm's probability of developing new products in domestic and foreign markets; they infer that firms perform more R&D activities because of the tax incentives. In Spain, Heijs *et al.* (2006) use the *propensity score matching* method to analyse the effect of tax incentives on Spanish manufacturing firms. They reject a crowding-out effect, but admit that fiscal incentives do not stimulate additional R&D investment. Lastly *et al.* (2009) have analysed the effectiveness of R&D grants for Canadian plants already benefiting from R&D tax credits and concluded that these firms introduced more new products, more world-first product, and were more successful in commercializing their innovations that their counterfactual part that only benefited from R&D tax credit.

The majority of studies that have used parametric approaches, nonparametric or both, controlling for the endogeneity of R&D subsidies and sample selection problems, have rejected full crowding-out effects. The exceptions are Wallsten (2000) who finds full crowding out of private R&D spending in firms benefiting from the U.S. Small Business Innovation Research (SBIR) programme; Busom (2000), in Spain, who rejects full crowding out of private funds but finds partial crowding out for 30% of the firms; Toivanen and Niininem (2000) in Finland, who show that the positive effect of R&D subsidies disappears in firms with higher cash-flow; and, Suetens (2002) in Belgium, who finds no significant effects of R&D subsidies.

3. R&D OBJECTIVES IN SPAIN AND PORTUGAL: TARGETS AND ACHIEVEMENTS

This is the goals-based R&D policy era (Carvalho, 2012). A growing number of countries around the world have set R&D intensity goals in their science, technology and innovation (S&T&I) plans to be achieved in a specific time frame. Currently, it is not uncommon to find explicitly highlighted on the first pages of a country's

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[9] The median of the elasticity is –0.85 and the average is -0.81 (European Commission, 2003b).

S&T&I plan the R&D objectives (GERD and BERD as a % of GDP) as a main reference for the plan itself. The EU's 3% goal for 2010 (renewed for 2020) is probably the best known example of a goals-based R&D policy framework, but many other countries have set R&D intensity goals over the recent years, including all the EU countries, the US, China, Brazil, Russia and Japan. For instance, Korea has set to invest 5% of GDP in R&D by 2012 (MEST and KISTEP, 2008). While many countries believe in a high level of R&D expenditures as the key to success, other countries like Spain and Portugal are concerned about correcting the structural underinvestment in R&D by the business sector and catching up with the EU average R&D spending. By setting specific R&D intensity goals, governments express the view that R&D is the pillar of knowledge and innovation economies of which they want to be a part of sooner than later, although history shows that the achievement of those (ambitious) objectives are often beyond government's control. Government's commitment (and leadership) is not enough to control dynamic variables such as BERD or GDP, which affect directly the R&D intensity indicator.

Table 1 compares the policy targets[10] and achievements for R&D spending (GERD as a % of GDP) in Spain, Portugal and the EU. It shows a timeline list of the R&D intensity goals set by each country, and identifies the year each objective has been set[11] and the target year of its achievement. Similar information for BERD is shown in Table 2. Of the three, Spain has the longest tradition of setting GERD objectives and it has done so systematically in the context of its four year S&T&I plan[12] since 1996. Unlike Spain, the S&T policy in Portugal, and R&D policy in particular, do not follow from principles, objectives and means set in a framework law and thus it is less structured and long-term oriented. Portugal has defined (even if unnoticed) goals for R&D expenditures for the first time in 2000, but only after 2005 the government had enough conviction and determination to achieve the ambitious goals it has set that year under the "Technological Plan" (The Government of Portugal, 2005). The EU has set R&D intensity goals for the first time in 2002 at the Barcelona Council, but after that it has put growing pressure on all EU countries to include specific R&D goals in their national reform programmes. Eventually, it became a fundamental element of the national R&D policy of all EU countries after the "Europe 2020 Strategy" (European Commission, 2010a).

It is clear from Table 1 that none of the R&D objectives (GERD as a % of GDP) set by Spain, Portugal and the EU has been achieved, and in many cases there are substantial discrepancies between targets and achievements. For instance, Spain invested 1,39% of GDP in R&D in 2010 (2% target); 1,33% in 2011 (2,2% target). Portugal invested 1,59% in R&D in 2010 (1,8% target). In 2005, the EU reaffirmed the 3% R&D goal for 2010 fully aware of its impracticality (Economic Policy Committee, 2005). These examples illustrate a general pattern of the goals-based R&D policy era since only in a few cases the GERD to GDP objectives were achieved (v.g., Finland in 1999: 3,17% (2,9% target); Denmark in 2010: 3,07% (3% target).

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[10] We have considered the lowest scenario (v.g., Spain 1996-1999: 0,9%; 1,0%; 1,3%) and the lowest interval range (v.g., Portugal 2011-2020: 2,7%-3,3%) when applicable.
[11] It is the date of approval or publication of the document where the goals are defined.
[12] "Plan Nacional de Investigación Científica y Desarrollo Tecnológico" which follows from the framework law of "Fomento y Coordinación General de la Investigación Científica y Técnica" (Ley 13/1986).

Table 1. R&D spending (GERD) in Spain, Portugal and the EU: targets and achievements

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	...2014	2015...	2020	R&D expenditures — GERD as a % of GDP (Year)(*)
Spain																				
	0,83→			0,90																0,86 (1999)
			0,86→				1,29													1,05 (2003)
							1,05→	1,22→	1,40											1,27 (2007)
									1,12→			1,60→		2,00						1,39 (2010)
											1,27→				2,20					1,33 (2011)
											1,27→					2,50				1,33 (2011)
																1,33→			3,00	1,33 (2011)
Portugal																				
					0,73→						1,00									0,99 (2006)
								0,78→							1,80					1,59 (2010)
															1,50	1,90→	2,70			1,50 (2011)
European Union (27 countries)(**)																				
							1,88→								3,00					2,01 (2010)
																2,01→			3,00	2,03 (2011)

Notes: (*) Target year or most recent. (**) 15 countries in 2002 when the 2010 objective was set.

Sources: Comisión Interministerial de Ciencia y Tecnología (1996), European Commission (2003a, 2010), Eurostat (data extracted on 21-02-2013), FECYT (2007a, 2007b), Gobierno de España (2011), Ministério da Ciência e da Tecnologia (2000), Ministerio de Ciencia y Tecnología (2003), Ministerio de la Presidencia (1999, 2005), The Government of Portugal (2005, 2011).

Table 2. R&D spending (BERD) in Spain, Portugal and the EU: targets and achievements

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	...2014	2015...	2020	R&D expenditures — BERD as a % of GDP (Year)(*)
Spain																				
					0,45→			0,84												0,57 (2003)
								0,57→	0,70→	0,82										0,71 (2007)
										0,71→				1,33						0,70 (2011)
										0,71→						1,63				0,70 (2011)
															0,70→		2,00			0,70 (2011)
Portugal																				
					0,20→						0,25									0,46 (2006)
								0,30→							0,80					0,73 (2010)
																0,69→	1,70			0,69 (2011)
European Union (27 countries)(**)																				
							1,20→								2,00					1,24 (2010)
																1,24→			2,00	1,26 (2011)

Notes: (*) Target year or most recent. (**) 15 countries in 2002 when the 2010 objective was set.

Sources: European Commission (2003a, 2010), Eurostat (data extracted on 21-02-2013), FECYT (2007a, 2007b), Gobierno de España (2011), Ministério da Ciência e da Tecnologia (2000), Ministerio de Ciencia y Tecnología (2003), Ministerio de la Presidencia (1999), The Government of Portugal (2005, 2011).

Table 2 shows a similar picture for BERD (as a % of GDP). With the exception of one case (Portugal in 2006) where the R&D spending goal for BERD has been largely exceeded, in all other cases there are discrepancies between targets and

achievements for the business R&D intensity indicator. There are large discrepancies in some cases; for instance, the Spanish BERD represented only 52,6% and 67,9% of the target goals set for 2011 and 2003, respectively.

Figures 2 and 3 compare the trends of the business R&D intensity objectives up to 2020 with the historical evolution of this variable for Spain and Portugal. It is noticeable the two trends are diverging significantly and it seems that the business R&D intensity objectives for 2020 set by both countries are just too ambitious and unlikely to be achieved, more in Spain than in Portugal though. Spain has registered a steady evolution of the BERD to GDP ratio, which has grown at an annual average rate of 4% from 1996 to 2011. The growth rate has to raise to about 12,4% for the 2% goal to be met in 2020. Portugal is somewhat different because the BERD to GDP ratio has grown at a 12,4% annual average growth rate between 1996 and 2011, but has registered a 27% annual average growth rate in the 2005-2009 period, a very high growth rate by any standards which is unlikely to occur in the near future. It is also clear that the BERD to DGP ratio is tailing off from a peak of 0,74% in 2008 (Spain) and 0,75% in 2009 (Portugal) (even taking into consideration the negative growth rates of the Portuguese GDP registered since 2008).
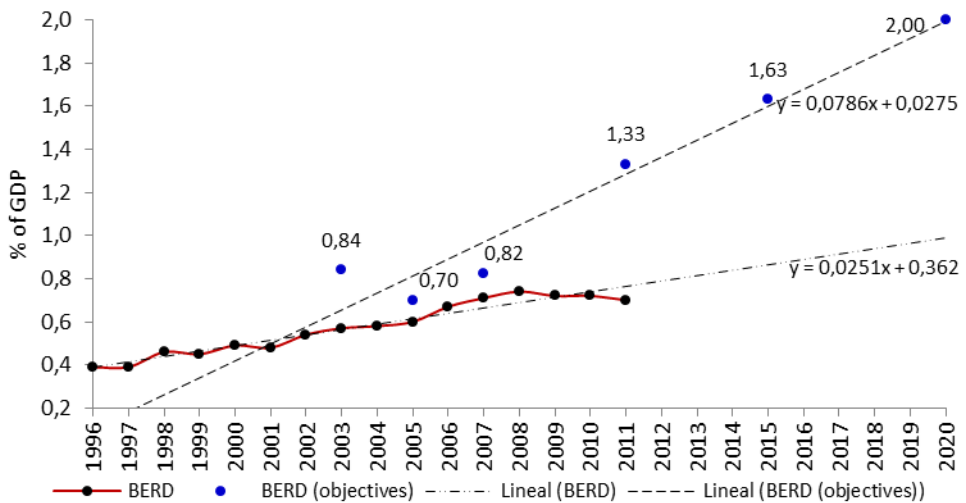
Figure 2. Evolution of BERD in Spain and objectives for 2020 (% of GDP)
Sources: Eurostat (data extracted on 21-02-2013), Table 2.

It is noticeable the Portuguese and Spanish governments and the EU are not good at establishing R&D intensity goals. They have failed most of the objectives they have committed to achieve and it is likely they will also fail to achieve the business R&D intensity goals for 2020, which raises questions about the way R&D objectives are set and the effectiveness of goals-based R&D policies. The EU *required* all the Member States to set R&D intensity goals in the context of the Europe 2020 strategy to get them committed to the EU's 3% goal. In 2011, Spain and Portugal have set ambitious R&D objectives despite the severe economic crisis they are going through and when the BERD to GDP ratio was already showing clear signs of downturn in both countries. Paradoxically, for Portugal these objectives "are

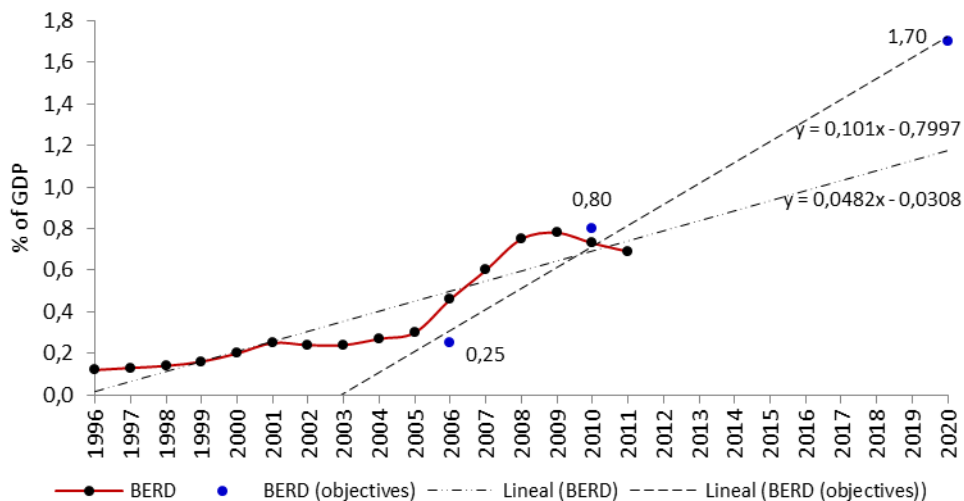consistent with the macroeconomic context" (The Government of Portugal, 2011)!

Figure 3. Evolution of BERD in Portugal and objectives for 2020 (% of GDP)
Sources: Eurostat (data extracted on 21-02-2013), Table 2.

How do the governments set GERD and BERD objectives? Are objectives and the rationale behind them two faces of the same coin? One thing is the underlying reasoning that leads governments to set R&D objectives; the other thing is the justification for a particular goal in a specific time frame. A major reason for setting specific R&D intensity objectives fully emerged with the Lisbon Strategy in 2000 and the purpose of making the EU "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion" by 2010. Suddenly, R&D expenditures became central in the governments' S&T policy worldwide for being a pillar of a knowledge-based economy and the nations' competitiveness. This urged governments to implement goals-based R&D policies to raise R&D expenditures. Since R&D intensity ratios vary greatly across countries, it is appropriate to distinguish three groups of countries that set R&D goals for a knowledge-based economy.

Some countries aim *to reach leadership* in S&T. This is the case of Korea that has set a 5% goal for 2012 to "Become one of 7 major S&T powers in the world" (MEST and KISTEP, 2008). Japan aims to spend over 4% of GDP in R&D by 2020 because "Making Japan a model country that leads the world in solving problems will be directly tied to strengthening the nation's research and development capabilities" (Cabinet Secretariat, 2009). "The aim of Swedish research and innovation policy is to make Sweden a leading knowledge and research nation characterised by excellence and a high capacity for product renewal" (Prime Minister's Office, 2008). Other countries are concerned about *not lagging behind the leading S&T countries* they consider to be major competitors. This is the case of the EU in relation to Japan and the USA. The USA's president believes the country should invest

at least 3% of GDP in R&D because "Currently, the U.S. enjoys a significant productivity advantage [but] continued innovation in products, business practices, and technology is essential for extending our productivity gains" (Executive Office of the President, 2009). A third group of countries is concerned about *catching-up with the EU/OECD average* R&D spending. Ireland, for instance, "is below the EU average at 1.4% of GNP but is making a huge effort to close this gap" (Inter Departmental Steering Group, 2004); Spain, which set to duplicate R&D expenditures to 2% of GDP by 2010 to reach the EU average R&D spending (Ministerio de la Presidencia, 2005); the increase of R&D expenditures was a priority objective to get Portugal closer to the EU average (The Government of Portugal, 2005).

Justifications for setting a R&D goal have evolved over time and vary across countries. It is not uncommon the inexistence of a strong economic rationale to justify the goals. On the contrary, justifications are often general and it is growingly common for governments to set R&D objectives as focal points or magnets that the S&T variables should bend to. Although this is a matter of public policy, there are at least three main ways that governments follow to set a particular R&D goal:

- *Goals are based on the historical evolution and prospective analysis of relevant economic indicators* such GDP and BERD. This is normally the strategy followed by governments in the first times they set R&D goals. In 1996, Spain presented three scenarios for the prospective R&D expenditures by considering its past 12,7% average annual growth and the expected evolution of the Spanish economy in the coming years (Comisión Interministerial de Ciencia y Tecnología, 1996).

- *Goals are set against a reference variable* such as the EU/OECD average R&D spending, the EU's 3% goal or the 2/3 performed by the business sector. Besides the risk and challenges of reaching a moving target, this strategy tends to overlook the country's economic basis. Canada committed itself to advance its ranking in the OECD from 15th to 5th place by 2010 (Government of Canada, 2001); Norway set to achieve the average OECD R&D intensity by 2005 (OECD, 2000). Since 1996, Spain has set to achieve the EU average R&D spending in the long term, but the late 2020 objectives point to the EU 3% goal (which is the same in case the EU achieves this goal). Portugal also used the 3% reference to set its R&D goals for 2020. According to Figures 2 and 3, it appears the strategies of Spain and Portugal were more concerned with the goal itself than the economic base to attain it!

- *Goals are set arbitrarily* by governments with no clear economic rationale or reference. This is typical of countries that aim S&T leadership and the case of the EU that has set a 3% R&D goal. Why 3%? It is also the case of Portugal when it set to "triplicate private effort in R&D" by 2010 (The Government of Portugal, 2005).

4. DIRECT AND INDIRECT INCENTIVES IN PORTUGAL AND SPAIN: A COMPARATIVE ANALYSIS

4.1 DIRECT FUNDING

Spain and Portugal have national structural programmes in place that offer different types of public funding for business R&D, either for individual R&D projects, for R&D projects in consortium with other firms and research institutions, or for sub-contracting R&D institutions to carry out research instead of firms. The annual reports of the Spanish main funding agency, CDTI, provide the following information about direct support over the period 2006-2011. In 2006, CDTI contributed with

802 million euros (M€) to 1032 projects, out of 1434 applications. Most of the funding (50%) was allocated to technological development projects (i); 14% to technological innovation projects (ii) (mostly adoption of innovations); 9% to cooperative industrial research; 25% to large public-private research consortia (CENIT projects). The first three types offered 0% interest loans and up to a 20% grant, depending on the features of the project. CENIT projects were offered grants of up to 50% of the R&D budget; these are 4 year-long projects, with budgets between 20 to 40M€. Loans were offered to new technology based firms of up to 70% of the project's budget, with a maximum funding of 400.000€ (Neotec Projects). In 2007, CDTI contributed with 1090M€ to 1111 projects. In 2008, projects i) and ii) were combined in a single category so as to comply with EU state aid rules. Total CDTI funding decreased to 766M€ that were allocated to 1124 projects. The grant rate increased to 25%. In 2009, CDTI contributed with 1157M€ to 944 individual R&D projects, 97 cooperative R&D projects, 75 Neotec projects and 18 CENIT projects. In 2010, CDTI contributed with 1249M€ to 1219 individual R&D projects, 151 cooperative R&D projects, 72 Neotec projects and 12 CENIT projects. In 2011, CDTI contributed with 1379M€ to 983 individual R&D projects, 191 cooperative R&D projects, 84 Neotec projects and 7 INNPRONTA. CDTI also provides advice about tax incentives to firms that obtain direct support.

Table 3. Public support from CDTI in Spain

Type of projects	Maximun support coverage	Refundable interest	Amortization	Nonrefundable portion
Cooperative and individual R&D projects	85% (75% + 10 p.p. credit exceptionally)	0%	10 years	15%-33% (sme)
8-23% (large firms)	75%	0%	10 years	Up 33%
NEOTEC	70%	0%	When cash-flow >0	-
FEDER-INTERCONECTA	EU framework	0%	10 years	-
INNPRONTA	75%	0%	10 years	Up 40% (sme) Up 35% (large firms)
Online bank R&D financing		Euribor -0,5	5 or 7 years 7 year if 2 year grace	

Source: CDTI Annual Report, 2011.

In Portugal it is currently running the QREN[13] 2007-2013 structural programme, which is the main public funding instrument to support business R&D (and other economic projects). QREN provides a diversified range of instruments do promote business R&D directly and indirectly through training, research facilities, creation of networks, strengthening the links of the National Scientific and Technologic System (SCT) and alike. In relation to direct funding (in general, non-refundable), the range of funding instruments include individual R&D projects, R&D centres, collective R&D, mobilising projects, projects of demonstration, co-promotion projects and R&D vouchers. The maximum public support varies according to the instrument and according to a number of other factors, such as the type of firm (SME or large firm), if the project includes or not SCT institutions, the type of research (industrial or not), whether the research in consortium includes SME or not, etc. Table 4

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[13] QREN - Quadro de Referência Estratégico Nacional.

shows some data on the execution of QREN up to December 2012.

Table 4. QREN report - Factors of competitiveness agenda (as on December 31, 2012)

Factor of competitiveness	Value
Number of direct beneficiary companies	8136
Total planned investment in the projects	8.208.012€
Total eligible investment in the projects	6.906.352€
Number of new enterprises/ start-ups supported	825
Number of new enterprises/ start-ups supported in knowledge-intensive sectors and medium-high technology sectors	399
Total R&D investment	1.889.967€

Source: QREN (2013).

Figure 4 shows the evolution of the public funding of business R&D in Portugal from 1997 (the year the tax incentives system was introduced in Portugal) and 2010. It is apparent the increasing effort of Portugal to support business R&D, particularly after 2005. Unlike Spain, where most government incentives for business R&D are in the form of direct financing (about 80% of the whole public funding in 2007, according to Figure 1), in Portugal, most of the public support is in the form of tax incentives (about 75% of the whole public funding in 2007).[14]
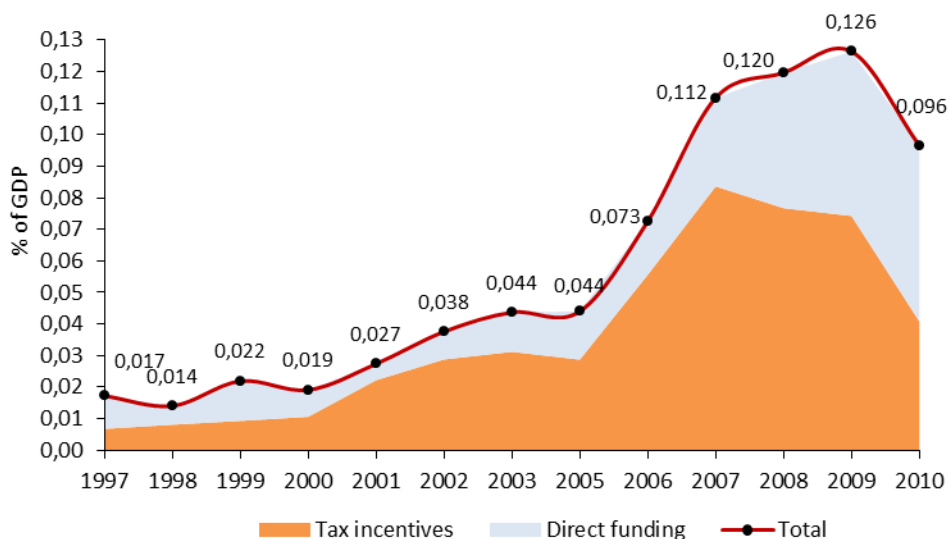
Figure 4. Public funding of business R&D in Portugal, 1997-2010 (% of GDP)
Notes: 2004 has been excluded due to missing data. The data for 2009 and 2010 are provisional.
Source: Carvalho (2013).

4.2 R&D TAX INCENTIVES

There is a growing tendency for countries to implement fiscal incentives systems

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[14] See Carvalho (2013) for detailed information.

for business R&D, even countries traditionally averse to this kind of public support. Tax incentives for business R&D already exist in most OECD countries and they have been gaining importance in relation to direct financial incentives (Carvalho, 2012)[15]. Many countries have developed their R&D tax incentives systems over the last decade and currently Spain and Portugal have two of the most generous and attractive tax incentives systems to promote business R&D of the OECD area, as can be seen in Figure 5. In 2008, for every euro invested in R&D in Spain and in Portugal, firms were able to benefit from a reduction of 0,349€ and 0,281€ in the tax burden, respectively. Only France and Canada could match such benefits.
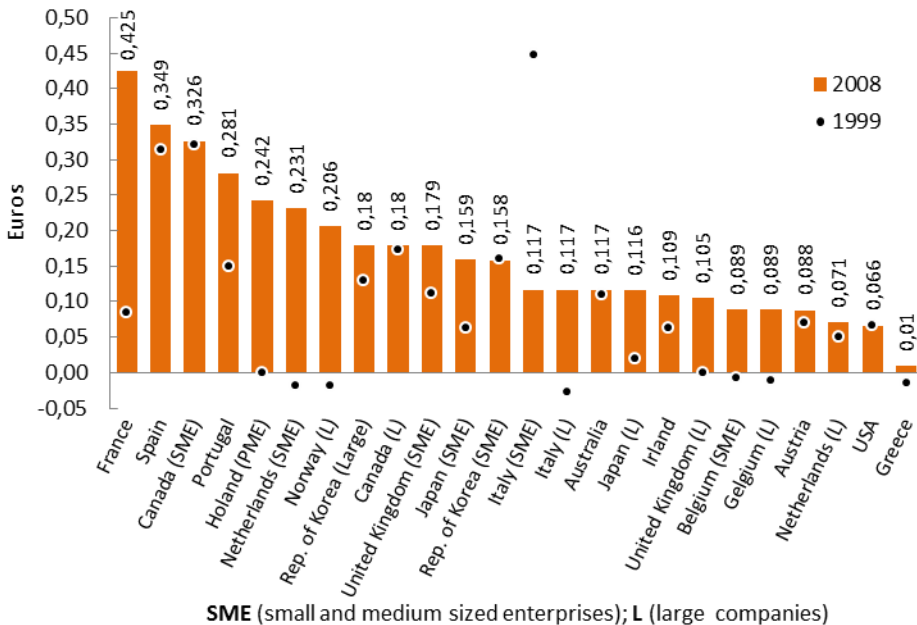
Figure 5: Change in tax treatment of R&D, 1999 and 2008 - Tax subsidy to R&D (calculated as 1 minus B-index)
Source: OECD (2010: Figure 2.2).

Spain and Portugal have superior tax incentives systems to foster business R&D with certain similarities, but Spain has played a leading role on the evolution of both systems. In Spain, R&D tax incentives for R&D have been in place since the early eighties, but major legal changes date back from 1995 when a new law on corporate taxation was introduced. Portugal first introduced a R&D tax incentives system (SIFIDE) in 1997. Portugal has seen the Spanish tax incentives system as a reference model, but as a competitor for international R&D investment as well. Three reasons are behind the creation of SIFIDE in 1997[16]: the low level of R&D in Portugal and the need to stimulate business R&D expenditures; Portugal was one

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[15] See Carvalho (2012) for a detailed analysis of the reasons behind the increasing preference of governments for tax incentives schemes to promote business R&D.
[16] Preface to Decree-Law no. 292/97.

of the few OECD countries without this sort of instrument; this was a penalising situation with regard to attracting qualified investment, particularly in relation to neighbour Spain. Among the reasons for the changes introduced to SIFIDE in 2001 is that "other countries, namely Spain, have changed their regimes too" and the Portuguese tax incentives system must remain "competitive with similar systems".[17]

Tables 5 and 6 show the timeline of the evolution and main characteristics of the Spanish and Portuguese R&D tax incentives schemes. The first point to highlight is the number of times the systems have changed, 8 in Spain and 5 in Portugal[18], showing the commitment of governments to improving and making more attractive this R&D instrument. A second point worth noting is that while in Portugal all changes were to improve the generosity of some benefit or to add new benefits, in Spain part of the benefits were reduced in the 2007 review and one of the benefits was cancelled. This might have to do with adjustments recommended by the accumulated experience or it might be the recognition that some benefits were excessive to the outcomes produced. In the case of Portugal, it has to do with the government's commitment to increase business R&D in the 2005-2010 period and to restore confidence in SIFIDE after its discontinuation in 2004 and 2005. A third point is the fact that both systems use a two-level deduction base: a "level rate" applied on the volume of a firm's R&D expenditures of the year; and an "increment rate" applied on the increment of a firm's average R&D expenditures over past two years. A fourth point is that the deduction base is the firm's income tax payable and firms can claim the benefit up to 6 years (Portugal) and 15 years (Spain) after the research expenditures have taken place. A fifth point is that both systems allow R&D projects to get direct public funding from the country's structural programmes and from the tax incentives system on the part not supported by direct funding.

Table 5. Evolution of the Spanish R&D tax incentives scheme, 1995 onwards

	1995	1999	2000	2001	2004	2007*	2008	2011
Level rate (volume of R&D expenditures of the year)	20%	30%	30%	30%	30%	27%	25%	25%
Increment rate (on the increment of R&D expenditures over past two years average)	40%	50%	50%	50%	50%	46%	42%	42%
Expenditures on R&D personnel	-	10%	10%	10%	20%	18%	17%	17%
Cooperation with universities and Technological Centres	-	10%	10%	10%	20%	20%	-	-
R&D capital expenditures (assets except buildings)	-	-	-	10%	10%	9%	8%	12%
Expenditures in innovation		10-15%	10-15%	10-15%	10-15%	10-15%	10-15%	10-15%
Deduction base	Income tax payable							
Carry forward (years to claim the tax benefit)	5	5	10	10	10	15	15	15
Tax credit limit per year	35%	35%	45%	45%	50%	50%	50%	60%

Note: (*) Alternative option of deducting from the social security tax liability.

Sources: Decrees-Law (3/00,4/04), Laws (43/95,55/99,24/01,35/06,16/07,4/08,2/11); Corchuelo (2004).

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[17] Preface to the Decree-Law no. 197/2001.
[18] In Portugal, SIFIDE has been replaced by "RFI – Reserva Fiscal para Investimento" (Fiscal Reserve for Investment) in 2004 and 2005, and reintroduced again in 2006.

In Spain, the definition of R&D eligible expenses follows the OECD Frascati Manual guidelines. Tax incentives are basically provided through deductions from corporate taxable income (100% of current R&D expenditures, and 100% write off of R&D fixed assets except buildings) and from the firm's tax liability (the tax credit). Spain has a hybrid system: part of the tax credit comes from the volume based R&D and part comes from the incremental R&D. In 1999, non-RD technological innovation expenditures became eligible for tax credit at a 10% or 15% rate, depending on the type of expenditure. Tax credit rates were initially 20% of R&D volume and 40% of the excess of the average R&D spending of the two preceding years, with a cap of 35% of the tax liability. In 2001, both rates were increased to 30% and 50%, respectively, as well as the cap (to 50% for SMEs if the credit was greater than 10% of the tax liability). In 2004, in addition, firms could deduct 20% of the labour cost of employees assigned exclusively to R&D tasks. Rates were somewhat reduced in 2007 and 2008. From 2007 onwards, firms could use the alternative option of deducting from the social security tax 40% of the liability corresponding to R&D personnel. There is a cap of 50% of the corporate tax liability on the maximum credit of a given year, and the excess can be carried forward up to 15 years. Firms that obtain R&D and innovation subsidies can claim tax credits on all remaining R&D expenditures after subtracting 65% of the subsidies received. Despite the recent reduction in the credit rates, Spain remains one of the most generous countries in tax credits for R&D. In 2008, tax incentives have expanded to income from intellectual property generated by R&D, the so-called "patent box". A patent box grants a lower corporate tax rate on profits generated from patents, that is, a preferential treatment of R&D investment over other types of investments.

Table 6. Evolution of the Portuguese R&D tax incentives scheme (SIFIDE)

	1997	2001	2005[a]	2009	2010
Level rate (volume of R&D expenditures of the year)	8%	20%	20%	32,5%	32,5%
Increment rate (on the increment of R&D expenditures over past two years average)	30%	50%	50%	50%	50% + 20%[b]
Deduction base	Income tax payable				
Carry forward (years to claim the tax benefit)	3	6	6	6	6
Tax credit limits per year: - volume-based tax credit - increment tax credit	No limit 249398,9€	No limit 498797,9€	No limit 750000,0€	No limit 1500000,0€	No limit 1800000,0€

Notes: (a) To take effect in 2006; (b) The increment rate increases 20 percentage points to cover expenses with R&D personnel holding a PhD degree.

Sources: Decrees-Law (292/97, 197/2001, 40/2005), Laws (10/2009, 3-B/2010); Carvalho (2012).

In Portugal, the R&D tax incentives system offers a large base for deduction of R&D expenses since its creation in 1997: new R&D fixed assets (except buildings); expenses with R&D personnel, including staff of R&D institutions; running costs up to a maximum of 55% of the expenses with R&D personnel; subcontracting R&D activities to R&D institutions with public utility status; equity capital of R&D institutions; costs related to patenting; acquisition of patents intended to carry on R&D activities; expenses for R&D audits. There are no limits for volume-based tax credits (expenses of the year) but the increment tax credit (on the increase of the aver-

age R&D in the last two years) is currently limited to 1,8M€, six times the amount of 1997. There were three major changes to SIFIDE: in 2001 the level rate increased from 8% to 20%, the increment rate from 30% to 50% and doubled the number of years for claiming the tax credit (from 3 to 6 years); in 2006 SIFIDE was reintroduced after being replaced in 2004 and 2005 by the unsuccessful Fiscal Reserve For Investment, and the limit for the increment tax credit has been doubled; in 2009 the level rate increased from 20% to 32,5% and the limit for the increment tax credit doubled again to 1,5M€. Since 2010 the increment tax credit can be increased by 0,3M€ to cover expenses with R&D personnel holding a PhD degree.

5. BUSINESS R&D EXPENDITURES IN SPAIN AND PORTUGAL: A COMPARATIVE ANALYSIS

Both Spain and Portugal have been implementing R&D policies to stimulate business R&D spending, but the evolution of BERD does not depend just on the public incentives, which have an indirect impact on business R&D. There are many other factors that might have an effect on the decision of firms to invest in R&D. Several studies attempted to measure the increment on the amount of business R&D expenditures for each euro of public incentive, although there is some inconsistency of the results. We have shown elsewhere that R&D objectives set by governments are hardly achieved and are not a reliable yardstick for the evaluation of business R&D policy. The assessment of the business R&D policy might be done against the three objectives that are of concern of both countries at least since the 1990s: to increase BERD as a percentage of GDP, catch up with the EU average business R&D spending, and increase the BERD to GERD ratio (hopefully) to about two thirds. These goals have justified the increasing generosity of the public incentives and now serve as a reference for evaluating the effectiveness of the R&D policy.

Information to assess these policy objectives can be found in Figures 6, 7 and 8. Figure 6 compares the evolution of BERD in Spain, Portugal and the EU (27 countries) between 1995 and 2011, Figure 7 measures the BERD of Spain and Portugal against the EU average, and Figure 8 shows the evolution of BERD as a percentage of GERD for both countries and the EU. Over this period, the EU BERD shows a steady trend to increase and so does the Spanish BERD up to 2008. Starting from a much lower point, the Portuguese BERD increased at a steady rate from 1995 to 2005, and increased at a high rate between 2005 and 2009, point after which it started decreasing. On the whole, between 1995 and 2011 there was a clear increase on the business R&D expenditures as a percentage of GDP in both countries, but it is also noticeable a decrease in the BERD to GDP ratio from the start of the current economic crisis onwards, suggesting that the change in the R&D structure of both countries occurred in the previous years was not yet consolidated. In general, it seems clear that the R&D indicators had a more smooth behaviour in Spain and a more irregular evolution in Portugal, with periods of faster growth (after 2005) and periods of sharpest decline (after 2008).

In Figure 7 it is manifest the effort of Spain and Portugal to catching up with the EU average BERD spending. In 1995, the Spanish and Portuguese BERD to GDP ratios represented about 34% and 10% of the EU ratio, but in 2008 that difference has been substantially reduced and both ratios reached over 60% of the EU average. This remarkable evolution, much more pronounced in Portugal especially after 2005, is the result of purposeful R&D policies implemented by both governments to

increase the amount of business R&D expenditures. The BERD to GDP ratio between Spain and Portugal evolved from a ratio of about 3,4 in 1995 to about 1 in 2011, but most of the catching up took place after 2005 in the context of the Portuguese "Technological Plan" (The Government of Portugal, 2005). Despite such evolution, the level of business R&D expenditures is still not enough and both countries will have enormous tasks ahead to reach the ambitious goals they have set for 2020 (Figures 3 and 4).
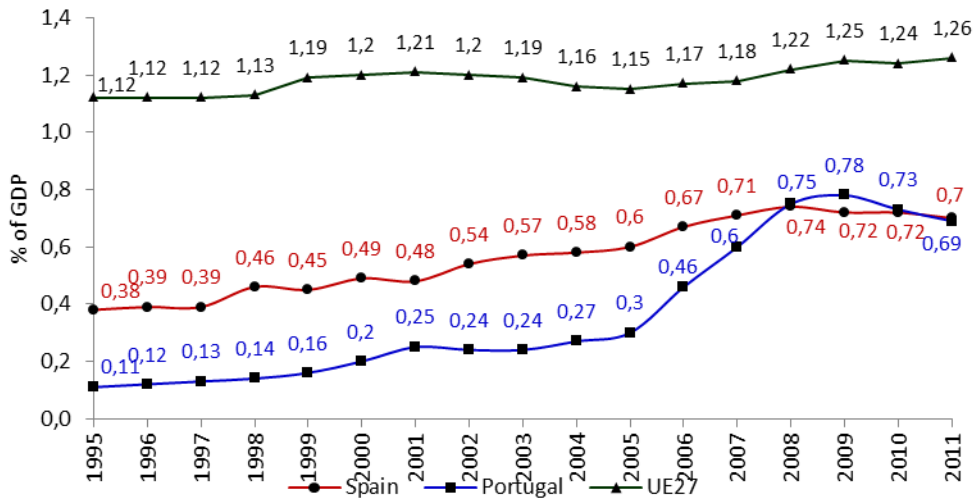
Figure 6. Evolution of BERD in Spain, Portugal and EU27, 1995-2011 (% of GDP)
Source: Eurostat (data extracted on 21-02-2013).
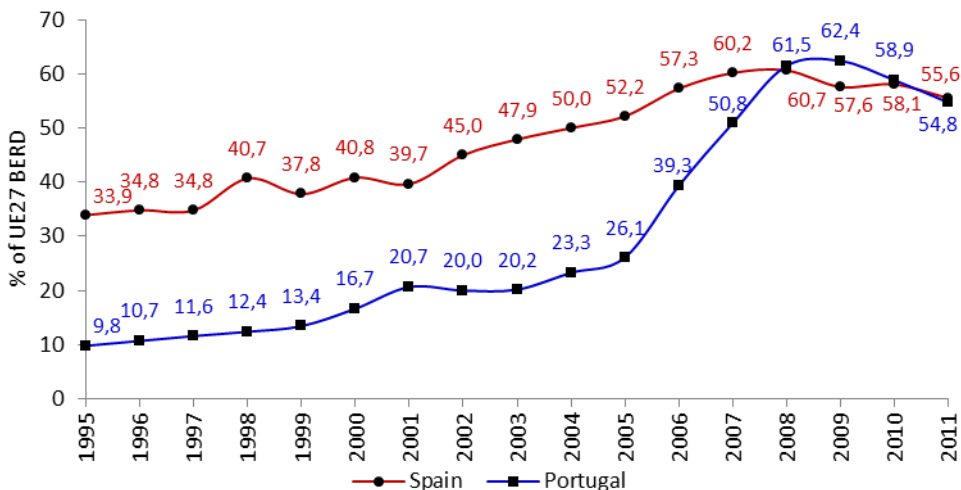
Figure 7. Evolution of BERD in Spain and Portugal as a % of EU27 BERD, 1995-2011

23
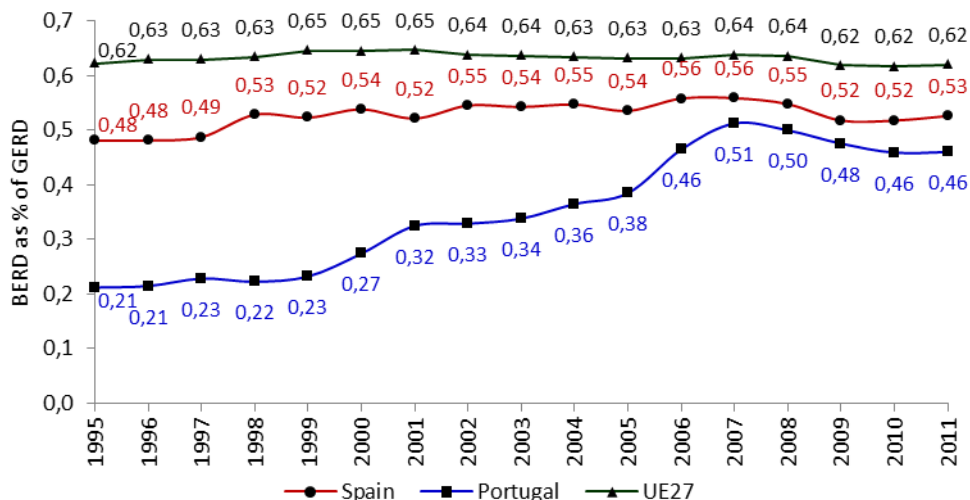
Figure 8. Evolution of BERD as % of GERD in Spain, Portugal and EU27, 1995-2011

Figure 8 shows that the EU's BERD to GERD ratio has remained in the range between 62% and 65% over the period under analysis. In Spain, the BERD to GERD ratio reached 50% in 1998, registered several phases of growth and decrease but remained in the range between 52% and 56% up to 2011. During this period, the rate of performance of the Spanish business sector remained on average about 9,7 points below the EU average. In Portugal, the behaviour of the business sector was very different. In 1998, the R&D performance of the Portuguese business sector was only 21%, representing about one third of the EU average and about 44% of Spain's. The BERD to GERD ratio recorded high growth rates up to 2007 and significant decrease rates thereafter. Only in 2007 and 2008 the business sector performance rates exceeded 50% of total R&D in Portugal. Again, in relation to R&D expenditures, it is apparent that in Portugal the business sector tends to react more sharply than in Spain and in the EU area.

6. CONCLUSION AND POLICY IMPLICATIONS

Spain and Portugal entered the European Union (former CEE) in 1986 and both started to build their system of S&T in the 1980s, after both having emerged from a dictatorship in the mid-1970s. The S&T indicators of both countries have always been poor compared to the OECD/EU average, although generally worse in Portugal. This applies to the R&D expenditures in general, and business R&D in particular. Spain has often played a leadership role on issues of S&T policy that served as a reference for Portugal, but Spain was also seen as a competitor for international R&D investment.

Spain and Portugal have similar structural problems and challenges of S&T to address, but they rarely have implemented common R&D policies or even coordinat-

ed their individual R&D policies. Over the last two decades, both countries have been implementing policies aiming to increase the historical low-level expenditures on R&D and business R&D, to increase GERD and BERD to the EU average R&D spending, to increase BERD to about two thirds of GERD, and to increase the number of full-time equivalent researchers. Both countries have done an enormous effort to strengthen their S&T system and catching-up with the EU average S&T indicators, not only to fulfill the EU's R&D objectives but also to build stronger economies based on knowledge and innovation.

Like the EU and many other countries around the world, Spain and Portugal have set specific goals for GERD and BERD (as a % of GDP) to achieve over specific time frames. Spain has a longer tradition of setting R&D goals than Portugal, and older than most other EU countries. But, like most other countries and the EU, Spain has never reached any of the set R&D goals and Portugal did it only once. In most cases there were considerable discrepancies between targets and achievements for the business R&D intensity variable. When comparing the trends of the business R&D intensity objectives up to 2020 with the historical evolution of this variable for Spain and Portugal, it is clear the two trends diverge significantly, suggesting that the objectives of both countries are just too ambitious and will not be achieved. This calls into question the relevance of the goals-based R&D policies and the ability of governments to set goals for R&D. Governments can only indirectly affect the amount of business R&D investment through R&D incentives.

The two countries are committed to increase business R&D expenditures and, in recent years, they have implemented a number of different types of direct and indirect incentives to do so. In general, any R&D project can benefit from both types of incentives. Most of the direct funding is channeled to business R&D projects through the national structural programmes in which it is set the national priorities for S&T. The indirect support is channeled to firms through tax incentives schemes. Over the last decade, many countries have developed their R&D tax incentives systems and currently Spain and Portugal have two of the most generous and attractive R&D tax incentives systems of the OECD area. The example of Portugal illustrates the current trend in the OECD countries of increasing the proportion of tax incentives in the whole amount of public funding for business R&D. Despite its generous tax incentives system and unlike Portugal, most of the Spanish incentives for business R&D are in the form of direct funding. While in Portugal the several changes made to the tax incentives system were to improve the generosity of some benefit or to add new benefits, in Spain some of the benefits were reduced after the 2007 review and one kind of benefit was cancelled. This is important and a learning opportunity for the Portuguese S&T policy considering that historically the Spanish S&T policy has been a reference to the Portuguese policymakers.

The effectiveness of the business R&D policy has to be assessed against the broad objectives referred to above. Despite de efforts, the increasing generosity of the public incentives and the tendency to reduce the gap with the EU average, none of those objectives has yet been achieved. Interesting and perhaps not expected is the fact that the BERD to GDP ratio in Portugal has grown at higher rates than that of Spain, leading to a faster approach of Portugal to Spain and the EU average, especially after 2005. There may be lessons to be learned by Spain from this rapid growth of the business R&D expenditures in Portugal.

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