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Why are Tax Incentives Increasingly Used to Promote Private R&D?[1]

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The use of public resources to support private R&D has long been deemed legitimate, and over the last decades governments have used many instruments to stimulate firms to increase R&D expenditures. Innovation and R&D is of concern to the European Union (EU) and many countries around the world, which have been adopting goals-based R&D policies to stimulate both based on two axiomatic principles: (business) R&D is the main driver of innovation and economic growth; and, current R&D expenditures are insufficient to reach the desired levels of innovativeness and competitiveness. Governments can stimulate private R&D in a number of ways, but two major types of instruments stand out: direct measures (or direct funding), which include subsidies, loans, grants and alike, and tax incentives (or indirect measures), such as allowances and tax credits. Private R&D is also publicly supported in many other indirect ways, including income tax and social security tax reductions for R&D personnel in order to reduce the cost of performing R&D, the funding of research undertaken in universities and public research institutions, the creation of public research institutions, stronger measures of protection of intellectual property rights, and by improving the system of education.

Although not new[2], tax incentives policies to promote business R&D have known major changes over recent years, and it is becoming an increasingly important instrument in the policy mix of many countries around the world. The relative weight of public funds for business R&D has been declining constantly and government funding of private R&D is nowadays increasingly taking place through tax incentives (Veltri et al. 2009). According to the OECD

[1]Paper presented at the "4th Annual International City - Break Conference: Business and Society in a Global Economy", 20-23 December 2010, ATINER, Athens, Greece.

[2]According to Hall and Van Reenen (2000), the first countries to introduce R&D tax incentives were Japan (1966), Canada (1960s), USA (1981), France (1983), Australia (1985).

(2008a), the evolution of tax incentives policies in recent years has been characterised by major changes, including: i) The implementation of R&D tax incentives systems by a growing number of OECD and non-OECD countries. The number of OECD countries with R&D tax schemes rose from 12 in 1995, to 18 in 2004, to 21 in 2008; ii) A steady substitution of direct funding schemes for tax incentives schemes to stimulate business R&D; iii) The many changes to tax incentives schemes most countries have done to increase the levels of generosity and attractiveness, which is raising concerns about the use of these policy instruments for competitive purposes. This picture portrays the increasing importance of R&D policy in a fast-changing international context and raises the question about the motives which might explain these trends. Increasing the amount of business R&D expenditures is at the heart of the R&D policy of many countries, now emphasized by goals-based R&D policies which require deeper involvement and commitment of governments, and a double strategy of reinforcing the internal R&D base and getting the country attractive to external R&D investments.

This paper is concerned with the recent trends of R&D tax incentives policies and addresses the following question: Why are tax incentives increasingly used to promote private R&D? This question involves political, strategic and economic considerations and, thus, any answer requires a multi-level approach. The reasons behind the growing preference for tax incentives go much beyond any possible advantage these policies might have over direct measures, and are also the consequence of a political change in the EU R&D policy after the Lisbon Strategy and the subsequent actions to stimulate R&D expenditures, a change in the economic rationale of public support of private R&D in face of the insufficiency of market failures to justify that public intervention in a new context characterised by a public determination to increase the amount of business R&D expenditures, and the growing competition between countries for international R&D investment.

The paper analyses the issue of tax incentives policies from three different, but interrelated perspectives. Section 2 examines the rationale of public support of private R&D to understand in what extent the conventional understanding on this matter is being challenged in the face of the changes of R&D policy and the new competitive environment for R&D investment. Section identifies major trends of today's political and strategic intent of R&D policy and their implications to the way governments can promote private R&D. Section 4 focus on the effectiveness of public support of private R&D to explain the relative advantages of taxes incentives over direct measures and the current understanding about the effectiveness of tax incentives. Some conclusions and policy implications end the paper.

Rationale of Public Support of Business R&D

The public support of research is generally deemed legitimate, not necessarily uncontroversial. There are several economic and social benefits of

funding basic research, in particular in the area of fundamental research and enabling technologies, but the case for public funding of business R&D is rather more controversial, especially in development stages directly linked to the introduction of commercial products or systems where it is likely that waste is avoided if it is funded by firms (Freeman and Soete 1997). This issue gained renewed interest for economics and public policy in the context of the Lisbon Agenda, the Action Plan for Europe for investing in research (European Commission 2003a) and the ambition of becoming 'the most competitive and dynamic knowledge-based economy in the world'. Not just the legitimacy of public support of business R&D has become 'officially' a rhetoric question, but the efficiency of the public support of private R&D has been equated in quantitative terms and all Member States were challenged to design appropriate policy mixes and work at full steam to reach the EU R&D objectives.

Market failure is no longer the sole justification for the public support of private R&D. Two other factors must be considered: innovation and economic growth, and the competition for R&D investment and researchers (Table 1). While the former started to gain shape in the public policy at least from the 1990s as the understanding about the R&D function within the firm and the systemic implications of R&D across the economy became clearer, the latter is new and is largely the result of the political efforts of many countries around the world to increase the R&D expenditures over the first decade of this century. Rivalry of tax systems to attract R&D investment is nothing new, but it is new the purpose, scale and intensity, both in terms of the benefits offered and the number of countries offering them. These factors are not mutually exclusive and on the whole justify the public support of private R&D.

Table 1. *Rationale of Public Support of Private R&D*[1]

Rationale	**Policy driver**	**Focus**
Market failures	Investment in R&D below social optimum	-Industries and technologies showing underinvestment in R&D; -Imbalance between private and social returns;
Innovation and economic growth	(Business) R&D as the basis of innovation and growth	-Technological change; -Accumulation of knowledge; -Absorptive capacity; -Spillovers of R&D activities to other firms and industries; -Interaction between firms, universities and research institutions;
Competition for R&D investment and researchers	Attracting and retaining R&D investment and resources	-Enhancing external attractiveness for R&D investment and researchers; -Retaining R&D resources and human talent;

Source: Author's elaboration.

[1]Obviously, these factors may have a wider relevance in terms of the S&T policy (e.g., basic research).

Market Failures

Many scholars believe that the production and dissemination of knowledge exhibit a range or market failures and these failures are likely to undermine incentives to invest in R&D and introduce new innovations (Geroski 1995). Knowledge is a public good and its production (R&D) suffers from the three sources of market failure (indivisibilities, uncertainty and externalities) and, as a consequence, firms tend to underinvest in R&D because the private rate of return to R&D investments tends to be lower than the social rate of return. That is, private R&D investment is not optimal from a societal point of view because social returns are higher than private ones, which discourages firms to invest (more) in R&D (Geroski 1995; OECD 2002; Van Pottelsberghe et al. 2003). A firm's incentive to invest in R&D is diminished to the extent that any findings from such activities are exploited by competitors and thereby diminish the innovator's own profits (Cohen and Levinthal 1990). In this line of reasoning, for instance, it is economically justifiable and strategically important the use of public funds for applied agricultural research in the case where the structure of industry is based on family farms with no resources to finance their own R&D; on the contrary, it is questionable the use of public funds to applied research in aircraft and nuclear industries, cases in which public funding is political in nature (Freeman and Soete 1997). It makes sense, thus, that public resources should be directed towards R&D activities with the highest discrepancy between social and private returns (Van Pottelsberghe et al. 2003). This is the conventional wisdom which provides governments the legitimacy to support private R&D efforts in the case of a great imbalance between private and social returns, even if it has never been clear how big that imbalance should be before any public support is deemed legitimate or necessary, or even how to accurately measure that imbalance. By urging Member States to implement tax policies to stimulate private R&D because they 'support a wide population of firms, including SMEs, while leaving enterprises a maximum of independence' (European Commission 2003a), the EU is no longer legitimating its business R&D policy (solely) on the basis of market failures and it also 'relaxes' the commitment of public policies to that principle.

Innovation and Economic Growth

The Action Plan for Europe clearly links the EU research goals and economic growth: 'Attaining the 3% of GDP objective for research investment would have a significant impact on long-term growth and employment in Europe' (European Commission 2003a). It is generally accepted in economics and empirically demonstrated the key role of (business) R&D in economic growth (Griliches 1995; Freeman and Soete 1997; Becker and Pain 2008). Put in a simple way, a country's economic growth is largely correlated with its investment in R&D, namely business R&D; business R&D is the major driver

of innovation which in turn is a major driver of competitiveness and economic growth. The EU set ambitious R&D goals for 2010 aiming to increase innovativeness and competitiveness across all Member States, catch-up with Japan and the United States and get stronger for the battles ahead with developing countries like China and Brazil. The third set of action to 'make Europe the most competitive and dynamic knowledge-base economy by 2010' says that 'it is all the more important to ensure that budgetary policies favour investments that will lead to higher sustainable growth in the future, among which research is a strong priority' (European Commission 2003a). 'For the first time, EU Member States report in a coherent manner about their priorities and activities in R&D […] aiming at the creation of economic growth and more and better jobs' (Veltri et al. 2009). It is probably the best example where economic growth has set the pace of public policy for promoting business R&D, but other countries such as Brazil and China are following suit.

The focus of R&D policy changed from industries showing evidence of market failures in business R&D to the economy as a whole, with different implications in terms of policy objectives, outcomes and efficiency. Governments stimulate private R&D not necessarily due to any imbalance between private and social returns in specific industries, but because it is believed to be a major driver of future economic growth based on knowledge and innovation. It is fair to say that R&D policies aiming to tackle the issue of market failures envisage, ultimately, more innovation and economic growth as well, but it is not the same as having economic growth leading public policies towards business R&D since it is likely that industries and firms not showing signs of underinvestment in R&D will benefit from public support. This is the case of R&D tax incentives, which are 'non-discriminatory' (OECD 2008a) and give firms a 'maximum of independence' (European Commission 2003a) in selecting the research to undertake and carry a greater risk of 'supporting projects which would have been performed anyway' (CREST 2004). Tax incentives are mainly intended to encourage firms, including SMEs, to increase R&D expenditures, but the growing trend of conducting R&D policy in function of set political R&D goals increases the potential for the inefficient use of public resources.

The rationale behind the public support of private R&D lies on the theories of technical change, absorptive capacity of firms, spillover effects from R&D activities and national innovation systems. R&D policies are based on a better understanding of the R&D function within the firm, the advantages of having a business research base within borders, the systemic effects of R&D activities across the economy, and the long run impact on productivity growth. All Member States acknowledge the relevance of an excellent research base in terms of the scientific quality and the relevance of research with regard to its potential economic use or societal relevance (Veltri et al. 2009). One critical component of a firm's innovative capabilities is its absorptive capacity, that is, 'the ability of a firm to recognize de value of new, external information, assimilate it and apply it to commercial ends' (Cohen and Levinthal 1990). Firms invest in R&D to generate innovation and to develop their absorptive

capacity, which might be particularly important in more difficult learning environments. Firms that conduct their own R&D are better able to use externally available information and an organization with higher levels of absorptive capacity will tend to be more proactive, exploiting opportunities present in the environment (Cohen and Levinthal 1990). Another important aspect of R&D is the spillover effect, that is, the benefits that a firm's research results can produce to other firms and industries, and the social returns that can accrue from that. Past research on R&D returns at the industry and national levels have found significant social returns to it (Griliches 1995). High levels of technological capability, including the ability to perform R&D, are therefore important for reaping both private and social returns from R&D within the economy (Clark and Arnold 2005).

Competition for R&D Investment and Researchers

Governments use a range of mechanisms to stimulate business R&D. It is said that the choice of approach – government research efforts, partnerships, direct support to business R&D, tax incentives, etc. – depends largely on the national context and conditions such as the overall innovation performance, perceived market failures in R&D, industrial structure, size of firms and the nature of corporate tax systems (OECD 2002). The optimal design of the policy mix depends on the specific strengths and weaknesses of national or regional research and innovation systems, and sector specific issues (European Commission 2003a). This R&D policy paradigm is, however, no longer suitable to respond to the new R&D international context where the new forms of internationalisation of R&D based on global sourcing and integration of complex knowledge bases are challenging national approaches (OECD 2008b). The R&D tax incentives schemes of many OECD and EU countries do not fit anymore in such a paradigm and show clear signs of competition for international R&D investment.[1] A country R&D tax policy's design is now a function of all other competing R&D tax schemes, and the impact of any tax incentives policy is affected by the magnitude of the incentive relative to other nations' tax policies (Tassey 2007). This new context has important implications on the design and strategic intent of R&D policies. On the one hand, national policy instruments should be revisited in light of the differential impact that the internationalisation of R&D has on their relative efficiency; on the other hand, efficient policies on internationalisation of R&D should respond to national concerns in terms of attractiveness and competitiveness, and to global challenges and the needs of the developing world (OECD 2008b).

There is a new 'market'-based rationale of public support to stimulate business R&D, retain R&D resources and human talent and enhance external attractiveness for R&D-related foreign direct investment and qualified researchers. Indeed, there is competition among countries to offer attractive fiscal R&D incentives as part of their wider activities to attract and retain

[1]The case of Portugal below illustrates this point.

mobile R&D investments (Clark and Arnold 2005; OECD 2008a). At the beginning of this century it was already expected that the new EU R&D policy would increase competition for international R&D investment and human talent. The EU R&D objectives for 2010 and the following policy actions taken to stimulate R&D across Member States has put greater pressure on the demand side of R&D resources and skilled researchers, and triggered many governments to increase the generosity of R&D tax incentives to the level of competition among countries. The Action Plan for Europe estimated that about 700000 additional researchers were deemed necessary to attain the 2010 objective, and that adjustment would imply greater efforts from all the stakeholders to attract a sufficient number of world-class researchers in Europe (European Commission 2003a). Similar policies have been put in practice by other countries such as China and Brazil which increased the competition to a global level.

Political and Strategic Motivations

A Political Push

The Lisbon Agenda and the Action Plan to reach the Barcelona objective are two major political facts of great impact on the implementation and design of tax incentives policies within and outside the EU. This is due to the change in the EU R&D policy and the ambitious goals envisaged, the 'competitive stance' for R&D investment taken by the EU and its worldwide political and economic weight. Some important consequences from this change are worth mentioning. First, it put great pressure on the demand side of R&D investment and skilled researchers which could hardly be met by an inelastic supply side. Second, the EU's message to non-EU countries that it would encourage and support policies to attract international R&D investment and qualified researchers called for a reaction even from EU countries that do not have tax incentives policies. Third, increasing the amount of (business) R&D expenditures, including the amount of R&D performed by SMEs, has become implicitly prevalent over other policy aspects, including the rationale of using public resources to support private R&D, or considerations about which industries or technological areas should be the target of public support from a social viewpoint. Member States were pressed to implement policies to increase (business) R&D expenditures even if at the expense of some inefficiency in the use of public resources.

Tax incentives schemes are flexible enough to respond to all of these political intents, can be used complementary to other policy instruments (namely direct measures), can be quickly adjusted to meet new policy R&D goals and are suited to be used by catching-up countries with structural underinvestment in business R&D.[1] This is the best instrument to promote

[1]In 2008, the 8 countries with the most favourable R&D tax treatment were Spain, Mexico, France, China, Portugal, Czech Republic, India and Brazil (OECD 2008a). Over the 2000-2006 period, 'with the exception of Austria, substantial increases in R&D intensity have almost

business R&D (Atkinson 2007), which can support a wide population of firms, including SMEs, while leaving enterprises a maximum of independence (European Commission 2003a). Tax incentives policies do not require a budget to be implemented which is very appealing to governments, especially in the context of economic crisis. Member States were, thus, encouraged by the European Commission and the CREST [1] group to use fiscal measures to promote private R&D (European Commission 2003a; CREST 2006) with no particular requirements to attend to its potential inefficiencies, including the support of R&D projects chosen by firms on the basis of private returns, support of research that generates mostly private returns, support of business R&D that would have been performed anyway, support of research undertaken by multinationals with minimal expectations about its additionality effects, and support of research in sectors or technologies not strategic or not showing symptoms of market failures.

Market-Oriented Policies

According to Hall and Reenen (2000), a tax-based subsidy seems the market-oriented response to bridge the gap between the private and social rate of return when the market fails to provide sufficient quantities of R&D, as it leaves the choice of how to conduct and pursue R&D programs in the hands of the private sector. This is not the only or even the main reason for the growing market-oriented approach of R&D policies since tax incentives have the potential to support R&D projects that would have been undertaken anyway. Other reasons are related to the fact that tax incentives are better at stimulating business R&D expenditures and meet political R&D goals, are easily adaptable instruments to respond to changes in competing tax incentives schemes, and might be the recognition that firms are more efficient than governments in allocating R&D resources and undertaking research. The latter is, moreover, the underlying principle of the system of Canada, one of the first countries to introduce R&D tax incentives in the early 1980s.[2] After all, the business sector already performs and finances about three quarters of all research in the OECD.

This is the era of goals-based R&D policies. The focus of R&D policy has changed several times since the World War II for political and economic reasons (Freeman and Soete 1997); currently, the R&D policy of many governments is designed in accordance with the specific (business) R&D intensity objectives they have set to achieve. Besides the EU, many countries have also set R&D intensity objectives. For example, Portugal aims to increase threefold the business R&D intensity over the 2005-2010 period (from 0,27%

exclusively taken place in those [EU] countries with lower initial R&D intensities' (Veltri et al. 2009).

[1] European Union Scientific and Technical Research Committee (CREST) is an advisory committee to the European Council and the European Commission on issues relating to scientific and technical research.

[2] See Klassen et al. (2004).

to 0,8% of GDP); Canada aims to increase R&D intensity to the level of the top five countries in the OECD by 2010 (Thomson 2009); China has committed to increase R&D intensity from 1.23% in 2004 to 2% of GDP in 2010 and to 2.5% by 2020 (OECD 2008a); Brazil aims to increase R&D intensity from 0,51% to 0,65% of GDP in 2010 (IEDI 2010). There is no other period in the history where the S&T policy of so many countries has been oriented to achieve specific (business) R&D intensity objectives.

Governments face a fundamental dilemma: they establish business R&D intensity objectives and implement R&D policies for achieving those objectives, but they depend greatly on the R&D system and particularly on firms to finance and undertake the research. Thus, the problem of governments is how to design and implement the best policy mix to stimulate firms to invest in R&D the necessary amount to meet the set political objectives. To solve this dilemma and get firms to invest more in R&D, including SMEs, the policy mix must be more market-oriented and leave firms the choice of how to conduct and pursue R&D, which is widely acknowledged as a major advantage of tax incentives. Solving the dilemma involves increasing the generosity of tax incentives as well as the potential for the inefficient use of public resources.

Another reason in favour of more market-oriented policies has to do with the acknowledgment that firms may be more efficient than governments in selecting the technologies and R&D projects to invest. Direct measures involve a competition for funding and competing R&D projects are subject to certain rules and conditions. Governments define which areas of research, technology fields and industrial sectors are strategically important to support, and select the 'best' R&D projects among competing ones that fit such political objectives or intents. This two-stage filtering process is not necessarily more successful than private firms in choosing the most productive way of investing in R&D[1], and governments incur the risk of not supporting valuable research projects or technologies. Tax incentives schemes do not have such kind of problem because the choice of which R&D projects to invest is left to the firm, and firms will choose R&D projects that best fit their needs. In today's fast-changing technology environment and globalised competition, firms might be better positioned to select the best R&D projects to invest and react more quickly to technological and market changes.

Striving for Mobile R&D Investment and Researchers

Countries compete for foreign R&D investment and qualified researchers while, at the same time, try to offer attractive conditions to avoid the displacement of firms, R&D investment and qualified researchers. R&D tax incentives are policy instruments used by governments to achieve national and international targets, and to enhance the business environment in order to attract new investment, spurred by an aggressive competition for R&D-based

[1]It does not imply that Governments should not support R&D projects in technologies or sectors considered important by the society.

investment worldwide (Warda 2006). Such 'aggressive competition' is the consequence of two main factors. On the one hand, it has to do with the worldwide concern of governments to increase R&D expenditures and the goals-based R&D policy of a growing number of countries, which are putting great pressure on the demand side of R&D resources at an international level. On the other hand, the current trend in the internalisation of business research where 'the progressive international re-localisation of R&D facilities is fast becoming a key element in the overall process of economic globalisation; in all ERA countries […] a significant part of business R&D is performed by affiliates of foreign parent companies' (Veltri et al. 2009). 'Access to public support for R&D' is an important factor for the firms' R&D location decisions (European Commission 2008b).

Tax incentives are appealing to governments because there is no other instrument in the government's armoury better equipped in terms of flexibility and effectiveness to deal with this increasing international competition for R&D investment, and it is prescribed by the EU to raise (business) R&D expenditures. A growing line of research over recent years has focused on the international comparison of R&D tax incentives systems, which vary greatly between countries, being B-index[1] the most popular indicator used to compare the relative generosity of tax incentives systems. This is an important source of information that helps governments to better design and fine-tuning R&D tax incentives to meet national R&D objectives and react to international competition. Table 2 illustrates the evolution of the Portuguese tax incentives system (SIFIDE[2]) since its introduction in 1997. Its generosity has improved enormously and currently Portugal offers one of the most attractive R&D tax incentives systems in the OECD. The preface to the Decree-Law no. 197/2001 is clear about the motives underlying the changes to SIFIDE in 2001, that is, because 'other countries, namely Spain, have changed their regimes too', and it must remain 'competitive with similar systems'. Currently, the maximum amount of combined tax credit can reach as much as 82,5% (32,5%+50%) of a firm's annual R&D expenditures. Besides that, firms can get direct subsidies for research from the Portuguese structural programme QREN 2007-2013.

[1] 'The B-index measures the minimum present value of before-tax income that a firm needs to generate in order to cover the cost of the intangible (e.g. R&D, patent, software, training etc.) investment and to pay the applicable corporate income taxes. The lower the index the greater is the incentive for a firm to invest in a given intangible' (Warda 2006).

[2] SIFIDE – Sistema de Incentivos Fiscais em Investigação e Desenvolvimento Empresarial. SIFIDE has been changed by the 'RFI – Reserva Fiscal para Investimento' (Fiscal Reservation for Investment) in 2004 and 2005, and reintroduced again in 2006.

Table 2. *Characteristics and Evolution of SIFIDE*

	1997	**2001**	**2005**[(a)]	**2009**	**% change** (2009/1997)
Level rate (volume of R&D expenditures of the year)	8%	20%	20%	32,5%	406,25%
Increment rate (on the increment of R&D expenditures over past two years average)	30%	50%	50%	50%	166,67%
Deduction base	Income tax payable				---
Carry forward (years to claim the tax benefit)	3	6	6	6	200,00%
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€	0,00% 601,45%

Source: Decrees-Law (no. 292/97, 197/2001, 40/2005), Law no. 10/2009; Carvalho (2006); author (right end column). Note: (a) To take effect in 2006.

While some countries like the UK are using tax incentives as a central role in the policy mix to promote business R&D (European Commission 2008a), in other countries such as in the United States, the tax incentives system has been getting weaker over the years and is raising concerns about its attractiveness as a location for R&D investment, namely in comparison with its neighbours Mexico and Canada (Atkinson 2007). Although Spain, Mexico, France and China had the most generous R&D tax incentives in 2008 (OECD 2008b), tax benefits have become moving targets as the international panorama changes rapidly with a growing number and variety of R&D tax incentives. Even countries that do not have R&D tax incentives, including Germany, Finland and Sweden, have a growing interest in its implementation to meet certain S&T policy goals such as stimulating R&D in SMEs or fostering cooperation between public research and industry (OECD 2008b).

Effectiveness of Public Support of Private R&D

Tax Incentives Vis-à-Vis Direct Measures

In the context of R&D policy, tax incentives and direct measures should be viewed as complementary tools that are suitable for different purposes (CREST 2006). The European Commission (2003a) incites Member States to design and implement a balanced policy mix, being common the coexistence of both instruments in a non-mutually exclusive way. The fact is the relative importance of each instrument in the policy mix has evolved in recent years and direct measures are being increasingly replaced by tax incentives in many countries (OECD 2008a; Veltri et al. 2009). Table 3 compares the advantages and disadvantages of each instrument from the perspective of the public policy, having in mind that direct measures and tax incentives represent distinct ways of public support of private R&D; the former funds the execution of private research with subsidies, loans or grants, while the latter compensates firms

through tax credits or allowances for research undertaken.

The efficacy of each policy instrument should be linked to the broad political objective it is meant to achieve. Direct measures are preferred when the rationale behind government support to R&D is that the amount of R&D undertaken in not optimal from a societal perspective (Van Pottelsberghe et al. 2003). Unlike tax incentives, direct measures may also be more appropriate to target specific actors or technology areas whenever there is a need to rectify weaknesses or build on strengths (CREST 2004). On the other hand, the appeal of tax incentives stems from their non-discriminatory nature in terms of research and technology fields or industrial sectors (OECD 2008a). Fiscal incentives are increasingly used to encourage business research as they can support a wide population of firms, including SMEs, while leaving enterprises a maximum of independence (European Commission 2003a), and tax credit is the principal tool a government has for influencing the overall level of corporate R&D (Atkinson 2007).

It is apparent from Table 3 that tax incentives are not a panacea for increasing business R&D expenditures, but the growing preference for tax incentives over direct measures can be explained at three different levels. At a political level, tax incentives are less restrictive, less selective and leave firms the decision of what R&D projects to undertake, three critical conditions to increase business R&D expenditures, appeal to a larger number of firms (including SMEs) to perform R&D and reach R&D political goals, provided there will be some degree of overlooking of the negative aspects of tax incentives systems. At an economic level, it is widely recognised that tax incentives involve smaller administrative costs to implement (Van Pottelsberghe et al. 2003), are less suitable 'to reward lobbyists and bureaucrats' (Hall and Reenen 2000), and, most important, do not require budget funding as public support is in the form of forgone tax revenues. Besides that, direct measures are not efficient to process a high number of applications (CREST 2006) and, thus, are not appropriate to encourage a larger number of firms, including SMEs, to increase R&D expenditures, which is implicit in a goals-based R&D policy. At a strategic level, tax incentives are better suited to respond to the growing competition for international R&D investment.

Table 3. *Advantages and Disadvantages of Tax Incentives vs. Direct Measures*

	Advantages	Disadvantages
Direct measures	– Best suited to encourage high risk projects and to meet specific policy goals [1,9] – Adequate to target R&D activities with the highest discrepancy between social and private returns [5] – Competition between firms ensures that public resources are directed to the best R&D projects [1] – Can be used to target specific technologies or scientific areas to overcome cyclical or sectoral slowdowns [3,5] – Encourage cooperation and technology transfer [3,9] – Better budget control [5]	– High administrative costs [1,5] – Administratively not feasible to process a high number of applications [1] – Firms may not undertake R&D projects not approved for public funding – Tendency to reward lobbyists and bureaucrats [7,8]
Tax incentives	– Encourage an increase of R&D across the whole spectrum of firms [1] (but can be used to target specific groups of firms) – The private sector can decide what is the most productive way to invest [1,4,6,7] – Non-discriminatory nature in terms of research, technology fields or industrial sectors [1,2,5] – Less risk of governmental failure in 'picking winners' (choosing the wrong R&D projects) [4,5] – Encourage companies to report their profits more accurately [4] – Avoid misappropriation of funds and rent-seeking activities by government's civil servants [5] – Avoid an up-front budget since support is by means of forgone tax revenues – Lower administrative costs of planning, allocation and management [1,4,5] – Least burdensome way of increasing business R&D [9]	– Poor budget control [5] – Greater risk of dead weight loss (supporting projects which would have been performed anyway) [4] – Less additionality in the case of very large companies [4] – Risk of firms relabeling other activities as R&D [4,9] – Government are not more successful than the private sector in 'picking winners' [5] – Private firms will choose R&D projects with the highest private rates of return [5,7] – Risk that the globalisation of R&D may reduce local R&D spillovers to society [9,10]

Sources: [1] CREST (2006); [2] OECD (2008a); [3] European Commission (2003a); [4] CREST (2004); [5] Van Pottelsberghe et al. (2003); [6] Atkinson (2007); [7] Hall and Reenen (2000); [8] Freeman and Soete (1997); [9] Veltri et al. (2009); [10] Griliches (1995).

Effectiveness of Tax Incentives

The wide interest for R&D tax incentives should be indicative of its effectiveness but, 'notwithstanding the world-wide enthusiasm for R&D tax incentives, the empirical evidence of their effectiveness is mixed' (Thomson 2009). Assessing the effectiveness of tax incentives policies is not an easy task but it is critical to understand and justify the public support of business R&D. The Expert Group on Fiscal Measures for Research found out that there is a severe lack of thorough evaluations and thus of reliable information on effectiveness and efficiency of tax incentives in the EU countries (CREST 2004, 2006). Ultimately, 'the effectiveness of fiscal incentives to R&D depends very much on the design of tax measures relative to policy objectives' (OECD 2002).

How can the effectiveness of tax incentives policies be measured? There are two approaches according to Hall and Van Reenen (2000): i) by asking if

'the level of the good supplied after the implementation of the policy is such that the social return is equal to the social cost', which 'would involve comparing the marginal return to industrial R&D dollars at the societal level to the opportunity cost of using the extra tax dollars in another way'; ii) by comparing 'the amount of incremental industrial R&D to the loss in tax revenue', which has been the preferred approach. According to the latter, if the ratio of the amount of R&D induced by the tax credit to the tax revenue that is lost due to the presence of the incentive 'is greater than one, the tax credit is a more cost-effective way to achieve the given level of R&D subsidy; if it is less than one, it would be cheaper to simply fund the R&D directly' (Hall and van Reenen 2000). Other approaches are also important, although not much explored yet. The effectiveness of tax incentives might be measured in the context of the police mix and the relative importance of each policy instrument (Guellec and Van Pottelsberghe 2003); in light of the impact that the internalisation of R&D has on its relative efficiency (OECD 2008b); and according to its capacity to drive and direct the globalisation of R&D (Thomson 2009)[1].

A major line of research attempted to know the extent to which can tax policies leverage business R&D by measuring the amount of additional business R&D per unit of forgone public revenue, and using as indicator the price-elasticity of R&D. In the Van Pottelsberghe et al.'s (2003) overview of studies on the effectiveness of fiscal R&D incentives, the R&D price-elasticity results ranged from -0,04 to -2,7, with an average value for the price-elasticity around -0,81, meaning that for each Euro of tax incentives business R&D expenditures increased by a magnitude of about 0,81 Euro on average.[2] 'A tax price elasticity of around unity is still a good ballpark figure, although there is a good deal of variation around' (Hall and Van Heenen 2000).

Despite the mixed results and the insufficiency of research, there is nevertheless a wide conviction that tax policies can indeed induce firms to increase R&D expenditures (Falk 2006; Atkinson 2007; Becker and Pain 2008; OECD 2008a). 'There is substantial evidence' of that relationship (Hall and Van Heenen 2000) and 'most studies also find that social returns to such R&D far outweigh private returns' (OECD 2002). Furthermore, the few evaluations carried out show a positive but moderate level of additionality, but a substantial amount of potential R&D spillovers which strengthen the positive impact of tax credit (European Commission 2003b). Atkinson (2007) is assertive when stating that 'the credit is an effective tool and that at minimum it produces at least one dollar of research for every tax dollar forgone.' Guellec and Van Pottelsberghe (2003) conclude that the effectiveness of R&D tax policies increases when the government funding of business R&D decreases.

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[1]Thomson (2009) analysed 25 OECD countries between 1980 and 2005 and found no evidence to support the hypothesis that tax incentives are effective in either inducing MNEs affiliates to undertake additional R&D or to encourage additional international R&D contracts.

[2]For an overview of studies into the effectiveness of R&D tax incentives see, for example, Hall and Van Reenen (2000), Van Pottelsberghe et al (2003), European Commission (2003b), and Atkinson (2007).

These claims sustain the idea that tax incentives are efficient as long as 'for each € of forgone tax income, at least one € of additional business R&D expenditure is undertaken' (Van Pottelsberghe et al. 2003) and are very much in favour of R&D tax policies. This is good news for governments, but these claims do not take properly into account neither the shortage of prior studies on the effectiveness of R&D tax incentives, nor the potential negative aspects of R&D tax incentives referred to elsewhere and the fact that the globalisation of R&D might reduce the positive R&D spillovers to society if such spillovers are obtained elsewhere (Griliches 1995; Veltri et al. 2009).

Conclusion and Policy Implications

Innovation and R&D, namely business R&D, are two fundamental, interrelated support pillars of a knowledge-based economy and governments worldwide are concerned about how to better stimulate both. This paper focuses on R&D tax incentives and attempts to explain the rationale behind the recent trends of tax incentives policies to promote business R&D, which show a growing number of countries implementing tax incentives policies, a steady substitution of direct funding for tax incentives, and the increasing generosity of most tax incentives systems worldwide to increase the level of attractiveness of countries. This is a complex issue that is best understood if three levels of analysis are considered in explaining the phenomenon, namely the recent changes in the economic rationale of public support of private R&D, changes in the political and strategic intent of R&D policies, and the effectiveness of public support of private R&D. All of this should be understood in the new international context of growing competition for international R&D investment and qualified researchers.

Market failure is no longer the sole economic rationale for the public support of private R&D, if it ever was. Two other factors are important: innovation and economic growth, and the competition for R&D investment and qualified researchers. The former can be empirically observed in the EU R&D policy at least from the 1990s as the understanding about the R&D function within the firm and the systemic implications of R&D across the economy became clearer, but the latter is new and is largely the result of the political efforts of many countries to increase business R&D expenditures over this decade. Market failure, pre-competitive R&D and similar expressions are rapidly becoming unused or meaningless words in R&D policy while the amount of R&D expenditures, business R&D goals and competition for R&D investment and skilled researchers are increasingly relevant in the political agendas. Today, the question is less about whether governments should stimulate business R&D (in industries showing market failures or not), but more about the best police mix to increase business R&D intensity and cope with the growing international competition for R&D. It should also be about the limits of generosity of public policies and the dividing line between public stimulation and public substitution of business R&D.

The Lisbon Agenda and the Action Plan to reach the Barcelona objective are two political facts with major implications for the growing interest of governments for tax incentives within and outside the EU. It has put great pressure on the demand side of R&D investment and researchers, and stirred up worldwide competition for international R&D investment. This is the goals-based R&D policy era. There is no other time in the history where the S&T policy of so many countries is designed to reach specific, often ambitious, (business) R&D objectives. Such objectives can only be achieved with more market-oriented policies, greater incentives and larger participation of firms, including SMEs, greater control over the allocation of R&D resources by the private sector, and greater risk of using inefficiently the public resources. Tax incentives are probably the best instrument that governments have at hand capable of rapidly increasing R&D expenditures and meet political objectives, even if at a cost of some inefficiency, which is flexible enough to respond to the growing international competition for R&D investment.

The wide interest for R&D tax incentives should be indicative of its effectiveness but the empirical evidence is mixed. Tax incentives have advantages over direct measures if the objective of R&D policy is to involve a larger number of firms in R&D activities, increase the amount of business R&D expenditures, avoid the rewarding of 'lobbyists and bureaucrats' and respond to international competition for R&D. Besides the insufficiency of research, especially in the EU countries, there is a certain *consensus* that, in general, for each € of forgone tax income at least one € of additional business R&D expenditure is undertaken, which is the landmark for the effectiveness of tax incentives policies. This is a poor measure of efficiency because it does not take properly into account neither the shortage of prior studies on the effectiveness of R&D tax incentives, nor the potential negative aspects of R&D tax incentives (less efficiency in the use of public resources) and the fact that, due to the globalisation of R&D, most of the R&D spillovers might not be obtained in the country that supports the research, which is more likely to happen in small open economies (Griliches 1995). The effectiveness of R&D tax incentives should also be assessed according to its contribution to increase the innovative capabilities of firms benefiting from such incentives.

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