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Abstract:

Setting targets to increase the levels of R&D, a component that is present in the political and economic agendas of the European Member States with the promotion of active tax policies, suggests that it is possible for R&D to cause an impact on economic growth. This research work aims at understanding the influence of the evolution of R&D expenditures, as well as the influence of tax incentives on economic growth. For that, a panel data of 15 European countries, during the period between 1995 and 2008, was used. The econometric study confirms the foreseen importance, both in this study and in the literature, of the countries' R&D efforts and their impact on economic growth. The positive effect of tax incentives on economic growth, combined with R&D levels, is highlighted and demonstrated, thus confirming a strategic orientation towards tax policies followed by the national institutions.

Keywords: R&D, tax incentives, economic growth, econometric analysis in panel data

JEL: C23, H20, H30

1 - Introduction

Research & Development is often considered a key factor in the promotion of economic growth, employment, innovation and consequent increase in the quality of products. The aim with this work is to assess the evolution of government and company spending on R&D, as well as the evolution of tax incentives and their impact on economic growth, using a panel of 15 European countries, in the period between 1995 and 2008.

The current political and economic agenda valorise science and technology, research and development, the contributions of science to the development of countries, as well as the connections between scientific and technological activities and productive sectors. The most visible developments in the majority of European countries are, on one hand, public funding for base R&D, followed by the incentives for R&D technology transfer activities; on the other hand, the public R&D policies have been constantly targeting the market, as a result of market signs and competition, in order to minimize possible distortions in the companies' R&D project choices, while the global level of R&D increases at lower costs, thus allowing several countries to introduce tax incentives, other than direct subsidies. An increasing number of countries support a certain level of private R&D via tax incentives.

Competitiveness and the stability of tax policies are the reasons to promote R&D and innovation in every European country. Much importance has been given to this area that favours companies by including suitable incentives and competitive R&D programmes. Tax incentives represent a fundamental pillar for incentive policies in most countries. In fact, tax incentives for R&D play a crucial role in R&D spending in the private sector, considering the commitment assumed at the Lisbon Summit for a 3% GDP target in 2010. We have seen that, over the last decade, Europe's concern with budget allocation for R&D expenditures has increased. In the centre of the Lisbon strategy, which aims at strengthening employment and economic growth in Europe, the research and development policy represents one of the European Union's priorities. Education, innovation and research constitute the «triangle of knowledge» that should allow Europe to preserve its economic dynamics and social model. The Seventh Framework Programme for Research (2007-2013) aims at strengthening the European Research Area, as well as promoting national investments in order to reach the 3% GDP target.

For all the reasons that were pointed out and because these perspectives haven't been sufficiently studied yet, the motivation to assess the impact of R&D investment comes from the observation of governmental policies for economic growth where the aim is to promote R&D public and private investments, creating several tax incentives for that purpose. While other works provide estimations of the impact that R&D investments have on economic growth, more focused on R&D spending within high-tech companies (cf. Martin Falk's study (2007) entitled *"R&D Spending in the high-tech sector and economic growth"*), this approach aims at assessing an additional factor by introducing tax related aspects to strengthen the importance of R&D investments to promote economic growth.

This work is organized as follows: in Chapter 2, entitled "Economic growth, R&D expenditures and tax incentives", a revision of economic growth theories in the literature is provided the analysis model and used variables are presented; Chapter 3 aims at presenting the estimation and the results of the econometric model in order to assess the importance of tax incentives in R&D investments and their consequent impact on economic growth. Lastly, the main conclusion of the work and new perspectives for future research works are presented.

2 – The economic growth model, R&D expenditures and tax incentives

The traditional vision of the neoclassical theory for economic growth believes that capital saving and formation are extremely important to explain economic growth on a short and medium-term perspective. However, on the long term, the explanation that was found for the differences in growth rates has to do with exogenous technological changes (cf. Solow (1956)). On the long term, growth rates are a constant that does not depend on saving rates and, as such, tax variables could affect incomes, but not the long-term economic growth. For Solow, economic growth is basically conducted by the accumulation of capital and by exogenous technological progress. In order to understand the wealth and poverty of each nation, the technological differences between them were analysed. A country was poor when it did not use the best technologies available and when it did not use production factors (inputs) efficiently. Human and physical capital, technology and market structure (Acemoglu (2006)) are the factors for the conceptual revolution of the economic growth theory provided by Solow.

In the MRW growth model (Mankiw et al., NG Mankiw, D. Romer and Weil, 1992) human capital is an accumulation factor, which means that individuals devote part of their time to acquiring competences in order to increase their human capital level (future productivity) that will allow them to earn higher salaries in the future. This investment in human capital is mainly performed through education. Thus, we can establish some analogies between investment in human capital and investment in physical capital because they both aim at increasing productivity.

In 1990, Romer, in a document entitled "Endogenous Technological Change", includes technological change in the growth model where technology is perceived as support to the production process that transforms consumption, and thus further R&D is fundamental as a source of technological change. The author also emphasised that the ideas that guide progress are very specific types of goods, classifying them as non-rivals, as opposed to other goods.

The implications of Romer’s model can be very close to the neoclassical ideas. His model can be seen as a "semi-endogenous" model because it considers sustainable growth only for the cases of endogenous technological progress and exogenous population growth. The workforce participates in the process of producing capital and ideas that lead to technological progress, and consequently to economic growth. Thus, investments in human capital are necessary in order to increase labour force productivity and capital. For Romer, education is the primary source of knowledge and a guide to apply that knowledge in the production process.

In the empirical literature, the importance of innovation activities, human capital, market products and reforms in the labour market are widely acknowledged in the attempt to achieve long-term economic growth (see Bassanini et al. (2001), Bassanini and Scarpetta (2002), OECD (2003)). The impact of human capital on economic growth is incorporated according to the definition of human capital, knowledge, skills, competences and other individual features that are relevant for economic activities (OECD, 1998).

Nonneman, W., Vanhoudt, P. (1996) broaden the concept of the MRV model by introducing the “Know-how” concept of technology accumulation. As proxy to human capital, the authors use R&D expenditures in GDP percentage on education. Other authors highlight the advantages of promoting R&D. For instance, Romer (1990) stresses the importance of imperfect competition and the scale advantages of R&D. In this context, one might support that it is necessary to develop a public intervention policy that will promote technological development and innovation.

Some authors support that fiscal instruments are fundamental to counterbalance economic cycles. Castro (2006) refers that tax policies have a permanent impact on the economic growth rate.

Robert J. Barro and Xavier Sala-i-Martin (1992) studied the role that tax policies play on economic growth endogenous models. If the social rate of return on the investment surpasses the private return, tax policies to promote investment may increase the growth rate and thus increase the aggregate utility as well. Tax incentives for investment are not as appealing to the private sector if the rate of return on the investment is equal to the social rate of return. This situation is applied in growth models if the accumulation of capital does not implicate lower rates of return, or even if technological progress leads to a wide variety of consumer products.

R&D tax concession policies practiced by countries within the OECD are an effective mechanism to increase the levels of investment in technology (Warda 1992). However, increasing technological property is only one of the elements that companies perceive as input in the innovation process. R&D tax incentive policies must be seen as an element among many in the diversification strategy to promote innovation in the private sector.

Falk (2005) studies the factors that affect R&D in the business sector, using a panel of OECD countries, for the period between 1980 and 2002. He concluded that there are two fundamental political instruments: providing a tax treatment that is favourable to companies that invest in R&D, and directly financing private investment in R&D projects. There are also other factors that affect countries as far as the intensity of business R&D is concerned, such as R&D expenditures by the public sector, the per capita GDP, the country's openness to external markets, human capital indicators and physical investment.

2.1 The analysis model and hypotheses

In this chapter, the economic theory components regarding the impact of R&D on production and on the increase in productivity are analysed. For that, Solow's arguments (1986) for labour and capital are used, as well as the developments achieved by Nonneman and Vanhoudt (1996) with the introduction of the R&D ratio in the GDP, and Falk's collection of studies (2007) on the economic model based on the impact of R&D in a subsector of high-tech companies. Taking into consideration the studies performed by Robert J. Barro and Xavier Sala-i-Martin (1992), who state that tax incentives for investments have an influence on economic growth, a panel of data is presented in order to explain the per capita GDP, which can be described with the following model:

$$\mathbf{Ln\ (Y_{it})\ = \beta_0 + \beta_1\ (INV_{it}) + \beta_2\ (HRST_{it}) + \beta_3\ (ID_{it}) + \beta_4\ (INCF_{it}) + \eta_i + \lambda_t + \varepsilon_{it}}$$

Where:

Yit is the GDP of the respective per capita population in country i, by period of time t; ηi is a non-observable specific effect present in each country; λt is the specific effect of a non-observable time period, and ε_{it} is the random error for country i, in period of time t.

Two dependent variable alternatives are used in the analysis: the per capita GDP and the GDP per worked hour. In the set of independent variables that describe the per capita GDP, the following variables were included: investment ratio on the GDP (INV), the weight of active Human Resources in the Science and Technology areas (HRST), the R&D expenditure ratio in GDP percentage (ID variable), and the index that represents the level of tax incentive provided to each country (INCF).

The investment ratio on the GDP (INV) is the indicator of the gross fixed capital formation, expressed in GDP percentage, for the public and private sectors. It also includes certain additions to the asset value, achieved by productive activity, as well as land improvements. The quotient gives us the part of the GDP that is used by the public and private sectors for investments (instead of being used for consumption or exports, for instance).

The HRST variable is the percentage of the labour force total in the group between the ages of 25 and 64, which means that the person has successfully concluded a third level of education in Science & Technology, or that that person is employed in a place where that type of education is usually required, according to the concepts defined by the OECD (1995). Thus, this is a substitute for human capital.

Experimental Research and Development comprehend the creative work carried out on a systematic basis in order to increase knowledge levels, including the knowledge of man, culture and society, and to use this knowledge for new applications. R&D expenditures include all the expenses that the business sector has had for a certain period of time, regardless of the funding source, as well as the costs incurred by the Government, Universities and other non-profit institutions. These are the subsectors that can be analysed as having R&D expenditures, according to Eurostat's – *Statistics Strututural indicators* – data.

The studied hypotheses focus on the key variables R&D/GDPB (ID) and Tax Incentive (INCF). In the first hypothesis, the positive influence of tax incentives provided to small and large firms is tested, as well as the influence of the R&D ratio on the GDP, and consequently on economic growth. In the second hypothesis, the positive influence of the investment ratio on the GDP and the percentage of human resources are tested in order to explain economic growth. At the same time, in a third hypothesis, the positive impact of the tax incentive on the increasing R&D expenditure is tested.
Following the proposed model, Table 1 presents the causality and the expected signs of the variable coefficients, according to the studied hypotheses, in order to explain the per capita GDP variable.

Table1. Causality and expected signs of GDP pc, R&D and variable coefficients

Variable	**Expected sign**	**Reasons**
R&D/GDP (ID)	(+)	Technological progress, innovation
Investment/GDP (INV)	(+)	Capital accumulation
Human Resources (HRST)	(+)	Qualified human resources
Tax Incentives (B-Index for small and large firms)	(-)	Policy to increase R&D expenditures, Lower taxes

2.2 Tax incentives

The representation of tax incentives (INCF) is carried out according to the index calculated for small and large firms – the B-index (McFedridge and Warda, 1983) – used in many OECD studies.

The B-index is the most common indicator to assess the impact of R&D tax incentives and expenditures. This is a synthetic indicator, a measure of tax generosity for R&D. This index measures how relatively attractive R&D expenditures are to a certain country (Warda (1992)).

The first step in calculating the B-Index is to determine the numerator – the after-tax value for every Euro spent on R&D. The second step is to determine the amount, before income tax, that is necessary to cover each Euro spent on R&D, and pay the applicable taxes. The expressions “expenditure” and “investment” in R&D are used indiscriminately. However, the B-Index was calculated with 90% current expenditures and 10% capital expenditures.

The B-Index is determined by the following formula:

$$B = \frac{1 - \mathrm{Zu}}{1 - \mathrm{u}}$$

The numerator represents the net present value of an R&D unit and the denominator represents the general income after taxation at the place of origin. *u* is the tax rate on the income; Z reflects a specific tax treatment for R&D investments that is equal to 1 if R&D expenditures are entirely deductable from the taxable base and, consequently, B = 1. If an investment is made on a fixed asset with long-term depreciation, Z < 1 and, consequently, B > 1. If the implemented tax makes it possible to deduct an amount that is higher than the amount that was effectively spent, then Z > 1 and B < 1. In his study, Warda (2001) lists several formula changes, especially in the Z value, which represent tax credits, depreciations and subsidies, according to what is provided in each country.

In Table 2, the B-Index selected for the EU-15 countries (2008) is presented. Spain, Portugal and the Czech Republic are at the top of the list, with an index lower than 0.8 (B-Index < 0,8). Spain’s B-Index – 0,609 – means that from the R&D marginal value, the amount paid after tax represents 60,9% of expenditures in the case of a general investment. Other countries, such as Finland, Italy and Luxembourg, for instance, have an index that is higher than 1 (B-index > 1). These countries either do not want to grant tax incentives or the tax incentives that they provide are lower than the actual impact of an R&D investment.

Table 2. Tax incentives – B-Index 2008 in the EU-15 countries

	(1 - B-index 2008)	
EU15	**SMEs**	**Large firms**
Austria	0,088	0,088
Belgium	0,089	0,089
Denmark	0,138	0,138
Finland	-0,020	-0,020
France	0,109	0,109
Germany	0,010	0,010
Greece	0,349	0,349
Ireland	0,425	0,425
Italy	0,117	0,117
Luxembourg	-0,014	-0,014
Netherlands	0,242	0,071
Portugal	0,281	0,281
Spain	-0,008	-0,008
Sweden	-0,015	-0,015
United Kingdom	0,179	0,105

Source: Warda, J. (2009) "An Update of R&D Tax Treatment in OECD Countries and Selected Emerging

The B-Index is a useful summary, a measurement of the R&D impact, of the tax incentives on R&D expenditures and it has countless advantages. Calculating it is a simpler and much more transparent methodology that uses simple assumptions to compare R&D tax incentive generosity between countries. However, there is some criticism to this index: the investment projects are perceived as being isolated from the firm's own economic structure; it does not take profitability into consideration, and neither the maximum limits of tax incentives or productivity gains in the firm; lastly, progressive tax loss carryovers are not taken into consideration.

The definition of R&D, which is included in the context of tax incentive, is crucial to the analysis. Even though most countries use the Frascati definition (OECD 2002), a starting point, some countries are quite restrictive when it comes to accepting only certain activities or types of R&D expenditure. The Netherlands and Belgium, for instance, focus on R&D personnel expenditures. Other than that, countries like Spain have a wider understanding when it comes to eligible activities (for instance, design, technological innovation). Some countries with a wider margin for types of eligible expenses in the context of the Frascati definition are, for instance, Austria, France, Portugal and Spain, which comprise capital expenditure together with current expenditure, including (to certain limits) expenditures pertaining to R&D activities. These countries show a higher tendency for tax reductions, as presented in Table 2.

As observed in Table 2, tax incentives for R&D that cause tax burdens to decrease differ greatly. We can list several types of incentives practiced in European countries with the aim of following more or less attractive policies to promote R&D (Elschner, Christina and Ernst, Christof, 2008).

Tax credits are applied in some countries, thus making it possible to strongly reduce tax burdens, as is the reference case in Portugal. Tax credit reduces the due tax up to 20% on volume and over 50% on R&D increments, in comparison with the experiences verified two years prior (base material). If the due tax is not enough to make the use of the entire tax credit, then the credit can be carried forward to the following years. According to the data in Table 7 of the annex, Spain has implemented a 30% tax credit on volume, 50% on the increase of current expenditures, 20% on costs with certain people and 10% on R&D investments and it is the second one for the tax credit reduces. There is, however, a 50% maximum global limit for the tax on companies in each specific year.

Another type of incentive is the reduction of the taxable base. Belgium, Czech Republic, Hungary, Malta, Poland, Slovenia and United Kingdom apply tax incentives in the form of extra-deductions of the taxable base, additional to the true spending with current expenditures mainly. In Belgium and in Poland, only incentives for investments in fixed assets are allowed.

Tax deferral is another type of incentive used in Belgium, Finland, Greece and United Kingdom, as observed in Table 6 of the annex. This process consists of granting accelerated depreciations for certain investments in fixed assets used in R&D. Finland is an example where the accelerated depreciation is the only granted incentive, but the effect is too small to arise in the results. This is not surprising since accelerated depreciation incentives only lead to timing effects insofar as taxes are payable deferred in time. The same is true for accelerated depreciation in Greece (equipments and buildings), Poland (new Technology) and Belgium (plant and equipment).

The reduction of personnel costs is also one of the mostly used incentives. Belgium and the Netherlands grant R&D tax incentives by reducing the income tax on the wages of the researchers withheld by the companies. This leads to a tax relief that is totally independent from the firm’s profitability or corporate tax burden.

2.3 Descriptive analysis of the EU-15 countries

At an empirical level, this analysis focuses on a sample of 15 European countries – EU-15 – for the period between 1995 and 2008, thus constituting a sample of 210 observations. The sample data of the per capita GDP, GDP per worked hour, R&D percentage and GDP percentage, the percentage of the population between the ages of 26 and 64 that have completed the third cycle of studies in the areas of Science and Technology, as well as the investment values in GDP percentage are available on the Eurostat Database - *Statistics in Science and Technologies*, and Eurostat *Statistics Structural indicators* (go to website: *epp.eurostat.ec.europa.eu*).

As far as the B-Index is concerned, the time series was obtained at *OECD* Science, Technology and Industry: Scoreboard 2007, OCDE and JPW Innovation Associates Inc.1990-2007 and at OECD Science, Technologies and Industry Working papers 2000/4, Guellec, D. and B. Van Pottelsberghe, OECD Science, Technology and Industry Scoreboard 2009 Warda J (2009) "An Update of R&D Tax Treatment in OECD Countries and Selected Emerging Economies, 2008-2009" for the years 1981-1996, 1996-2004, 2006-2007 and 1999-2008, respectively.

Table 3. presents the descriptive statistics of the observed variables. The main variables of the analysis are ID and the tax incentive indexes BINDSC (for small firms) and BINDLC (for large firms), as well as the way they contribute, together or individually, to explain the variable and the behaviour of other variables in the model.

Table 3. Descriptive statistics

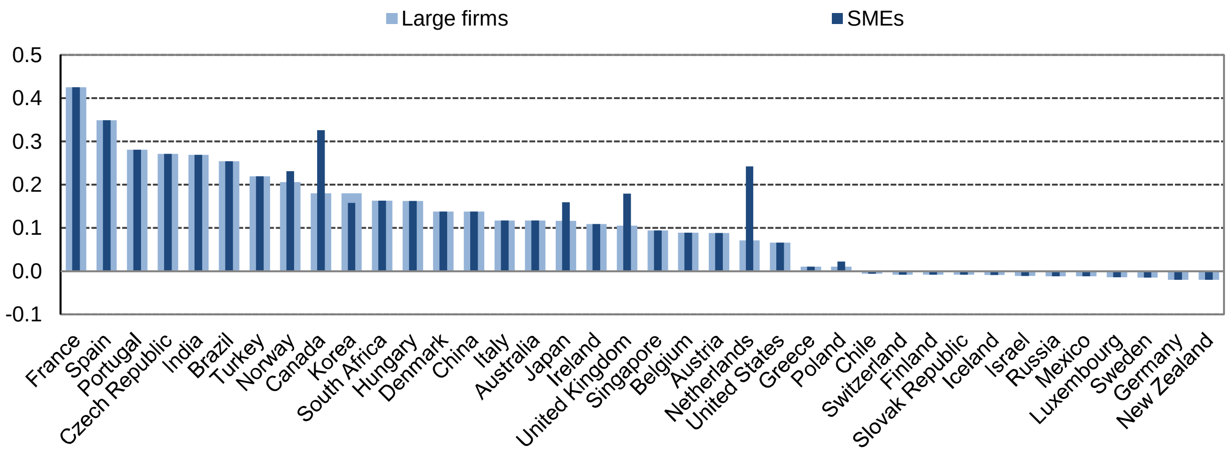
	ID	HRST	INV	BINDSC	BINDLC
Average	1,81	36,79	20,75	0,882	0,914
Median	1,82	38,03	20,4	0,912	0,937
Maximum	4,17	52,3	31	1,05	1,05
Minimum	0,43	16,15	15,5	0,549	0,552
Std. Dev.	0,86	8,53	2,88	0,151	0,13
Observations	194	210	203	199	199
Number of countries	15	15	15	15	15

Research and Development expenditures of the EU-15 in the verified period of time represents 1,86 % of the GDP. The lowest value (0,43%) was observed in 1995 in Greece, while the highest value (4,17%) was observed in Sweden in 2001. Although these countries start with different R&D levels in GDP percentage, as far as R&D

investment policies are concerned, these countries register low tax incentives, with a B-Index for small and large firms that is higher than 1.

We can observe the R&D expenditures in EU-15 increase from average levels of 1,6% to approximately 2% of the GDP between 1995 and 2007, which is justified by the policies to promote R&D implemented by Europe's member states over the past few years.

Figure 1. Tax incentive for 1 USD spent in R&D in OECD countries, 2008



Source OECD Science, Technology and Industry Scoreboard 2009

Figure 1 refers to the tax exemption amount for each US dollar spent in R&D, in comparison with the reference index – B-Index – of R&D expenditures. Negative values do not necessarily mean that R&D is not taxed according to other investments. In fact, it simply means that R&D receives a tax treatment that is less generous as opposed to other cases.

3 – Results of the econometric models

Panel data models are the most adequate way of studying a large set of repeated observations because they assess evolutions throughout time. With panel data, we can simultaneously explore variable variations throughout time and between different individuals. The use of such models has been increasing largely and, in fact, combining time and sectional data brings many advantages: it is possible to use a larger number of observations; the degrees of freedom in estimations are increased, thus making statistic inferences more credible. At the same time, the risk of multicollinearity is reduced since the data between countries present different structures. Also, this model provides access to further information; the efficiency and stability of the estimators increase, while enabling the introduction of dynamic adjustments (Greene William, 2002 and Gujarati, 2000).

Regression was estimated using the fixed effect model for time and for each country. This means that we assumed that the regression coefficients using the fixed effect model for explanatory variables do not vary between countries or throughout time, after the individual effects of the country and time (year) are corrected. The estimation is carried out assuming that the countries' heterogeneity is captured in the constant part and that it differs between countries. The fixed effect model is the most suitable when there is correlation between errors and variables (Greene William, 2002).

In order to assess the abovementioned research hypotheses, three regression models were carried out, estimated with fixed effects. The first hypothesis for the positive influence of tax incentives and R&D ratio on the GDP and on economic growth is presented in Table 4 and the results were obtained for three specifications. Specification (I) includes the B-Index variable for small firms (BINDSC), which measures the influence of the tax incentive index in small firms. Specification (II) includes the B-Index variable for large firms (BINDLC), which measures the influence of the tax incentives in large firms. In specification (III), there are two B-indexes for small and large firms.

In order to test the second hypothesis, the investment ratio and the percentage of qualified human resources were included on the GDP in order to explain economic growth. The variable that was most sensitive to these specifications was the weight of qualified human resources in the total workforce (HRST) as it becomes more or less important while the incentive moves from small to large firms. This result is expectable since the incentive can be granted through the recruitment of qualified human resources. The higher the qualification of the workers, the higher is the company's ability to succeed in the innovation process. When two indexes are tested together, the B-index for small firms (BINDSC) becomes less important, as opposed to the B-index for large firms (BINDLC).

As can be observed, the three regressions are globally significant for a 5% significance level. The following table – Table 4 – presents the results of the estimation by the least squares method, using the fixed effect model for the studied data.

Table 4. Results of the economic growth estimation – econometric models

	(I)	(II)	(III)
C	4,456305	4,447640	4,515032
	(0,074578)	(0,073950)	(0,077805)
ID	0,037305	0,032867	0,032965
	(0,012239)	(0,012264)	(0,012208)
HRST	0,002105	0,001667	0,001917
	(0,001201)	(0,001180)	(0,001186)
INV	0,013078	0,013604	0,013220
	(0,001979)	(0,001944)	(0,001951)
BINDSC	-0,146691		-0,083839
	(0,048093)		(0,054712)
BINDLC		-0,149277	-0,111984
		(0,042388)	(0,048707)
R2	0.963557	0.964279	0.964856
S.E. of regression	0.039576	0.039182	0.039000

Effects Specification
Cross-section fixed (dummy variables)
Period fixed (dummy variables)

	GEO_ID15	Effect	GEO_ID15	Effect	GEO_ID15	Effect
1	at	0.090132	at	0.082758	at	0.085942
2	be	0.065294	be	0.065165	be	0.069381
3	de	0.044685	de	0.045773	de	0.052024
4	dk	0.098023	dk	0.097637	dk	0.095422
5	es	-0.273163	es	-0.279935	es	-0.288332
6	fi	0.046656	fi	0.043534	fi	0.048114
7	fr	0.046406	fr	0.036906	fr	0.037810
8	gr	-0.229256	gr	-0.239048	gr	-0.228150
9	ie	0.063640	ie	0.064606	ie	0.070109
10	it	-0.010365	it	0.014229	it	-0.003020
11	lu	0.948981	lu	0.945426	lu	0.949921
12	nl	0.117687	nl	0.138031	nl	0.123721
13	pt	-0.359257	pt	-0.377799	pt	-0.375654
14	se	0.055549	se	0.064613	se	0.068497
15	uk	0.083870	uk	0.088086	uk	0.087328

	DATEID	Effect	DATEID	Effect	DATEID	Effect
1	01-01-1995	0.037309	01-01-1995	0.030401	01-01-1995	0.033262
2	01-01-1996	0.024256	01-01-1996	0.017382	01-01-1996	0.020112
3	01-01-1997	0.022964	01-01-1997	0.019843	01-01-1997	0.020819
4	01-01-1998	0.019382	01-01-1998	0.014497	01-01-1998	0.016403
5	01-01-1999	0.012572	01-01-1999	0.015165	01-01-1999	0.014978
6	01-01-2000	-0.000996	01-01-2000	0.004659	01-01-2000	0.003381
7	01-01-2001	-0.004090	01-01-2001	-0.001469	01-01-2001	-0.002603
8	01-01-2002	0.006803	01-01-2002	0.010286	01-01-2002	0.008360
9	01-01-2003	0.001300	01-01-2003	0.005869	01-01-2003	0.003665
10	01-01-2004	-0.000389	01-01-2004	0.003678	01-01-2004	0.002337
11	01-01-2005	-0.017491	01-01-2005	-0.013586	01-01-2005	-0.015612
12	01-01-2006	-0.024447	01-01-2006	-0.026868	01-01-2006	-0.026238
13	01-01-2007	-0.040544	01-01-2007	-0.043070	01-01-2007	-0.042243
14	01-01-2008	-0.037526	01-01-2008	-0.036785	01-01-2008	-0.036621

The study is complemented with the inclusion of a third hypothesis: the impact of the B-index tax incentive for small and large firms, which are considered both and associated to Investment (INV) in order to explain the increasing R&D expenditure. Technological innovations are typically incorporated in new machines, hence the positive influence of physical capital in R&D expenditure.Given the effect of the economic crisis started in 2008 and decreasing de value of the variables it was necessary to verify the alone effects of the year 2008. In sequence, almost European countries decreased the R&D expenditures and the investment. Some countries had change fiscal policies and contracted the tax incentives.

Table 5. Impact of the B-INDEX on R&D

C	1,796740 (0,0001)
INV	0,031707 (0,0116)
BINDSC	-0,191269 (0,6102)
BINDLC	-0,475625 (0,1748)
YEAR="2008"	0,353029 (0,0001)
R2	0.901787
S.E. of regression	0.279686

Effects Specification

Cross-section fixed (dummy variables)

	GEO_ID15	Effect
1	at	-0.117138
2	be	0.292421
3	de	0.531539
4	dk	-0.033510
5	es	0.206681
6	fi	-0.572762
7	fr	-1.274.633
8	gr	0.241660
9	ie	1.269.648
10	it	-0.701771
11	lu	-1.055.045
12	nl	-0.299658
13	pt	-1.243.517
14	se	1.999.577
15	uk	0.076238

As presented in Table 5, it is possible to obtain significant regression results when the impact of the tax incentive and the B-index for large firms are analysed. Results are less significant when tax incentives for small firms are analysed.

4 – Conclusion

This work aims at contributing to explain the influence that R&D investment and tax incentives have on economic growth. The relevance that was given to science and technology, to research and development, to the contributions from science to the country's development and the connections between scientific and technological activities are linked both to the national R&D goals and to the goals that were established by the European Union in order to increase R&D expenditures to 3% of the GDP until 2010.

Encouraging tax incentive policies as a way to increase R&D expenditure is one of the European Commission's guidelines currently being implemented in several countries that will have a positive influence in fostering R&D and, consequently, in economic growth.

In conclusion, there is empirical evidence to state that in the EU-15, according to the results that were obtained, R&D tax incentives used as a policy to promote R&D expenditure, together with human resources and investment, can explain economic growth.

In this work, a simultaneous equation model could be used, or new explanatory variables could be introduced in order to help understand the private and public effects of R&D. Further research in this area is then possible, particularly on the public and private business subsector.

Appendix

Table 6: Implementation of tax incentives in R&D

		Personnel Expenditure	Other current expenditures	Capital Expenditures	Carry-forward possible?
Tax Deferral					
	BE			Accelerated Dep.	
	FI			Accelerated Dep. buildings	
	GR			Accelerated Dep.	
	UK				
Reduction of tax base					
Volume	BE	-	-	Extra dep. 13,5%	No limit
	CZ	200%	200%	-	3 years
	HU	200%	200%	200%	No limit
	MT	150%	150%	-	No limit
	PL	-	-	Extra dep. 50%	3 years
	SL	120%	120%	120%	5 years
	UK	150%	150%		Cash refund
Increment	AT	135%	135%		
	GR	150%	150%		
Reduction of tax due					
Volume	AT	8%	8%	8%	Cash refund
	BE	25% - 50%			Cash refund
	ES	30%+20% max. 50%	30% max. 50%	10% max 50%	15 years
	FR	10% max.€10M	10% max.€10M	10% no real estate	No limit
	HU	10%			4 years
	IT	10% max.€15M	10% max €15M		Forbidden
	IR			20% no real estate	
	NL	42% (110.000)/14%			Cash refund
	PT	20%	20%	20%	6 years
Increment	ES	50%	50%		
	FR	40%	40%	40%	
	IR	20% base 2003	20% base 2003	20% base 2003, no real estate	
	PT	50% max. €750K	50% max. €750K	50% max. €750K	

Source: IBFD and research Elschner, Christina and Ernst, Christof, (2008)

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