Discussion Paper No. 08-124

The Impact of R&D Tax Incentives on R&D Costs and Income Tax Burden

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Non-technical summary

The structure of public support to corporate R&D has been rapidly changing over the last decade. Government R&D policies are increasingly oriented towards market signals and competition in order to minimise the potential distortions in the R&D decisions of firms. This led several countries introduce tax-based R&D incentives in addition to project-specific direct subsidies. A recent development in funding R&D therefore is the shift towards a higher share of indirect funding through tax incentives rather than direct subsidies.

Significant tax incentives for R&D in most of the OECD member states have been introduced or modified within the past decades. Countries apply several forms of R&D tax incentives which all reduce taxes at the level of the company. First, a common form of incentive is to reduce the company's taxable base by allowing extra amounts to be deducted over current R&D expenses from the taxable income (deduction), or by accelerated depreciation of assets. Second, there are tax credits which reduce the tax due and are determined based on the amount of R&D expenses. Third, special tax rates or even zero-tax rates are granted to firms under certain conditions, e.g. for young innovative corporations. A fourth form of R&D tax incentives is to reduce wage taxes for R&D personnel and thus reduce employment costs.

The B-Index by Warda (2001) is a frequently used indicator that compares the different forms of R&D tax incentives across countries. This indicator is well accepted but it has some shortcomings when it comes to tax incentives with limitations or companies with losses or poor profitability of companies. In this paper, we analyse R&D tax incentives in a more detailed way, in a multi-period setting and under economic assumptions which reflect a more realistic setting. We measure the incentive's impact on the firm's total tax payments (effective tax burden) and the R&D cost by means of the simulation model European Tax Analyzer. Using different economic settings and model firms, we run sensitivity analyses and get by that a more detailed view on the effects from R&D tax incentives.

The results show that R&D tax incentives in the EU-27 member states have a significant impact on the effective corporate tax burden. Countries with highest tax subsidies are Portugal, Spain, and the Czech Republic. The level of tax subsidies does not depend so much on the kind of incentive but rather on its design. We analysed the impact of certain design parameters of R&D incentives as well as the framing tax regime on the effective tax burden and on the resulting tax subsidy. Taking e.g. Spain and Hungary, where the granted tax incentives often cannot be used in the period in which expenditures have taken place, it becomes evident that the design of the tax incentive must be in accordance with the framing tax system in order to be efficient. An immediate cash refund in case tax incentives cannot be used in the respective period is found to be a good solution for this problem. The most important drivers of tax subsidies turned out to be the design of the incentive itself, its fitting to the general tax system, and the firm's profitability relative to the level of R&D expenditures.

Kurzzusammenfassung

Die öffentliche Förderung von Forschung und Entwicklung (FuE) der Unternehmen hat sich in den letzten Jahren stark verändert. Zunehmend wird darauf geachtet, die Marktverhältnisse, den Wettbewerb sowie die gegebene, unternehmensinterne Struktur der Forschungs- und Entwicklungstätigkeit möglichst wenig zu verzerren. Viele Staaten haben daher, zusätzlich zu direkten Beihilfen (z.B. projektbasierte Zuschüsse), steuerliche Anreize für Forschung und Entwicklung eingeführt. In vielen Staaten ist ein deutlich erhöhter Anteil der steuerlichen Förderung an der gesamten öffentlichen Förderung für FuE der Unternehmen zu erkennen. Die meisten OECD-Staaten haben innerhalb der letzten Jahrzehnte spezifische steuerliche Anreize für (FuE) entwickelt. Die Anreize sind sehr unterschiedlich gestaltet. Einige Staaten erlauben die erhöhte Abzüge von der steuerlichen Bemessungsgrundlage, Investitionsfreibeträge oder beschleunigte Abschreibungen. Steuergutschriften auf Basis der FuE-Aufwendungen reduzieren direkt die Ertragsteuerbelastung. Zudem werden reduzierte Steuersätze, Steuerfreistellungen oder Verminderungen der abzuführenden Lohnsteuer und Sozialabgaben (für FuE-Personal) beobachtet. Der sogenannte B-Index von Warda (2001) wird vielfach für einen internationalen Vergleich der sehr verschiedenen Formen der Anreize genutzt. Allerdings schränken manche der stark vereinfachenden Annahmen die Aussagekraft der Ergebnisse ein. In dieser Arbeit werden daher steuerliche Anreize für FuE mit einer wesentlich verfeinerten Methode in einer mehr- statt nur einperiodigen Betrachtung und unter realistischen ökonomischen Rahmenbedingungen untersucht. Es wird der Einfluss der Anreize für FuE auf die Steuerbelastung von Unternehmen (Effektive Durchschnittssteuerbelastung) sowie das Subventionsvolumen der steuerlichen Anreize durch Simulation mit dem am ZEW in Zusammenarbeit mit der Universität Mannheim entwickelten European Tax Analyzer analysiert.

Die Ergebnisse zeigen, dass die steuerlichen Anreize einen starken Einfluss auf die effektive Steuerbelastung der Unternehmen haben, besonders Portugal, Spanien und Tschechien bieten großzügige Anreize. Mittels Sensitivitätsanalysen werden auch die Effekte einzelner Designelemente und den Einfluss des allgemeinen Steuersystems des jeweiligen Landes betrachtet. Beispielsweise können die eigentlich großzügigen Anreize Spaniens und Ungarns wegen Begrenzungen bzw. einer hohen Belastung durch weitere Steuern (Business tax) nicht in voller Höhe genutzt werden und entfalten daher nicht die zunächst zu erwartende Wirkung. In der Analyse schneiden jene Staaten besser ab, in denen die steuerlichen Anreize sinnvoll mit dem allgemeinen Steuersystem abgestimmt sind. Beispielsweise wirkt sich die Auszahlung steuerlicher Anreize (cash refund) im Vereinigten Königreich und in Österreich vorteilhaft aus. Als wesentliche treibende Faktoren erscheinen daher nicht nur die Höhe der Anreize, sondern auch spezifische Parameter (interperiodische Verrechnung, Methode), Einbettung in das allgemeine Steuersystem und die Ertragslage sowie der Umfang der FuE-Tätigkeit des Unternehmens als sehr wichtige Einflussfaktoren.

The Impact of R&D Tax Incentives on R&D Costs and Income Tax Burden

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December 2008

Abstract

We analyse R&D tax incentives in a detailed way considering a multi-period setting and economic assumptions which reflect a realistic economic environment. We measure the incentive's impact on the firm's total tax payments and the R&D cost by means of the simulation model European Tax Analyzer. Using different economic settings and model firms, we run sensitivity analyses and get by that a more detailed view on the effects from R&D tax incentives against the background of the framing tax system. We find that not so much the kind but rather the specific design of R&D tax incentives, the interplay with the framing tax system and the firm's profitability relative to the level of R&D expenditures heavily influence the amount of tax subsidy for R&D.

Keywords: R&D, Tax incentives, Corporate Tax Burden, EU

JEL-Codes: H25, O38, O31

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1 Introduction

The structure of public support to corporate R&D has been rapidly changing over the last decade. Two major developments can be observed in a significant number of countries: On the one hand, public funds for basic R&D performed by universities are increasing and linked via additional stimuli for technology transfer (e.g. grants for collaborative R&D projects) to corporate R&D activities. On the other hand, government R&D policies are increasingly oriented towards market signals and competition in order to minimise the potential distortions in the firm's choice of R&D projects while increasing the overall level of R&D in combination with relatively low compliance costs.[2] This led several countries introduce tax-based R&D incentives in addition to direct subsidies. A growing number of countries support a significant share of private R&D via tax incentives.

A recent development in funding R&D therefore is the shift towards a higher share of indirect funding through tax incentives rather than direct subsidies. Significant tax incentives for R&D in most of the OECD member states have been introduced or modified within the past two decades.[3] Others think about introducing such incentives (Spengel et al. 2008). Countries apply several forms of R&D tax incentives which all reduce taxes at the level of the company such as corporate tax, business taxes, or wage taxes withheld by the employer. First, a common form of incentive is to reduce the company's taxable base by allowing extra amounts to be deducted over current R&D expenses from the taxable income (deduction), or by accelerated depreciation of assets. Second, there are tax credits which reduce the tax due and are determined based on the amount of R&D expenses. Third, special tax rates or even zero-tax rates are granted to firms under certain conditions, e.g. for young innovative corporations. A fourth form of R&D tax incentives is to reduce wage taxes for R&D personnel and thus to reduce employment costs.

As can be seen from this short enumeration of incentives, the design of R&D tax incentives is very diverse and it is not clear which incentive is the most effective. The B-Index by Warda (2001) is a frequently used indicator that compares the different forms of R&D tax incentives across countries. This indicator is well accepted but it has some shortcomings when it comes to tax incentives with limitations or companies with losses or poor profitability. In this paper, our objective is to analyse R&D tax incentives in a more detailed way, in a multi-period setting and under economic assumptions which reflect a more realistic setting. We measure the

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[2] One of the most important arguments pro R&D tax incentives is the belief that it is neutral considering the structure and the choice of R&D projects, e.g. Atkinson (2007). The incentive effect should then be equal for all participants and projects if the policy is not to change the composition of R&D but to raise the level of R&D and to offer the subsidy to smaller firms as well. However there are arguments for direct subsidies as well, which are seen to be more likely to influence the composition of R&D, see Tassey (2007a) and Tassey (1996). Both forms of support for R&D are seen to be complementary.

[3] 19 out of 27 examined OECD nations R&D tax incentives in place in 2005 (Warda 2006).

incentive's impact on the firm's total tax payments (effective tax burden) and the R&D cost by means of the simulation model European Tax Analyzer.[4] Using different economic settings and model firms, we run sensitivity analyses and get by that a more detailed view on the effects from R&D tax incentives.

The remainder of the paper is as follows. Section 2 describes in short the B-Index and more detailed our simulation model and the measurement of the impact of R&D tax incentives. In Section 3, we apply the model to the EU Member States. Section 4 compares our results with the B-Index. Section 5 concludes.

Compared to an earlier version of this paper, there were some important modifications concerning details in the calculation of R&D tax incentives. The accountability for trading losses and for the possibility to carry forward R&D deductions or tax credits were improved. We use more detailed information concerning eligible R&D expenditures, details of the tax incentive and the information on the ability to carry forward. The model firms have been adjusted to reflect the latest R&D statistics. There is now a detailed description of the European Tax Analyzer in the Annex and Romania and Bulgaria were included as additional countries in the survey.

2 Measuring the Impact of R&D Tax Incentives

2.1 The B-Index Methodology

The most common indicator for evaluating the impact of R&D tax incentives on R&D cost is the B-Index (McFedridge and Warda 1983; Warda 1996 and 2001) often used in OECD studies. It measures the relative attractiveness of expenditures for R&D at a given tax jurisdiction. The index is based on the theoretical frameworks by Hall and Jorgenson (1967) and King and Fullerton (1984). It is designed as a simple and easily understandable policy tool.[5] The B-Index puts the after-tax net present value of one monetary unit of expenditure for R&D and the after-tax income of one monetary unit into perspective. The B-Index is determined by

$$B = \frac{1 - zu}{1 - u}$$

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4 The location of R&D rather depends on the availability of infrastructure and skilled personnel than on pure cost considerations. However, empirical studies suggest that tax incentives have an impact on the volume of R&D expenditures. Moreover, there are several results in the literature that reveal an effect of R&D tax incentives on the relocation of R&D. Paff (2005) found effects that are explained by the relocation of R&D activity to use tax based incentives in California, Wilson (2006) found a strong effect of relocation of R&D among US-states, Billings (2003) found a higher average growth rate of R&D for US-foreign affiliates in countries offering tax incentives compared to countries without incentives and Bloom and Griffith (2001) suggest that UK firms react to a more beneficial treatment of R&D in other countries.

5 McKenzie (2008) provides a measure where the R&D tax treatment is embedded in the marginal effective tax rate and which considers at the same time the specifics of an R&D investment as opposed to a general investment.

while the numerator represents the net present value of one unit of R&D spending and the denominator represents income after general taxation at the location. u is the corporate income tax rate; z reflects the specific tax treatment of R&D investments. z equals 1 if R&D expenditures are fully deductible from the taxable base, and $B = 1$. In case of an investment in a fixed asset which is depreciable over time, $z < 1$ and $B > 1$. If a tax incentive is in place which allows the deduction of a higher amount of expenditures as actually spent, $z > 1$ and $B < 1$. Warda (2001) lists several amendments of the formula, particularly of the value z, which account for tax credits, depreciation and allowances.

Table 1 shows the B-Index for selected EU Member States drawn from OECD (2007). Spain, Portugal, and the Czech Republic are at the top of the ranking with a B-Index below 0.8. The Spanish B-Index of 0.609 says that the marginal R&D expenditures after taxes amount to 60.9% of the expenditures in case of a general investment. Eight countries in the sample have a B-Index above 1. They either do not grant tax incentives or the tax incentives are lower than the negative impact of an R&D investment in fixed assets.

Table 1: B-Index 2006/2007 in selected EU member states

	SMEs	Large firms		SMEs	Large firms
Spain	0.609	0.609	Ireland	0.951	0.951
Portugal	0.715	0.715	Poland	0.978	0.990
Czech Republic	0.729	0.729	Finland	1.008	1.008
France	0.811	0.811	Slovakia	1.008	1.008
Hungary	0.838	0.838	Switzerland	1.010	1.010
Denmark	0.839	0.839	Greece	1.011	1.011
United Kingdom	0.894	0.904	Luxembourg	1.014	1.014
Belgium	0.911	0.911	Sweden	1.015	1.015
Austria	0.912	0.912	Italy	1.023	1.023
Netherlands	0.761	0.934	Germany	1.030	1.030

Source: OECD STI Scoreboard 2007.

The B-Index is a useful summary measure to show the impact of R&D tax incentives on R&D costs in general and has numerous advantages. Its calculation is very transparent and offers, using some simplifying assumptions, a methodology for a fast and easy calculation of a measure to compare the generosity of R&D tax incentives across countries. However, it considers investment projects in isolation from the economic structure of the company itself. It does not account for the company's profitability. Ceilings for incentives, tax or earnings exhaustion, loss reliefs and progressive tax rates are not considered either. Moreover, only corporate income taxes are considered, but there are many tax incentives which are integrated in other taxes such as lump-sum taxes.

2.2 Simulation Model European Tax Analyzer

The simulation model European Tax Analyzer was developed at the ZEW and the University of Mannheim (Spengel 1995; Jacobs/Spengel 1996; Jacobs et al. 2005). It measures the overall tax burden of a model firm. The model firm is defined by an industry-specific mix of assets and liabilities. Business plans include estimates on production, sale, procurement, staff, staff costs as well as investment, financing, and distribution habits. In addition, economic data such as lending and borrowing interest rates and inflation rates are taken into account. The company is funded with shareholder's equity and debt.

For the sake of comparability of the tax burden across countries and to allow identifying tax drivers, it is necessary to have an identical economic "starting point". The used model firm (benchmark case) therefore shows identical business data before taxes in all surveyed countries. The model firm is based on data from the Deutsche Bundesbank (2003) which contains averaged firm-level data over several sectors in Germany.[6] For the benchmark case, we consider a medium-sized manufacturing firm. It has an annual net profit of €214K, a balance-sheet total of €6m and a turnover of €8m. The financial parameters of our model firms are displayed in detail in the Annex. Moreover, we use additional model firms reflecting several industries for the sensitivity analyses, which are as well deducted from the Bundesbank data. In this study, we solely refer to corporations and do not consider the tax burden on the shareholder level or in case of partnerships.[7]

We include the specific average R&D properties (R&D intensity, structure of R&D expenditure) from national R&D statistics (Stifterverband 2007). In the manufacturing sector, firms typically invest about 4.5% of turnover p.a. in R&D. In our case, this is around €361K. R&D costs comprise 49% labour costs, 25% other current expenditures (such as material cost), and 6% investments in fixed assets, such as machinery as well as 20% for R&D that is contracted out to external service providers. Since the firm's turnover depends on the production plan (of the current and of former years), the price level and sales, the amount of R&D expenditures also varies over time. This might have a considerable impact on the results since several countries apply tax incentives only in case of increases of expenditures.

The simulation model accounts for that by allowing three alternatives of implementing R&D expenditures: First, expenditures can be defined as a specific share of the turnover in each period. Second, a fixed amount of expenditures can be used which is constant over the whole ten-year period. Third, one starting level of R&D expenditures with a specific annual growth rate can be implemented. The first option gives more or less randomly results, in particular in what concerns incremental tax incentives, because the turnover can also decrease over time. The second option allows the isolated analysis of volume-based tax incentives which favour the whole amount of R&D expenditures. The third option can be used to analyse incremental tax incentives.

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6 One might receive other results in case one considers country-specific firms. In this study, however, we are interested in the incentive's impact on the firm's tax burden, seen from a more (tax) technical perspective. We thus abstract from all potential economic differences.

7 The taxation of the shareholder is not considered for three reasons. First, we want to show effects of R&D tax incentives which are applicable by the company. Second, it would mitigate the effects found at the level of the company partly if we would look on the overall level including the shareholder where effects from distribution policy and taxation of dividends play a relevant role. Third, we want to compare our results to the B-Index which focuses on the level of the company as well.

In order to calculate post-tax profits, the tax liabilities are derived by taking into account national tax bases and applying the national tax rates. Concerning the tax bases, the most relevant parameters regarding assets and liabilities as well as accounting profits and losses are considered. The rules for profit computation cover depreciation, inventory valuation, R&D costs, employee pension schemes, elimination of double taxation on foreign source income and loss relief. The assessment takes into account all relevant taxes, i.e. taxes on real estate, innovation tax, payroll taxes, business taxes, (regional) surcharges, and corporate income tax. The simulation model allows for statutory linear and progressive tax rate structures, as well as special tax rates. A more detailed description of the European Tax Analyzer is given in the Annex.

The economic framework is deterministic in the sense that the development of the company depends on the investment program of the company which is defined in advance and which is not changed in the run of the simulation. From that follows that any differences between pre-tax and post-tax data (for the computation we employ the measure of the final value before and after tax) in the model are caused only by taxation effects, according to the implemented taxation regime in the considered jurisdiction or country.

The effective average tax burden tb is derived as the difference between the pre-tax final value FV and post-tax final value FV_{tax} of the corporation at the end of the simulation (e.g. after ten periods):

$$tb = FV - FV_{tax}.$$

In order to measure the specific tax reducing impact of R&D incentives $\Delta tb^{R\&D}$, we focus on the increase of the final value after tax including the R&D tax incentive in perspective to the final value after tax excluding the tax incentive.

$$\Delta tb^{\mathrm{R}\&D} = \mathrm{FV}_{\mathrm{tax}}^{\mathrm{R}\&D} - \mathrm{FV}_{\mathrm{tax}}$$

In addition, the impact of the reduced effective tax burden in perspective to R&D costs (the tax subsidy) is shown. We therefore relate $\Delta tb^{R\&D}$ to the amount of the expenditures for R&D over time in prices at the end of the tenth period, denoted by T. The total amount of R&D expenditures is expressed as:

$$RD = \sum_{t=1}^{T} E_t * (1+\rho)^{T-t},$$

where E_t are expenditures for R&D in the year t with t=[1,T] and where ρ is the constant rate of price increase.

The effective average tax reduction ϑ for one unit R&D expenditure, i.e. the tax subsidy for R&D, thus is:

$$\vartheta = \frac{\Delta tb_{R\&D}}{RD}.$$

Accounting for more details of tax incentives and for firm-specific features make our results only valid for the particular firm considered in the simulation. Therefore, the impact of R&D incentives needs to be approved in sensitivity analyses in which various industries are considered. Hence, we vary the different economic parameters of the underlying model firm so that they resemble the industry-specific average firms in the Bundesbank data. For analysing and understanding the impact of a tax incentive on a specific company's tax level and under realistic economic settings in a multi-period setting, our analysis seems to be beneficial and seems to give relevant additional information to the B-Index.

3 Impact of R&D Tax Incentives: Quantitative Analysis

We apply the European Tax Analyzer to all EU member states offering specific tax incentives on R&D inputs and compare the results with the other member states without incentives.[8] The following countries are considered including tax incentives for R&D: Austria, Belgium, the Czech Republic, France, Greece, Hungary, Ireland, Italy, Malta, the Netherlands, Poland, Portugal, Slovenia, Spain, and the UK. We solely consider R&D tax incentives which are in general available for all companies in order to receive a manageable analysis. Different treatments according to the size are included (e.g. SME vs. large), but not incentives which are e.g. specifically available for young companies or companies with a strong growth rate, a certain ownership structure or companies in certain regions. We consider the situation in the year 2006, except for the recently introduced incentive in Italy in 2007.

3.1 Corporate Income Tax Burden

3.1.1 Comparison without Incentive

In a first step, we determine the effective average tax burden of our model firm (benchmark) for the manufacturing industry in 27 EU Member States without considering R&D tax incentives. Table 2 presents the results in the second and third column.[9] Estonia is ranked top with the lowest effective tax burden of €647K. It is closely followed by Ireland and Bulgaria. Companies in France face by far the highest effective tax burden of €2,359K which is more than 360% of the tax burden in Estonia. The second highest tax burden arises in Germany with €1,874K.

The effective tax burden is heavily driven by the corporate income tax rate. It is 12% and 10% respectively in Ireland and Bulgaria. It amounts to 23% in Estonia – but is solely levied on distributed profit, i.e. only on a rather small part of annual income. In France, the corporate tax rate is 33.33%. In addition, there are several surcharges levied on the corporate taxable income plus a considerable non-profit tax. In Germany, the result is driven by a comparably

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8 Incentives which are available irrespective of R&D like general investment credits are not included.

9 Countries are ranked according to the effective tax burden after accounting for incentives (column 5).

high combined statutory tax rate of 38.3% (corporate and local business tax) plus a non-profit related taxation as part of local business tax.[10]

3.1.2 Tax Incentives

In a second step, we consider specific R&D tax incentives on R&D inputs in the tax assessment for the above mentioned 16 countries with incentives in place and compare it with the no-incentive situation, i.e. with $\Delta tb^{R\&D}$.

As can be seen from column 5 in Table 2, the Czech Republic is the most attractive location in case R&D incentives are claimed. Without the incentive, it falls back on 10th position (see also column 7 in brackets which indicates the won or lost positions in the ranking due to incentives). The model firm faces a tax burden of €1,122K in the Czech Republic after ten simulation periods without accounting for the incentive. The incentive reduces the tax burden substantially by €729K so that the firm ends up with a tax burden of only €393K. Recall, that the R&D cost is around €360K p.a. or €3.6m after the ten year period.

In the ranking with tax incentives, the Czech Republic is followed by Portugal which is characterised by an even more pronounced decrease of the tax burden compared to the case when there is no incentive (€845K). These two countries obviously offer very generous incentives which trigger a strong reduction in the tax burden. What about the other 14 countries with R&D tax incentives? As can be seen from the table, the decrease of the tax burden (column 6) differs enormously. It amounts to more than €800K in Spain and to around €500K in Malta and Hungary. But there are also minor effects as in Poland, Greece, Ireland, and Belgium with less than a €100K reduction. Most countries with incentives, can improve their ranking for at least one position. However, France remains at the bottom of the ranking. Moreover, the span of tax burdens decreases. The span before accounting for incentives is €1,892K. It is €1,708K in case of incentives.

Table 2: Effective Tax Burden in EU Member States and Impact of Tax Incentives on Firm Value

(1) Country	(2) Tax burden (€1,000)	(3) Ranking without incentive	(4) R&D tax incentive	(5) Tax Burden incl. R&D incentive (€1,000)	(6) Decrease of tax burden	(7) Ranking [delta]
Czech Republik	1,122	10	yes	393	729	1 [9]
Portugal	1,285	13	yes	440	845	2 [11]
Ireland	684	2	yes	608	76	3 [-1]
Estonia	647	1	-	647	-	4 [-3]
Bulgaria	696	3	-	696	-	5 [-2]
Latvia	799	4	-	799	-	6 [-2]
United Kingdom	1,179	11	yes	817	362	7 [4]
Romania	848	5	-	848	-	8 [-3]
Slovakia	928	6	-	928	-	9 [-3]

[10] For more details on the tax drivers in case of general taxation see Jacobs and Spengel (1996), and Jacobs et al. (2005).

Poland	959	7	yes	929	30	10 [-3]
Hungary	1,433	18	yes	963	470	11 [7]
Netherlands	1,398	16	yes	966	432	12 [4]
Cyprus	970	8	-	970	-	13 [-5]
Spain	1,801	25	yes	995	806	14 [11]
Lithuania	999	9	-	999	-	15 [-6]
Malta	1,616	22	yes	1,103	513	16 [6]
Slovenia	1,457	20	yes	1,256	201	17 [3]
Finland	1,267	12	yes	1,267	0	18 [-6]
Greece	1,334	15	yes	1,282	52	19 [-4]
Sweden	1,324	14	-	1,324	-	20 [-6]
Italy	1,730	24	yes	1,371	359	21 [3]
Luxembourg	1,410	17	-	1,410	-	22 [-5]
Austria	1,742	23	yes	1,422	320	23 [0]
Denmark	1,453	19	-	1,453	-	24 [-5]
Belgium	1,585	21	yes	1,526	59	25 [-4]
Germany	1,874	26	-	1,874	-	26 [0]
France	2,539	27	yes	2,101	438	27 [0]

The resulting relief through an R&D tax incentive depends heavily on the incentive's design. So what are the drivers behind these reductions? In order to analyse this, the countries are grouped according to the applied incentives. An overview of analysed R&D incentives is given in the Annex.

Tax credits

Tax credits for R&D expenditures are granted in Austria, France, Ireland, Italy, the Netherlands, Portugal, and Spain. They differ according whether they can be applied on the whole R&D expenditures (volume-based) or only on the increase in expenditures (incremental). The strongest decline for the tax burden with €845K for the benchmark case is achieved by Portugal. Its tax credit reduces the tax due by 20% on the volume and by additional 50% on the increment of R&D expenditures compared to the expenditures 2 years before (rolling base). If the tax due is not sufficient to take use of the whole tax credit, the credit can be carried forward in the following 6 years. Spain implemented a tax credit of 30% on the volume and 50% on the increase of current expenditures, 20% on the costs for certain personnel and 10% on capital expenditures for R&D and is second for the reduction of the tax burden. There is however an overall limit at 50% of the corporate tax in the specific year. The exceeding amount qualifies to be carried forward. Austria, France, Italy, and the Netherlands still have reductions in the tax burden of between €320K and €438K.

In contrast to these countries with a significant decrease of the tax burden, the decrease is moderate for firms in Ireland. The reason for this is primarily that Ireland applies only an incremental tax credit.[11]

[11] R&D expenditures in this simulation are not fixed (see Section 2.2), they increase moderately at rate 1.9% on average. So the impact of the tax incentive is not very pronounced. A more detailed analysis on the impact of incremental tax incentives is given in the sensitivity analysis.

The impact of tax credits in general does not depend on the corporate tax rate. It is mostly driven by the tax credit's volume and the amount of favoured expenditures. Portugal and Spain grant credits of 70% (20%+50%) and 80% (30%+50%), the Austrian tax credit is only 8%. An influence, though, of the corporate tax rate is given insofar as the resulting reduction in the corporate tax due remains in the company and itself generates financial returns for the company. A lower corporate tax rate therefore slightly increases the value of the tax credit and a higher corporate tax rate decreases the beneficial impact of a tax credit.

Reductions of the Taxable Base

Belgium, the Czech Republic, Hungary, Malta, Poland, Slovenia, and the United Kingdom apply tax incentives in the form of extra-deductions from the taxable base that exceed the actually realised expenditures. They are mostly based on current expenditures; Belgium and Poland allow the incentive for investments in fixed assets only.

The Czech Republic has the third highest decrease in tax burden with €729K due to its extra deduction of 100% from the corporate tax base for current expenditures and certain capital R&D expenditures. There is an option to carry forward unused deductions up to 3 years if the tax base of the period is not sufficient to cover the deduction. Malta is the second country with a strong decline of the effective tax burden due to the extra deduction of 50% on the volume of expenditures for R&D. Hungary offers a generous extra deduction of 100% (at the same level as the Czech Republic) and achieves a significant but less strong reduction as the Czech Republic or Malta.

The tax incentive in Poland consists of a 50% extra deduction[12] on the volume of capital expenditures for investments in goods which represent "New Technology" and decreases the tax burden only by a very small amount (€30K) as the qualifying R&D expenditures in our simulation are fairly low. For Greece granting a 50% tax incentive on the increase of R&D expenditures the impact is moderate as well.

The relief induced by an extra deduction for R&D depends on its volume, on the volume and kind of eligible R&D expenditures and on the framing corporate tax system, in particular the applicable corporate tax rate. A higher tax rate results in a higher reduction of the tax burden, as can be seen for the Czech Republic and Hungary which both grant an extra deduction of 100% on current expenditures, but have different corporate tax rates of 24% and 16%. Accordingly, the absolute relief for the Czech Republic is more distinct compared to the Hungarian incentive. The UK applies a progressive corporate tax rate. Consequently, we find that the extra deduction causes progression effects in that way that smaller firms with lower tax rates receive lower reductions as large firms. In our case however, the reduction is moderate with €362K.

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[12] Besides that, Poland grants incentives for R&D centers which, however, are not considered here.

Tax Deferral

Belgium, Finland, Greece, and the United Kingdom grant accelerated depreciation for certain investments in fixed assets used for R&D. As can be seen from Finland, where the accelerated depreciation is the only incentive granted, 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. Similar is true for accelerated depreciation in Greece (equipment and buildings), Poland (New Technology) and Belgium (plant and equipment). The effect is slightly stronger for the full depreciation for R&D equipment in the UK with an isolated reduction of nearly €2K.

Reduction of Costs for Personnel

Belgium and the Netherlands apply a special form of R&D tax incentive. They reduce the costs for R&D personnel by reducing the income tax on the wages of these researchers withheld by the company. Thus the company does only have to pay a certain percentage of the withheld income tax to the fiscal authorities and can keep the rest. This results in a relief which is quite independent from the profitability or the corporate tax burden of the firm. The tax incentive is more generous in the Netherlands, especially for SME companies, as the tax relief decreases with personnel expenditures. The effect is significant with €432K. Belgium offers its credit for highly qualified personnel or personnel which is working in projects with certain public institutions. Beside accelerated depreciation and extra deduction for capital expenditures, the effect is €59K.

3.1.3 Definition of Favoured R&D Expenditures

The definition of R&D expenditures which fall under the tax incentive is crucial for the amount of tax reduction. Although most countries use the Frascati definition (OECD 2002) as a starting point, some countries are quite restrictive and accept only certain R&D activities or kinds of expenditures. The Netherlands and Belgium, e.g., focus on expenditures for R&D personnel. In addition, there are countries like Spain which have a broader understanding of eligible activities (e.g. design, technological innovation).[13] Countries with a wide scope for the kind of eligible expenditures within the Frascati definition are for example Austria, France, Portugal and Spain as they include capital expenditures beside current expenditures and they do include (up to certain limits) expenditures for contracting out R&D activities. These countries in tendency show higher tax reductions as is shown in the results.

[13] The latter point is not considered in the simulations, where we included expenditures based on the Frascati definition of R&D.

3.1.4 Losses and Low Profitability

All tax incentives reduce the tax due of the respective period. However, in periods with losses or in periods where the profitability of the company is low, the incentives either create or increase losses (in case of allowances or tax deferral) or cannot be used (in case of tax credits) since there is no tax payment which they could reduce.

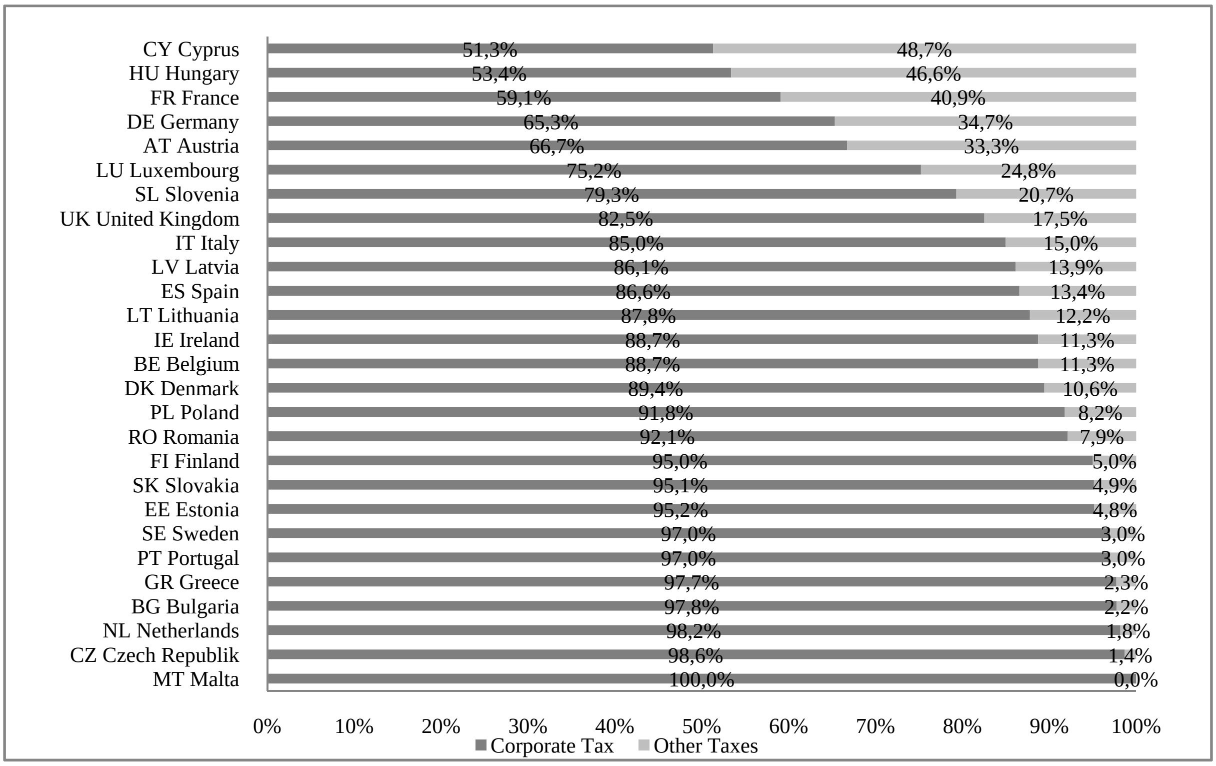
It then depends if the exceeding incentive is allowed to be carried forward in order to be used in future periods with higher profits. And, if there is any possibility for carrying forward, if the allowed time horizon is long enough to reach periods with a higher corporate taxable base or if the potential deduction is lost. Most countries link the possibility for carry forward to the general rules for loss carry forward. Austria, the Netherlands, and the United Kingdom, however, give immediate cash refund in order to increase the firm's liquidity. Italy does not allow for any carry forward of the incentives. We do not observe losses for our benchmark firm as the firm itself is profitable in all observed periods, but we find periods where not all tax credits (e.g. Spain, France) or tax deductions (e.g. Hungary) are useable in the respective period and are thus carried forward. This is especially true for those countries which offer a generous tax incentive in combination with firms with a low profitability. We discuss that point later in the sensitivity analysis (please see 3.2.1.).

3.1.5 Impact of Other Taxes

Other taxes levied on the firm level, such as real estate tax, business tax, payroll tax, and their interaction with the granted R&D incentives play an important role in the incentive's impact on total tax burden. Most taxes are deductible from the corporate taxable base. In consequence, these taxes lower the corporate tax base and the probability to use the full R&D tax credit or extra deduction and thus might have a negative impact on the incentive's efficiency. Figure 1 displays the share of non-corporate taxes of total tax burden (calculated without accounting for R&D tax incentives).

The total tax burden in Cyprus, Hungary, France, Germany, and Austria contains other taxes to more than 30%. In case of the countries with an incentive the impact can be clearly seen, the incentives compete for tax base or corporate tax due with other taxes (see Section 3.2.1. for a more detailed analysis across different industries). Thus the probability that the incentive can be used in full in the respective year is lower for those countries with a higher share of other taxes. Hungary has a business tax which is deductible two times from the corporate tax base leaving a small amount of tax base for the R&D extra deduction. We find a similar but smaller effect for France. We find no effect of other taxes for Malta, which has only corporate income tax and a share of other taxes of zero. The incentive of 50% extra deduction there can be used in full in all periods as the corporate tax base is high enough and not reduced through the deduction of other taxes. The effect in Czech Republic is small as well, as only real estate tax reduces the corporate tax base being another important influence for the different impact of the quite similar extra deduction of 100% in Hungary and Czech Republic.

Figure 1: share of corporate tax and other taxes on the effective tax burden of the benchmark model firm.



3.2 Sensitivity Analyses

3.2.1 Comparison of Industries

In the next step we run sensitivity analyses and consider the tax burden in case of selected industries: chemical, electric, food, mechanical engineering, metal, and motor vehicle. For this purpose, the underlying firm specific parameters in the simulation model are changed. While all other economic parameters like the specific national tax regimes or the parameters for the different kinds of R&D expenditures remain the same, the model firms have different economic structures and financial ratios. The level of R&D intensity of each of the model firms reflects the average level of the respective industry.

The results are presented in Table 3 by means of the tax subsidy per monetary unit of R&D expenditure. The second column shows the tax subsidies of the already considered firm in the manufacturing sector (benchmark). The tax subsidy amounts to 21.1% in Portugal, i.e. €1 of R&D expenditure is subsidised with €0.211 in addition to general treatment of expenditures. The tax subsidy is close to zero in Finland and only 0.8% in Poland.

Comparing the industries, there is some variation in the tax subsidies. The Portuguese tax subsidy is 21.7% in the mechanical industry, but only 17.2% in the motor vehicle industry and 18.0% in the electric industry. The impact of the Spanish incentives even is between 30.5%

for metal and 14.5% for motor vehicle. In the Czech Republic, the tax subsidy is between 18.5% for food and 15.0% for motor vehicle. If we focus on Malta, the impact looks much more stable compared to the top three countries ranging from 12.6% to 12.8%. The impact for the countries at the lower end of the ranking is much more stable as well, the standard deviation being close to zero. The inter-country effects are high enough to change even the ranking for some model firms, e.g. Portugal and Spain change places for metal, chemicals and food. The same is true for Hungary and Malta concerning chemicals, food, and metal.

Table 3: Tax subsidy per unit R&D expenditure in % per industry

Country	Bench-mark firm	Chemi-cals	Electric	Food	Mech. enginee-ring	Metal	Motor vehicle	Mean (6 ind.)	Std. dev.
Portugal	21.1	21.1	18.0	21.3	21.7	21.5	17.2	20.3	1.9
Spain	20.1	22.3	16.4	30.4	21.7	30.5	14.5	22.3	6.2
Czech Republik	18.2	18.5	16.0	18.5	18.4	18.5	15.0	17.6	1.4
Malta	12.8	12.8	12.7	12.8	12.8	12.8	12.6	12.7	0.1
Hungary	11.7	14.0	9.7	28.6	12.5	25.4	9.5	15.9	7.8
France	10.9	10.4	10.9	10.6	11.4	11.2	11.1	10.9	0.4
Netherlands	10.8	9.5	7.9	14.4	11.2	14.4	8.8	11.0	2.6
United Kingdom	9.0	10.9	9.8	9.4	9.9	11.6	8.5	9.9	1.1
Italy	9.0	9.9	9.7	8.9	9.9	9.9	8.6	9.4	0.6
Austria	8.0	8.0	7.5	8.0	8.0	8.0	7.9	7.9	0.2
Slovenia	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0.0
Ireland	1.9	1.9	2.4	1.9	2.8	2.2	2.6	2.2	0.4
Belgium	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.0
Greece	1.3	1.2	1.6	1.3	1.8	1.5	1.8	1.5	0.3
Poland	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.0
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	8.9	9.2	8.1	10.8	9.3	10.9	7.8		
Std. dev.	6.9	7.3	5.9	9.7	7.1	9.3	5.5		

There are some interesting effects concerning the industry averages and the R&D intensity measured as R&D expenditures in % of turnover. On average, tax subsidies in the food sector and in the metal sector are highest with 11%. However, as can be seen from Table 4, these two sectors display by far the lowest R&D intensity. The table also lists the firm's profit (net of taxes) in period 6 and compares with the R&D expenditures. The industries with lowest average tax subsidies are motor vehicle sector and electric albeit they showh the highest R&D intensities of the considered industries. The food and the metal sectors spend 41% and 29% of their profits in R&D activities. The electric and motor vehicle sectors have R&D expenditures which are three times their annual profits.

Table 4: Selected economic parameters of the considered firms (period 6).

	Bench-mark firm	Chemicals	Electric	Food	Mech. enginee-ring	Metal	Motor vehicle
R&D intensity in % of turnover	4.5%	4.6%	7.6%	0.7%	4.0%	0.8%	6.1%
R&D expenditures in 1,000 €	363	453	703	64	331	75	542
Profit in 1,000 €	214	288	236	155	209	261	184
R&D expend. / profit	1.70	1.57	2.98	0.41	1.59	0.29	2.95

Note: Details are given in Table 9.

Given these high amounts of R&D expenditures it becomes evident that firms in the electric and motor vehicle sector cannot always make use of the whole tax incentives in the same period the expenditures arise, since the taxable bases or the tax due are too low. In tendency, this is rather not the case for the two industries with low R&D intensity. Thus, profitability in combination with the amount of R&D expenditures plays an important role for the effect of R&D tax incentives.

The need for sufficient profits clearly can be seen in the results for Spain and Hungary. There, the tax subsidy is around 30% for the food and metal sector while it is considerably lower for sectors with higher R&D intensities. In Spain, the limitation that the R&D incentive may reduce the tax due by 50% at the maximum is responsible for this result. This result is interesting as one would expect that the Spanish incentive is significantly better than the Portuguese one. In Hungary, the necessary corporate tax base itself is considerably low since business tax is deductible twice from the corporate taxable base. The business tax thus limits the effect of the Hungarian extra deduction. In other words, the effects in the two countries show that governments should choose the level of a tax incentive in accordance with the framing general tax system. If the incentive is too high relative to the general taxation (e.g. Hungary) or if the incentive is too high compared to the corporate income tax (e.g. Spain), firms with high R&D intensities, in particular, are not able to profit from the incentive and different and unequal impacts across a sample of firms can occur. Malta in contrast displays a quite stable effect across all model firms, as the share of other taxes is zero in Malta. That improves the probability at a given profitability that the full tax incentive (extra deduction) can be used in the respective period as no deductions for other taxes lower the corporate tax base.

There are several countries which account for these problems. Austria, the United Kingdom (and the Netherlands in case of payroll taxes) give cash refunds if the incentive cannot be used completely in the respective period. As can be seen from Table 3, there is only little variation between the considered industries. However, in the United Kingdom the cash refund is less generous (24% of un-useable R&D deductions) than the Austrian one.

Concluding, the comparison of several industries clearly shows that a firm's profitability has a considerable impact on the R&D incentive's effect. This is counterproductive since the incentive is meant to support R&D expenditures of firms which do not have enough liquidity to undertake R&D on their own. One of the important arguments which support the use of tax incentives is the intention not to distort the decision of the firms concerning the composition of its R&D. A tax incentive that has (strongly) different effects depending on the profitability of a firm causes different incentive effects and thus distortion depending on firm and industry specific parameters and economic cycle. A way to solve this problem is the Austrian or British way where non-useable incentives can be refunded by cash so that liquidity is guaranteed in the period it is needed.

3.2.2 Varying R&D Expenditures

How does distribution of R&D expenditures over time influence the incentive's efficiency? To find out we measure the effect on the tax burden with constant R&D expenditures over time in a first step and with highly increasing expenditures over time in a second step. We thus simulate two extreme distributions of R&D expenditures over time.

For the first simulation we assume €361K R&D expenditures over all periods. Table 5 displays the results. The found effects are almost the same for those countries which solely grant volume-based incentives. But we find significant decreases of the tax subsidies for those countries which offer (parts) of their R&D incentive on the increment. These effects are strong enough to change the ranking of the impact for Portugal and Spain as well as for Ireland and Greece. Ireland and Greece, as they both solely offer incremental incentives, rank last. However, only Greece shows a tax subsidy of zero. For Ireland, there is still a positive subsidy because the incentive is also given on capital expenditures for R&D buildings. The decreases of tax subsidies are less pronounced in Spain and Portugal, since they offer both a volume-based and an incremental incentive.

Table 5: Tax subsidies in % in case of constant R&D expenditures

Country	Benchmark firm
Spain	20.0
Portugal	19.8
Czech Republik	18.1
Malta	12.7
Hungary	12.3
Netherlands	11.2
France	9.9
Italy	9.1
United Kingdom	8.9
Austria	8.0
Slovenia	5.0
Belgium	1.6
Poland	0.8
Ireland	0.3
Greece	0.0
Finland	0.0
Mean	8.6
Std. dev.	6.9

In the second simulation, the R&D expenditures are set to zero in the first period. We assume an R&D intensity of 4.5% for periods 2 to 10 (like in the standard case, please see table 4, first row for the R&D intensities of the other model firms). Consequently, we expect that countries with generous incremental incentives show high tax subsidies since the increase in R&D expenditures is 100% in the second period.

The average tax subsidy for Portugal increases from approx. 20.3% to 23.6%, Spain changes its ranking position with the Czech Republic and is now second with 20.8%, France shows an enormous increase which results in a rank on the fourth position and Ireland is now on the fifth position, followed by Malta and Hungary. The most important parameter for the displayed changes in the ranking of tax subsidies is the rate of the incentive. Spain and Portugal have a rate of 50%, France of 40% and Ireland of 20% on the increment.[14] This sensitivity analysis reveals a strong impact of the development of R&D over time which can change the ranking of the best locations from an investors view. The decision to choose a location and to conduct R&D needs a detailed look on the probable future development of the company's R&D activity. If a strong increase of the R&D activity is expected, it can make sense to turn to countries with a beneficial way to calculate the base (fixed base) for the R&D increase like Ireland. The effect for Ireland is as strong because the increment is calculated with reference to the year 2003. That means that an increase in the second year not only increases the base for the incentive in the next two periods (like it would be the case for the rolling two year average method) but also in all other periods. This simulation reflects an upper limit of the incentive for a company that is about to begin R&D activity (e.g. for the first time).

Table 6: Tax subsidies in % per industry in case of R&D expenditures with industry specific R&D intensity in periods 2 to 10 but zero in period one

Country	Bench-mark firm	Chemi-cals	Electric	Food	Mech. enginee-ring	Metal	Motor vehicle	Mean (6 ind.)	Std. Var.
Portugal	24.6	25.7	17.9	26.6	26.3	26.7	17.3	23.6	4.2
Spain	17.8	20.0	14.2	30.1	19.5	30.2	14.0	20.8	6.8
Czech Republik	16.2	16.5	14.1	16.5	16.6	16.6	13.1	15.7	1.4
France	15.3	14.9	15.2	15.2	15.7	15.6	15.1	15.3	0.3
Ireland	12.1	13.3	10.7	15.7	12.5	16.4	10.1	13.0	2.4
Malta	11.4	11.4	11.4	11.4	11.5	11.4	11.3	11.4	0.1
Hungary	10.7	13.3	8.9	26.5	11.5	23.9	8.4	14.7	7.4
Netherlands	10.0	8.9	7.4	14.0	10.4	14.0	8.2	10.4	2.7
Italy	8.1	9.1	8.9	8.1	9.1	9.1	7.8	8.6	0.6
United Kingdom	7.4	9.3	8.2	7.7	8.4	10.0	7.4	8.3	1.0
Austria	7.2	7.2	6.8	7.2	7.2	7.2	7.1	7.1	0.2
Greece	4.7	5.9	5.8	8.1	8.2	8.2	4.3	6.5	1.7
Slovenia	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
Belgium	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0
Poland	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.0
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mean	9.5	10.1	8.5	12.1	10.2	12.2	8.2		
Std. dev.	6.7	7.1	5.3	9.4	7.1	9.1	5.2		

Overall, the simulations show that R&D tax incentives in general do have a considerable impact on a firm's tax burden. But they also show that the design of an R&D incentive must be in accordance with the overall tax system it is embedded in. Given the background that the incentive is meant to increase liquidity it is necessary to grant immediate cash refund in case the incentive is not useable since profits or tax payments are too small.

14 Other countries that do not have an incentive on the increase of expenditures over time show, as expected, slightly lower impacts because the R&D expenditures in period one are lost for their incentives.

4 Comparison to B-Index

Section 2 gave a brief discussion to what extent the methodological approaches of measuring the impact of R&D tax incentives by means of the B-Index and by means of the European Tax Analyzer differ. The following Table 7 compares the tax subsidies determined by both approaches for the EU27. Considering first the rankings in the last two columns it turns out that there are only few differences. There is a considerable difference for Italy because in the simulations we take the 2007 situation into account whereas all other data is based on 2006. Similar is true for Denmark.[15] The other countries more or less show a similar position in the ranking.

Table 7: Comparison of tax subsidies determined by means of the European Tax Analyzer and the B-Index, in %, 2006.

	Tax subsidy in %		Ranking	
	European Tax Analyzer	(1 – B-Index)	European Tax Analyzer	B-Index
Portugal	21.1	28.5	1	2
Spain	20.1	39.1	2	1
Czech Republic	18.2	27.1	3	3
Malta	12.8	n/a	4	
Hungary	11.7	16.2	5	6
France	10.9	18.9	6	5
Netherlands	10.8	23.9	7	4
United Kingdom	9.0	10.6	9	8
Italy	9.0	-2.3	8	18
Austria	8.0	8.8	10	10
Slovenia	5.0	n/a	11	
Ireland	1.9	4.9	12	11
Belgium	1.5	8.9	13	9
Greece	1.3	-1.1	14	15
Poland	0.8	2.2	15	12
Finland	0.0	-0.8	16	13
Bulgaria	0.0	n/a	17	
Cyprus	0.0	n/a	17	
Denmark	0.0	16.1	17	7
Estonia	0.0	n/a	17	
Germany	0.0	-3.0	17	19
Latvia	0.0	n/a	17	
Lithuania	0.0	n/a	17	
Luxembourg	0.0	-1.4	17	16
Romania	0.0	n/a	17	
Slovakia	0.0	-0.8	17	13
Sweden	0.0	-1.5	17	17

Note: The B-Index is shown as (1 – B-Index) x 100. The table lists the B-Index for small firms. The OECD data shows the Italian 2006 value while our simulation consider the introduced rules in 2007.
Source: OECD (2007), own calculations.

However, the level of tax subsidies is not similar for all countries. There are two main reasons why the tax subsidies determined by means of the European Tax Analyzer differ from the B-Index.

[15] Denmark offers an extra deduction of 50% for R&D expenditures which occur for projects undertaken from private firms together with public institutions. This incentive, however, is not considered in our simulation.

The European Tax Analyzer takes into account limitations such as maximum ceilings up to which the incentive can be applied. A prominent example for this is Spain which has the highest tax subsidy in the B-Index ranking, but only the second highest in our simulations. The 50% maximum reduction of the corporate tax due in Spain is not considered for in the B-Index. As can be seen from the simulations with the European Tax Analyzer, firms easily reach this ceiling, so that the tax subsidy is much lower for the European Tax Analyzer than for the B-Index. The differences are much less distinct in Portugal where no such limitations exist. The same is true for carry forwards of unused tax incentives. In case of Austria and the United Kingdom, where immediate cash refunds are granted, the tax subsidies of B-Index and European Tax Analyzer are close together.

A more technical reason is that we compare the situations with and without having a tax incentive while the B-Index compares the taxation of R&D expenditures with general taxation. E.g. in case of investments in fixed depreciable assets, the B-Index exceeds 1 (i.e. the tax subsidy is negative) if there is no tax incentive in place in the country considered (see Germany, Italy 2006, Slovakia, Sweden). The tax subsidy determined with the European Tax Analyzer is zero because it is assumed that the investment nevertheless is undertaken. Moreover, the composition of R&D expenditures differs.

Altogether, the comparison shows that both methodologies more or less come to the same ranking of countries. However, since the European Tax Analyzer can account for much more parameters which have an impact on the R&D tax incentive's efficiency, the level of determined tax subsidies differs in some countries.

5 Conclusions

In this paper, we analyzed the impact of R&D tax incentives on the effective corporate tax burden. Our calculations are based on the simulation model European Tax Analyzer which determines the tax burden of a firm over a certain period of time. It was thus possible to receive additional information on the impact of R&D tax incentives that go beyond the commonly used simple model of the B-Index.

The results showed that R&D tax incentives in the EU-27 member states have a significant impact on the effective corporate tax burden. Countries with highest tax subsidies are Portugal, Spain, and the Czech Republic. The level of tax subsidies does not so much depend on the kind of incentive but rather on its design. Portugal and Spain grant high rates of tax credits, the Czech Republic applies a generous extra-allowance for R&D expenditures. Only in case of progressive tax rates, the kind of incentive has an impact on the tax subsidy's volume as the progressive corporate income tax in the United Kingdom shows.

We analysed the impact of certain design parameters of R&D incentives and the framing tax regimes on the effective tax burden and the resulting tax subsidies. Taking e.g. Spain and Hungary, where the granted tax incentives often cannot be used in the period in which expenditures have taken place, it became evident that the design of the tax incentive must be in accordance with the framing tax system in order to be efficient. An immediate cash refund for unused tax incentives is found to be a good solution of this problem. In Austria and the United Kingdom, where cash refunds are in place, the tax subsidies do not depend as much on a firm's profitability as in Spain or in Hungary. The most important drivers of tax subsidies turned out to be the design of the incentive itself, its fitting to the general tax system, and the firm's profitability relative to the level of R&D expenditures.

Our simulation results are more or less similar to those of the B-Index, in what concerns the ranking of countries. However, since the European Tax Analyzer accounts for much more specifications of the incentive, the framing tax system, and the firm there are several differences with respect to the level of tax subsidies. In particular, there are differences for countries with limited tax incentives.

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ANNEX

Table 8: Implemented R&D tax incentives

		Expenditures for personnel	Other current expenditures	Capital expenditures	Carry forward possible?
Tax deferral					
	BE			accel. dep.	
	FI			accel. dep. buildings	
	GR			accel dep.	
	UK			full depreciation if no real estate	
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% Tech	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% qual. R&D-personnel	-		cash refund
	ES	30%+20% max. 50% CIT	30% max. 50% CIT	10% max. 50% CIT	15 years
	FR	10% max €10m	10% max €10m	10% (no real est)	no limit
	HU	10%			4 years
	IT	10% max. €15m	10% max. €15m		forbidden
	IR			20% (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 own research.

Table 9: Financial ratios of benchmark case and model firm (period 6)

	Benchmark case	Chemicals	Electric	Food
Net profit (€)	214,146	287,839	235,819	155,405
Balance-sheet total (€)	5,995,166	6,771,834	6,321,627	5,533,259
Turnover (€)	8,073,092	9,840,934	9,249,152	9,082,228
Share of fixed assets	27.73%	31.97%	17.39%	31.11%
Return on sales	2.65%	2.92%	2.55%	1.71%
Return on equity	19.37%	16.90%	15.26%	15.66%
Equity ratio	22.02%	29.40%	28.18%	20.75%
Return on assets	7.70%	7.47%	6.65%	7.62%
Inventories to total capital	25.90%	21.75%	29.54%	18.81%
Costs for personnel to turnover	29.71%	22.97%	27.65%	17.46%
R&D expenditures to turnover	4.50%	4.60%	7.60%	0.70%

	Mechanical engineering	Metal	Motor vehicle
Net profit (€)	208,864	261,194	183,776
Balance-sheet total (€)	6,189,490	6,027,552	5,528,685
Turnover (€)	8,285,232	9,431,545	8,887,880
Share of fixed assets	18.69%	28.93%	25.98%
Return on sales	2.52%	2.77%	2.07%
Return on equity	17.71%	22.97%	21.68%
Equity ratio	22.43%	23.20%	18.66%
Return on assets	6.25%	8.51%	6.28%
Inventories to total capital	31.96%	24.69%	24.03%
Costs for personnel to turnover	32.91%	25.65%	27.23%
R&D Expenditures to turnover	4.00%	0.80%	6.10%

Detailed Description of the European Tax Analyzer Model

The European Tax Analyzer is a computer program for a model firm that calculates and compares effective average tax burdens for companies located in different jurisdictions.[16] The current version covers the tax systems of 27 EU member states. Since the standard model firm is designed as a (limited) corporation, the effective average tax burden can be calculated at the level of the corporation as well as at the level of the shareholders. This study exclusively considers the effective average tax burden at the corporation level. The effective average tax burden is derived by simulating the development of a corporation over a ten year period. For the computation of the effective average tax burden the model uses the economic data of the corporation and tax data as inputs.

[16] For detailed descriptions of the model see Spengel, 1995; Jacobs and Spengel, 1996; Meyer, 1996; Stetter, 2005; Gutekunst, 2005, Hermann, 2006.

The following description therefore highlights the basic assumptions and the most recent amendments of this approach. The European Tax Analyzer calculates and compares effective average tax burdens for companies over a period of ten years. The development of the corporation is based on the initial capital stock and the estimates for its future development (further called corporate planning).

Initial capital stock: The capital stock includes the firm's total assets and liabilities which are either new or have already existed before. The assets consist of real estate, office and factory buildings, plant and machinery, office equipment, intangibles (patents and royalties), financial assets, shares in other corporations (both domestic and foreign), inventories, trade debtors, cash funds, and deposits. The liabilities include new equity capital, long-term and short-term debt, and trade creditors.

Development of capital stock: Corporate planning supplies data about the expected development of the capital stock over the simulation period of ten years. Estimates are based on periodical assumptions for production and sales, acquisition of goods, staff expenditure (e.g. number of employees, wage per employee and pension costs), other receipts and expenses (e.g. expenses for R&D), investment, distribution, and costs of financing. Goods are assumed to be either stocked or sold on the market in the same period as they are produced. Therefore, multi-period production is possible. Additional assumptions are made for material and labour with regard to production costs. It is further assumed that depreciable assets (i.e. buildings, plant and machinery, office equipment, and intangibles) are run down at the end of their expected economic life. Reinvestments in new assets are made at that point based on the historical costs of the deposited assets adjusted for inflation. The model's assumptions regarding investment make sure that the initial capital stock at least remains constant. In addition to differing rates of price increases, other macro-economic data considered are credit and debit interest rates, exchange rates for the given countries and the costs of energy and electricity.

Corporate finance: The initial capital stock contains new equity as well as both long and short term debt capital. Since the corporate plans, inter alia, make assumptions about the distribution policy, the company can be financed by retained earnings (e.g. the distribution rate is below 100%) in addition to new equity and debt financing. If the national tax codes allow for internal book reserves (e.g. book reserves for bad debts), the money put into these reserves can also serve as a source of internal financing.

For the sake of comparability, it is assumed that the model firm always shows identical data before any taxation. Due to this necessary assumption any differences between pre- and post-tax data in the model can be solely attributed to the applied national taxation rules.

Computation of the Effective Average Tax Burden

The measures for tax base and for tax burden are expressed in currency units (€). The effective tax burden is the difference between the pre-tax and the post-tax value of the firm at the end of the simulation period (i.e. period 10). The value of the firm represents the equity, which includes the capital stock and the cumulative net income of each of the ten periods. At the end of period ten, the tax value of assets and liabilities may differ from their fair value, depending on the tax rules which are to be applied. These hidden reserves and liabilities are added to the taxable income in period ten and are taxed accordingly. As a consequence, only the effects of different tax accounting rules on the liquidity are taken into account. Remaining loss carry forwards at the end of the simulation are dissolved liquidity-related whereas a devaluation of 50 per cent is made if there are no restrictions for the use of loss carry forwards and a devaluation of 75 per cent if there are any restrictions. The computation of the absolute effective average tax burden requires two steps.

In the **first step**, the pre-tax value of the firm at the end of the simulation period is calculated. The pre-tax value of the firm is derived from the estimated cash flows and the value of the net assets at the end of the simulation period. The cash flows are derived from estimates for the cash receipts (sales and other receipts, gains upon the disposal of assets, interest and dividend income) and expenses (wages and pension payments, expenses for material, energy consumption and other expenses, new investment, interest expenses and distributed profits) included in the corporate planning. The cash flow (= liquidity) is calculated in each period. Thereby it is assumed that any given amount of surplus cash flow at the end of a single period can be invested at a given interest rate and any given deficit can be covered by borrowing money at a given debit rate (balancing investment or credit). The interest receipts or expenses plus the amount of the underlying balancing investments or credits are considered for the calculation of the cash flow in the following period. The value of the net assets at the end of the simulation period is computed by deducting the liabilities of the corporation from the assets. Both the assets and the liabilities are valued at calibrated parameters that are the same in each country. For assets we use replacement prices and for liabilities nominal values.

Pre-tax cash flow at the end of the simulation period + Value of the net assets at the end of the simulation period (= assets in the capital stock at replacement prices – liabilities in the capital stock at nominal values)
= Pre-tax value of the firm at the end of the simulation period

In the **second step**, we calculate the post-tax value of the firm at the end of the simulation period. The determination of the post-tax value of the firm only has cash flow effects and no impact on the value of the net assets. The post-tax cash flow is derived in each period by deducting the tax liabilities from the pre-tax cash flow. In order to calculate the absolute amount of tax liabilities, receipts and expenses enter into the tax balance sheet and/ or into the tax profit and loss account following national taxation rules (e.g. regarding the computation of depreciation allowances). After having applied the national tax rates, we allow for other relevant components such as loss carryovers and tax credits in order to come to the amount of tax liabilities. The reduction of the cash flow due to tax payments (liabilities) also has an impact on the balancing investment or credit and the connected interest receipts or credits. By taking into account these tax-induced effects on the interest income or expense of each period, the deferral of tax payments is integrated into the model. Hidden reserves and liabilities are only relevant for taxation matters at the very end of the simulation.

	Pre-tax cash flow at the end of the simulation period
-	Tax liabilities in each period
=	Post-tax cash flow at the end of the simulation period
+	Value of the net assets at the end of the simulation period
	(= assets in the capital stock at replacement prices
–	liabilities in the capital stock at nominal values)
- /+	Tax liabilities on hidden reserves / tax refunds on hidden liabilities
=	Post-tax value of the firm at the end of the simulation period
	Pre-tax value of the firm at the end of the simulation period
-	Post-tax value of the firm at the end of the simulation period
=	Effective average tax burden

In contrast to models which compute tax burdens solely based on pre-tax returns (yields), calculations based on cash receipts and cash expenses regarding balancing investments allow for the entire computation of all tax bases at any time during the period of simulation (because all relevant income and assets have been entered into the tax base). As a consequence, the model can include complicated tax provisions such as progressive tax rates, tax credits (e.g. for foreign taxes) with upper ceilings, and loss carryovers without any difficulty.

Tax Parameters Incorporated into the Model

The tax base and the effective average tax burden are calculated for the EU-27 member states. In order to calculate the tax liability in each country the European Tax Analyzer takes into account all taxes that may be influenced by the investments and financing at the level of the corporation. A detailed description of the tax parameters is not given here. When calculating the tax bases, the most relevant assets and liabilities and the effects of the corporate planning are considered. Finally, referring to the tax rates, the calculations consider statutory linear as well as progressive tax rate structures. In the case of progressive rates – relevant for special provisions for SMEs in some countries - the tax rates enter into the model as functions of the relevant income or net assets (non-profit taxes) according to the tax laws.