



R&D tax incentives

How to make them most effective?

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MAIN POLICY MESSAGES

- Governments in the EU and across the world are increasingly using tax incentives for Research and Development (R&D) in an effort to boost business R&D investments, increase productivity and economic growth.
- R&D tax incentives should be considered complementary to other measures of public support to business R&D. R&D tax incentives can be effective in stimulating business investment in R&D, innovation and productivity growth but their design, administration and implementation are crucial for their effectiveness.
- Targeting specifically young innovative companies is justified from a welfare perspective. Evidence suggests that the impact of R&D tax incentives in terms of stimulating business R&D is stronger for young companies and SMEs.
- Good practices in the design of R&D tax incentives include carry-forward provisions, cash refunds or relief from labor taxes, such as payroll taxes or employer social contributions, which can stimulate R&D also in young innovative companies with negative tax liability.
- Good practices in the administration of R&D tax incentives include among others one-stop, online application procedures and guidelines for businesses, short times for decisions on eligibility, assessors of R&D tax incentives claims with expertise in the field, use of risk-based control mechanisms.
- Patent boxes do not stimulate R&D and may rather be used as a profit-shifting instrument, leading to high revenue losses.
- Governments should ensure that R&D tax incentive schemes provide value for money, through regular and rigorous evaluation, based on high-quality firm-level data.
- As part of an EU effort to improve framework conditions for innovation, the European Commission proposed in 2016 an EU-wide tax incentive in the re-launch of its proposal on a common consolidated corporate tax base.

1. RATIONALE FOR AND THE SPREAD OF R&D TAX INCENTIVES

EU governments increasingly use R&D tax incentives, especially since the outset of the financial and economic crisis, to stimulate business investments in R&D, boost productivity and economic growth. Tax incentives for R&D are used also by most advanced and many emerging market economies including US, Japan, Brazil, China, India and South Africa. The rationale for state intervention in research and innovation activities derives from the market failures theory and the characteristics of R&D, including public good characteristics (non-rivalry, non-excludability), externalities, limited appropriability of R&D benefits, technological and market uncertainty, asymmetric information and access to finance problems, indivisibility of large R&D projects and coordination problems (Arrow 1962, Martin & Scott 2000, Mohnen 2013).

R&D tax incentives are used to stimulate business R&D with potential spillover effects

R&D tax incentives, being one instrument of public support to business R&D, are most often associated with market failures related to credit constraints and positive externalities, e.g. in the form of knowledge spillovers (IMF 2016). Returns on investments in R&D are difficult to fully appropriate by firms as some of the resulting knowledge will leak out or 'spill over' to other firms, to the benefit of society and the economy as a whole. Private firms do not take these spillovers into account when deciding about the amount of investment in R&D. This leads to a socially suboptimal level of investments in R&D, i.e. 'underinvestment' in business R&D from a welfare point of view (IMF 2016). By lowering the price of doing R&D, R&D tax incentives stimulate businesses to undertake more R&D activities with potential

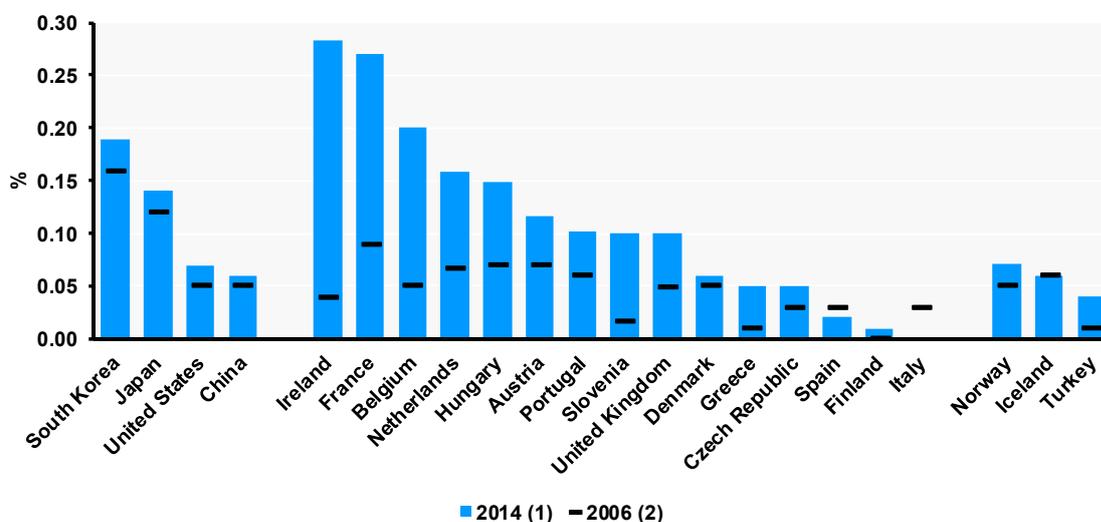
spillover effects to other companies in the same industry, in different industries and even across countries. In fact, when granting R&D tax incentives many countries follow the Frascati 2015 definition of R&D, which sets five core criteria for an activity to be recognised as R&D: novel, creative, uncertain, systematic, transferable and/or reproducible (OECD 2017). These criteria reflect to a certain extent the market failures arguments and the R&D characteristics justifying state intervention.¹

Asymmetric information in R&D and the lack of the traditional collateral create financing problems for young innovative companies in particular. R&D tax incentives can only partly mitigate this problem, especially because the money is received ex post and young companies may still have financial difficulties in initiating their R&D projects. For continuous R&D performers, who continuously can rely on R&D tax incentives, financial support from tax incentives can ease but not entirely remove the financial constraint. The power of R&D tax incentives in solving the financing problem is strongly reduced if tax incentives are unstable, unpredictable, non-refundable or if there is a large time lag between the R&D expenditure and the collection of R&D tax benefits (Mohnen 2013).

EU governments increasingly rely on fiscal incentives to support business R&D...

In response to the challenging economic environment and in order to stimulate business R&D investments many EU Member States expanded their existing R&D tax incentives, while other countries have introduced new measures (Garnier et al. 2014). As a result, the amount of foregone tax revenues due to R&D tax incentives has increased substantially in most EU Member States using R&D tax incentives and across the EU in total (Fig. 1). Estimations based on OECD data show that for every euro invested in business R&D in the EU, Member States give on average an R&D tax subsidy of 12 cents (European Commission 2016).² Within the EU, currently only Germany, Estonia and Finland do not have any tax policy aimed at stimulating business R&D.

Figure 1: Tax incentives for R&D as % of GDP, 2006-2014



Graph prepared by: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

Data sources: OECD, Eurostat

Notes: ⁽¹⁾BE, US: 2012; FR, IT, IS, CN: 2013. ⁽²⁾BE, DK, IT, SI, KR: 2007; TR: 2008; CN: 2009; IS: 2011.

¹ For example, 'transferable and/or reproducible' activity implies potential externalities and spillover effects to other companies and the economy as a whole.

²A systematic comparison of the generosity levels of R&D tax incentives requires a measure which condenses different features of the tax system (rate, design of the tax incentive, etc.) into one indicator. Such an indicator of tax support to R&D is the 'B-index', which summarises a large array of qualitative and quantitative information about R&D tax incentives and depreciation regimes for R&D assets as collected by the OECD.

R&D tax incentives can take different forms to influence the tax burden on R&D activities. They can target R&D inputs by supporting R&D related expenditure. Such measures either reduce the tax base by granting a deductible enhanced allowance or they directly reduce the amount of tax to be paid in form of a tax credit. Support measures can also be based on output, i.e. income directly generated by R&D outcomes such as patents.

... while the instruments used and the design of tax incentives differ widely.

Although tax incentives are common, they are far from homogeneous and differ substantially, with most countries offering more than one type of instrument. R&D tax credits are the most popular type of incentive, followed by enhanced allowances and accelerated depreciation. The vast majority of tax incentives are based on corporate income taxes, while some countries have (additional) incentives that apply to social contributions and/or wage taxes (Table 1).

Over the past years, countries have shifted from tax incentives that only apply to increments in a firm's R&D expenditure (incremental schemes) towards incentives that apply to total R&D expenditure (volume-based schemes). While tax incentives are essentially a generic policy instrument, targeting to specific groups of firms is quite common. Some countries explicitly target SMEs or young companies. Most countries put a ceiling on the amount that firms can receive and in some countries the generosity of the scheme decreases with the size of a firm's R&D expenditure (CPB 2014).

An EU-wide R&D tax incentive is proposed in the CCCTB to spur investments in R&D

While across the EU there are different R&D tax incentive schemes with different generosity levels, the EU Commission has recently proposed an EU-wide R&D tax incentive to encourage companies in the EU to invest in research and innovation. The EU initiative for a Common (Consolidated) Corporate Tax Base (CCCTB)³ introduces a proposal for an EU-wide R&D tax incentive, in form of an enhanced allowance (super-deduction) for R&D expenditure, which is most generous for start-up companies with R&D expenditure up to a certain threshold (Box 1). The CCCTB proposals aim to create more transparency with regard to the effective corporate tax situation in Member States. While the proposals cannot eliminate tax competition within the EU, they strive to make the competition fairer. The CCCTB would not fully replace national R&D tax incentive schemes: it is to be mandatory for the large companies (groups) in the EU in order to cover those with the greatest capacity to tax plan, while it is to remain optional for the rest of the companies.

R&D tax incentives play a role in tax competition and can influence the location decisions of multinational enterprises (MNEs) investing in R&D. Evidence suggests that the volume of R&D conducted in one country responds to changes in the cost of doing R&D in competitor countries (Bloom & Griffith 2001). R&D tax incentives seem to play a role especially in the final stages of the decision making process, when having two or more relatively similar location alternatives, government incentives can tilt the investment decision (OECD 2011a).

However, evidence also suggests that even if tax incentives might affect the location of MNEs R&D investment, there are other more important factors such as: access to local science and technology, proximity to university frontier research and centres of excellence, availability of a skilled workforce, engineers and scientists, and strong intellectual property rights. These factors are found particularly important for MNEs laboratories specialised in research (the "R" in R&D). Other factors, such as access to local markets and proximity to other corporate activities, such as production sites, and proximity to local customers influence the location of R&D labs engaged in development (the "D" in R&D) and in the transfer and commercialization of knowledge from the MNE R&D centre to the host country lab (OECD 2011b).

³ In October 2016 the European Commission re-launched the proposal for a Common Consolidated Corporate Tax Base (CCCTB) from 2011.

Table 1: Existence and design of R&D tax incentives in the EU

Country	Type of R&D tax incentive					Type of Tax		
	Expense-based				Input-based	Corporate income tax	Personal income tax	Wage tax / SSCs
	Tax credits	Enhanced allowance	Accelerated depreciation	Existing expense-based incentive	Patent Box			
BE	X	X	X	X	X	X		X
BG	X		X	X		X		
CZ	X*	X		X		X		
DK	X	X	X	X		X		
DE								
EE								
IE	X			X	X	X		
EL		X		X	X	X		
ES	X			X	X	X		
FR	X			X	X	X	X	X
HR		X		X		X		
IT	X		X	X	X	X		
CY		X		X	X	X		
LV		X	X	X		X		
LT		X	X	X		X		
LU					X	X	X	X
HU		X		X	X	X		X
MT	X			X	X	X		
NL	X	X		X	X	X	X	X
AT	X			X		X	X	X
PL	X*	X	X	X		X	X	
PT	X			X	X	X		
RO		X	X	X		X		
SI		X	X	X		X	X	
SK		X		X		X		
FI								
SE	X			X				X
UK	X	X	X	X	X	X		
EU	15	15	10	24	13	24	6	7
Norway	X			X		X		
Canada	X		X	X		X	X	X
US	X		X	X		X		
Israel	X*	X	X	X		X		
Japan	X	X	X	X		X		

Source: European Commission 2016; CPB 2014

Notes: The temporary scheme in Finland has expired. Ireland has introduced a knowledge box. *: Reduced corporate tax rate. SSCs stands for social security contributions.

Box 1: R&D tax incentive in the European Commission proposals for Common (Consolidated) Corporate Tax Base (CCCTB)

The relaunched initiative of the EU Commission for a Common Consolidated Corporate Tax Base foresees, as in the CCCTB proposal from 2011, a deduction of 100% of R&D costs, which are immediately and fully deductible, except for R&D costs related to immovable property. Furthermore, the relaunched initiative offers additional deduction of 50% for R&D spending up to EUR 20 million, and additional 25% for R&D spending over EUR 20 million, which are deductible in the same tax year, except for the cost related to movable tangible fixed assets. The additional deduction is even more generous for start-up companies, which decide to opt in to the CCCTB, and reaches 100% for expenses up to EUR 20 million. To be eligible for this generous super-deduction companies need to meet all of the following criteria:

SME: it is an unlisted enterprise with fewer than 50 employees and an annual turnover and/or annual balance sheet total that does not exceed EUR 10 million.

young: it has not been registered for longer than five years.

anti-tax avoidance: it has not been formed through a merger and it does not have any associated enterprises.

2. ADVANTAGES AND DISADVANTAGES OF R&D TAX INCENTIVES VIS-À-VIS DIRECT MEASURES OF BUSINESS SUPPORT

The advantages and disadvantages of R&D tax incentives are often discussed in comparison to other measures of public support to business R&D, in particular direct measures such as grants and subsidies (Table 2). R&D tax incentives differ from direct support of business R&D in important ways. Tax incentives are usually available to all firms that invest in R&D—although they can be designed to target specific groups of firms. R&D tax incentives are attractive because of their relative simplicity and stability (compared to direct funding modes which tend to change over time as they follow new strategies and direct funds towards specific sectors, agents or goals, and often involve more cumbersome procedures to access funds) and because they are neutral and provide a level playing field; all private R&D activities get equal treatment. The drawback, however, of such a neutral, market-based approach is that R&D activities with low potential for spillovers and low social return will be equally supported as R&D activities with higher social return (IMF 2016).

Subsidies, in contrast, often take the form of specific support to targeted R&D projects. Thus, they are more often of a discretionary nature and largely designed by the government. If the government is able to target them well based on appropriate information about the size and nature of the spillovers, subsidies can be more efficient than tax incentives. Furthermore, they can also account for nonmarket benefits, such as a cleaner environment (IMF 2016). Thus subsidies are especially useful for supporting the research component of R&D—the early phase of the innovation process in which knowledge spillovers tend to be larger (Zuniga-Vincente et al. 2014). Tax incentives can complement these subsidies by providing across-the board incentives to all firms investing in R&D (IMF 2016).

Tax incentives and direct support to business R&D are complementary measures to stimulate business R&D

The effects of the two instruments are found to vary across industries and firms. For example, higher R&D subsidies are found to increase TFP growth more in industries that are highly dependent on external finance (where R&D cannot be accommodated by current cash flow) and in the information technology sector. R&D tax incentives are found to have a larger effect in industries characterised by high R&D intensity and for small firms (those with fewer than 50 employees). These variations make it difficult to conclude in general terms which instrument more effectively fosters innovation and productivity (IMF 2016). A recent OECD study concludes that policymakers should consider balancing indirect support for

business R&D through tax incentives with the use of direct support measures to foster innovation where the market is less likely to deliver it on its own (Criscuolo et al. 2016).

Table 2: Advantages and disadvantages of R&D tax incentives vs. direct support to business R&D

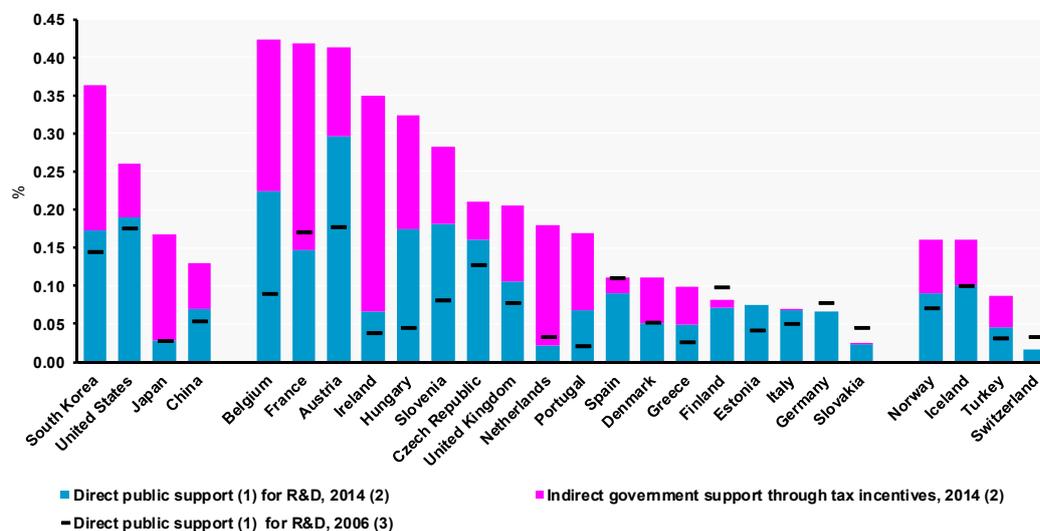
	Advantages	Disadvantages
Tax incentives	<ul style="list-style-type: none"> ▪ Less burdensome for companies ▪ Lower administrative costs of planning, allocation and management ▪ Generally less distortive, especially if not focused on certain areas of specialization, and therefore more easily in line with EU State aid rules. Encourage an increase of R&D across the whole spectrum of firms (but can be used to target specific groups of firms) ▪ The private sector can decide what is the most productive way to invest ▪ Technology neutral: non-discriminatory nature in terms of research, technology fields or industrial sectors ▪ Less risk of governmental failure in 'picking winners' (choosing the wrong R&D projects) ▪ Encourage companies to report their R&D activities more accurately ▪ Avoid misappropriation of funds and rent-seeking activities by government's civil servants ▪ Avoid an up-front budget since support is by means of forgone tax revenues 	<ul style="list-style-type: none"> ▪ Poor budget control ▪ Greater risk of dead weight loss (supporting projects which would have been performed anyway) ▪ Private firms will choose R&D projects with the highest private rates of return (not taking into account spillovers) ▪ Less additionality in the case of very large companies ▪ Risk of firms relabeling other activities as R&D ▪ Limited incentives for technology transfer ▪ Risk of tax competition and rent-seeking by companies
Direct support	<ul style="list-style-type: none"> ▪ Better suited to encourage high risk projects and to meet specific policy goals and societal challenges ▪ Adequate to target R&D activities with the highest discrepancy between social and private returns, i.e. highest spillovers ▪ Competition among firms ensures that public resources are directed to the best R&D projects ▪ Can be used to target specific technologies or scientific areas to overcome sectoral slowdowns ▪ Encourage cooperation and technology transfer ▪ Better budget control 	<ul style="list-style-type: none"> ▪ Higher administrative burden for companies ▪ Administratively difficult to process a high number of applications ▪ Firms may not undertake R&D projects not approved for public funding ▪ Risk of rewarding lobbyists

Source: adapted from Carvalho 2011

As R&D tax incentives gain in popularity, some evidence suggests possible substitution effects with direct support measures

Some evidence suggests that over the last years there have been substitution effects between direct and indirect public support for business R&D in some EU Member States. For example in the Netherlands, an explicit choice has been made to primarily support R&D through tax incentives rather than through direct funding, which is reflected in the considerably lower level of direct government funding of business R&D as % of GDP compared to indirect support through tax incentives (Figure 2). The case of France is interesting in that the strong increase in the use of R&D tax incentives since 2008 has been accompanied by an increase in absolute amounts of government budget appropriations or outlays for research and development (GBAORD) in 2008 and 2009, followed by a decline in GBAORD since 2011, while tax incentives money continued to increase. This suggests at least a partial substitutive effect in the 'austerity' period. In some countries such as Belgium, a substitution between direct and indirect public support is less probable, because R&D tax incentives fall under the realm of federal policy, while direct support to R&D is mostly in the hands of the Regions and Communities, which take decisions independently from the federal state (Nauwelaers 2016).

Figure 2: Public support for business R&D as % of GDP, 2006 and 2014



Graph prepared by: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

Data sources: OECD, Eurostat

Notes: ⁽¹⁾Estimated direct public support for business R&D includes direct government funding, funding by higher education and public sector funding from abroad. Public sector funding from abroad is not included for DE and NL. ⁽²⁾BE, CH, US: 2012; FR, IT, IS, CN: 2013. ⁽³⁾BE, DK, IT, SI, KR: 2007; CH, TR: 2008; CN: 2009; IS: 2011. ⁽⁴⁾Elements of estimation were involved in the compilation of the data.

In the few EU countries, which do not offer fiscal incentives for R&D, such as Germany, there are recurrent discussions on the introduction of R&D tax incentives, considering the advantages and disadvantages of R&D tax incentives, the effectiveness and fiscal impact of different design options (box 2).

Box 2: The discussion about introducing R&D tax incentives in Germany

Unlike the majority of EU and OECD countries, Germany relies entirely on direct government funding to business R&D such as through grants and does not provide preferential tax treatment to business R&D expenditure. While there are different proposals to introduce R&D tax incentives, the government is still carefully considering the advantages and disadvantages of R&D tax incentives, compared to direct support measures in particular.

Investment in public R&D in Germany has increased in recent years, while public support to business R&D is relatively low in international comparison and does not include R&D tax incentives. The federal government has provided additional EUR 3 billion for public research over the current legislative term,

including funding of universities and non-university research institutes. However, government support to business R&D in Germany (0.08 % of GDP in 2014) is significantly lower than in Belgium (0.44%), France (0.42%) or Austria (0.40%) and other EU Member States, as well as in OECD countries like South Korea (0.36%), Russia (0.41%) or the United States (0.26%) (OECD 2016).

Recently, different proposals for the introduction of R&D tax incentives have been presented in Germany. R&D tax credits have been proposed as an instrument to stimulate business investment in R&D. Tax credits can be deducted from personal or corporate income tax liabilities and or refunded in case of a negative tax liability. Therefore, they would also be effective for new firms in their start-up phase that often generate negative profits.

Alternative models are being discussed in Germany and their fiscal impact estimated (see below the estimates in brackets)⁴. The proposals offer a tax credit between 10% and 15%. In some proposals eligible costs are only the costs for R&D personnel. In some simulations only companies up to a certain threshold of employees are eligible for R&D tax incentives, in others all companies. In some scenarios external R&D costs are eligible, in others they are excluded.

- 10% tax credit for R&D personnel costs of all companies (€ 3.5 billion)
- 10% tax credit for all R&D costs of all companies (€ 5,4 billion)
- 10% tax credit for R&D personnel costs of companies < 500 employees (€ 530 million)
- 15% tax credit for all R&D costs of companies < 250 employees (€ 528 million)
- all models are up to 20 % more expensive, if they include external R&D costs

As Germany has several grants and loans schemes for SMEs, for example the Central Innovation Programme for the Mittelstand (*Zentrales Innovationsprogramm Mittelstand (ZIM)*), which offers relatively fast assessment of proposals and a high success rate, the advantages and disadvantages of R&D tax incentives are often weighted against those of direct support measures. Opponents of R&D tax incentives fear dead weight losses, i.e. supporting projects which would have been performed anyway, abuse of the system by stretching R&D definition and eligible costs, and not addressing societal challenges. Supporters of R&D tax incentives point towards the decreasing share of R&D expenditure by SMEs in total business R&D expenditure and advocate the introduction of R&D tax incentives as a less burdensome measure to stimulate business R&D investments, by young innovative companies in particular.

3. THE IMPACT OF R&D TAX INCENTIVES

To quantitatively assess the impact of R&D tax incentives, econometric studies look at measures such as the elasticity of R&D expenditure with respect to the user cost of R&D capital, i.e. the response in a firm's R&D expenditure to changes in the user cost of R&D capital. The user cost of capital is defined as the 'actual costs' of R&D faced by firm, where the R&D tax incentive is one of the determinants, next to the wage rate of researchers and the price of equipment (Hall & Van Reenen 2000). Another widely used measure is the input additionality, which is defined as the firm's R&D expenditure that can be attributed to the policy intervention relative to the size of the tax incentive itself (CPB 2014). If a firm spends every euro it saves on taxes on R&D, then input additionality is equal to one; if the firm spends ten percent more than it receives from the tax incentive, input additionality is 1.1.

Some researchers suggest that it is not enough to look at the additionality of tax money spent on R&D support in terms of R&D expenditure. A full cost-benefit analysis would include in the calculation of the return to tax incentives externalities, administration and compliance costs, and the deadweight loss. The magnitude of the externalities is a major determinant of the effectiveness of R&D tax incentives, but their estimates are considered not robust (Mohnen 2013).

⁴ Calculations by the Ministry of Economic Affairs and Energy on the basis of the R&D expenditures of the private sector, which are regularly published by the „Stifterverband für die deutsche Wissenschaft“.

Tax incentives can increase private R&D spending...

The vast majority of empirical studies from different countries conclude that R&D tax incentives are effective in stimulating business investment in R&D. The estimates of the size of this effect are diverging, with input additionalities ranging from 3 to 0.3 (Köhler et al. 2012), due to differences in the countries and the sub-populations of firms covered by the studies, the design of the R&D tax incentives schemes and the evaluation methodologies employed. Although findings on the input additionality vary, most studies show that companies tend to respond to R&D tax incentives by increasing their R&D expenditure. However, as with direct support measures, a loss in tax revenue amounting to one euro is often found to result in growth in R&D spending of less than one euro (Belitz 2016, CPB 2014, Köhler et al. 2012).

.. but their design and implementation are crucial for their effectiveness

Recent meta-analyses attempt to verify and sum up the abundance of findings from econometric studies (Castellacci & Lie 2015, Gaillard-Ladinska et al. 2015). Although they find a bias in the publications towards positive effects (publication bias), they ultimately confirm robust, albeit moderate, effects of R&D tax incentives on increasing private R&D spending. However, there are variations in the effects for different groups of companies, for instance in low and high-tech sectors, or for SMEs. The additionality effect of R&D tax incentives is found to be on average stronger for SMEs, firms in the service sectors, and firms in low-tech sectors (Castellacci & Lee 2015). In Canada, the Netherlands, Norway, and the United Kingdom, R&D tax incentives for small firms are found to be two to three times more effective in promoting R&D investments than for an average size firm. The impact for start-up firms is also found to exceed the average impact (CPB 2014). This effect might occur because small firms (and especially those that are new) find it harder to obtain finance—for example, because lenders may have less information about them and because new firms may face a higher risk of failure (IMF 2016).

Targeting young innovative companies is a good practice with a stronger impact

Some evidence suggests that knowledge spillovers of large firms exceed those of small firms (Bloom et al. 2013). This finding weakens the case for targeting tax incentives primarily towards SMEs - even when SMEs would increase their R&D expenditure more strongly in response to incentives (CPB 2014). Furthermore, some recommendations suggest that tax incentives should not be linked to the size of a company, because preferential tax treatment for SMEs may discourage companies from growing. Therefore, targeting young companies can be considered a better practice than targeting SMEs (CPB 2014, IMF 2016, Appelt et al. 2016). R&D tax incentives, on average, are found to be associated with a more concentrated growth distribution in R&D intensive sectors, suggesting that they might be favouring incumbent firms (Bravo-Biosca et al. 2013). Young companies can challenge incumbent businesses and generate disproportionately more jobs. The EU has currently fewer young leading innovative companies than the US in fast moving sectors (Cincera & Veugelers 2013). Tax incentives can hence be designed to support young innovative companies with relatively more generous provisions (Crisuolo et al. 2016). Of crucial importance when targeting young innovative companies would be to avoid incentives for splitting parts of a company just in order to meet the age criteria. This can be done for example through restrictions on associated enterprises and mergers.

Best practices include carry-forward provisions, cash refunds or reductions in social security contributions

New firms in their start-up phase often have negative profits and cannot immediately benefit from tax incentives that can only be used against a positive tax liability. Therefore, offering carry-forward provisions and cash refunds if there is a negative tax liability is considered an effective measure for stimulating R&D in young innovative companies (Crisuolo et al. 2016). While most of the R&D tax incentives offer a carry forward facility, cash refunds are available only in some countries (CPB 2014). R&D tax incentives can also be used to provide relief from labor taxes, such as payroll taxes or employer social security contributions. Firms still benefit from those incentives, even if they do not report positive taxable income. Furthermore, these incentives target a type of R&D expenditure, researchers' wages, which is likely to generate higher knowledge spillovers than other types of R&D expenditure, as researchers move from one employer to another and take their former employer's knowledge with them

(CPB 2014). An OECD study concludes that R&D tax incentives should be carefully designed to take into account the heterogeneity among potential R&D performers and the position of 'stand-alone' firms without cross-border tax planning opportunities, as well as those of young, innovative firms without the profit-generating capacity on which to realise allowances or credits (Crisuolo et al. 2016).

Incremental schemes compared to volume based cause less deadweight loss but have higher administrative and compliance costs

Volume (level) based R&D tax incentives are proportional to the amount of R&D undertaken. Incremental-based R&D tax incentives are proportional to the increment in R&D expenditure with respect to a base level (which is for instance the average R&D amount of the last three years). Both incremental and volume-based R&D schemes are found to result in additional R&D expenditure, but the evidence on which type of scheme is more effective is mixed (CPB 2014), with some recent studies finding higher additionality in countries with incremental schemes (Castellacci & Lie 2015). Compared with tax incentives that apply to all R&D expenses, incremental incentives are cheaper because they avoid a windfall gain for existing R&D below the baseline (i.e. the deadweight loss which arises from supporting projects which would have been performed anyway). However, incremental incentives can be more complex and have higher administrative and compliance costs as a percentage of total support, which can reduce take-up. Furthermore, incremental R&D tax incentives may trigger firms to change the timing of their R&D investment plans. For example, incremental schemes make it more attractive for firms to gradually increase their R&D investment than to do a single large investment (CPB 2014). Some countries have therefore moved away from incremental schemes or have simplified them (IMF 2016).

Evidence points towards a positive impact of R&D tax incentives on innovation

The impact of R&D tax incentives on innovation and productivity is less studied and methodologically more difficult to capture, as the impact on output will take longer to materialise than the impact on R&D expenditure and the output of an R&D project is fundamentally uncertain, which means that the intended innovation might not materialise or might not be a commercial success. The limited available evidence points towards a positive impact of R&D tax incentives on innovation (CPB 2014). Most studies use patent applications, introduction or sales of new products as a measure of innovative output. One study found that Canadian firms receiving R&D tax incentives have a higher probability to introduce new products, both to a national market and the world market (Czarnitzki et al. 2011). Further studies show that R&D tax incentives are positively related with patenting (Ernst & Spengel 2011, Westmore 2013). However some evidence (Ernst et al. 2014) suggests that R&D tax incentives have a negative impact on patent quality, which might indicate that while R&D tax incentives appear to be effective in increasing incremental innovations, they might not result in more radical innovations (CPB 2014). With regard to the impact of R&D tax incentives on productivity, evidence suggests that R&D expenditures play a key role in determining the differences in productivity across firms and the evolution of firm-level productivity over time (Doraszelski & Jaumandreu 2013). Some empirical studies find that R&D tax incentives can raise on average the productivity of firms. However, an evaluation of the Italian R&D tax incentives scheme shows that the impact is heterogeneous across less and more productive firms, with the impact being stronger for firms on the lower bound of the productivity distribution (Caiumi 2011).

Effective administration is crucial to minimise compliance costs and avoid abuse

Effective administration is critical to avoid abuse of R&D tax incentive schemes and to minimise compliance costs for firms. It is considered a good practice to have a one-stop, online application procedure and guidelines for businesses (e.g. on what are eligible costs etc.). This is already in place in many countries (IMF 2016). In addition, the time it takes for the authorities to take decision on eligibility should be as short as possible, not exceeding a year (CPB 2014). The assessors of the R&D tax incentives claims in the administration should ideally have an expertise in the field in order to be able to assess if the R&D criteria and the novelty requirement in particular are met (Box 3).

Finally, governments should ensure that R&D tax incentive policies provide value for money, through effective ex-post evaluation linked to the ex-ante assessment of reforms and new initiatives (Crisuolo et al. 2016). Evaluating the effectiveness of R&D tax incentives also requires an assessment of the potential

distortions of competition between incumbents and new entrants. High-quality firm-level data, collected according to international standards, is indispensable for a rigorous quantitative evaluation. No evaluation studies are available for a number of countries which offer R&D tax incentives (CPB 2014). Only few countries are found to have frequent evaluations, for example The Netherlands and France. The quality of evaluation studies is found to be mixed, in many cases not meeting the standards of peer-reviewed academic journals (CPB 2014).

Box 3: Mutual Learning Exercise (MLE) on Administration and Monitoring of R&D tax incentives

In 2016 the European Commission conducted a MLE on Administration and Monitoring of R&D tax incentives⁵ which focused on three main topics, which EU Member States considered of large operational relevance but relatively less researched: (1) The definition of R&D in tax incentive schemes; (2) The eligibility of costs; and (3) The administration and control of the R&D tax incentives.

The R&D definitions used for R&D tax incentives vary across EU Member States. Most of the time, they are based on the OECD definition in the Frascati Manual or the EU definition of R&D in the state aid regulation. The main difference between countries is how they distinguish between experimental development, which falls under the R&D definition, and other innovation activities, that are not regarded as R&D. Most countries require that experimental development must have the objective to create knowledge or skills that are new in comparison with the existing stock of knowledge in the industry – in line with the 2015 version of the Frascati Manual. Without this requirement, an R&D tax incentive scheme would give support to innovative activities without any potential for knowledge spillovers. All MLE participants face the challenge of drawing the line between R&D and other innovation activities, in particular in the area of software development, and explaining it to companies. To overcome this difficulty, most countries have developed different types of guidance for applicants, in some cases also supported by pre-application check.

The costs eligible for the R&D tax incentive differ considerably across the EU. Countries have for example different rules related to whether all R&D wage costs are eligible, or only certain categories of personnel and how the wage cost is computed (e.g. if there are caps and limits and if extra benefits can be included); whether only operating costs may be included, or also capital costs; whether only in-house activities are eligible or also procured R&D; to which degree and how the tax incentive may be combined with public grants and whether an overhead cost may be added to the direct costs.

With regard to the administration and control of R&D tax incentive schemes governments face a trade-off. On the one hand, the administration of tax incentives influences how targeted the scheme is in practice and how much it is prone to abuse. On the other hand, total administrative costs must be kept down because such costs may reduce the value of the R&D tax incentive for businesses and may increase the burden for the public budget. The outreach efforts made by the public bodies responsible for administering the R&D tax incentives schemes in individual countries vary considerably both in intensity and methods used. Some administrations meet companies face to face, some give special assistance to first time applicants, and some have websites with considerable guiding material, including webinars.

A considerable variation between countries exists regarding the assessment of claims for R&D tax incentives (i.e. which administrative body makes the assessment and who are the assessors). Most countries aim at having assessors with professional expertise in the subject and a relevant business experience. The impartiality and absence of conflict of interest of assessors are considered of crucial importance. Some countries assess whether a project can be regarded as R&D before the project has started (ex-ante) while others only verify (a sample of) claims afterwards (ex-post). The ex-ante approach increases the predictability for businesses and reduces possible tension between the company and the public authorities, because a ruling will be made before the R&D costs have been incurred.

⁵ The MLE was carried out within the framework of the Horizon 2020 Policy Support Facility. Final report: Uhlir D, Straathof B, Hambro C (2017). Mutual Learning Exercise Administration and Monitoring of R&D tax incentives.

Countries which provide R&D tax incentives also take measures to avoid misuse of the R&D tax incentives schemes and to prevent abuse of the system. Most countries provide clear requirements to claimants before the firm submits an application (e.g. the need to keep records of the R&D projects in a pre-defined manner). The approaches used in controlling vary among countries. The use of a risk-based approach to controls can be considered a good but fairly recent practice.

Due to the increased use of R&D tax incentives by businesses, a market for consultants assisting companies in making claims for R&D tax incentives has developed. The activities of the consultants vary from consultant to consultant and from country to country. In some cases, consultants may help to spread awareness about the R&D tax incentive and reduce the administrative burden for firms, while in other cases consultants help firms to find the weak points in the administration of the tax incentive scheme and try to stretch the definitions of R&D and eligible costs. Some members have introduced measures to curtail unhealthy consulting practices, such as guidelines for good consultant practice or (voluntary) certification of consultants.

Patent boxes do not stimulate R&D and may rather be used as a profit-shifting instrument

Output-related tax incentives, mainly patent boxes, refer to tax reductions on the income earned from exploiting intellectual property. Evidence suggests that patent boxes do not stimulate R&D (Alstadsæter et al. 2015) and may rather be used as a profit-shifting instrument by multinational firms, leading to substantial reductions in tax revenue (Griffith et al. 2014). Tax incentives for R&D expenditure are intended to reward firms for the societal benefits from innovation that they themselves are unable to appropriate. However, patent boxes do not serve the same purpose as they offer a preferential rate for income from innovations that are already protected by Intellectual Property Rights (IPRs). IPRs enable firms to capture a large part of the societal benefits, such that the rationale for a tax incentive for protected innovations becomes unclear. As patent boxes reward successful innovations which already profit from an intellectual property protection, they can make research efforts that are not patentable, with potentially higher social spillovers, less attractive. Furthermore, the use of intellectual rights is sector specific. The empirical evidence suggests that for many sectors patents seem an ineffective way to appropriate returns and secrecy and lead times are used extensively (Arundel 2001; Hanel 2008; Hall et al. 2013). Hall et al. (2013) find that in the UK even among firms that conduct R&D, only 4% patent. OECD studies conclude that income-based incentives should be treated with caution, given the lack of evidence of their effectiveness and the risk that they will disproportionately benefit established, large firms, MNEs and innovations susceptible to protection by patents (Crisciuolo et al. 2016, Neubig et al. 2016).

4. CONCLUSION

This working paper has presented the rationale and the spread of R&D tax incentives, discussed their advantages and disadvantages and reviewed the latest evidence on the effectiveness of tax incentives for business R&D. Currently, 25 Member States in the EU are using R&D tax incentives to stimulate business R&D in an effort to boost business R&D investments, increase productivity and economic growth. R&D tax incentives are becoming more and more popular for different reasons, for example because of their administrative simplicity and because they are neutral and provide a level playing field. R&D tax incentives have their advantages and disadvantages, and a careful policy balance and complementarity between direct and indirect measures is necessary to maximise the effectiveness of public support to business R&D. The existing evidence shows that R&D tax incentives can be effective in stimulating business investment in R&D, innovation and productivity growth but their design, administration and implementation are crucial for their effectiveness. Good practices in the design of R&D tax incentives include carry-forward provisions, cash refunds or relief from labor taxes, such as payroll taxes or employer social security contributions, which can benefit also young innovative companies with negative tax liability. Evidence suggests that the additionality effects are higher for SMEs and young companies. Furthermore, if R&D tax incentives succeed to encourage small and young firms to devote some continuous budget to R&D, this will help them develop and keep a certain level of absorption capacity. Patent boxes do not stimulate R&D and may rather be used as a profit-shifting instrument, leading to high revenue losses. Good practices in the administration of R&D tax incentives include one-stop, online application procedure and guidelines for businesses, short time for tax authorities to take decision on

eligibility, assessors of the R&D tax incentives claims with expertise in the field, use of risk-based control mechanisms. Governments should ensure that R&D tax incentive policies provide value for money, through regular and rigorous evaluation, based on high-quality firm-level data.

References

- Alstadsæter A, Barrios S, Nicodeme G, Skonieczna A M, Vezzani A (2015). Patent Boxes Design, Patents Location and Local R&D. Taxation Papers. Working Paper N. 57 – 2015
- Appelt S, Matej Bajgar M, Chiara Criscuolo C, and Galindo-Rueda F (2016). R&D tax incentives: evidence on design, incidence and impacts. OECD Paris.
- Arrow K J (1962). Economic welfare and the allocation of resources for invention. In R. Nelson (Ed.), *The Rate and Direction of Inventive Activity*: 609-626: Princeton Univ. Press, Princeton, NJ.
- Arundel A (2001). The relative effectiveness of patents and secrecy for appropriation. *Research Policy*, 30(4): 611-624.
- Belitz H (2016). Support for Private Research and Development in OECD Countries on the Rise but Increasingly Inefficient. *DIW Economic Bulletin* 8.2016.
- Bloom N, Griffith R (2001). The Internationalization of UK R&D, *Fiscal Studies*, 22(3):337–355.
- Bloom N, Schankerman M, Van Reenen J (2013). Identifying technology spillovers and product market rivalry. *Econometrica. Journal of the Econometric society*. 81(4):1347–1393.
- Bravo-Biosca A, Criscuolo C, Menon C (2013). What Drives the Dynamics of Business Growth? *OECD Science, Technology and Industry Policy Papers*, No 1, OECD Publishing.
- Caiumi A (2011). The Evaluation of the Effectiveness of Tax Expenditures- A Novel Approach: An Application to the Regional Tax Incentives for Business Investments in Italy, *OECD Taxation Working Papers* 5.
- Carvalho, A. (2011). Why are tax incentives increasingly used to promote private R&D? Working Paper (4). Portugal: CEFAGE-UE.
- Castellacci F, Lie C M (2015). Do the effects of R&D tax credits vary across industries? A meta-regression analysis. *Research Policy* 44(4):819-832
- CPB Netherlands Bureau for Economic Policy Analysis (2014). A Study on R&D Tax Incentives. Final Report. TAXUD/2013/DE/315
- Criscuolo C, Bajgar M, Appelt S, Galindo-Rueda F (2016). R&D tax incentives: design and evidence. Organisation for Economic Co-operation and Development. DSTI/IND/STP(2016)1
- Czarnitzki D, Hanel P, Rosa J M (2011). Evaluating the impact of R&D tax credits on innovation: A microeconomic study on Canadian firms. *Research Policy*. (40):217-229.
- Doraszelski U, Jaumandreu J (2013). R&D and productivity: Estimating endogenous productivity, *The Review of Economic Studies*, 8(4):1338-1383.
- Ernst C, Spengel C (2011). Taxation, R&D tax incentives and patent application in Europe, *ZEW Discussion Papers* 11-024.
- Ernst C, Richter K, Riedel N (2014). Corporate taxation and the quality of research and development, *International Tax and Public Finance*, 1-26.
- European Commission (2016). Impact Assessment on a Common Consolidated Corporate Tax Base (CCCTB). Forthcoming.
- Gaillard-Ladinska E, Non M, Straathof S (2015). More R&D with tax incentives? A meta-analysis. CPB Discussion Paper. CPB Netherlands Bureau for Economic Policy Analysis.
- Garnier G, György E, Heineken K, Mathé M, Puglisi L, Rua S (2014). A wind of change? Reforms of Tax Systems since the launch of Europe 2020. *Taxation Papers* 49.

- Griffith R, Miller H, O'Connell M (2014). Ownership of intellectual property and corporate taxation. *Journal of Public Economics* 112: 12–23.
- Hall B, Helmers C, Rogers M, Sena V (2013). The importance (or not) of patents to UK firms, NBER Working Paper Series, 19089.
- Hall B, Van Reenen J (2000). How effective are fiscal incentives for R&D? A review of the evidence, *Research Policy* 29, (4):449-469.
- Hanel P (2008). The use of intellectual property rights an innovation by manufacturing firms in Canada', *Economics of Innovation and New Technologies* 17: 285-309.
- International Monetary Fund (2016). *IMF Fiscal Monitor. Acting Now, Acting Together.*
- Nauwelaers C (2016). Public research and innovation policies and investment and their evolution since the crisis. *Science, Research and Innovation performance of the EU. A contribution to the Open Innovation, Open Science, Open to the World agenda.*
- Köhler C, Philippe Laredo P, Ramme R (2012). The Impact and Effectiveness of Fiscal Incentives for R&D. *Nesta Working Paper No. 12/01.*
- Martin S, Scott J T(2000). The nature of innovation market failure and the design of public support for private innovation. *Research Policy*, 29(4–5):437-447.
- Mohnen (2013). R&D Tax Incentives. *Innovation for Growth – i4g. Policy Brief N°25.*
- Neubig T, Galindo-Rueda F, Appelt S, Criscuolo C, Bajgar M (2016). Fiscal incentives for R&D and innovation in a diverse world, *OECD Taxation Working Papers, No. 27, OECD Publishing, Paris.*
- OECD (2011a). *Attractiveness for Innovation: Location Factors for International Investment, OECD Publishing, Paris.*
- OECD (2011b). *Testimony by the Organization for Economic Cooperation and Development. United States Senate Committee on Finance. September 20, 2011. Tax Reform Options: Incentives for Innovation. The International Experience with R&D Tax Incentives*
- OECD (2016). *Science, Technology and Innovation Outlook. OECD Publishing, Paris*
- OECD (2017). *OECD Review of national R&D tax incentives and estimates of R&D tax subsidy rates, 2016. TAX4INNO Project. Deliverable 3.1: Summary report on tax subsidy rates –core countries. Version 13 February 2017.*
- Westmore B (2013). *R&D, Patenting and Growth: The Role of Public Policy, OECD Economics Department Working Papers 1047.*

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