# Tax incentives for R&D: Are they effective?*

R. Schoonackers

## Introduction

Boosting research and development (R&D) investment remains one of the top priorities of advanced economies, the reason being that R&D is an important driver of innovation and long-run economic growth. Moreover, the transition to a sustainable economy requires new technologies. Hence, incentivising and providing the necessary conditions for R&D investment by the business sector ranks high on the innovation policy agenda of OECD countries and partner economies (Appelt *et al.*, 2019). In line with this, one of the key targets of the Europe 2020 strategy includes that 3 % of EU GDP has to be invested in R&D by the end of 2020.

Due to its long-term and risky nature and the presence of knowledge spillovers, private business investment in R&D is mostly lower than socially optimal, justifying government support. To address the private underinvestment in R&D, governments have different policy responses at their disposal. Against the backdrop of sustainable public finances, the evaluation of the effectiveness – in terms of input and output additionality – of these policy instruments is important.

This article focuses on the effectiveness of R&D tax incentives, in other words indirect government support. The remainder is structured as follows. Section 1 discusses why government support for investment in R&D is important and describes different support mechanisms. Section 2 then gives a broad international comparison of R&D public stimuli, followed by a more detailed discussion of Belgian R&D tax incentives in section 3. Finally, section 4 analyses the effectiveness of R&D tax incentive schemes and section 5 concludes.

## 1. The importance of public support for R&D investment

### 1.1 Rationale for government intervention

When it comes to structural long-run economic growth, both the theoretical and empirical economic literature recognises investment in R&D as a major contributor (see, amongst others, Romer, 1990; Aghion and Howitt, 1992; Coe *et al.* 2009). The growth-enhancing impact of R&D is both direct, through its effect on total factor productivity (TFP) and innovation within a country, and indirect through the positive impact on a country's capacity to absorb worldwide available technology.

* The author would like to thank Saskia Vennix and Karl Boosten for their help with the BELSPO data and Luc Van Meensel for his constructive remarks and suggestions.

Yet, private business investment in R&D tends to be sub-optimal due to several reasons. For one thing, relative to investment in physical capital, R&D spending typically has a higher uncertainty of success in outcomes, it takes longer to yield profitable output and the R&D activity is more open to imitation by a large number of firms (Guceri, 2016). As investment in R&D is riskier, this makes it more difficult for investors and banks to monitor innovative firms causing a large information asymmetry between innovators and investors. As a result, firms will find it difficult to obtain funding ; this is especially the case for young innovative enterprises (EC, 2014).

Another – and probably more important – reason is that R&D generates spillover effects. Following, amongst others, Bloom *et al.* (2013), one can broadly define two types of spillover. The first are technology or knowledge spillovers. Knowledge creation can have positive externalities on other firms' activity and even on the whole economy as technology spillovers raise the productivity of other firms that operate in similar technological areas. The second type of spillover is the product market rivalry effect of R&D, where innovations through R&D lead to more market share vis-a-vis competing firms. Whereas knowledge spillovers are beneficial to other firms, R&D work by product market rivals has a negative effect on a firm's value as it loses market share. So, if the product market rivalry effect dominates the knowledge spillover effect, there may be too much investment in R&D from a social perspective, meaning that the conventional wisdom regarding under-investment in R&D should be overturned. Bloom *et al.* (2013) and, more recently, Lucking *et al.* (2019) analysed both spillover effects and found that positive spillovers significantly exceed negative ones [1].

Consequently, the overall return to society from investment in R&D is much higher than the individual return to the investing firm, which leads to significant socially suboptimal private under-investment in R&D in the market equilibrium. A strong case for public support for R&D can therefore be made.

## 1.2 Direct and indirect support for private R&D investment

Governments can choose between different policy responses to tackle the problem of under-investment in R&D by the private sector. Traditionally, these measures can be sub-divided into direct support, such as public sector R&D and direct R&D subsidies, and indirect support via R&D tax incentives. Finally, governments may also provide support for the university research system and the formation of high-skilled human capital.

Direct R&D support refers to direct R&D spending by public research institutions and universities (public sector R&D) and government funding of business-performed R&D (grants or subsidies). In the latter case, the results of the R&D investment belong to the private (business) performer.

From a theoretical viewpoint, the effects of direct R&D support are ambiguous. The macroeconomic impact may be positive when public sector involvement reduces the risks and costs for the business sector. This is the case when basic or fundamental research – where the wedge between private and social return is probably the highest – is conducted by the public sector and/or universities and when results are made publicly available. Another way is to provide subsidies, which may lift potential cash constraints in private firms or provide a buffer when high financial risk is involved. Public money will then crowd in private money. Effects may also be negative. R&D in the public sector may increase demand for researchers, which may in turn raise their wages and consequently make private R&D investment more costly. Moreover, public sector money – subsidies or grants – can act as a substitute to private money, i.e. governments may subsidise projects that would have been implemented anyway.

Recently, the policy mix aimed at stimulating business R&D investment has seen a growing use of tax incentives. The main difference between direct measures and tax incentives is that the latter leaves the direction of innovation in the hands of individual firms, while direct funding usually allows a larger role for the government

1 Back-of-the-envelope welfare calculations in Lucking *et al.* (2019) show that the ratio of the social to the private return to R&D is about four to one.

in choosing the projects to be funded (Hall, 2020). Tax incentives are thus considered to be more market-oriented than direct subsidies. In practice, the optimal choice between grants and tax-related measures largely depends on the type of firm targeted and type of R&D project.

Tax policy can target the inputs of innovation – R&D tax incentives – or the output of innovation through a patent/intellectual property (IP) box, where IP-derived income is taxed below the statutory corporation tax rate. Existing evidence suggests that IP boxes do not necessarily stimulate R&D investment, one argument being that they do not reduce the *ex-ante* risk of innovation, because they only reward successful projects. Moreover, they can be used as a profit- shifting instrument, although recent international rules – the so-called Nexus rules – should limit this (EC, 2020).

In this article, we focus on the effectiveness of input-related R&D tax incentives. They may take on various forms such as R&D tax credits, accelerated depreciation schemes or enhanced allowances. In general, public support via R&D tax incentives affects business R&D spending through three channels: (i) Tax support for R&D reduces the effective average tax rate, which induces firms to relocate their R&D activity towards the jurisdiction where the support is given. (ii) Conditional on already having R&D activity in a certain jurisdiction, tax incentives reduce the user cost of R&D which encourages firms to undertake more R&D in that location. (iii) Finally, R&D tax incentives have a positive effect on a firm's cash flow, which relaxes financing constraints and boosts R&D by firms for which such constraints are binding (Guceri, 2016).

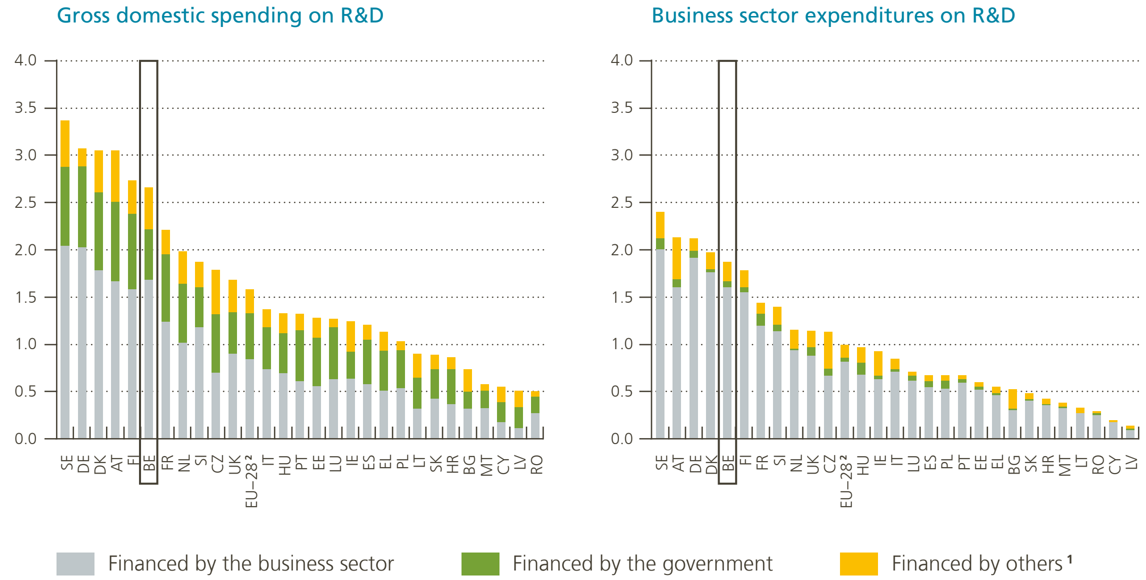
## 2. R&D and public support: a cross-national comparison

Gross domestic R&D spending in Belgium reached a level of 2.7 % of GDP in 2017. This is slightly below the 3 % target set out in the Europe 2020 strategy, but significantly above the EU28 country average of 1.6 % of GDP. Within the EU, only Sweden, Germany, Denmark, Austria and Finland spend more on R&D. In all EU countries, most of gross domestic R&D spending is funded by the private sector, while direct government support varies between 0.2 % and 0.8 % of GDP. In Belgium, government funded domestic R&D spending equals 0.5 % of GDP.

## Chart 1

**R&D spending within the European Union**

(2017, in % of GDP)




Source: Eurostat.
1 "Others" include the higher education sector, the private non-profit sector and financing from abroad.
2 Unweighted country average.

When only considering R&D spending within the business sector, Belgium obtains a business R&D intensity of 1.9 % of GDP in 2017. This was also among the highest of the EU28. Chart 1 thus confirms the European Innovation Scoreboard 2020 which considers Belgium to be a strong innovator, mentioning attractive research systems and innovative SMEs collaborating with others as two of the country's strengths.

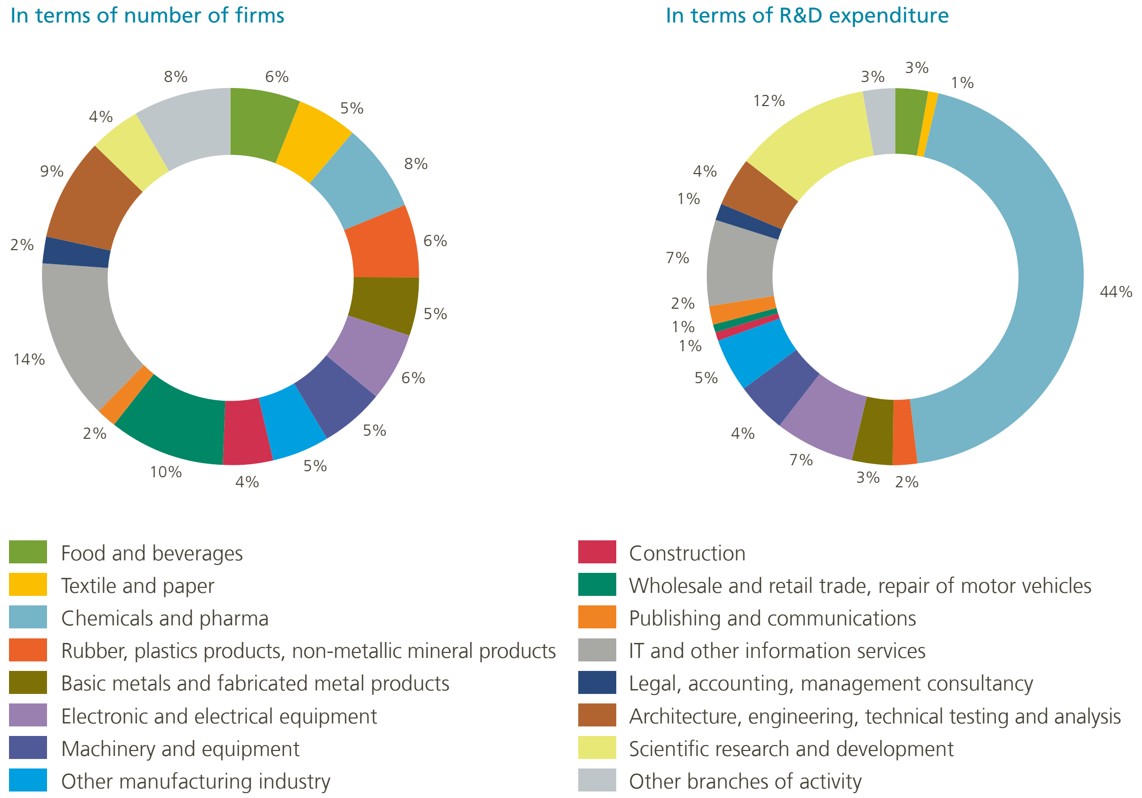
A more detailed portrait of Belgian companies investing in R&D is given by Vennix (2019), based on the biannual survey performed by the Belgian Science Policy Office (BELSPO)[1]. An update, based on the most recent survey data for 2017, of the importance of the different economic branches of activity with respect to R&D is given in chart 2.

1 Vennix (2019) clearly shows that information from the financial statements cannot be used to determine the amount of a firm's R&D expenditure. Therefore, a sample needs to be defined to give a clear view of Belgian companies investing in R&D. The biannual survey from BELSPO is therefore used as a source for R&D expenditure at the micro level.

Chart 2

**Share of branches of activity in R&D expenditure**

(2017)




Source: Vennix (2019), updated with the most recent biannual BELSPO survey of 2017.

The figure shows that in terms of R&D expenditure, the chemicals and pharmaceuticals industries are by far the most important branches of activity[1]. They account for 44.4% of all business R&D spending. As noted by Vennix (2019), this is mainly due to pharmaceutical companies. Considering the total number of companies that incurred R&D expenditure, the IT sector accounts for the lion's share. But it still only accounts for 7.4% of total business R&D expenditure.

### *Evidence on the use of R&D tax incentives*

When considering public support to private investment in R&D, governments can choose between direct support via subsidies or indirect support via the tax system. However, the heterogeneity in the design of R&D tax provisions across countries makes an international comparison very challenging. To facilitate cross-country analysis, the OECD has recently created a database – the R&D Tax Incentives Database – to examine the use and impact of R&D tax incentives in promoting business R&D investment (OECD, 2017; Appelt *et al.*, 2019). Drawing on this dataset, chart 3 gives an overview of the magnitude of direct and indirect support to business R&D for

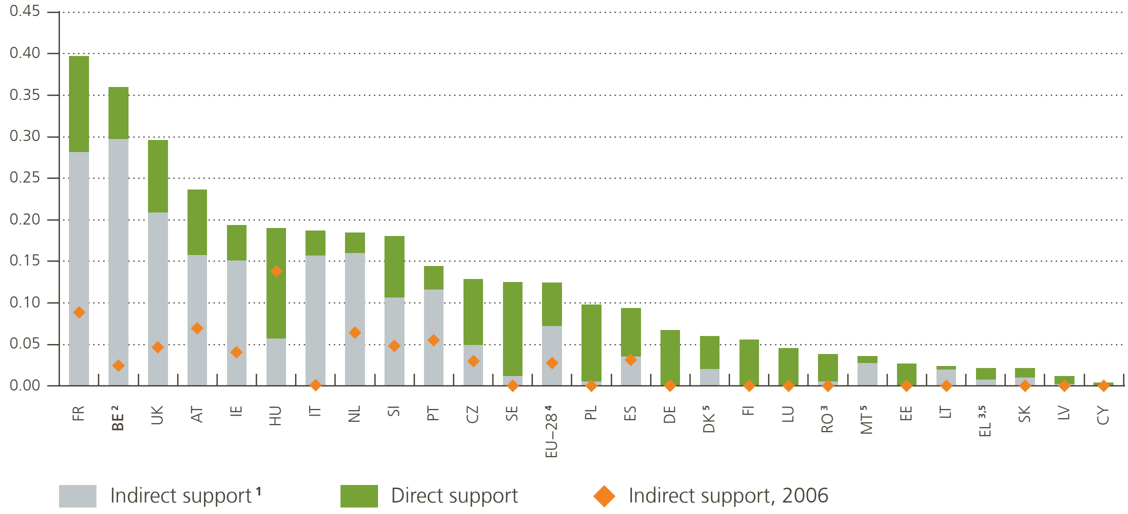
1 Annex 2 from Vennix (2019) gives a clear definition of the different branches of activity in terms of NACE codes.

the latest year available, being 2017. To capture the amount of indirect support, an OECD measure is chosen that reflects the amount of R&D tax expenditure at the macro level, i.e. the amount the central government has spent on R&D tax support, which comprises both foregone tax revenues and refunded amounts. It thus measures the actual amount of tax support provided by governments, which is the outcome of both the presence of R&D tax incentive design features and firms making use of these provisions.

Chart 3

**Government support to business R&D**

(2017, % of GDP)




Source: OECD.

1 As a measure for indirect support, the "GTARD"-series of the OECD (OECD(2017), Appelt *et al.* (2019)) was chosen. This data series reflects the actual cost of R&D tax support to the central or federal government. More specifically, GTARD focuses on capturing the cost of provisions that imply a more favourable treatment of R&D relative to other non-R&D-specific expenditure.

2 For Belgium, data on indirect funding (GTARD series from the OECD) refer to the R&D tax credit and partial exemption from payment of the withholding tax for private companies, young innovative companies and partnership agreements with universities. The investment deduction for environmental projects is excluded as the R&D component cannot be identified.

3 For Greece and Romania, the data refer to 2016.

4 Unweighted country averages, no data available for Bulgaria and Croatia.

5 The "GTARD"-data from the OECD was not available for 2006.

Chart 3 shows that, as a percentage of GDP, France provides the largest combined support for business R&D investment in 2017 (0.4 % of GDP), closely followed by Belgium. In Belgium, the federal government is responsible for indirect support via R&D tax incentives, while direct R&D subsidies are a regional competence.

When considering only direct support, the highest values are obtained in Hungary, France and Sweden. Direct R&D subsidies in Belgium are relatively low and were only worth 0.06 % of GDP in 2017. Expressed as a percentage of total government support, they accounted for 17 % of total support in Belgium in 2017, which is amongst the lowest in the European Union.

For indirect support through R&D tax incentives, the most is spent in Belgium and France. Belgium, together with countries such as the Netherlands, Italy, Lithuania and Portugal, provide more than 80 % of total public support through tax relief provisions. On the contrary, some countries like Germany and Finland do not provide any R&D assistance through their tax system.

It should be noted that according to EU Competition Law, R&D tax incentives may constitute state aid which is prohibited by the EC Treaty. However, in some cases of market failure, state aid is considered compatible with the Common Market under specified conditions, as is the case with state aid for R&D (EC, 2014).

Over time, tax support for business R&D expenditure has increased significantly. In 2006, the EU28 country average was less than 0.03 % of GDP, whereas it more than doubled to 0.07 % of GDP in 2017. In Belgium, indirect support increased significantly from 0.02 % of GDP in 2006 to 0.30 % of GDP in 2017. As such, one can state that there has been a proliferation in the use of R&D tax incentives by governments as a key instrument in their policy toolbox for inducing higher levels of business R&D expenditure (Appelt *et al.*, 2019).

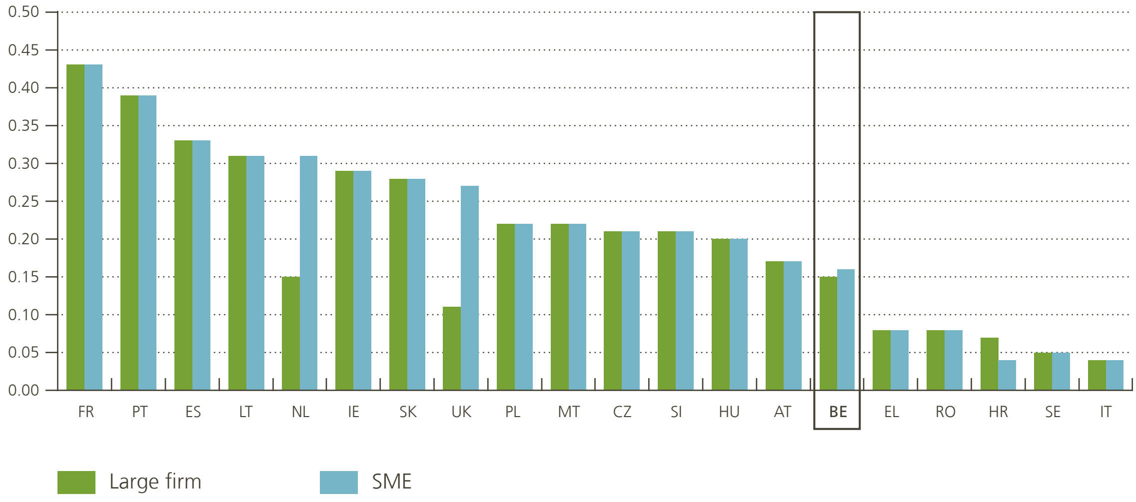
So far, we have only considered R&D tax expenditure as a measure to capture the generosity of the tax system. But it is also important to understand the potential implications of tax relief provisions for the cost of R&D work. One can also explicitly focus on the qualitative features of R&D tax support schemes by constructing forward-looking measures that quantify a number of qualitative features of the national tax code in a synthetic indicator that reflects the overall generosity of specific R&D tax relief provisions. In addition, these indicators also consider specific business characteristics – such as profitability – as they also relate to the overall R&D tax generosity.

An often-used synthetic indicator is the so-called B-index (Warda, 2001). This a composite index that is computed as the present value of income before taxes necessary to cover the initial cost of R&D investment and to pay the corporate income tax so that it becomes profitable to perform research activities i.e. the before-tax break-even economic return required by firms. The more generous the tax provisions for R&D, the lower the pre-tax break-even return by firms (i.e. the lower the B-index) and therefore the higher, the implied marginal R&D tax subsidy. For this reason, it is standard practice to present this indicator in the inverse form of an implied subsidy rate, expressed as 1 minus the B-index. (Warda, 2001, OECD, 2017, Appelt *et al.* ,2019). More details on the B-index and its construction can be found in box 1.

Chart 4

**Implied tax subsidy rate for R&D[1]**

(2019)




Source: OECD.

1 Only EU-28 countries with a positive B-index lower than 1 are reported. This means that countries without any R&D tax incentive provisions are excluded from the figure.

The implied marginal R&D tax subsidy rates for profitable firms are presented in chart 4, which shows a large variation across countries. A value of 0.10 suggests that the price for a firm to invest in R&D is 10 % lower than it would have been in the absence of any R&D tax incentives. In 2019, implied tax subsidy rates were the highest for France and Portugal. The figures also show that, in the Netherlands and the UK, there is a considerable preferential tax treatment for SME compared to large firms. In Belgium, the user cost for an R&D investment for large profitable firms is 15 % lower due to preferential tax treatment, this is very close to the EU28 country average. The combination of an average implied subsidy rate, together with a relatively high amount of eligible business R&D spending in Belgium (see chart 1), leads to a relatively high budgetary cost, in terms of foregone tax revenues, of Belgian R&D tax incentives[1].

1 One can also calculate a macroeconomic *ex-post* average subsidy rate by dividing R&D tax expenditure by total business R&D expenditures. For 2017, this gives an average implied subsidy rate of 16 % for Belgium, which is almost equal to the forward-looking implied subsidy rate based on the B-index.

**BOX 1**

## The B-index: a forward-looking synthetic indicator measuring R&D tax treatment

When focusing on the qualitative features of R&D tax provisions, synthetic indicators can be computed to compare the relative importance of R&D tax support across countries. A widely used indicator is the B-index, which calculates the tax component of the user cost of R&D.

More concretely, the B-index specifies the present value of pre-tax income needed for a representative firm to break even on a marginal, € 1 of R&D spending and to pay the applicable taxes (Warda, 2001, OECD, 2017).

The formula for the measure is given by:

$$B = ATC/(1 - CIT),$$

where ATC is the current value of the after-tax cost (ATC) of a one dollar of expenditure on R&D, taking into account all R&D tax relief provisions and where CIT is the applicable corporate income tax rate. ATC is thus converted into pre-tax terms, allowing a comparison across countries with different tax rates (Appelt *et al.*, 2019)

In general terms, ATC can be expressed as (Thompson, 2012):

$$ATC = 1 - NVTDeductible \times CIT - Credit,$$

where NVTDeductible is the net present value of tax allowances and Credit stands for any applicable tax credits.

The value of tax allowances is determined by both the net present value of the stream of allowable claims and by any augmented deduction policy, where claimable amounts are multiplied by a factor greater than 1.

Different tax provisions can be modelled and rendered comparable through the B-index. In other words, consider all R&D expenditure to be fully deductible in a current year (not an augmented deduction policy), and assume there is an R&D tax credit, which is equal to 15 % of R&D spending, then ATC becomes:

$$ATC = 1 - (1 * CIT) - 0.15.$$

Finally, when calculating the B-index, one takes into account that a representative R&D investment is not only comprised of current expenditure but also of machinery and equipment and buildings. For each expenditure type, the tax price is calculated separately. Afterwards, a weighted average is taken that represents the most likely division between the types of R&D expenditure. In most cases, the assumption is made that a representative R&D investment is comprised of 90 % current expenditure (of which two-thirds account for the labour component), 5 % machinery and equipment and 5 % investment in buildings.

## 3. R&D tax incentives

### 3.1 Conceptual issues [1]

When analysing the conceptual issues in the construction of R&D tax relief provisions, one notices that the specific design, type and number of R&D tax incentives deviate substantially across countries. As pointed out by the EC (2014), R&D tax policies differ according to three broad categories: (i) the scope of the underlying policy measure, (ii) the targeted groups of firms and (iii) the exact organisation of the measure which mainly encompasses administrative practices. In what follows, we will elaborate more on the scope and targeted groups of R&D tax relief provisions.

#### 3.1.1 Scope

The scope of an R&D tax incentive relates to the intrinsic construction of the R&D tax relief provision, where three important choices need to be made regarding to (i) the type of instrument, (ii) the eligible expenses and the type of costs targeted and (iii) the tax liability to which the R&D tax benefit can be applied.

***Type of R&D tax relief measure***

Different approaches co-exist in the way countries shape their R&D tax incentives. Broadly speaking, four categories of instruments can be distinguished: tax credits, enhanced allowances, accelerated depreciation schemes and reduced rates. Chart 5, taken from EC (2014), gives a clear overview of the particularities of each of these instruments. The first three types clearly target R&D inputs, while "reduced rates" in the form of an IP box clearly target the output of an R&D investment. As mentioned before, in this analysis, we focus on the input-type R&D tax incentives.

1 Section 3.1. is mainly based on EC (2014).

Chart 5

**Different types of R&D tax incentives**

| | |
|---|---|
| Tax credits (R&D expenditure) | • Tax credit decreases the corporate income tax rate a firm has to pay.<br>• Rate can be applied to either corporate tax, payroll tax paid for R&D workers or personel income in case the incentive is targeted to self-employed. |
| Enhanced allowances (R&D expenditure) | • An enhanced allowance effectively decreases the base amount that is taxed by allowing to 'inflate' the R&D expenditure base.<br>• Example: if R&D expenditure is € 100 and the rate of enhanced allowance 1.5 then the total R&D expenditure will be increased to € 150. This will decrease the base of taxable income. |
| Accelerated depreciation (R&D expenditure) | • Accelerated depreciation sheme permits to depreciate the purchased fixed assets at higher rates in the first years of the asset's life. This allows, therefore, to decrease the overall taxable income in the specific perions. |
| Reduced corporte tax rate (R&D expenditure) | • Reduced corporate tax rate on intellectual property income ("IP Box") are an outcome related incentive.<br>• It reduces the corporate income that firms pay on commercialization of innovative products that are protected by intellectual property (IP) rights. |

Source: EC (2014).

In practice, many countries that provide R&D tax measures do use a combination of different types of instruments. For example, most EU countries that allow for a tax credit, also offer the possibility of an enhanced allowance.

### *Defining the base: eligible expenses and targeted costs*

Another aspect in the design of R&D tax incentives is the way their base is calculated. In general, there are two approaches: a volume-based approach that applies to all qualified R&D expenditure and an incremental approach that only applies to the extra R&D expenditure. To define this incremental part, the base amount is an average amount that the firm had spent in the past over a specified period of time.

The definition of R&D is also important when defining the base eligible for tax relief. Many European countries explicitly note the existence of the OECD Frascati Manual definition[1] (OECD, 2015) as a general reference or starting point but then go further in explaining distinctive features of R&D for tax relief provisions. In Belgium, there is no formal definition but the definition of R&D in the context of tax support measures largely corresponds to that found in the Frascati Manual. (OECD, 2017).

1 The OECD's Frascati Manual (2015) is the international standard for the definition of R&D and its components and thus the methodology for collecting R&D statistics. The manual provides a basis for a common language about R&D and its outcomes.

Furthermore, R&D tax provisions can also differ by the nature of the incentive base. Instead of focusing on total R&D spending they can be targeted to different expenditure sub-categories. For example, one can choose to limit qualified R&D expenditure to R&D costs that are made domestically or one can focus particularly on R&D wages.

#### *Tax liability*

Finally, a choice needs to be made about the tax liability to which the R&D tax benefit can be applied. Most R&D tax relief provisions are deducted from corporation tax. However, some countries have R&D tax incentives that are based on social security contributions (e.g. France) or tax schemes that are set against the wage tax (e.g. Belgium, the Netherlands).

### 3.1.2 Targeted firms

Beyond the conceptual design of the R&D tax incentive scheme, governments also need to decide on the type of firms it wants to target. Targeting can be done explicitly by defining the beneficiary subjects, that can either include all firms or specify a particular group. Often SMEs and start-up companies are targeted as these firms may find it harder to attract the funds needed to invest in R&D work. In addition, some tax instruments are designed to promote R&D spending in specific industries or are focused on certain types of technologies, such as environmentally friendly investment.

Instead of explicitly targeting specific types of firms, countries can also focus on a sub-set of firms by implementing tax brackets with different rates, which would make it possible to apply more generous deduction rates for R&D expenditure below a certain amount. This makes the tax incentive relative more generous for smaller firms, which have mostly lower R&D expenditure. Another way to achieve this is by putting a ceiling on the amount that firms can claim.

To fully benefit from R&D tax incentives, small firms and start-ups often lack the amount of taxable income on which the tax reduction would apply. The option to carry the tax benefit back or forward, whether or not in combination with a cash refund, can also be used as another type of indirect targeting.

## 3.2 Main R&D tax incentives in Belgium

In the first decade of the 21st century, the Belgian federal government introduced several tax incentives for supporting business investment in R&D. The most important of these are the partial exemption from payment of withholding tax on the wages of R&D personnel that was introduced in 2005 in the private sector and gradually extended in the subsequent years; and the tax credit for investment in R&D that has been available since tax year 2007.

### 3.2.1 Partial exemption from payment of the withholding tax

The partial exemption from payment of the withholding tax on wages of R&D employees reduces the R&D wage costs for firms because part of the withholding tax does not need to be transferred to the government. The scheme has been in place since 2003 for research organisations. In 2005, it was applied to the private sector and gradually extended from employees with a PhD to employees with a Master's degree. Four schemes were introduced over time: (i) for companies involved in research cooperation with a university, a higher education institution or a scientific institution, (ii) for R&D employees with a doctoral degree and civil engineers, (iii) for R&D personnel with a Masters degree and (iv) for Young Innovative Companies (YIC)[1]. For YIC, it should be noted that the exemption for remittance of the withholding tax not only applies to knowledge workers but can also

1 Small enterprises can be defined as a Young Innovative Company, based on several conditions. These prerequisites can be found on the BELSPO website (http://www.belspo.be/belspo/fisc/profit_YIC_nl.stm).

be applicable to supporting staff. The 2017 reform of the Belgian corporation tax has led to the introduction of a fifth scheme as the partial exemption of payment of the withholding tax has been further extended to researchers with Bachelor's degrees.

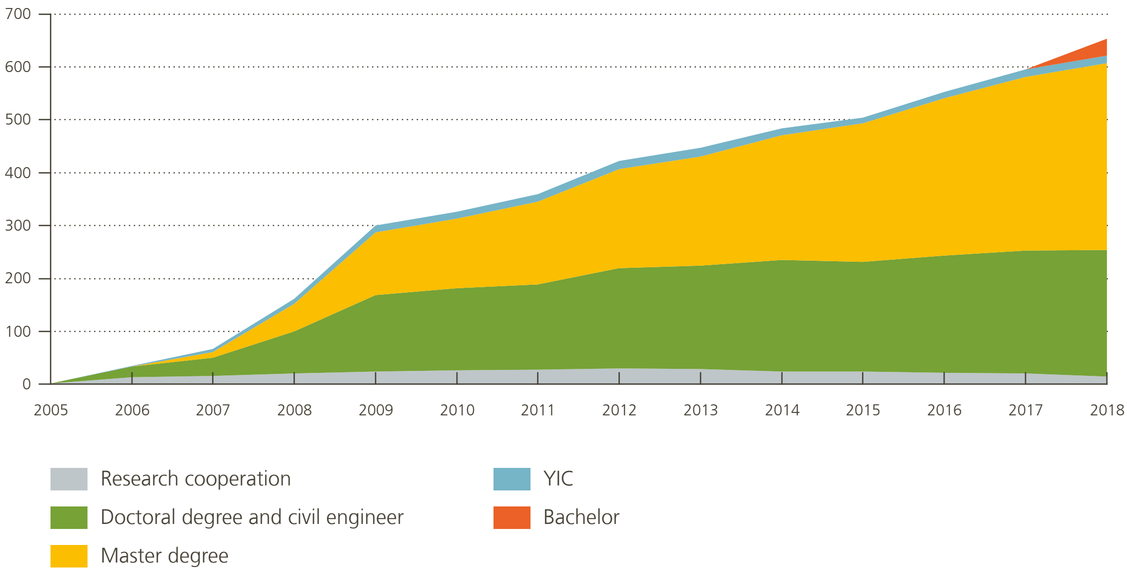
Over the years, the discount rate on the payroll withholding tax has also gradually risen from 25 percent in 2005 to 80 percent in 2013. Moreover, as shown by Dumont (2019), there has been a steady increase in the number of firms that have made use of the partial exemption schemes. As a result, the budgetary cost of the measure has grown significantly over time. As can be seen from chart 6, the schemes for research employees with a doctoral and Master's degree account for the bulk of the budgetary cost and the steady increase over the last few years is mainly due to the change in the cost of the scheme for R&D employees with a Master's degree.

Based on the sample of R&D active firms of Vennix (2019), updated with the BELSPO (2017) survey data, one can derive that almost 63 percent of R&D active firms are making use of the partial exemption schemes. The branches of activity that benefit the most, in terms of number of companies using the partial exemption schemes, are the IT sector, the chemicals and pharmaceuticals branches of activity and the scientific research branch of activity (see chart 7). This is not surprising as the IT sector is the branch of activity with the most R&D active firms and the research branch of activity has a specific partial exemption scheme.

## Chart 6

**Budgetary cost[1] of the partial exemption from payment of the withholding tax for R&D employees.**

(€ million)




Source: Belgian House of Representatives – Inventory of federal tax expenditure.
1 Measured as foregone tax revenues.

### 3.2.2 R&D tax credit or investment deduction

Firms that invest in innovative products can choose between an R&D tax credit and an investment deduction for investment in patents and environmentally friendly or "green" R&D investment[1]. The tax credit is deducted from the corporate income tax liability while the investment deduction leads to a decrease in the taxable base. An important difference between the two R&D tax incentives is that the tax credit, if not fully used after four years, becomes refundable while the investment deduction is simply carried forward.

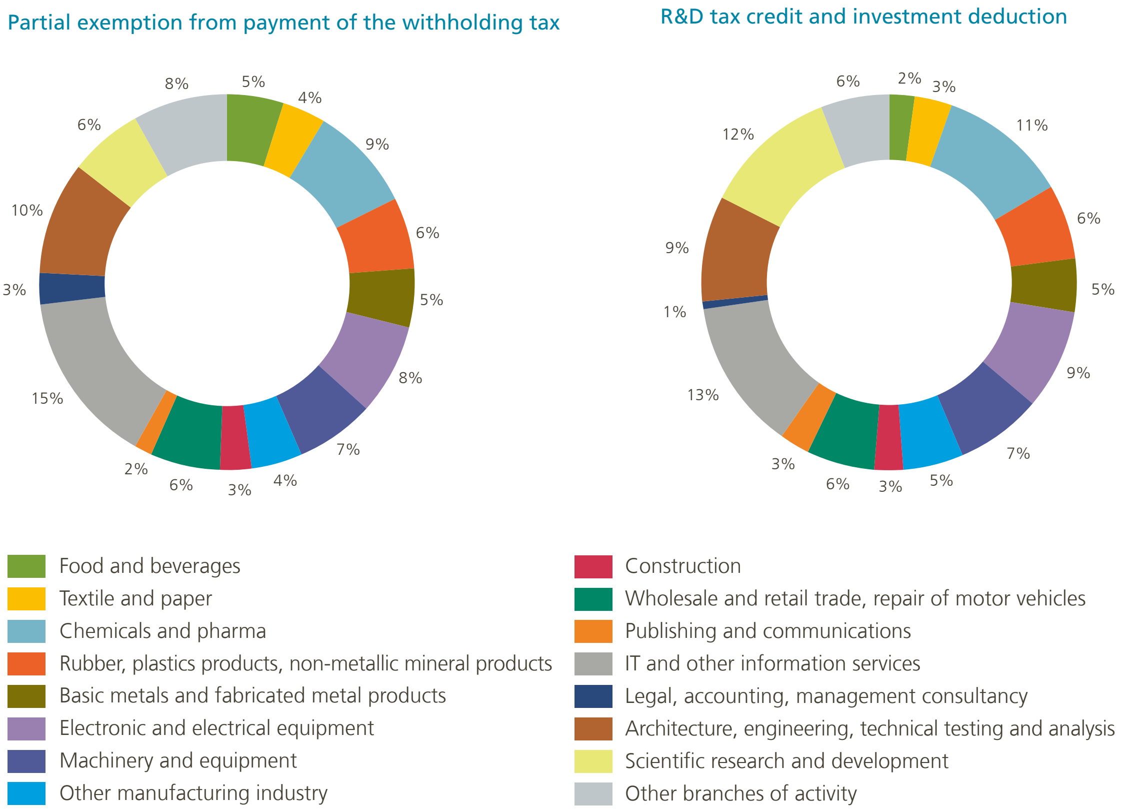
For both R&D tax relief provisions, a company can choose to apply the tax relief all at once or to spread it out based on the depreciation of the R&D investment. If the one-time option is preferred, the tax relief will be calculated based on the annual investment in R&D at a rate of 13.5 % for revenue year 2020 (tax year 2021). To obtain the R&D tax credit, this is multiplied by the normal statutory corporation tax rate, i.e. 25 % for revenue year 2020. If a firm wants to spread it out over time, the annual depreciation is multiplied by a rate of 20.5 %. Dumont (2019) illustrates that in the past most firms, especially SMEs, opted for a tax deduction rather than for a tax credit.

1 The specific types of investment that are eligible for a tax credit are broadly equivalent to those eligible for an investment deduction: The investment should promote the research and development of new products and technologies that have no effect or aim to limit the negative effect on the environment as much as possible and it should be new investments in tangible or intangible fixed assets , obtained or accomplished in the year itself. Furthermore, the use of the assets cannot be transferred to a third party.

Chart 7

**Share of branches of activity in making use of R&D tax incentives[1]**

(2017)




Source: BELSPO (2017) based on the sample of R&D active firms as defined in Vennix (2019).
1 In terms of number of firms.

Making use of the BELSPO (2017) survey data, one can calculate that almost 18 % of the Vennix (2019) sample of R&D active firms benefit from an R&D tax credit or deduction, which is significantly less than firms using the partial withholding tax exemption schemes. Again, the branches of activity that are the best represented are the IT sector and the chemicals and pharmaceuticals branches of activity.

#### 3.2.3 Targeting the output of innovation: the Belgian IP box

Although this article focuses on input-related R&D tax incentives, it is worthwhile briefly describing the patent/intellectual property (IP) box in Belgium, where IP-derived income is taxed below the statutory corporation tax rate to create a tax advantage for income derived from intellectual property.

From 2008 until 2016, the Belgian federal government granted a deduction of 80 % of qualifying gross patent income from the taxable basis for corporate income taxation – the Belgian deduction for patent income. However, in line with OECD guidelines on Base Erosion and Profit Shifting (BEPS), patent box regimes needed to be modified, conform to the Nexus approach and the deduction for patent income has been abolished.

Since July 2016, a new system has been in place – the deduction for innovation income – that applies a Nexus ratio. This implies that the favourable tax regime for income from intellectual property can only apply if the work designed to acquire intellectual property is actually done by the entity concerned. To judge whether the entity actually carries out sufficient activities, R&D expenditure is used as approximation. In other words, the tax advantage thus depends on the Nexus fraction, which corresponds to the ratio between the amount spent on R&D by the company itself (or expenditure outsourced to an unrelated company) and the total amount that has been spent on developing or buying the intellectual property. Furthermore, the deduction for innovation income applies to net income [1] and a rate of 85 % is granted.

Finally, it should be noted that a transitional system has been introduced until the end of June 2021 for patents applied for before July 2016.

## 4. Evaluation of R&D tax incentives

### 4.1 Main findings in the literature

When considering the effectiveness of government support for private R&D investment, one needs to ask whether the government is subsidising (directly or indirectly) R&D work that would be done even in the absence of such support mechanisms. As for the exact choice of instrument, the question then arises whether a tax incentive is the best instrument to stimulate private R&D investment, or would a direct subsidy be preferable in certain cases.

When it comes to the effects of direct funding by the government of private sector R&D, the most recent empirical evidence tends to be positive, i.e. private and public funds tend to complement each other, meaning that the full crowding-out hypothesis is rejected (e.g. Guellec and Van Pottelsberghe, 2003; Westmore, 2014; Becker 2015; Buyse *et al.* 2020). Direct subsidies mainly have an impact on small and young firms' R&D decisions as these companies are more likely to face financing constraints because they have less collateral to secure external funding. Moreover, they also encounter stronger information asymmetries in the capital market (Guceri *et al.*, 2020). It further appears that the level of public subsidisation is important. Both Guellec and Van Pottelsberghe (2003), Goerg and Strobl (2007) and Buyse *et al.* (2020) find an inverted U-shaped relationship, with the strongest positive effects on private R&D for public subsidy rates that are neither too low, nor too

1 Instead of gross income as was the case in the deduction for patent income. The difference being that gross income includes R&D spending.

high. In the former case, support may be too weak to help firms overcome the risks and uncertainties involved in innovation projects, while in the latter case, support may be wider than the number of (new) projects that firms can develop, so that in the end they simply use public resources to finance projects that would have been carried out anyway[1].

The findings of Becker and Hall (2013)[2] are worth mentioning as they imply that direct government support stimulates private R&D investment by businesses in low-tech industries in particular, while R&D by high-tech firms does not increase significantly when receiving public subsidies. Based on these findings, one could conclude that direct subsidies targeted at low-tech industries may be able to support aggregate R&D more effectively than in high-tech businesses. As such, the results suggest that high-tech firms may substitute incremental public funding for internal funding, leaving aggregate R&D unchanged. As noted by Becker and Hall (2013), an R&D tax incentive could therefore be the more effective policy instrument in high-tech industries, as it will support incremental R&D investment by the firm.

Over the last few years, governments have chosen to rely more on R&D tax incentives (see chart 3). They are more market-oriented than direct subsidies as the decision on which projects to invest in is left up to the firms. Firms themselves know the market better and therefore can invest in more profitable opportunities. Moreover, administrative costs are also potentially lower as the government no longer has to set up committees of experts to assess projects and select among them. However, this also comes at a price. The overall budgetary cost of R&D tax incentives, in terms of foregone tax revenue, is much larger and not directly predictable in the future. That is because the government has to subsidise all private sector R&D and not only incremental projects. As a result, the government ends up paying for some project that would also have taken place when no R&D tax relief provisions where present (Guceri *et al.* 2020).

A large volume of empirical research, both macro and micro, exists to see whether R&D tax incentives lead to incremental private R&D investment. Empirical estimates of the size of the impact are widely divergent and not always comparable across studies. The wide range of estimates is the result of differences in methodology, countries and time periods studied and differences in specific R&D tax policies. However, it should be noted that most studies in the available literature show positive effects of tax incentives on private R&D spending (see, for example, Hall and Van Reenen, 2000; Guellec and Van Pottelsberghe, 2003, Thomson, 2017, Alvarez-Ajuso *et al.*, 2018; Buyse *et al.*, 2020). This is confirmed by Becker (2015) in her survey which concludes that recent evidence suggests much more unanimously – compared to surveys of earlier work – that R&D tax credits have a positive effect on private R&D investment. Generally, she states that the negative demand elasticity of R&D with respect to the tax component of its user cost is estimated to be broadly around unity, at least in countries with a tax credit[3].

Interestingly, empirical results suggest that tax incentives and R&D subsidies might to some extent be substitutes. In a macro panel of OECD countries, Guellec and Van Pottelsberghe (2003) found that increased intensity of either tax incentives or subsidies reduces the effect of the other on business R&D. Using a sample of Belgian R&D-active firms, Dumont (2017) confirms that the effectiveness of R&D policy tools declines when firms benefit from different support schemes at the same time. This is especially the case when firms combine subsidies with several R&D tax benefits.

Despite the enormous volume of research on the impact of R&D tax incentives, challenges remain for researchers. One important methodological issue is how to separate the causal impact of tax incentives from relationships that run in the opposite direction. Ideally, for policy evaluation, one should be able to compare the actual behaviour

1 Considering the use of macro data in Guellec and Van Pottelsberghe (2003) and Buyse *et al.* (2020), the non-linear relationship for direct government support is also a macro feature. Low or high macro rates of subsidies may hide large firm-level heterogeneity in the subsidies.

2 Becker and Hall (2013) test the pooling assumption – whether coefficients should be homogeneous across industries or not – for different R&D determinants for a panel of manufacturing industries for the UK over the period 1993-2000.

3 A decrease of the R&D user cost, due to R&D tax stimuli, with 1 %, will, ceteris paribus, lead to an average increase of private R&D spending with 1 %.

of a firm enjoying a tax incentive with the counterfactual situation in which a firm with similar characteristics does not have this incentive. This could be done by simulating a social experiment where R&D tax credits are randomly allocated to firms. However, due to the nature of R&D tax incentives, this is not possible. In that sense, an interesting analysis has been conducted by Guceri and Liu (2019) for the UK, where they exploit the changing definition for SMEs which increased the R&D tax generosity for certain medium-sized companies. This policy reform provided an excellent quasi-experimental setting to identify the causal impact of R&D tax incentives. Their main results underline the positive impact of R&D tax incentives as they found that companies in the treatment group raised their R&D spending significantly in response to the increased generosity of tax incentives[1].

A critique on R&D support mechanisms relates to its positive impact on the demand for researchers, which may push up researchers' wages. Consequently, higher R&D private spending, due to R&D support, could mainly reflect higher spending on existing R&D personnel. Lokshin and Mohnen (2013) provide micro-level evidence for a panel of Dutch firms that there is indeed a wage effect related to R&D tax incentives. They find that a part of the R&D tax credit gets transferred to higher wages, i.e. they estimate the wage effect to reduce the quantity effect – more real R&D spending – by some 25 percent. All in all, these findings suggest that most of the impact really does go to the quantity of R&D, rather than the price. Moreover, as also noted by Lokshin and Mohnen (2013), higher wages might be the price to pay to retain high-skilled researchers with promising returns in the future.

In order to evaluate the impact of R&D tax incentives, it is also important to look at the presence of R&D spillovers[2], due to higher R&D spending caused by public support. New technology and knowledge may spill over to other firms and countries, so that all may benefit from an improvement in the world level of technology, although not necessarily to the same extent. Buyse *et al.* (2020) use an unobserved common factor approach to capture this global level of technology and show that it is an important driver of private R&D spending. The findings in Everaert *et al.* (2015) also suggest that the worldwide level of technology and knowledge and a country's absorptive capacity are very important for long-run TFP growth. As such, sustained public investment in education and high-skilled human capital is important to reap the fruit of worldwide available technology.

Finally, by introducing generous R&D tax incentives, countries also try to attract R&D operations of foreign multinational firms. A tax competition element is thus present when assessing the effectiveness of R&D tax incentives. Montmartin and Herrera (2015), for example, use spatial dynamic panel data methods to illustrate for a sample of 25 OECD countries the possibility of a substitution effect between in-country and out-of-country R&D policies. This suggests that the effects of national R&D policies on in-country private R&D investment can be cancelled out by the effects of external R&D policies[3].

## 4.2 Effectiveness of Belgian R&D tax incentives

To explicitly focus on the effectiveness of Belgian R&D tax incentives (discussed in section 3.2.), we rely mainly on the work done by Dumont (2019). For a panel of Belgian R&D active companies, he analyses the impact of Belgian R&D tax incentives over the period 2003-2015 and provides robust evidence that the four different schemes of partial exemption from payment of the withholding tax on the wages of R&D personnel are effective in stimulating additional R&D activities. Especially for the partial exemption granted to R&D employees with a Master's degree, very consistent and significant evidence for input additionality is provided[4].

1 More specifically, they found that a 10 percent reduction in the user cost of R&D induces firms to increase R&D spending by around 16 percent.

2 Hall, Mairese and Mohnen (2010) illustrate that social returns to R&D are almost always estimated to be substantially greater than private returns, implying the existence of significant technological spillovers.

3 In their empirical analysis, Montmartin and Herrera (2015) find that a 1 % drop in the B-index in all neighbouring countries reduces private R&D intensity in the home country by 1.4 % in the long run.

4 As pointed out by Dumont (2019), it should be noted that the rate of partial exemption from payment of the withholding tax for masters is the same as for researchers with a PhD or civil engineers, who have by definition a Master's degree. The usefulness of the distinction with the scheme for Master's degrees is therefore not clear.

However, Dumont (2019) finds no clear evidence that R&D tax credits induce extra R&D spending. Over different specifications and for his sample, R&D tax credits are in general found to have a positive, but limited and statistically insignificant effect on R&D spending. For a specific sub-sample of firms with no more than 50 employees, the impact of R&D tax credits becomes significantly positive when it comes to stimulating extra private R&D spending. One suggestion that could raise the effectiveness of the R&D tax credit would be to pay out the unused tax credit immediately and not after four years.

Dumont (2019) further confirms earlier results regarding the combined use of different R&D support mechanisms. When firms combine direct support with indirect tax incentives, input additionality decreases. As mentioned by Dumont (2017), this could give an indication of a lack of coordination in Belgium between regional – responsible for granting subsidies – and federal – responsible for tax incentives – authorities. When combining different support mechanisms, firms could achieve a support rate above the optimum rate – the point from which additional support just substitutes private R&D funding for public funding. Coordination and consultation between the regional and federal authorities is thus important for efficient use of public resources in stimulating private R&D spending.

In its country report for Belgium, the EC (2020) also mentions that the efficiency of government support for business investment in R&D could be improved. To make their point, the authors refer to the work done by Dumont (2019) and an analysis by the Belgian Court of Auditors (2019) concerning partial withholding tax payment exemption schemes for R&D personnel. The Court of Auditors concluded that there was a lack of controlling function, meaning that there are insufficient checks to see if the beneficiary really is eligible for the exemption granted. By developing an adequate controlling mechanism and rigorously applying it to potential beneficiaries of the partial exemption schemes, benefit abuse could be much more easily detected and efficiency could be improved.

Finally, in Vennix (2019), it is shown that less than 3 percent of Belgian R&D spending in the private sector comes from firms younger than five years. However, as pointed out by the OECD (2019), some of these young firms have the best growth potential, especially when it comes to further digitalisation of the Belgian economy – which is primordial for boosting productivity and innovation. With respect to public R&D support for these young firms, the OECD (2019) notes that the tax benefits that are provided through corporate tax allowances, i.e. R&D tax credit or deduction, are biased against R&D-active young firms as these often have no profits and it thus takes time before they can benefit from the public support granted [1]. This is in line with existing empirical evidence, i.e. direct public funding is more effective for small and young firms (see above). The OECD (2019) therefore suggests that a rethink of Belgium's R&D support policy could be beneficial and could increase its efficiency. More concretely, the OECD (2019) states that the return on public R&D spending and the targeting of young firms, with high growth potential and possibly the largest return from public support, has to improve. One suggestion they make for tax support via corporation tax is to cut off eligible sums at an upper limit. As a result, small and young firms could receive a larger part, vis-à-vis big and multinational firms, for a given amount of support. This could prevent that the bulk of public resources for R&D ending up in the hands of a small number of large firms. Another proposed and potentially promising reform to target young firms would be to shift R&D support via corporation tax towards direct government funding. However, such a reform is challenging as these government competences are divided between public authorities in Belgium.

1 The Belgian R&D tax credit, if not fully used after four years, becomes refundable, while the investment deduction is simply carried forward.

## 5. Conclusion

Investment in research and development is an important driver of innovation and long-run economic growth. However, private business investment in R&D tends to be sub-optimal due to the wedge between its private and social returns. Government involvement in promoting business R&D investment is thus highly justified. Nevertheless, in the post COVID-19 environment in which governments will need to restore the sustainability of public finances, and hence increase public policy efficiency, the question arises whether public support mechanisms for private sector R&D investment are actually effective.

In addressing the under-investment in R&D by the private sector, governments have different instruments at their disposal. Traditionally, they can be sub-divided into direct support, such as direct R&D subsidies, and indirect support via R&D tax incentives. Over the last decade, R&D tax support has increased significantly in Belgium and in the European Union. The main R&D tax relief provisions in Belgium are, in terms of input-related R&D support, the partial exemption schemes from payment of the withholding tax on the wages of R&D employees and the R&D tax credit or investment deduction in the corporate tax system. When it comes to targeting the output of innovation, Belgium has a system where IP-derived income is taxed well below the statutory tax rate.

A sizeable amount of empirical research has been done to evaluate the effectiveness of public R&D support mechanisms. Compared to some earlier studies, recent evidence suggests more unanimously that both direct public support and R&D tax incentives have a significant positive effect on private R&D investment. Governments' optimal choice of exact policy instrument, however, depends on the type of firms targeted. Direct subsidies mainly have an impact on small and young firms' R&D decisions, while R&D tax incentives are more market-oriented as the decision on which projects to invest in is left up to the firms themselves. Larger firms seem to benefit more from the latter. To some extent, R&D subsidies and tax relief measures might be substitutes, as their effectiveness declines when firms benefit from both at the same time.

For Belgium, the evidence on the effectiveness of R&D tax incentives is somewhat mixed. Dumont (2019) shows that the partial withholding tax exemption schemes significantly contribute to stimulating private R&D investment, whereas the stimulating impact of the R&D tax credit cannot consistently be illustrated. In Belgium, only a small amount of R&D spending comes from young firms, and these firms often have the best growth potential. It could therefore be beneficial to rethink Belgian R&D support mechanisms.

## Bibliography


Aghion P. and P. Howitt (1992), "A model of growth through creative destruction", *Econometrica*, 60(2), 323-351.

Alvarez-Ajuso L., C., Kao and D. Romero-Jordan (2018), "Long-run effect of public grants and tax credits on R&D investment: A non-stationary panel data approach", *Economic Modelling*, 75, 93-104.

Appelt S., F. Galindo-Rueda and A.C. Gonzales Cabral (2019), *Measuring R&D tax support: Findings from the new OECD R&D tax incentives database*, OECD Science, Technology and Industry Working Papers, 06.

Becker B. and S.G. Hall (2013), "Do R&D strategies in high tech sectors differ from those in low-tech sectors? An alternative approach to testing the pooling assumption", *Economic Change and Restructuring*, 46(2), 183-202.

Becker B. (2015), "Public R&D policies and private R&D investment: a survey of the empirical evidence", Journal of *Economic Surveys*, 29(5), 917-942.

Belgian Court of Auditors, (2019), "Vrijstellingen van storting van bedrijfsvoorheffing – een complexe regeling ter ondersteuning van werkgevers".

Bloom N., M. Schankerman and J. Van Reenen (2013), "Identifying technology spillovers and product market rivalry", *Econometrica*, 81(4), 1347-1393.

Buyse T., F. Heylen and R. Schoonackers (2020), "On the impact of public policies and wage formation on business investment in research and development", *Economic Modelling*, 88, 188-199.

Coe D., E. Helpman and A. Hoffmaister (2009), "International R&D spillovers and institutions", *European Economic Review*, 53(7), 723-741.

Dumont M. (2017), "Assessing the policy mix of public support to business R&D", Research Policy, 46(10), 1851-1862.

Dumont M. (2019), *Tax incentives for business R&D in Belgium: Third evaluation*, Federal Planning Bureau, Working Paper 4.

EC (2014), *A study on R&D tax incentives*, Taxation Papers, Working Paper 52.

EC (2020), *Tax policies in the European Union – 2020 survey*, DG Taxation and Customs Union.

Everaert G., F. Heylen and R. Schoonackers (2015), "Fiscal policy and TFP in the OECD: measuring direct and indirect effects", *Empirical Economics*, 49(2), 605-640.

Goerg H. and E. Strobl (2007), "The effect of R&D subsidies on private R&D", *Economica*, 74(294), 215-234.

Guceri I. (2016), *Tax incentives for R&D*, Working Paper, University of Oxford.

Guceri I. and L. Liu (2019), "Effectiveness of fiscal incentives for R&D: Quasi-experimental evidence", *American Economic Journal: Economic Policy*, 11(1), 266-291.

Guceri I., M. Köthenbürger and M. Simmler (2020), *Supporting firm innovation and R&D: what is the optimal policy mix?*, EconPol Policy Report, March, 3.

Guellec D. and B. Van Pottelsberghe (2003), "The impact of public R&D expenditure on business R&D", *Economics of Innovation and New Technology*, 12(3), 225-243.

Hall B. and J. Van Reenen (2000), "How effective are fiscal incentives for R&D? A review of the evidence", *Research Policy*, 29(4-5), 449-469.

Hall B., J. Mairesse and P. Mohnen (2010), "Measuring the returns to R&D", *Handbook of the Economics of Innovation*, 2, 1304-1076.

Hall B.H. (2020), *Tax policy for innovation*, NBER, Working Paper, 25773.

Lokshin B. and P. Mohnen (2013), "Do R&D tax incentives lead to higher wages for R&D workers? Evidence from the Netherlands", *Research Policy*, 42(3), 823-830.

Lucking B., N. Bloom and J. Van Reenen (2019), "Have R&D spillovers declined in the 21st century", *Fiscal Studies*, 4(40), 561-590.

Montmartin B, and M. Herrera (2015), "Internal and external effects of R&D subsidies and fiscal incentives: Empirical evidence using spatial dynamic panel data models", *Research Policy*, 44(5), 1065-1079.

OECD (2015), *Frascati Manual 2015: Guidelines for collecting and reporting data on research and experimental development, the measurement of scientific, technological and innovation activities"*, 7th edition, OECD Publishing Paris.

OECD (2017), *OECD review of national R&D tax incentives and estimates of R&D tax subsidy rates,* Version 18, April 2018.

OECD (2019), *In-depth productivity review of Belgium*, OECD Publishing, Paris.

Romer P. (1990), "Endogenous technological change", *Journal of Political Economy*, 98(5), 71-102.

Thomson R. (2012), *Measures of R&D tax incentives for OECD Countries*, Melbourne Institute Working Paper series, 17.

Thomson R. (2017), "The effectiveness of R&D tax credits", *Review of Economics and Statistics*, 99(3), 544-549.

Vennix S. (2019), *Research and development activities in Belgium: A snapshot of past investment for the country's future*, NBB, Working Paper, July, 373.

Warda J. (2001), *Measuring the value of R&D tax treatment in OECD Countries*, STI Review No 27: Special issue on new science and technology Indicators, OECD Publishing.

Westmore B., (2014), "Policy incentives for private innovation and maximising the returns", *OECD Journal: Economic Studies*, 2013(1), 121-163.