Tax incentives for R&D: supporting innovative scale-ups?

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Abstract

This article investigates the impact of tax incentives targeting young innovative firms and broader R&D tax incentives where effects on young firms are observed. It examines effects on R&D additionality, R&D wages, employment growth, turnover growth, and sales growth from innovative activities. It draws on academic literature and policy evaluation studies and uses a mixed-method approach based on evaluation synthesis. Evidence on the effectiveness of tax incentives on young and small firms’ employment and economic performance is relatively limited, largely due to a dearth of evaluations. This analysis, based on a limited number of studies, finds that with regard to R&D additionality, generic R&D tax incentives tend to have a larger, or at least as large, effect on young companies, both when compared with companies of average age (with the exception of a study on an Irish tax instrument), and when compared with grants and loans. Some evidence also shows a positive effect on wages. More limited evidence shows that R&D tax incentives targeted at young companies tend to have positive effects on R&D intensity and wages, but that effects decrease relatively if combined with other instruments such as subsidies. With regard to output additionality, generic R&D tax incentives have a limited impact on innovation for all companies and a positive impact on turnover, turnover share of new products or services and labour productivity. There is some evidence of positive effects on employment, productivity, sales and added-value of targeted measures, but these results should be validated using more robust methods.

Key words: R&D tax incentives; impact evaluation; policy design; innovative scale-ups.

1. Introduction

Tax incentives to support R&D in private businesses have become an important part of the policy mix in most European Union (EU) Member States (MS). At the same time, policy interest in support measures targeted at young innovative companies is increasing, since new entrants that bring new products and services to the market play an important role in technological innovation, in addressing societal challenges, promoting economic growth, and in stimulating incumbents to innovate. Evidence shows innovative firms not only grow twice as much as their non-innovative counterparts in terms of employment and sales, but also faster growing firms continue to innovate providing stimuli to the economy (Nesta 2009).

Tax incentives reduce a firm’s tax depending on the volume (or change) in the total expenditure the firm allocates to R&D and are neutral in terms of the content of R&D activity supported. They have become more generous and simpler for firms to use over the past decade.

While there is sufficient evidence to show that high-growth innovative firms can be beneficial for the economy, an innovative firm’s capacity to grow may be limited by local financial constraints. Understanding what makes these firms financially constrained has been the subject of intense research interest. Young innovative firms are increasingly seen as key protagonists for continuing innovation, particularly in fostering disruptive technology developments.
Nevertheless, models of entrepreneurship under liquidity constraints suggest that banks prefer lending to firms in established industries, and with predictable cash flows, rather than young innovative firms (see Berger and Udell 1955; Stiglitz and Weiss 1981; Petersen and Rajan, 1994; among others). This is partly because the assets of innovative firms are largely intangible (such as marketing knowledge or technology). Other studies, such as Spence (1984) suggest that firms with high growth potential might be discouraged in their R&D spending by the presence of R&D externalities.

Tax incentives can be an attractive option for young innovative firms. Their non-discriminative set-up and corresponding low administrative burden may suit the requirements of young companies. However, evidence shows that tax incentives tend to support the larger incumbent R&D firms, and incremental rather than new-to-market innovations (OECD 2013). Nevertheless, tax incentives for small firms are a relatively simple and flexible policy option frequently used by many governments (Laredo, Köhler and Rammer 2015), particularly when alternative sources of funding to cross the so-called ‘Valley of Death’ are restricted (House of Commons Science and Technology Committee 2013). Knowledge spill-overs that arise from R&D activities form one of the primary economic rationales for government intervention policies. As a way to mitigate funding constraints faced by companies, governments have viewed R&D tax credits, in a variety of forms, as an attractive option to promote ‘input additionality’ through reducing the unit cost of R&D and thereby increase the R&D efforts of firms (Laredo, Köhler and Rammer 2015).

The set-up of tax incentives may, however, render them inaccessible for financially constrained companies that incur expenses before getting reimbursed. The design and implementation of tax incentive schemes can therefore have important impacts on the capacity of young innovative companies to access them. More broadly, the overall effect of fiscal incentives on firm dynamics is important, and effects between new or scaling entrants and incumbents correlate closely. One assessment finds more generous R&D tax incentives support incumbent firms while raising entry barriers for potential scale-up entrants (Bravo-Biosca, Criciuto and Menon 2013). Targeted measures as well as certain design features and implementation mechanisms could therefore help extend firm access to tax incentive schemes.

It can be argued that R&D input is only a proxy measure for innovation activity and fails to capture the effect and impact of any additional spending. Therefore, this report examines both the input (i.e. share of firm’s R&D investment due to the tax incentive) and output additionality (i.e. share of firm’s output measured by firm growth in employment, turnover or innovative activities due to the tax incentive) of tax credits aimed at young innovative firms in a number of EU countries and beyond. In particular, results for Belgium, France, Italy, Ireland, the Netherlands, and the UK are presented in this article given the availability of evaluations or academic studies on tax incentives in this selection of countries.

By reviewing the most relevant and recent literature, and building on the review made by Laredo, Köhler and Rammer (2015), this study investigates the impact of tax incentives targeting young innovative firms and broader R&D tax incentives along the following dimensions: R&D additionality, employment growth, turnover growth, and sales growth from innovative activities. It also looks at the impact on R&D wages.

The main findings of the analysis in this report are that evidence on the effectiveness of tax incentives is relatively limited with regard to their effects on young firms’ employment and economic performance, especially when compared with the large body of literature on their effects on R&D intensity of firms. The analysis, based on a limited number of studies, finds that with regard to R&D additionality, generic R&D tax incentives tend to have a larger, or at least as large, effect on young companies both when compared with companies of average age (with the exception of a study on an Irish tax instrument) and when compared with grants and loans. Some evidence also shows a positive effect on wages. More limited evidence shows that R&D tax incentives targeted at young companies tend to have positive effects on R&D intensity and wages, but that effects decrease relatively if combined with other instruments, such as subsidies. With regard to output additionality, generic R&D tax incentives have a limited impact on innovation for all companies and positive impact on turnover, turnover share of new products/services and labour productivity. There is evidence of increased private R&D for the large companies and for a reduction of entry barriers (regarding implementation of R&D activity) for the smaller companies. There is some evidence of positive effects on employment, productivity, sales and added-value of targeted measures but these results need to be validated using more robust methods.

This article presents researchers and policymakers with a review of the available evidence of the impact of generic and targeted R&D tax incentives on young companies. It also invites policymakers to provide more robust evaluations of R&D tax incentives’ effects on young companies since the available studies suggest these have relatively stronger effects than when applied to established companies.

The article sets out to assess tax incentives as follows: Section 2 introduces the methodological approach and discusses the limitations of this research. Section 3 provides an overview of key design features of extant tax incentives in selected MS. The results of academic literature and policy evaluations are discussed in Section 4. Conclusions and policy implications drawn from the study are provided in Section 5.

2. Methodological framework

2.1 Research design

The empirical research exercise in this study consists of examining evaluations of tax incentive instruments in six EU MS adopting Edler, Ebersberger and Lo (2008) evaluation synthesis approach. It predominately relies on qualitative analysis of existing impact evaluations and interpreting the research findings taking into account differences in policy contexts and methods. The key aim of this useful framework of analysis is to address issues of validity and to enhance the quality of the research.

2.2 Research methods

Policy evaluations are most often the assessments of a single instrument in a specific implementation context. Yet, by combining insights from several evaluations it is possible to go beyond the specificity of the case study and derive more general lessons learned as previously done in R&I policy (Edler, Ebersberger and Lo 2008; Gök and Edler 2012) as well as in other areas (e.g. education, development aid, or health). There is a dispersed yet valuable body of evidence available on policy evaluations of the impact of public policies (Edler et al. 2012; Gök and Edler 2012). Figure 1 provides a schematic overview of this methodological approach, which provides the basis for this study. The diagram represents the collection activities of policy evaluations considered to represent the impact of R&D tax incentives on young innovative firms’ performance.

Our identification of available policy instruments and evaluations was based on Scopus database searches, contacts with...
national experts in each country, desk research and use of the SIPER database. Therefore, the review considers both academic literature and evaluation studies, addressing a policy-making audience.

The policy measures in EU MS were identified and classified according to the type of interventions and beneficiaries. The countries included in our research reflect those with R&D tax incentives used by young (or small) innovative companies and those policy initiatives that were evaluated. Furthermore, the study focuses on output additionality. Information was collected to capture the effect of R&D tax incentives on the widest possible dimensions of firm performance, namely R&D additionality, innovation activities, employment growth, economic performance, and R&D wage effects.

The evaluations were assessed based on two criteria: their inclusion of small and/or young firms in the sample, as well as the relative robustness of the methodology, for example, use of econometric methods, existence of a control sample. Given the limited evidence, all relevant studies are described in this article, but the conclusions are drawn only from studies with more robust methodologies.

2.3 Research limitations

Given the ex-post definition of high-growth firms and difficulties with their sampling, in this report, we refer to the group of young innovative companies with growth potential which is a heterogeneous, but recognizable group of innovative companies. A number of tax incentive evaluations or studies identify what constitute young innovative companies based on parameters such as age criteria and minimum levels of R&D intensity. An important consideration is whether young firms can be directly equated with small firms. Eligibility criteria in some of the schemes analysed stipulate a maximum firm size, while others focus on a maximum age. It is clear therefore that policymakers often equate the two to an extent. As with all innovation policy instruments, there is a degree of complexity within this binary choice of categories. Therefore, the analysis in this report presents the heterogeneity of policy options applied in MS.

The evaluations and studies in this article vary considerably in their design and use of input and output variables. As noted by Laredo, Köhler and Rammer (2015), while many countries have undertaken evaluations of R&D fiscal incentives, the majority tend to focus on input additionality, that is, the contribution of the tax incentive to increased business R&D expenditure. It could be argued that the main direct objective of R&D tax incentives is to raise business R&D expenditure, hence most evaluations have analysed the effectiveness of this instrument based on input additionality.

In contrast, evidence on output additionality—the effects of R&D tax incentives on innovation and economic performance—is much more limited. Finally, at that time, no study had examined behavioural additionality, examining lasting structural changes in enterprise innovation practices, and societal impacts mostly linked to jobs. Additional complexity is introduced by the design options for tax credits: Laredo, Köhler and Rammer (2015) identify ‘seven key dimensions’, namely the type of incentive, its approach (volume vs. increment based), eligibility criteria, scale of funding, the beneficiaries, rules of credit consumption, and timescale. An enormous number of designs are therefore available through the various possible combinations of these dimensions. In our analysis, we were unable to control for the variability of these approaches, which further contributes to the scarcity of data.

Another strand of literature investigates instead the determinants of firms’ preference for R&D tax incentives, as opposed to other available instruments. It has been argued that the firms’ choice of using R&D tax credits may not have the same determinants, or may not be influenced in the same way by, for example, firm characteristics, compared with R&D grants. Busom, Corchuelo and Martinez-Ros (2014), for instance, find that older and larger firms tend to benefit most from R&D tax schemes, whereas young firms tend to favour and benefit more from R&D grants. The set of evaluations and academic literature examined here confirms findings of a 2014 European Commission study (DG TAXUD), which found that only a few countries prepare regular evaluations (e.g. the Netherlands and France) (EC 2014). Since then, Ireland and the UK have evaluated their tax credits for R&D. Evaluations and academic literature on R&D tax relief schemes targeted towards young firms exist for only a handful of countries (e.g. JETI in France, YIC in Belgium and the R&D Tax Credits in the UK).

It can also be argued that the empirical literature has placed too much emphasis on additionality and failed to offer a cost-benefit

Figure 1. Methodological approach of the study.

Source: Gampfer et al. (2016).
calculation. The magnitude of the externalities is a major factor behind the effectiveness of R&D tax incentives. Unfortunately, available estimates are far from robust or estimated with sufficient precision (Mohnen 2013).

The study is therefore limited in providing a robust comparison of outputs. Firstly, the use of different output indicators and its subsequent reporting that differs in granularity, makes it difficult to compare the impact of instruments. Secondly, the instruments differ in design, eligibility, and implementation, further hindering comparability of results. Finally, most of the evaluations do not control for multiple simultaneous treatment effects and therefore the attribution of causality is problematic.

An important example of limitations within certain measures of performance is that of the impact on employment, an outcome variable that many of the available studies focus on. The problem with the use of employment as a variable in this context is that many high-tech small firms rely substantially on sub-contracting as a way to supplement workforce capacity, particularly in the short term. To the extent that such figures are not captured by employees’ returns in the datasets used, the measured impact on employment may be an underestimation of the true impact.

A further limitation, noted by Cunningham, Gsok and Shapiro (2015) in their review of the impact of direct R&D grant support schemes for firms, is that the outcomes of econometric studies are highly sensitive to the specific econometric model selected and the choice of variables. While the use of econometric approaches was more limited in the evaluation of direct R&D support for firms, compared with that of the evaluation of fiscal incentives, this finding echoes those of Klette, Moen and Griliches (2000) and Siegel et al. (2003).

Despite their relative scarcity, the evaluations available on the impact of R&D tax incentives on young innovative companies represent an important basis of analysis for consideration in innovation policymaking.

3. National tax schemes to support young innovative companies

The majority of R&D tax schemes in the EU are open to all firms, but a small number of national schemes specifically target firms by age or size or by including wage tax relief—including young and new companies (as shown in Table 1, see also indications on EU tax incentive schemes and availability of evaluations in annex, Table 11). They may be more generous for small- and medium-sized firms (SMEs) (each country defines the parameters of SME participation) as in the Netherlands, or more generous for recently created firms, for example, France. Schemes designed to support the wage costs of firms are also shown since these may help support the growth of companies, as included in schemes in Belgium, France, and the Netherlands. Tax incentives are increasingly used to support small and young firms (Nesta 2012), even though there are still few EU countries doing so, and even fewer that address labour costs. Consequently, there are limited evaluations of schemes that target small and/or young companies, as also indicated in Tables 1 and 10, where only four evaluations are available for schemes in a sample of nine countries.

Belgium and France are the only countries that specifically target young firms with a tax incentive scheme. The Belgian Young Innovative Companies (YIC) scheme is for small firms up to ten years old and with at least 15% of spending on R&D, to receive a partial exemption of wage tax to personnel involved in R&D activities. Eligible R&D personnel includes those with a PhD degree in exact or applied sciences, doctoral degree in (veterinary) medicine or a civil engineering degree, as well as R&D personnel with a master degree, except social and human sciences. The scheme offers a single rate (80%) for all categories of researchers (in-house researchers; those affiliated to eligible universities or public research organizations; and those affiliated to young innovative companies). The French Jeune Entreprise Innovante (JEI) scheme supports firms who have been in business for less than 8 years and whose R&D expenditure represents at least 15% of tax-deductible expenditure. Small technology companies are the main beneficiaries of this scheme (fewer than 20 employees).

Other schemes provide measures such as in the Netherlands where the WBSO scheme distinguishes between entrepreneurs who withhold payroll taxes (inhoudingsplichtigen) and those subject to wage tax (belastingplichtigen). Two types of R&D projects are supported: development projects, which concern the development of technically new (components of) physical products, physical production processes or software; and technical scientific research, which concern explanatory research that is technical in nature. In the UK, SMEs can deduct an extra 130% of qualifying R&D costs from their yearly profit, as well as the normal 100% deduction, to make a total 230% deduction. Companies can also claim a tax credit if it is loss-making, worth up to 14.5% of the surrenderable loss.

3.1 Design features of tax schemes to support innovative scale-ups

Small and young firms show a strong response to R&D tax incentives, and certain features can be important for small and young companies (e.g. with insufficient profit and/or projects involving basic research):

Table 1. Tax schemes and availability of analyses showing effects for young innovative companies

| EU MS   | R&D tax incentives                                                                 | Analyses of effects |
|---------|------------------------------------------------------------------------------------|---------------------|
|         | Expense-based/ input based credit | Differentiated schemes by firm age | Differentiated scheme by firm size | Includes wage tax relief | Evaluation | Study |
| Belgium | X                                    | X                     | X                                | X                       | X          |       |
| France  | X                                    | X                     | X                                | X                       | X          | X     |
| Ireland | X                                    | X                     | X                                | X                       | X          | X     |
| Italy   | X                                    | X                     | X                                | X                       | X          | X     |
| Netherlands | X                        | X                     | X                                | X                       | X          | X     |
| UK      | X                                    | X                     | X                                | X                       | X          | X     |

Source: JRC desk research, 2017.
3.1.1 Carry forward provisions

This allows a company (or individual) to carry the tax exemption implied by the scheme over to a future fiscal year of profit. The provision acts as a ‘negative profit’ for tax purposes. Even if a company’s expenses exceed revenues, making the company unprofitable, they are still eligible to claim the tax credit. The company can obtain a rebate equivalent to the allowance, or refund of unused credits. A number of schemes in MS feature this provision, for example, France, Lithuania, Belgium, Hungary, and the Czech Republic. This design feature is particularly relevant for young companies with weak credit.

3.1.2 Cash refunds

With this provision, even loss-making companies can benefit from the R&D tax credit by receiving a cash refund of the credit, subject to some conditions. Schemes in Belgium, France, Netherlands, Hungary, Spain, and Sweden contain this kind of provision (OECD 2016a,b).

3.1.3 Tax relief for wages/social security contributions

Schemes may allow companies or entrepreneurs to lower the labour costs of R&D by paying less wage tax and national insurance contributions. Examples include the Dutch R&D tax credit (WBSO). Whereas in some countries firms that are not subject to corporate income taxes cannot claim any R&D tax credit, in the Netherlands firms can deduct the tax credits directly from the employer’s social security contributions. Similarly, eligible costs in the Innovation tax credit (CIR) in France include salaries and related social expenses (incl. gross salaries and the employers’ social tax costs, e.g. national insurance) for researchers, with up to double the amount for young PhD holders under specific conditions. More recently, a scheme introduced in Poland in 2016, directed at entrepreneurs conducting R&D activities, also covers labour income. Part of the gross wages and compulsory contributions of R&D employees can be deducted from the tax base. The generic volume-based scheme in Austria includes deduction on taxes on wages and salaries for R&D. In Belgium, the YIC scheme gives a partial exemption of wage tax to personnel involved in R&D activities.

3.1.4 Additional pre-financing

Outside of the tax incentives scheme, other provisions can support the uptake of R&D tax credits, such as pre-financing for R&D expenses. France’s public investment bank offers a pre-financing solution covering 80% of expected eligible expenses (for companies based in France for more than 3 years, having previously received the research tax credit). SMEs, innovative new companies, start-ups and ailing companies may ask for an immediate research tax credit rebate (Table 2).

### Table 2. Member States (MS) schemes with tax incentives design features aimed at SMEs, start-ups, and young firms

| Feature                                      | SMEs          | Start-ups/young firms          |
|----------------------------------------------|---------------|--------------------------------|
| Enhanced tax credits/allowance rates         | Poland, UK    | Netherlands, Portugal          |
| Exclusion of excess claims                   | France        |                                |
| Other favourable terms                       | Spain (innovative SMEs); Belgium (YICs); France (JEI/JEU) | |

Source: OECD (2017). http://www.oecd.org/sti/rd-tax-incentives-compendium.pdf.

To ensure the targeting of new firm entrants, aggregation rules that restrict companies from creating subsidiaries are also important features within a tax incentive (e.g., in France).

More generally, stable, predictable incentives have a stronger impact on R&D investments as companies plan expenditures and allocate resources inter-temporally. The power of R&D tax incentives in solving the financing problem is reduced if tax incentives are unstable, unpredictable, and non-refundable or if there is a time lag between the R&D expenditure and the collection of R&D tax credits (Appelt et al. 2016). Efficiency in managing tax credits is a relevant feature supporting their uptake by firms, much like other features such as the availability, simplicity, and generosity of these incentives (OECD 2013). These aspects have improved in most countries, including France and Ireland. Finally, when schemes are subject to evaluations, their findings can support improvements in their uptake and adjustments in the targeting of firms, with the added benefits of better data collection and development of an analytical infrastructure.

4. Evidence on scheme effectiveness

This section presents the available evidence of the effects of tax incentives on young companies, focusing mostly on schemes in EU MS, in order to examine whether tax incentives support innovative scale-ups. The evidence relates to the R&D additivity of schemes, as well as their effects on firm employment, innovation, economic performance, and wages. This study considers evaluations by Moutaabbid (2016), Hallépée and García (2012), and Lelarge (2008) from France; Verhoeven, Van Stel, and Timmermans (2012) and Mohnen and Lokshin (2008) from the Netherlands; Dumont (2013) from Belgium; Achenes and Malone (2016) from Ireland; and Fowkes, Sousa and Duncan (2015) from the UK. It also examines academic studies by Ernst and Spengel (2011) and Ernst, Richter and Riedel (2014) from the EU; Bozio, Iac and Py (2014) from France; Dechezleprêtre et al. (2016) and Guceri and Liu (2017) from the UK; Dumont (2017) and (2013) from Belgium; Cornet and Vroomen (2005) from the Netherlands; and Lee (2011) from Canada, Japan, Korea, Taiwan, India, and China.

4.1 Input additiveness

4.1.1 Effect of tax incentives on R&D investment (Table 3)

Dechezleprêtre et al. (2016) exploit a change in UK tax credit policy in 2008 as a quasi-experiment to conduct a regression discontinuity analysis, which shows statistically significant effects of this policy change on both private R&D investment and patenting activity (even after controlling for patent quality).7 For the specific subset of young firms, the authors focus only on the additional R&D spending caused by the policy and find a stronger effect for these firms compared with the average-aged firm. In particular, they estimate a tax-price elasticity of around 4.7 which means a 1% increase in foregone tax revenue due to the tax credit leads to a 4.7% increase in R&D expenditure at the young firm level (1.6% for old firms). As a possible explanation, they point to young firms being more likely to be financially constrained and hence benefitting more from the tax credits.7 The analysis carried out by the authors contains a number of sound robustness checks for the empirical identification strategy and the quality of patents. Despite the generally positive results, an important caveat for policy conclusions is that, even though targeting R&D policy on financially constrained SMEs is worthwhile,
a first-best response would be to remove the credit market imperfections that cause underinvestment in R&D among these firms in the first place.

Exploiting this same policy reform in the UK (i.e. the increase in the size thresholds for qualifying as an SME), Guceri and Liu (2017) use difference-in-differences and other panel regression techniques to investigate the impact of R&D tax credits on R&D spending. Their empirical strategy consists of separating R&D spending between a treatment group of firms, which became eligible after the policy change and a control group of firms, which were unaffected by the policy reform. For the subset of young firms in the sample, they find a smaller, but still positive effect. For the extension, it is 10–20 cents.

In a later paper, Dumont (2017) investigated how the effectiveness of public support to business R&D changes when different support schemes are combined, and shows that it decreases when firms benefit from different schemes at the same time, especially when firms combine subsidies with several tax benefits. The study includes an analysis of firms under the YIC tax credit programme. The author found that, although in principle this wage-based tax benefit seems appropriate for the cost structure of young firms (as these firms cannot access benefits provided through corporate income taxation), there is no significantly positive effect on the total amount saved through partial exemption of the withholding tax on the wages of R&D personnel in the YIC programme on the amount of R&D expenditure net of public support for R&D. No potential explanations are given as to why this might be the case.

A study by Cornet and Vroomen (2005) found that the Dutch WBSO provides large, positive benefits for start-ups. It used a quasi-experimental design to show how each euro deduction through the Starter Facility results in additional R&D spending of around 50–80 cents. The extension of the first tax bracket in 2001 is found to have a smaller, but still positive effect. For the extension, it is 10–20 cents extra R&D labour per euro deduction. However, the explanatory power of the latter result is relatively limited because the research design does not meet the conditions of a natural experiment.

Lee (2011) used firm-level data for nine industries across six non-EU countries (1,500 firms in total) to study the impact of different forms of public R&D support (namely tax credits, R&D grants and loans) on firms’ R&D intensity. Even though a subsample of young firms only was not explicitly analysed, the average age of the firms in the dataset is about three years (at the time they received the support). Hence, their results can be considered to be relevant to young innovative firms. The inclusion of this study reflects the methodological soundness of the work, providing a clear econometric

Table 3. Effect of tax incentives on R&D investment/elasticity—academic studies

| Study            | Country | Programme/instrument/policy change | Target firms | Period       | Methodology                  | Impact                      |
|------------------|---------|------------------------------------|--------------|--------------|-----------------------------|-----------------------------|
| Dechezleptré et. al. (2016) | UK      | Changes in eligibility to the R&D Tax Relief Scheme | Young firms – Old firms | 2006–2011 | Regression discontinuity analysis | Tax-price elasticity of: – 4.7% – 1.6% |
| Guceri and Liu (2017) | UK      | Changes in eligibility to the R&D Tax Relief Scheme | Young firms identified as the bottom quartile in the firm age distribution | 2002–2011 | Difference-in-difference technique | Tax-price elasticity of 3.6% |
| Dumont (2017)    | BE      | Young innovative companies         | Young innovative companies | 2003–2011 | Fixed effects and GMM dynamic model | No significant effect |
| Dumont (2013)    | BE      | Young innovative companies         | Young innovative companies | 2001–2009 | OLS regression, two-step Heckman procedure, and a maximum likelihood estimation technique | Around 1.8 additionality effect. Positive impact of generosity of scheme |
| Cornet and Vroomen (2005) | NL      | WBSO                              | Start-up programme (introduced in 2001) | 1994–2004 | Quasi-experimental design | 0.5–0.8 Euro additional R&D intensities |
| Lee (2011)       | CA, JPN, KR, TW, IN, CN | Different forms of R&D tax credits | Young firms and old firms | 1997 | OLS and instrumental variable regressions | Young/small firms, which receive tax credits, display R&D intensities about 0.23 percentage points larger than non-receivers |
strategy, and featuring an average firm age of three years (very young). Although it analyses countries outside of the EU, some of these (e.g. Canada, Japan, Korea), feature similar innovation systems to those of the EU MS and therefore lessons from this article can be relevant for the EU.

Based on an empirical strategy that tries to control for endogeneity issues, their main conclusions on the effect of R&D tax credits are: (1) the overall effect on private R&D intensity is positive and statistically significant, even after including a relevant set of controls, (2) R&D tax credits show a greater and statistically more significant complementarity (understood as the additional private investment spurred by the policy instrument) effect than R&D grants and loans, and (3) results differ according to the growth profile of firms: firms classified as low-growth (based on sales) experience statistically significant positive effect from tax credits on their R&D intensity levels, whereas for high-growth firms the effect is statistically not significant. Thus, for young firms in the period of high growth, R&D tax credits seem not to make a difference in terms of private R&D intensity. No explanation is provided for why this might be the case. It may be that those R&D intensive firms in a phase of high growth are focusing on expansion rather than on developing new products and services (Table 4).

Acheson and Malone (2016) evaluate the impact of the Irish R&D tax credit scheme on R&D investment additionality by firms. The additionality is calculated using a treatment and control group framework. In particular, a policy change, consisting of the introduction of a repayable credit in 2009, is exploited to assess whether firms conducted additional R&D as a result of the tax credit scheme. The main analysis implements difference-in-difference estimation through fixed-effects regression analysis.

Despite the a priori expectation of a significant effect of the introduction of repayable R&D tax credits on private R&D investment, especially in the case of young firms, the authors find no evidence that this group of firms is particularly responsive. Despite a number of controls, they observe that, relative to other firms, young firms actually do significantly less R&D in the post-treatment period. Although their R&D does increase in the post-treatment period, it is increasing more slowly than other, older firms, and so it cannot be concluded that the repayable tax credit causes additionality for this specific type of firm. Among the explanations behind this absence of effect, the authors mention that, compared with older firms, young firms may not experience the same economies of scale or have access to the necessary infrastructure to perform R&D, or have the same ability to attract a skilled workforce. The authors assert that such firms likely face other non-financial barriers to R&D expansion, which could be the subject of further research.

Fowkes, Sousa and Duncan (2015) examined the take-up and use of the UK’s R&D tax credit and, using econometric techniques, assess the impact of the relief on R&D investment in the UK. Their approach employs a range of models, ranging from a very simple ordinary least squares approach via a fixed-effects estimator, to the more complex Arellano–Bond model. They also attempt to control for the effect of the financial crisis in the modelling by the inclusion of a proxy for the credit conditions, which is intended to capture the ease of firms obtaining capital. Their analysis revealed that the proxy for credit conditions was an important control and allowed the effect of the user cost of capital on R&D expenditure to be more clearly isolated.

They found that, in line with economic theory predictions, the estimates for elasticity were negative in all models, indicating that a decrease in the user cost of capital for R&D leads to an increase in expenditure on R&D and vice versa. This verifies the assumption that using tax credits to decrease the user cost of R&D increases R&D expenditure. Using the elasticity estimates, the authors calculated the change in the user cost from a change in the credit rate and the associated change in R&D expenditure, the so-called incremental ratio, tax sensitivity ratio, or additionality ratio.

For large companies, it was estimated that each £1 of tax foregone, £2.35 of R&D expenditure is stimulated, that is, the R&D expenditure increases more than proportionally in relation to the cost of providing the tax credit for large companies. In the case of SMEs making an enhanced deduction claim, the additionality ratio was 1.88 (following a change in the SME enhancement rate from 225% to 226%), while a change in the credit claim (from 11% to 12%) generated a ratio of 1.53. Thus, the additionality ratios depend both on the estimated price elasticity and on the basis of the enhancement rate.

The latest evaluation of the Dutch WSBO scheme (Verhoeven, Van Stel, and Timmermans 2012) for the period 2006–10 shows the average leverage (extra R&D wage expenditure per euro of WSBO tax credit) is estimated between €1.55 and €1.99, with the most likely estimate being €1.77. It also finds that the WSBO results in an increase of private R&D for the large companies and for a reduction of entry barriers (regarding implementation of R&D activity) for the smaller companies.

### Table 4. Effect of tax incentives on R&D investment/elasticity—evaluations

| Evaluation | Country | Programme/instrument | Target firms | Period | Methodology | R&D investment/elasticity |
|------------|---------|-----------------------|--------------|--------|-------------|-----------------------------|
| Acheson and Malone (2016) | IE | Introduction of a repayable credit in 2009 | Young firms (3 years) and older firms | 2007–2014 | Difference-in-difference regression analysis | No significant effect, but firms' under 3 years average R&D jumped substantially in 2009 compared with other firms |
| Fowkes, Sousa and Duncan (2015) | UK | Research and Development Tax Credit | High-tech SMEs and larger companies | 2008–2013 | GMM | Large companies: £1.53–£2.35 additionality SMEs: £1.88 |
| Verhoeven, Van Stel, and Timmermans (2012) | NL | WSBO | Start-ups, young companies, established companies | 2006–2010 | Regression models | 1.55–1.99 EUR average |

4.1.2 Wages

Mohnen and Lokshin (2008) find the WSBO tax credit leads to an increase in wages for R&D personnel. However, although the effect is sizeable, the effect on real R&D investment still outweighed the wage increase (Table 5).
Dumont’s (2013) evaluation outlined above studied both the impact of payroll withholding tax deductions and subsidies in the period 2000–9 on R&D personnel wages. The highest additiveness was observed for the measure that provides incentives for cooperation and the measure that offers exemption from the advance payment for R&D personnel with a PhD degree. The additiveness effect was lower for the YIC scheme and subsidies. Dumont found that the effect was lower for firms that used several instruments, for example, combined payroll withholding tax incentives with subsidies. Regressing the average wage on the amount of regional subsidies and partial exemption from advance payment for R&D personnel, it finds a statistically significant positive effect of these on the average wage for YICs.

4.2 Output additiveness

4.2.1 Firm employment

Companies that benefited from the JEI scheme in 2004 or 2005 experienced higher annual employment growth, with an estimated growth differential of 8.4 percentage points compared with similar firms that did not receive the JEI scheme support. Further findings are that the JEI scheme significantly increased firm productivity, their sales as well as their added value (Lelarge 2008) (Table 6).16

Using the same dataset, Hallépeé and Garcia (2012) also find that firms which benefited from the JEI scheme in 2004–5 experienced higher annual employment growth than that of firms with the same characteristics that did not benefit from the JEI support. According to their study, with an average workforce of 10 employees per firm in 2006, this effect would correspond to almost one additional job per firm in 2006. When considering a longer time period (2004–9), the authors find that the effect on the employment level persists: 1.75 additional jobs were created on average among the JEIs against 0.38 additional jobs among the non-JEIs. This translates into a total effect over the whole 2004–9 period of 7.239 more employees hired by the JEIs than their counterparts. This indicates that the JEI scheme had a positive and long-lived effect on young firms’ employment.

4.2.2 Firm innovation

Ernst and Spengel (2011) use firm-level data from a sample of European countries (Table 7). They combine firm-level financial data with patent data in order to investigate a firm’s patenting activity response to a change in R&D tax incentives and corporate tax burdens. When considering patent application as a binary indicator, the authors find R&D tax incentives have a positive effect on patenting activity: a ten percentage point rise in R&D tax incentives would increase the likelihood of observing a patent application by 11% [and 189% for large firms (5,000+ employees)]. The statutory corporate income tax rate is instead not significant in affecting the firm’s propensity to file a patent application. However, this tax rate bears a negative and statistically significant negative effect on firms’ patenting intensity (i.e. total count of patent applications), whereas R&D tax incentives do not have a statistically significant impact on this dimension.

Ernst, Richter and Riedel (2014) find that R&D tax credits and tax allowances combined have a negative impact on the quality of R&D projects for a sample of European firms between 1998 and 2007. When evaluating the impact of each tax instrument in isolation, however, this study shows that lowering patent income taxes has a positive impact on the quality of patents, while R&D tax incentives are found not to be statistically significant in affecting project quality. This may suggest that R&D tax policy instruments may help to increase the size of R&D projects (i.e. patent quantity), whereas patent boxes are found to exert a positive effect on patent quality. However, the review conducted by Laredo, Kohler and Rammer (2015) offers conflicting evidence on the effects of R&D tax incentives on firms’ propensity to patent.

Bozio, Irac and Py (2014) analyse the impact of R&D tax credits on R&D and innovation after the 2008 French reform.18 Using

| Study | Country | Programme/Instrument | Target firms | Period | Methodology | Wage effects |
|-------|---------|----------------------|--------------|--------|-------------|--------------|
| Mohnen and Lokshin (2008) | NL | WBSO | Firms younger than 5 years | 1996–2004 | Random and fixed effects methods | Increase of wages for R&D personnel |
| Dumont (2013) | BE | Young innovative enterprise scheme | YIC | 2001–2009 | OLS, panel, selection model | Advance payment for R&D personnel, statistically significant positive effects |

Table 6. Effect of tax incentives on firm employment—evaluations

| Evaluation | Country | Programme/Instrument | Target firms | Period | Methodology | Employment growth | Number of jobs |
|------------|---------|----------------------|--------------|--------|-------------|------------------|---------------|
| Lelarge (2008) | FR | Young innovative enterprise scheme | Young innovative companies (SMEs with less than 8 years old) | 2004–2005 | Difference-in-difference | 8.4% employment growth differential | 1 additional job per firm |
| Hallépeé and Garcia (2012) | FR | Young innovative enterprise scheme | Young innovative companies | 2004–2009 | Difference-in-difference | 1.75 additional jobs on average among the JEIs against 0.38 additional jobs among the non-JEIs |
a propensity score matching analysis, they find positive, sizeable effects on input additionality (i.e. $e_1$ of tax credit generates $e_2.3$ of additional R&D spending), but the effects on output additionality (where output is measured by the number of patents at the firm level) are not significant. This suggests that the French R&D tax credit system may have a lower impact on innovation than expected.

### 4.2.3 Effects on firm economic performance

Moutaabbid (2016) provides descriptive statistics for firms that benefited from the JEI between 2004 and 2015 in France, including a survey showing that 3,459 enterprises benefited from the JEI scheme in 2015, employing nearly 26,000 employees (Table 8). The majority of firms have fewer than ten employees (78%), and account for 38% of the total JEI labour force, and 46% of social security contribution exemptions. The majority (86%) of beneficiaries were active in information and communications technologies (ICT) and specialized, scientific and technical activities sectors. More than 60% of JEI participants generated positive turnover and value added, and nearly 50% succeeded in making profits. Moreover, the author finds that most subsidized firms were financially constrained and their salary costs accounted for nearly half of their operating costs (43%). The author concludes that according to the answers of firm respondents, the JEI scheme was effective because it ‘allows firms to lower labour costs for employees involved in research, development, innovation (RDI), thus giving access to the skilled labour needed for their growth’. Whilst informative for this study, given the lack of rigour in the data provided, the findings do not count as evidence of positive impact on firm turnover.  

Hallepeé and Garcia (2012) estimate the relevance of the JEI scheme on sales growth, finding that between 2004 and 2009, JEIs and non-JEIs sales rapidly grew, but the JEIs grew nearly twice faster than non-JEIs.\(^{19}\) These results are important for the design and scope of schemes targeting young innovative companies, albeit their reliability is questioned since estimation results and econometric specifications are not documented.  

Verhoeven, Van Stel, and Timmermans (2012) investigate the effects of the WBSO scheme on both input and output additionality from 2006 to 2010 in the Netherlands. Interesting results are obtained when focusing on firm innovative sales and economic performance as dependent variables (i.e. using the turnover share of new products and services and the value added per worker respectively). The authors find statistically relevant effects of the WBSO scheme in explaining variation in firm innovative and economic performance.
performance. More precisely, when looking at the effects of the WBSO on firm innovative performance, the authors find that when the WBSO tax credit sum for a company increases by 1%, the turnover share of new products and services increases from 0.19% to 0.26%. With an average share of innovative sales out of total turnover of 8.2%, this implies that an increase of the total sum of WBSO tax credits by 1% would lead to an increase of the turnover share to about 8.6% for an average company. When focusing on firm economic performance, they find that when the WBSO tax credit sum for a company increases by 1%, the nominal value added per worker increases from 0.13% to 0.17%. The evaluation study points out that the number of businesses that use the WBSO increased sharply—from 12,000 in 2006 to over 15,000 in 2010, and, importantly, small firms (up to 10 workers) increasingly use the WBSO scheme. However, the overall return is lower for small companies. Overall, WBSO leads to a higher percentage of R&D activities in small companies that would not have arisen without it.

Freitas et al. (2017) investigate the impact of R&D tax credits on firms’ innovative sales in different types of sectors (grouped in different taxonomies\(^2\)) in Italy and France (Table 9). Specialized sectors in Italy perform better when granted a tax credit (4.8% more turnover from new products), followed by supplier sectors (3.9%), science-based (3.3%) and scale intensive sectors (3.2%). In contrast, supplier-dominated, followed by specialized firms, in France are science-based (3.3%) and scale intensive sectors (3.2%). In contrast, supplier-dominated, followed by specialized firms, in France are science-based (3.3%) and scale intensive sectors (3.2%).

Caiumi (2011) finds that the Italian R&D tax incentive programme raises the overall total factor productivity of firms. The impact however is rather heterogeneous across less and more productive firms. The impact is stronger for firms on the lower end of the productivity distribution; for low productivity companies, the magnitude of the extra increase in productivity for firms that received the credit is equal to 17% per annum, whereas for high-productivity companies it is 3.5% per annum. This finding has an important policy implication: the amount of resources provided through the tax system affects the likelihood of less productive firms moving upward in the productivity distribution, thereby partly addressing the problem of increasing productivity performance gaps among firms.

### 5. Conclusions

Having explored the R&D tax credit design features that may support young innovative companies and the evidence of the impact of R&D tax incentives on firms, this section draws conclusions to be considered, in the context of the limitations set out earlier. It also reflects on policy implications and areas of further research.

#### 5.1 Main results and policy implications

Results on input additionality and leverage are mixed across countries and the specific policy context and it is difficult to arrive at any general consensus, although a number of positive results for young companies can be found.

While the UK studies point to large and significant tax-price elasticities for young firms of R&D investment with respect to tax credits, the only study identified in Ireland seems to find no significant effect of tax credits on young firms’ R&D investment. Dissimilar results arise from different Belgian studies depending on the variable under analysis—two studies show positive results concerning R&D intensity, but no significant impacts with regard to R&D worker wages. Finally, for some non-EU countries, R&D tax credits targeted at young firms seem to spur significantly higher R&D investment levels than in the absence of such policies.

Importantly, it seems that low-growth young firms experience statistically significant positive effects from tax credits on R&D intensity levels. The effect on high-growth companies is not significant. A possible policy implication therefore is that tax credit policies should target slow-growth instead of high-growth enterprises, as the former might deal with tighter financial constraints; or that high-growth enterprises are in need of other instruments (e.g. venture capital) that allow for a faster expansion.

Analyses of output additionality of tax incentives for young firms in EU MS (e.g. innovation, productivity, employment) seem to be restricted to France, Italy and the Netherlands, whereas the majority of studies in other countries focus on input additionality (i.e. R&D investment) only. Thus, in France the evidence points to significant positive effects of the JeI programme on employment, productivity, value added and sales (turnover from new products), while in Italy companies granted the investment tax credit performed better in terms of turnover from new products. Companies using the WBSO scheme in the Netherlands found positive effects on the turnover share of new products and services and the value added per worker.

Concerning productivity, the three studies analysed above point to positive effects of R&D tax credits in fostering both labour productivity and total factor productivity (TFP) at the firm level. Importantly, one study by Caiumi (2011), points to higher productivity effects of R&D tax credits on relatively low-productivity firms.

### Table 9. Effect of tax incentive on firm economic performance—academic studies

| Study            | Country   | Programme/instrument | Target firms                          | Period     | Methodology                     | Turnover from new products | Total factor productivity |
|------------------|-----------|----------------------|----------------------------------------|------------|---------------------------------|----------------------------|--------------------------|
| Freitas et al. (2017) | IT, FR, NO | R&D tax credit       | Innovative small firms and other firms | 2002–2008  | Propensity score matching, treat-| 4.8% for specialized sectors in IT | 17% for less productive firms3.5% for more productive firms |
| Caiumi (2011)    | IT        | Investment tax credit| Innovative small firms (with less than 30 employees) form 93% of firms using the scheme | 1998–2005  | OLS regression, GMM estimators | 2.8% for specialized sectors in FR |                      |
Table 10. Effect of tax incentives in young companies in generic and targeted schemes

| Generics and targeted incentives | Generic tax incentives (UK, NL, IE, non-EU countries) | Targeted tax incentives (BE, FR) |
|----------------------------------|------------------------------------------------------|---------------------------------|
| Input additionality              | Larger effects on R&D intensity (UK, NL) but weaker in IE: | Positive effects on R&D intensity (BE) but effects decrease if combined with other instruments (subsidies) |
| • Larger effects on young companies compared with companies of average age—higher price elasticity (UK), while lower effects on R&D additionality relative to other (older) firms reported in IE | | |
| • Positive effects on start-ups—R&D additionality (NL) | | |
| Larger effects on R&D intensity of tax instruments on young companies than grants and loans (non EU countries) | | |
| Effect on wages                  | Positive effect for young companies (NL) | Positive effect but only if specific instruments used, effects decrease when using combined instruments (BE) |
| Output additionality             | Employment, innovation, economic performance | Positive effect on employment, productivity, sales and added-value (FR) but results needs to be reproduced using more robust methods |
| Limited evidence on output addi-
| tionality                       | Limited impact on innovation for all companies (FR)/Positive effects on all companies, in turnover share of new products/services, however, the overall return is lower for small companies. (NL) | |

Notes: Countries studied in this project are written in bold (see left column) and shaded in grey in the right column; Evaluations by countries in shaded black lines have not been the subject of this research.

Source: European Commission, JRC.

Table 11. R&D tax incentives in the EU, targeted schemes, and evaluations

| EU Member State | R&D tax incentives | | | |
|-----------------|--------------------|---|---|---|
|                 | Expense-based/input based credit | Plus differentiated schemes by firm age | Plus differentiated scheme by firm size | Includes wage tax relief | Evaluation available for selected countries |
| Austria         | X                   | X | X | X |
| Belgium         | X                   | X | X | X |
| Bulgaria        | X                   | X | X | X |
| Croatia         | X                   | X | X | X |
| Cyprus          | X                   | X | X | X |
| Czech Republic  | X                   | X | X | X |
| Denmark         | X                   | X | X | X |
| Estonia         | X                   | X | X | X |
| Finland         | X                   | X | X | X |
| France          | X                   | X | X | X |
| Germany         | X                   | X | X | X |
| Greece          | X                   | X | X | X |
| Hungary         | X                   | X | X | X |
| Ireland         | X                   | X | X | X |
| Italy           | X                   | X | X | X |
| Latvia          | X                   | X | X | X |
| Lithuania       | X                   | X | X | X |
| Luxembourg      | X                   | X | X | X |
| Malta           | X                   | X | X | X |
| Netherlands     | X                   | X | X | X |
| Poland          | X                   | X | X | X |
| Portugal        | X                   | X | X | X |
| Romania         | X                   | X | X | X |
| Slovakia        | X                   | X | X | X |
| Slovenia        | X                   | X | X | X |
| Spain           | X                   | X | X | X |
| Sweden          | X                   | X | X | X |
| United Kingdom  | X                   | X | X | X |
| Total           | 25/28               | 5/28 | 9/28 | 7/28 |

Notes: Countries studied in this project are written in bold (see left column) and shaded in grey in the right column; Evaluations by countries in shaded black lines have not been the subject of this research.

Source: European Commission, JRC.
Likewise, Verhoeven, Van Stel, and Timmermans (2012) note an evidence of positive effects of targeted R&D tax incentives on young firms R&D intensity and country specific (e.g. in Italy and France) and a particularly strong effect in specialized and supplied sectors in both countries.

Targeting young firms with tax incentive schemes may be an effective way to broaden the uptake of tax credit measures (see Table 10). The importance of the explicit consideration of young innovative companies among the design features of tax credits supporting access to credit is evident in the greater participation rates and effectiveness achieved by schemes in Belgium and France, which explicitly target these types of companies. Likewise, Verhoeven, Van Stel, and Timmermans (2012) note an increased use of the WBSO scheme by small firms between 2006 and 2010.

The limited number of studies on the impact of fiscal schemes makes it difficult to draw any major policy conclusions, or to distinguish between the merits of the various designs of these instruments (particularly since the opportunity for intra-country comparisons is extremely constrained as the majority of countries use only a single design). Nevertheless, despite the noted limitations, we conclude that there is sufficient evidence to suggest that the range of tax credit schemes and incentives implemented by governments offer an attractive source of support for young and small companies and that many have gained significant benefits as a result. More specifically, there is some evidence on the larger effects of generic R&D tax measures on young firms R&D intensity and country specific (e.g. in France) evidence of positive effects of targeted R&D tax incentives on firms employment, productivity, sales and added-value which call for more comparative research.

Moreover, governments could capitalize on the flexibility offered by the inherent design variability of fiscal instruments in order to experiment with the full range of policy options offered by such measures including targeted measures for young innovative firms—-with the proviso that such experimentation is accompanied by rigorous evaluation of effects and impacts.

It is worth noting that the overall goal of governments in providing tax incentive schemes is to raise firms’ innovative activity and to contribute to social and economic development—the stimulation of additional R&D activity can only be considered a proxy for this. There is therefore a need for governments and the evaluation community to explore the output and behavioural additionality effects of tax credit schemes in order to determine why such effects do (or do not) emerge rather than looking for the existence of (often marginal) input additionalities. This could have significant potential for policy learning.

A further promising avenue of future evaluation research could be to explain the choice of type of instrument (e.g. tax credits versus grants) based on the characteristics of firms (e.g. size, sector, technological level). Understanding the motivation underlying the choice of one instrument over another, would give an idea of the so-called behavioural additionality of policies aimed at promoting companies’ growth and innovation activities, although it is recognized the problem of attributing any effects and impact to a single support instrument is a constant challenge to evaluators.

Notes
1. At present, a total of 25 MS are currently using fiscal incentives to encourage investment in R&D (European Commission, DG TAXUD, 2016).
2. Given the scarcity of studies for this narrow definition of firms in EU countries, one study applying to non-EU economies is included.
3. Using the Scopus database, we carried out two separate search protocols that each contained a set of keywords to identify papers on our study subject (i.e. the type of enterprise), in combination with a second keyword targeting access to finance. We then employed a manual identification of central papers to establish the relevant corpus of academic literature.
4. National experts with knowledge of national policy measures facilitating access to finance for young innovative companies in their countries.
5. SIPER is an on-line searchable repository of science, technology and innovation policy evaluation reports (http://si-per.eu/).
6. There are obvious similarities between academic studies and evaluations, but there are also some notable differences. Unlike evaluations, academic studies’ primary objective is to quantify economic relations, that is, provide numerical estimates of the parameters involved in the analysis of economic data.
7. In brief, the policy change consisted of a reduction of the asset-based size threshold for eligibility, implying a higher number of firms could participate in the scheme after the change.
8. The threshold used for the subsample of young firms is 12 years of age, a slightly higher age cut-off point than what is normally considered to be young in the policy world.
9. A precise definition of young is not however provided in this study.
10. Specifically, depending on the econometric method used, the leverage coefficient was estimated at 0.77 (Heckman procedure) or 0.81 (Maximum Likelihood).
11. These were years when there were changes in the generosity of the schemes.
12. A Young Innovative Company is defined (see Belgian Science Policy, 2006) as a company which: carries out research projects; has been set up for less than 10 years before January 1 of the year during which the advance payment exemption is granted; is not set up within the framework of concentration, a restructuring, an extension of a pre-existing activity or resumption of such activities; has made expenditures on R&D representing at least 15% of the total costs in the foregoing taxable period.
13. The exact years the panel data covers are not known.
14. A recent line of thought has emerged arguing that small young firms may not exhibit the linear growth profile that is normally a priori expected in the literature. Instead, authors ascribing to this view argue that firms’ performance might be stepwise incremental, which could be due to the need to develop a necessary capital (human and/or physical) basis before being able to take off.
15. It is worth noting that the authors consider as young those firms aged 0–3 years, a somewhat narrow definition.
16. The magnitude is however not reported.
17. Measured by a composite quality index accounting for forward citations, family size, and industry classes.
18. In France, the R&D tax credit was initiated in 1983 but since then has been significantly changed. It was initially incremental (based on R&D spending increases). In 2004, a ‘share in volume’ regime based on the amount of R&D was introduced in parallel. In 2008, there was the adoption of a purely in volume R&D scheme.
19. The magnitude is however not reported.
20. Freitas et al. (2017) refer to the sectoral taxonomy developed by Pavitt (1984), who aggregated manufacturing sectors into four categories of sector - traditional ‘supplier dominated’, ‘scale-intensive’, ‘specialized equipment suppliers’ and ‘science-based’—on the basis of similarities and differences among sectors in the sources, nature and organizational modes of innovative activities.
21. The caveat remains, however, that no general policy implications can be drawn from a single study focused on one country only.

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