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Supporting Firm Innovation and R&D:
What is the optimal policy mix?*

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Abstract: This policy report provides an overview of firm R&D support policies used by European countries, reviews the empirical evidence on the effectiveness of these policies, and discusses implications for policy. Existing literature suggests that firm R&D support policies stimulate private R&D within a country and that in most cases, the positive impact of government support is stronger on smaller firms. Recent evidence also indicates that some of the policy instruments, such as patent box policies, are tools that multinationals use to lower their total tax bill through profit shifting. Despite the data issues that limit the ability to quantify the impact of tax incentives on global R&D, these recent findings together suggest that R&D support policies indeed promote national R&D activities. But governments also use some of these tax instruments to compete for R&D and mobile tax bases, which makes them less cost-effective in stimulating aggregate private sector R&D.

Keywords: R&D, Innovation, Patent Boxes, R&D Tax Credit, Public Subsidies, Public R&D.

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1. Introduction

Governments find it beneficial to stimulate private sector's research and development (R&D) and innovation efforts, because there are positive externalities from R&D and the outcomes of private R&D efforts are highly uncertain. In the absence of government intervention, these factors would cause firms to invest lower amounts of R&D than would be socially desirable. Therefore, stimulating firm R&D through government support is likely to be welfare-increasing (Arrow (1962) and Nelson (1959)). The question about the best policy mix for supporting innovation, however, is still open to debate. In principle, firm R&D can be supported through two main channels. First, governments may fund public R&D undertaken by universities or research institutes which then stimulates private R&D via knowledge spillovers and other network effects. Second, governments can support private R&D projects financially. This can be achieved by providing direct (cash) subsidies or a beneficial tax treatment to income from R&D (patent box regimes) and/or expenses for R&D (R&D tax credits).

Our report aims to stimulate the discussion about the optimal policy (mix) to promote firm R&D. We proceed in three steps. First, we provide some descriptive evidence on how European countries support private sector R&D. Second, we summarize the empirical literature on the effectiveness of different firm R&D support policies. Third, we discuss the implications of the empirical evidence for the optimal policy mix.

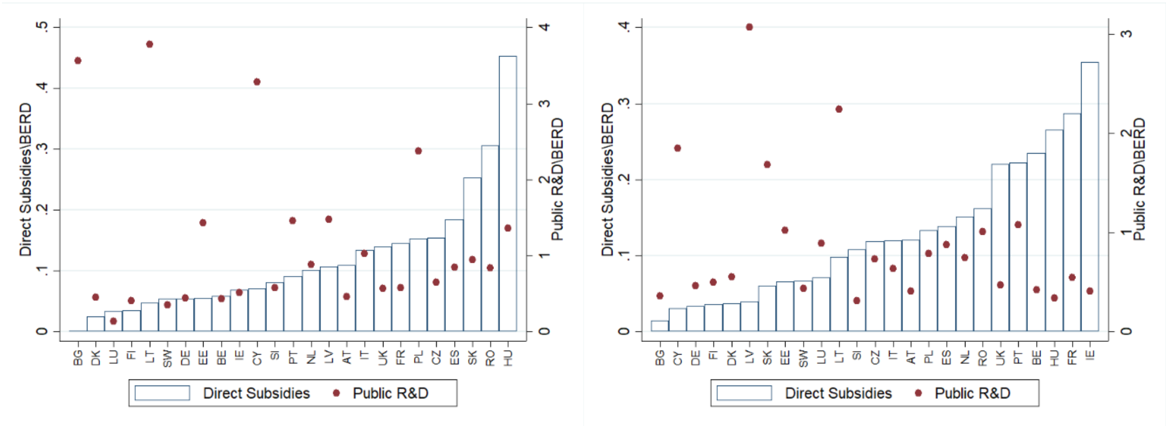
2. Trends in Stimulating Firm R&D Policies

In this section, we report some descriptive statistics on the (changing) relevance of different R&D support policies for the private sector. We focus on the EU 28 countries except for Malta, Greece and Croatia due to missing information. The data used stems from the OECD Research and Development Statistics and from Eurostat.

The left-hand side of Figure 1 shows direct subsidies (bars), either via cash and tax (system) subsidies, and public R&D (R&D expenditure in the higher education and government sector) relative to overall business enterprise R&D (BERD) for 2003/2004. The right-hand side of Figure 1 does the same for 2015/2016. Further, Figure 2 plots the change in direct subsidies and public R&D relative to BERD between 2003/2004 and 2015/2016.

The figure for 2003/2004 highlights three facts. First, all countries rely more on public R&D than on direct subsidies: The average country spends approximately for each euro for public R&D around 18 cent in direct subsidies. Second, countries with a relatively low share of direct subsidies (below the median) rely more on direct subsidies in relative terms (1 to 0.12 for public R&D to direct subsidies) and countries with a relatively high share of direct subsidies rely less on public R&D (1 to 0.24 for public R&D to direct subsidies). Third, there is a small set of largely peripheral countries (e.g. Bulgaria, Cyprus, Latvia, Lithuania, Estonia and Portugal) which rely very strongly on public R&D.

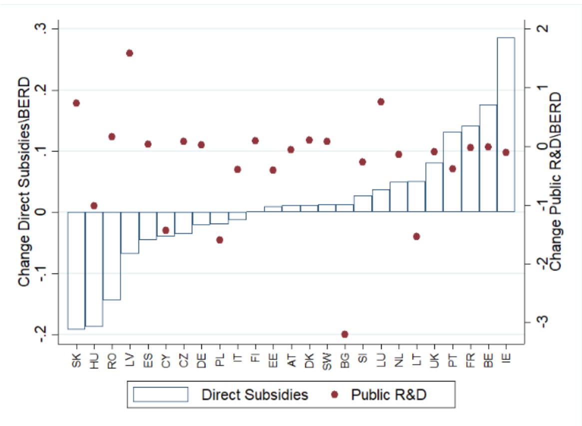
Figure 1: Direct Subsidies and Public R&D Relative to BERD in 2003/2004 (left) and 2015/2016 (right)



Notes: The left-hand side of the figure shows direct subsidies for firm R&D (bars) and public R&D relative to business enterprise R&D (BERD) for 2003/2004 and the right-hand side of the figure shows the same for 2015/2016. Direct subsidies include cash subsidies and tax system subsidies (R&D tax credits and patent box regimes) and public R&D includes R&D expenditures in the higher education and government sector. Countries are ordered according to their level of direct subsidies relative to BERD. Source: OECD Research and Development Statistics and Eurostat, 2003-2016.

For 2015/2016 the pattern has changed partly. While all countries still rely more on public R&D and also the ``outlier'' countries still exist, the different relative use of public R&D relative to direct subsidies between countries with a low and high direct support share is even larger. For example, 5 out of the top 8 countries with the lowest share of direct subsidies are among the countries with the highest direct support share for direct subsidies. These are the UK, Belgium, Hungary, France and Ireland.

Figure 2: Change Direct Subsidies and Public R&D Relative to BERD between 2003/2004 and 2015/2016

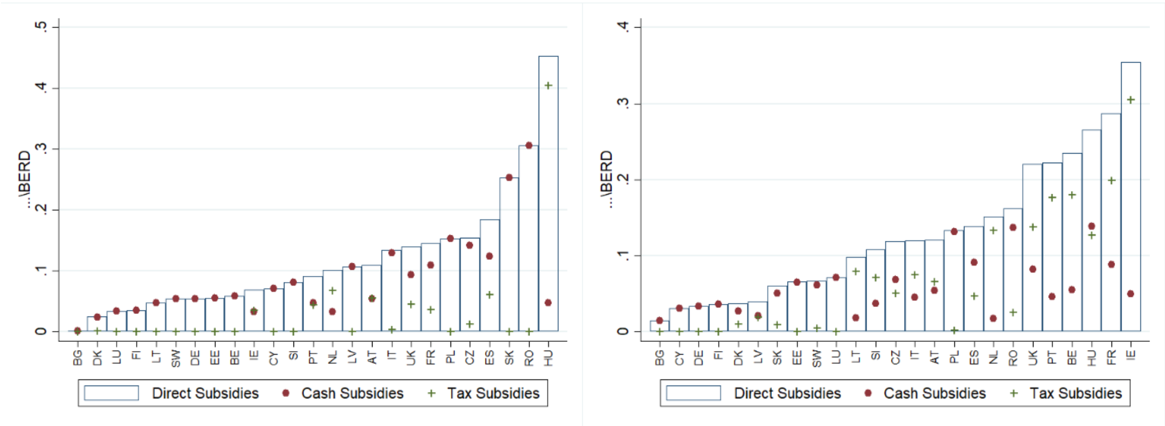


Notes: The figure shows the change in direct subsidies (bars) and the change in public R&D relative to business enterprise R&D (BERD) between 2003/2004 and 2015/2016. Direct subsidies include cash subsidies and tax system subsidies (R&D tax credits and patent box regimes) and public R&D R&D expenditures in the higher education and government sector. Countries are ordered according to their change in direct subsidies relative to BERD. Source: OECD Research and Development Statistics and Eurostat, 2003-2016.

To assess whether there has been a systematic shift, away from public R&D and towards direct subsidies, Figure 2 plots the change in direct subsidies and public R&D relative to BERD between 2003/2004 and 2015/2016. Two facts emerge: First, most countries have left the share of public R&D

unchanged. Second, while some countries increased the direct subsidy share, other countries decreased it or have left it largely unchanged. Thus, the descriptive evidence does not suggest a shift in the policy mix away from public R&D towards direct subsidies over the last decade for the countries included in the analysis.

Figure 3: Direct Subsidies, Cash Subsidies and Tax Subsidies Relative to BERD in 2003/2004 (left) and in 2015/2016 (right)



Notes: The left-hand side of the figure shows direct subsidies for firm R&D (bars), cash subsidies (dots) and tax subsidies (+) relative to business enterprise R&D (BERD) for 2003/2004 and the right-hand side of the figure shows the same for 2015/2015. Direct subsidies includes cash subsidies and tax system subsidies (R&D tax credits and patent box regimes). Countries are ordered according to their level of direct subsidies relative to BERD. Source: OECD Research and Development Statistics and Eurostat, 2003-2016.

Next, we inspect the extent to which countries rely on cash subsidies versus tax system subsidies as direct subsidy policy. The left-hand side of Figure 3 shows direct subsidies (bars), cash subsidies (dots) and tax subsidies relative to business enterprise R&D (BERD) in 2003/2004 and the right-hand side of Figure 3 shows the same in 2015/2016. The figures suggest that in 2003/2004 and 2015/2016 countries with a relatively low share of direct subsidies (below the median) relied almost exclusively on cash subsidies and that countries with a relatively high share of direct subsidies are more likely to rely in addition on tax subsidies. The latter relationship is even stronger for 2015/2016 as countries with high direct subsidy shares rely stronger on tax subsidies.

To assess whether countries have moved away from cash subsidies towards tax subsides, Figure 4 plots the change in direct subsidies (bars), cash subsidies (dots) and tax subsidies relative to BERD between 2003/2004 and 2015/2016. The figure shows that countries that have decreased their level of direct subsidies have cut down cash subsidies, while countries that have increased their level of direct subsidies have expanded tax subsidies. There is, however, little evidence that moving towards tax subsidies (moving away from cash subsidies) is related to lower cash subsidies (higher tax subsidies), except for a few countries. While the Czech Republic, Italy and Slovenia increased tax subsidies and decreased cash subsidies, Hungary did the opposite. Thus, similar to the evidence for direct subsidies and public R&D there is no evidence for a general shift in policies.

Figure 4: Change in Direct Support, Cash Subsidies and Tax Subsidies Relative to BERD between 2003/2004 and 2015/2016

Notes: The figure shows the change in direct subsidies for firm R&D (bars), change in cash subsidies (dots) and change in tax subsidies (+) relative to business enterprise R&D (BERD) between 2003/2004 and 2015/2016. Countries are ordered according to their change in direct subsidies relative to BERD. Source: OECD Research and Development Statistics and Eurostat, 2003-2016.

Summing up, we find that all countries spend more on public R&D than direct subsidies. In relative terms, countries that have a higher level of direct subsidies relative to BERD rely less on public R&D. However, there is no evidence for a general trend towards direct subsidies and away from public R&D, rather, the level of public R&D was largely unchanged and in some countries the level of direct subsidies increased, while it decreased or was unchanged in others. Furthermore, the descriptive evidence shows that countries with a larger share of direct subsidies relative to BERD are more likely to rely on tax subsidies and this relationship is stronger today than it was in the early 2000s. Countries that increased their share of direct subsidies increased their support for firm R&D and innovation using the tax system, while countries that decreased it have cut down cash subsidies. Only for very few countries the increase in one dimension coincides with a reduction in the other. Taking the evidence together suggests that countries have chosen the level of support for each policy instrument largely independent of the level of support for other policy instruments. This indicates that (i) governments are not constrained in their financial resources for supporting private sector R&D and (ii) that they believe that the different instruments are not substitutes.

3. Indirect Firm R&D Support Policies: Public R&D

We now turn to the review of the empirical literature for the different firm R&D support policies. Probably the oldest R&D support policy around the globe is the establishments and funding of universities, which provide higher education teaching and engage in R&D (in the following labelled public R&D). Moreover, since WW II public R&D is not only undertaken by universities but also more and more by governmental research institutes as well as publicly funded non-governmental research institutes.

While a large body of literature has shown that industry R&D labs prefer to locate close to public R&D producers (see, for example, Abramovsky et al (2007, UK) and Woodward et al (2006, US)) and that more public R&D substantially increases (close-by) firm R&D expenditures and the number of firm patents (e.g. Jaffe (1989, US), Autant-Bernard (2001, France) and Anderson et (2009, Sweden)), the transmission channel(s) at work are less well understood. The reason is that measuring the interaction between public and private R&D producers is challenging, as several transmission channels might be at work. Potential candidates include, for example, the provision of highly trained graduates for employment in the industry, university-spin offs, consultancy, provision of research infrastructure, collaboration as well as knowledge spillovers, either in the form of technology or in the form of ``non-specific'' knowledge spillovers.

Recent work suggests that the large spillovers of public on private R&D are unlikely to result from the degree production of universities (e.g. highly trained graduates for employment in the industry) as the labour force is mobile (Abel and Deitz (2011, US)) and similar results are found for non-university public R&D (Koch and Simmler (2020, Germany)). Moreover, given the low number of local citations of public patents as well as the relatively low share of (successful) collaboration (although the latter may be undercounted), neither technological nor collaboration spillovers seem to be the dominant driver (see, for example, Koch and Simmler (2020)). Thus, the existing evidence suggest that the relatively large local spillovers of public R&D may result from ``non-specific'' knowledge spillovers, e.g. spillovers of knowledge of "what does not work, what approaches have been previously tried, and led to dead ends" (Feldman and Kogler (2010), p. 386). Since this knowledge is highly tacit as it is usually not included in patents or scientific publications, it can explain why public R&D spillovers are so localized (see, for example, Andersson et al. (2009) and Belenzon and Schankerman (2013)). Moreover, the high relevance of non-specific knowledge spillovers is in line with the results by Branstetter and Sakakibara, (2002). They study research consortiums in Japan and find that firms that are included in a research network increase their R&D spending substantially and that the effect is stronger the larger the potential level of R&D spillovers within the network.

An important dimension of effect heterogeneity identified in the literature is that public R&D seems to increase in particular R&D activities of smaller firms. While Link and Rees (1990, US) find that large firms are more likely to participate in university research, they also show that small firms are better able to transfer this knowledge. Acs et al. (1994, US) show that geographic proximity is more important for small firms and that university R&D has a larger impact on their R&D. Similar evidence is found by Koch and Simmler (2020) for Germany. One potential explanation for the stronger impact on small firm R&D in the light of the above suggested dominant transmission channel is that small firms may learn more from the ``trial and error'' of public R&D projects as they face tighter R&D budgets due to financing constraints (e.g. Hall and Lerner (2010)).

Furthermore, there is some evidence that basic public R&D, in other words, public R&D with a high technological value, has a stronger impact on firm R&D than more applied public R&D (see, Cassiman et al (2012) for industry-university collaborations and Koch and Simmler (2020) for local knowledge spillovers of public R&D), a pattern which is also observed for firm collaborations (see Branstetter and Sakakibara (2002)).

Lastly, Koch and Simmler (2020) provide evidence that the impact of public R&D on firm R&D is decreasing in the level of public R&D. This could results from the interaction of public and private R&D producers in the labour market (e.g. higher public R&D drives up wages of researcher and thus crowds out private R&D) or from the fact that ``trial and error'' knowledge does not necessarily increase one to one in the level of public R&D.

Summing up, the results of the existing literature on the impact of public on private R&D suggests that public R&D has a strong impact on local firm R&D and in particular on small firm R&D and that the impact is larger for public R&D that has a higher technological value. Since the magnitude of local knowledge spillovers of public R&D seem to be decreasing in the level of public R&D, public R&D in many different locations is likely to have a larger impact on firm R&D than if concentrated in only very few regions.

4. Direct Firm R&D Support Policies

Additional to the provision of public R&D, which is a rather indirect firm R&D support policy, governments around the globe also rely on more direct R&D firm supports policies, either in the form of direct subsidies or in the form of tax incentives for R&D (projects)[2].

4.1 Direct Subsidies

Direct subsidies – upon application by firms and granted after the positive evaluation by experts – are a widespread firm R&D support policy used by governments around the globe. Similar to the provision of tax incentives, direct subsidies reduce firms' cost of R&D and therefore may increase R&D expenditures and innovation if the R&D projects would not have been undertaken in the absence of the subsidies. If the projects would have been undertaken in any case, the direct subsidies only increase firm profits without any additional impact on R&D spending or innovation. This means that the effectiveness of direct subsidies largely depends on the question whether private and public funds are complements (e.g. additionality) or substitutes within a firm (e.g. crowding out).

While earlier literature has presented evidence in support of both views (see David et al (2000)), more recent work strongly rejects the full crowding out hypothesis (see Becker (2015)) and reports that direct subsidies mainly affect small (young) firm R&D (see, for example, Lach (2002, Israel), Hyytinen and Toivanen (2005, Finland), Gonzales et al (2005, Spain). Bronzini and Iachini (2014, Italy) and Howell (2017, US)). The suggested reason for this finding is that smaller companies are more likely to face financing constraints as they have less collateral to secure external funding and suffer stronger from information asymmetries in the capital market (e.g. Hall and Lerner (2010)). This, however, does not imply that smaller companies ought to be subsidized repeatedly, as Howell (2017) finds that - in the US and the analysed industry - first round but not second round subsidies have a strong impact on firm R&D. She suggests that this is the case as first-round subsidies allow firms to fund technology

[2] Sometimes, the R&D tax credits literature uses the term 'indirect support' to refer to tax incentives for businesses that support R&D and innovation. Our use of the terms 'direct' and 'indirect' in this paper differs from the categorization in the R&D tax credits literature. We use the term 'direct support' to refer to the funds that are channeled directly to businesses, rather than indirectly via spillovers from university or research institute R&D.

prototyping and thus reduce technological uncertainty. Another reason for the larger impact on small firm R&D, brought forward in the literature, is that smaller firms are less likely to engage in R&D activities at all (Hall et al (2009, Italy)). Thus, direct subsidies induce R&D spending for these firms and can therefore not crowd out R&D spending for other projects. A second important dimension of effect heterogeneity identified in the literature relates to the subsidization rate. Guellec and Van Pottelberghe (2003) as well as Goerg and Strobl (2007) provide evidence that the impact of subsidization rates on firm R&D has an inverted U-shape. The underlying reason for this is, however, not yet clear.

Due to the presence of (positive) technology and (negative) product market rivalry spillovers, the impact of direct subsidies on aggregate firm R&D may be smaller or larger than the one for the subsidized firm. While this was for a long time an open question, recent work by Bloom et al. (2013) suggests that the aggregate impact is larger as technological spillovers seem to outweigh product market rivalry spillovers.

Summing up, the empirical literature on direct subsidies for firm R&D suggests that they are most effective in stimulating small firm R&D and that one-off funding with a moderate subsidization rate for a large number of firms has a stronger impact than a high subsidization rate for a small number of firms as well as a moderate subsidization rate for re-occurring subsidies for a small number of firms.

4.2 Tax Incentives

Countries around the globe have started in the last few decades to rely more and more on tax incentives to support private R&D (see Section 2). R&D-intensive countries such as France, Canada and China channel more than half of their public funds for private sector's R&D via the tax system (OECD, 2018). These countries, among many others, started using tax instruments for R&D support even before a body of literature on the effectiveness of R&D tax incentives emerged.

The reasons policymakers started to find simply-designed tax breaks to be preferable over direct subsidies are the potentially lower administrative costs for using tax incentives, and the ability of the government to stimulate private R&D while leaving to the firms the decision of which projects to invest in.[3] By choosing the tax system, the government no longer has to set up committees of experts to evaluate the projects and select among them, as in the case for direct subsidies. Further, firms themselves know the market better and therefore can invest in more profitable opportunities. This convenient aspect of using the tax system comes at a cost: the overall cost of the scheme in terms of foregone tax revenue is much larger than the cost of direct subsidies for the government's budget. That is because the government then has to subsidise all private R&D and not just incremental firm R&D, meaning that the government ends up paying for some projects that would already have taken place in the absence of the policy.

[3] Over the same period, some developing countries implemented a series of tax incentives with complex procedures with the aim of tackling evasion. More complex designs did not have the same advantages over direct subsidies as simpler schemes.

Conceptually, two different types of tax incentives can be distinguished (which may, however, also be both in place as, for example, in the UK). The first type of tax incentives are R&D tax credits. They allow firms to deduct more than their actual R&D expenses from the tax base (e.g. 150%) and thus decrease firms' cost of capital by lowering their tax bill. The second type of tax incentives are patent (intellectual property, IP) box regimes. These provide a lower tax rate (than the standard corporate income tax rate in a country) for the returns from R&D and thus increase the net present value of R&D projects.

R&D Tax Credits

Owing to the increased availability of micro-level data from tax authorities, more robust empirical evidence has recently become available on if and how R&D tax credits may be effective. This evidence finds that companies on average spend more on R&D if they benefit from a tax credit, and depending on the design, the credits mostly benefit young and high-growth firms.

Because tax credits subsidise both the *marginal* projects – those that would not have taken place in the absence of the policy - and also the projects that would have gone ahead regardless of the policy, the literature on the evaluation of R&D tax credits has focused on finding increased activity in *marginal* projects. Since it is both impractical and unethical to conduct randomised trials in this field, most studies used *quasi-experiments*, situations where a group of companies were eligible for generous tax breaks whereas others were not and compared the relative performances of the two groups in a set of outcomes. These studies have found positive and statistically significant effects of tax breaks on R&D spending (Rao (2016, US); Guceri and Liu (2019, UK); Agrawal et al (2019, Canada)) and R&D headcount (Guceri (2017, UK)), and to a lesser extent, higher innovation (Dechezlepretre et al (2019, UK)) and increased total factor productivity (Chen et al (2019, China)). The effects vary a lot across different groups of firms. Small and young firms appear to respond more strongly, suggesting that the policy may be addressing the financing difficulties of particularly constrained groups. Most studies find policy effects on R&D with generally comparable magnitudes. As an example of cost-effectiveness, Guceri and Liu (2019) find that *on average*, medium-sized companies with the more generous R&D tax treatment increased their spending by around 20 percent relative to the group of larger companies without the additional benefits. They also find that the government recovered more than its £1 of foregone tax revenue in terms of newly-generated R&D thanks to the policy.

There remain unanswered questions about the effectiveness of tax incentives for R&D. First of all, how generalisable are the results from certain eligible groups to the broader economy? In addition, does this newly-generated R&D address the bigger goals of the government, which may include a larger number of successful innovations and improving productivity? Second, and relatedly, do firms relabel their existing spending as R&D to access the benefits? If this is the case, then the newly-generated R&D should not be very productive. Chen et al (2019) show some evidence that in China, a significant proportion of the R&D that the tax break generates is a result of relabelling; nevertheless, the authors also highlight important productivity effects of the policy. The third point of caution relates to international flows. By introducing R&D tax breaks, do governments merely attract R&D that is carried out in other jurisdictions, or do they stimulate the generation of new knowledge that would otherwise not have taken place anywhere in the world? Wilson (2009) addresses this issue and calls R&D tax credits a 'zero sum game', based on data from the US inter-state transfers of R&D spending in the case of state-level tax incentives. The positive state-level effects of R&D tax incentives are offset by the negative effects on states with less generous tax treatment of R&D. Wilson's finding may be specific to a federal system with multiple states, as movements of R&D operations may be easier within the US than across different countries. This is nevertheless among important policy questions to which the existing literature has not yet found an answer.

Patent (IP) Box Regimes

The use of patent (intellectual property (IP)) box regimes to stimulate firm R&D is the latest innovation in the field of firm R&D support policies. Starting in the early 2000s, many countries introduced patent box regimes. Mostly after 2007, several European countries including Belgium, Cyprus, France, Hungary, Ireland, Lichtenstein, Luxembourg, Malta, the Netherlands, Portugal, Spain, Switzerland (Nidwalden), and the United Kingdom followed. Similarly, the 2017 US corporate tax reform `Tax Cuts and Job Acts' (TCJA) has also introduced a patent box regime for the US tax system. All IP box regimes feature a substantially lower tax burden on IP income vis-à-vis income derived from a firm's standard business activity. For instance, in France and the United Kingdom, a separate rate of 15 percent and 10 percent, respectively, is applied in taxing IP income.[4] The effective tax rate on IP income varies greatly across countries and amounts to around 5 percent in Belgium, Luxembourg, and the Netherlands, around 10 percent in Spain, Hungary, and the United Kingdom, and up to 15 percent in France (EY, 2015; Evers et al., 2015).

Patent boxes are not uncontroversial in their effects. The intended effect of patent boxes is to stimulate R&D that leads to IPs and finally to higher firm productivity and growth. Given the difficulty in tracing firms along the "value chain", the empirical literature focuses on these different outcomes along the "value chain" separately. The productivity-enhancing role of patent boxes is in line with the empirical finding that patent boxes increase R&D, either directly in MNE affiliates in the patent box country (Ohrn (2016)) or indirectly in MNE affiliates that are not located in a patent box country, but have a sister affiliate in a patent box country (Schwab and Todtenhaupt (2019)). A series of recent papers provide more direct evidence on productivity effects. They document a rise in patent registration in response to patent boxes (e.g. Bradley et al. (2015), Alstadsaeter et al. (2018), and Boesenberg and Egger (2017)). These findings are in line with the general observation that corporate income taxes affect patent applications, as found in earlier literature (Karkinsky and Riedel (2012), Boehm et al. (2014)).

The literature on productivity effects is more sparse. Related to the existence of output effects, Chen et al. (2017) find evidence that MNE affiliates in patent box countries increase employment relative to MNE affiliates in non-patent box countries. Looking directly at productivity effects (i.e. after

[4] Other countries resort to adjustments of the tax base, exempting between 50 percent and 80 percent of the income derived from IP when computing taxable income.

controlling for inputs), Koethenbuerger et al. (2019) show that domestic firms in European countries that have access to the tax benefit of patent boxes (proxied by historical patent ownership) show a higher productivity after the introduction of the patent box. The productivity effect is evaluated relative to a matched sample of domestic firms in patent box countries that cannot access the tax benefit.

A frequently raised concern is that patent boxes do have desirable economic effects (to which the above reviewed literature lends support) but might also be used by MNEs to save on taxes. MNEs can use the preferential tax treatment by adjusting the royalty payments for intangible assets to report higher taxable income in countries that offer a patent box. High-tax countries and the OECD express concerns about the tax minimization strategies that patent boxes allow (OECD (2015)). The policy concerns are heightened by the unique nature of IP rights, which makes it difficult, if not impossible for tax authorities to find comparable market transactions as a benchmark to detect tax-induced profit shifting. As a consequence, patent boxes appear to be a `low-risk' tax saving option for MNEs. Empirical work on the use of patent boxes for profit shifting has only evolved very recently, although the basic notion that IPs are used for transfer pricing is well established in the literature. However, direct evidence on the extent to which IPs are used for profit shifting is scarce, if not non-existent. The introduction of patent boxes provides a policy variation that allows to provide such evidence.

For instance, Chen et al. (2017) study whether patent boxes affect the earnings before interest and taxes (EBIT) of affiliates of European MNEs. They exploit cross-country variation in the implementation of patent boxes and compare MNE affiliates in patent box countries as compared to MNE affiliates in non-patent box countries. The finding of a positive effect on EBIT suggests that patent boxes are used for profit shifting. Similarly, royalty payments for the use of intellectual property (IP) between the U.S. and foreign countries increase in response to the introduction of patent boxes in these foreign countries (Ohrn (2016)). The positive effect holds provided restrictions on the eligibility of existing and acquired patents do not apply, i.e. the patent box benefit is not restricted to newly and self-created patents.

To provide a more comprehensive understanding of the fiscal effects of patent boxes, Koethenbuerger et al. (2019) adopt a MNE affiliate-level analysis within patent box countries. The design allows to control for various unobserved characteristics of MNE affiliates and to measure the overall effect of patent boxes on profit shifting, including payments from the U.S. Koethenbuerger et al. use a matched sample of MNE affiliates that can or cannot access the tax benefit, as proxied by historical patent ownership. Historical patent ownership includes patents that are directly owned by the affiliated or indirectly via the majority shareholder of the affiliate. Indirectly owned patents might be relocated to patent box country at presumably low cost and can be used to profit shifting. The view is consistent with the literature on the tax-sensitive choice of IP location (Dischinger and Riedel (2011), Karkinsky and Riedel (2012) and Griffith (2014)) and with the finding that patent boxes tend to have a bigger impact on patent trading as compared to patent filing (Egger and Boesenberg (2017), Gaessler, Hall, and Harhoff (2018)).

The analysis in Koethenbuerger et al. (2019) suggests that MNE affiliates that can benefit from the preferential regime report 8.5 percent higher pre-tax profits and 11 percent higher EBIT. The difference between the two measures is informative about the extent to which MNEs shift profits in the patent box country to benefit from the low tax treatment, but at the same time shift profits out of the country via internal debt shifting. While the former effect increases corporate tax revenues according to the low patent box tax rate, the latter effect is presumably unintended and reduces corporate tax revenues, since interest payments are deductible and lower the MNE's tax obligation proportional to the higher standard corporate tax rate. This implies that, contrary to expectation, the overall tax base adjustment might lower tax revenues collected from MNEs after the introduction of patent boxes. The research appears to provide a foundation for policy concerns, as expressed in e.g. Hall (2019) and Bloom, van Reenen and Williams (2019), that patent boxes are actively used in fiscal competition rather than only being a pro-innovation policy instrument.

5. Conclusion

Our review of the empirical literature suggests that the most prevalent support policies are effective in fostering private enterprise sector R&D, at least from a national perspective. In particular, small and young firms seem to benefit the most from both public R&D and R&D tax incentives, as they potentially suffer strongest from financing constraints. While public R&D seems to help small firms by allowing them to learn from the trial and error knowledge of public R&D projects, cash subsidies and R&D tax credits alleviate financing constraints more directly. Since patent boxes only reward successful R&D projects that have resulted in patents or other IPs and as they are used for profit shifting as well, they are suggested to be less cost-effective in stimulating private sector R&D and thus less likely to be part of the optimal policy mix.

Given that public R&D and direct subsidies stimulate firm R&D via different channels, both are expected to be part of the optimal policy mix to promote R&D. More research on the interaction between the two transmission channels is, however, needed to understand their contribution for the optimal policy mix.[5] The relative importance of cash subsidies vs R&D tax credits for the optimal tax policy mix depends on their administrative costs, among other factors. Administrative costs include auditing costs to limit a mere re-labelling of R&D expenses to benefit from R&D tax credits on the one hand and screening costs to select the most promising R&D projects under a subsidy scheme on the other hand. Financing costs might equally differ under the two policies. For instance, an R&D tax credit generally applies to all rather than only new R&D projects, which increases the fiscal costs of such a policy scheme. There are not many studies that focus on whether the different firm R&D support policies only increase national R&D at the expense of R&D in other countries, or whether they also increase global firm R&D. There is academic interest in this area, and with the increasing availability of administrative micro level data, we are optimistic that future research will address the question of whether R&D support policies a zero-sum game, or if they are useful policy tools at a global scale.

[5] A theoretical analysis is available by Akcigit, Hanley and Stantcheva (2019).

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