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R&D Tax Incentives: Evidence on design, incidence and impacts

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OECD

FOREWORD

This document was authored by Matej Bajgar and Chiara Criscuolo from the Structural Policy Division (SPD) and Silvia Appelt and Fernando Galindo-Rueda from the Economic Analysis and Statistics Division (EAS), all from the OECD Directorate for Science, Technology and Innovation (STI).

A previous version of this document was presented and discussed by the OECD Committee for Industry, Innovation and Entrepreneurship (CIIE), the OECD Committee for Scientific and Technological Policy (CSTP) and its Working Party of National Experts on Science and Technology Indicators (NESTI). This report was approved and declassified by the CIEE and the CSTP on 12 and 15 March 2016, respectively, and prepared for publication by the OECD secretariat. The release of this policy paper has been also authorised by Andrew Wyckoff, OECD Director for Science, Technology and Innovation and by Pascal Saint-Amans, Director, OECD Centre for Tax Policy and Administration.

Note to Delegations:

This document is also available on OLIS with the cote:
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R&D TAX INCENTIVES: EVIDENCE ON DESIGN, INCIDENCE AND IMPACTS

Silvia Appelt, Matej Bajgar, Chiara Criscuolo and Fernando Galindo-Rueda

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This STI policy paper benefits from comments from colleagues from the Tax Policy and Statistics and the International Cooperation and Tax Administration Divisions at the OECD Centre for Tax Policy Analysis and Administration (CTPA). Some of the key findings contained within this paper have also been reported in a joint STI-CTPA chapter in the latest *OECD Business and Financial Outlook* (OECD, 2016).

This document draws on data featured in the 2015 OECD STI Scoreboard's *Data and Statistics brief on R&D Tax Incentives* (www.oecd.org/sti/RDTaxIncentives-Data-Statistics-Scoreboard.pdf) and more detailed information and data contained in the OECD website dedicated to the description and measurement of R&D tax incentives available at http://www.oecd.org/sti/rd-tax-stats.htm. The data and indicators presented in this analysis would not have been possible without the systematic information provided by the OECD network of national official contacts on R&D tax incentives.

This work has benefitted from funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 674888, as part of the joint CSTP-CIIE project on the incidence and impact of public support for business R&D. Participants at a workshop held in Brussels at DG Research and Innovation in January 2016 provided useful comments.

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ABSTRACT

This paper provides an overview of OECD work on measuring the extent and impact of public support for R&D through tax incentives carried out as part of the Programme of Work and Budget of the OECD Committee for Industry, Innovation and Entrepreneurship (CIIE) and the OECD Committee for Scientific and Technological Policy (CSTP). The report discusses the policy rationale for R&D tax incentives in the broader context of public support for business R&D, describing the main features of different modes of expenditure-based tax relief. It presents evidence on how much financial support is provided through R&D tax incentives and how this has evolved in recent years. This paper also looks at indicators of the implied R&D tax subsidy rate based on tax incentive design features.

This document reviews the empirical evidence on the impact of government support for business R&D through tax incentives, covering in detail different categories of impacts including potential unintended effects of R&D tax incentives. The use and impacts of income-based R&D tax incentives are also discussed. Although the evidence is more scant than for expenditure-based incentives, there is a growing body of evidence that this section helps bring to the attention of policy makers. This paper concludes with a synthesis of the main policy recommendations in this area contained in key OECD policy documents, in particular the 2015 update of the OECD Innovation Strategy, and highlights future measurement and analytical work planned in this area.

Keywords: R&D, tax incentives, public support, innovation, statistics

1. Introduction

Investment in research and development (R&D) is a key factor driving innovation and economic growth. Governments worldwide adopt various financial support instruments to promote R&D by business, which throughout the 2000-13 period have accounted for nearly 70% of all R&D performed in OECD countries. In addition to providing grants and buying R&D services ("direct" support), many governments increasingly rely on fiscal incentives. These can take the form of advantageous tax treatment of innovation inputs (R&D expenditures), as well as preferential treatment of R&D outputs (incomes from licensing or asset disposal attributable to R&D or patents). Building on recent OECD research and evidence, this note discusses the rationale, aggregate trends, design features, empirical evidence as well as policy implications related to such incentives.

This document is structured as follows:

- Section 2 discusses the policy rationale for R&D tax incentives in the broader context of public support for business R&D.
- Section 3 describes the main features of different modes of expenditure-based tax support for business R&D that shape the design of tax relief schemes.
- Section 4 presents evidence on how much financial support is provided through R&D tax incentives, covering both indicators of the implied R&D tax subsidy rate based on tax incentive design features, and indicators on the actual cost of tax support.
- Section 5 provides a review of the empirical evidence on the impact of government support for business R&D through tax incentives. This section covers in detail different categories of impacts including potential unintended effects of R&D tax incentives.
- Section 6 focuses on the evidence on the use and impacts of income-based R&D tax incentives. Although the evidence is more scant than for expenditure-based incentives, there is a growing body of evidence that this section helps bring to the attention of policy makers.
- Section 7 concludes with a synthesis of the main recommendations available in OECD, in particular the 2015 update of the OECD Innovation Strategy, and highlights future work planned in this area.

2. The policy rationale for R&D tax incentives

Policy rationale for public support for R&D

Government support for business R&D seeks to encourage firms to invest in knowledge that can result in innovations that transform markets and industries and result in benefits to society. All industries rely extensively on fundamental science and ideas originating from or developed within the government sector itself or publicly-funded institutions, but support of a financial nature is also provided for a number of reasons. Most often, support is provided to firms with the intention of correcting or alleviating difficulties to appropriate the returns to their investment in new knowledge and shortcomings in the market for the financing of risky projects, especially for small start-up firms without collateral. These are, as widely acknowledged, two major types of market failure:

- **Difficulties by firms to fully appropriate the returns to their investment.** Returns on investments in R&D are difficult to appropriate by firms as some of the resulting knowledge – non-rival and partially non-excludable in nature – will leak out or "spill over" to other firms, to the benefit of society. This leads firms to underinvest in innovation relative to what would be the socially optimal level.

- **Difficulties in finding external finance, in particular for small or young firms.** Innovation is a highly uncertain activity with large differences between the information available to inventors and that available to investors. This may imply that external capital for innovation will only be available at too high a cost or will not be available at all.

Public support for business R&D is typically justified as a means of overcoming these market failures. In addition, countries may use tax incentives to attract the R&D activities of multinational corporations (MNEs) which typically account for a substantial share of R&D expenditure. For example, in some small open economies, such as Ireland, Belgium and Israel, more of 60% of business R&D is accounted for by affiliates of foreign companies (OECD, 2015a).

Rationale for R&D tax incentives versus direct grant support

The optimal balance of direct and tax support for R&D varies from country to country and can evolve over time, as each tool addresses different market failures and stimulates different types of R&D under changing conditions. Grants can be directed to specific projects that governments considered likely to offer high social returns, but they depend on discretionary decisions by government officials or bodies acting on their behalf. Their administration, especially the selection process, can entail significant costs if it aims to provide effective targeting.[1] Tax incentives, on the contrary, do not condition the provision of support other than as implied by pre-defined rules and leave the choice of how to conduct and pursue R&D programmes in the hands of the private sector. For this reason, they are considered as market-based instruments.

Compared with direct, discretionary subsidies, the reduced scope for discretionary selective measures on the side of public authorities makes tax incentives more easily compliant with competition and international trade rules (OECD, 2014), provided they do not simply affect the location of where R&D activities take place but also influence how much R&D is carried out, and as long as the rules are not overly restrictive. This comparative advantage in compliance with international rules appears to have contributed to their increased adoption by governments in the OECD area over a period in which the ability of government to identify "winning" firms or technologies has been subject to considerable debate.

A downside of this is that tax incentives have limited scope for identifying and supporting projects with the highest expected social returns that would not be realised in the absence of relief. For this reason, countries differ in the degree of scrutiny imposed on R&D projects for which tax incentives can be claimed, on an ex-ante or ex-post basis. While typically nondiscretionary and demand-driven, some countries do require pre-approval of R&D projects or accreditation. Some expenditure-based tax relief schemes may have functional features very close to direct grants, for example when they are subject to a high degree of pre-approval scrutiny and relief can be taken for granted afterwards. The approach and stringency of audits by tax authorities can also have significant effects on the level and nature of take-up of R&D tax support among firms. By the same token, countries may offer direct funding of business R&D through grants that – like R&D tax incentives – are non-discretionary in nature and available to all business R&D performers that meet a pre-defined set of rules. New Zealand's Growth Grant programme, introduced in 2013, is one case in point. The degree to which any type of business R&D support measure is discretionary is a relevant policy design or implementation feature to account for when considering its impacts.

Another potential downside of "on-demand" tax incentives compared to grants is the challenge of accurately forecasting and managing the impact on public finances. For this reason, some countries introduce budgetary limits that are implemented by rationing the number of approved claims or adjusting the tax subsidy rate, similarly to the way in which funding for R&D grant programmes can be allocated.

When rationing is involved, policy makers face the choice between reducing the unit subsidy per eligible firm and applying selection mechanisms. These mechanisms may take into account project or firm-level characteristics or could be applied on a random or first-come first-served basis. If not carefully managed, this can create uncertainty among potential relief recipients and reduce the potential effectiveness of the tax support measures.

Overall, and leaving aside differences in design and implementation that can blur the dividing line between tax support and grants, there appears to be broad consensus that tax incentives are more suited in principle to encourage R&D activities oriented towards the development of applications that have the potential to be brought to the market within a reasonable timeframe. In contrast, direct grant support is more suitable for supporting longer-term, high-risk research and for targeting specific areas that generate public goods (health, defence...) or that have particularly high potential for spillovers.

3. Modes of expenditure-based tax support for business R&D

The generosity of R&D tax support is inherently linked to the design of tax incentives. Tax incentives for business R&D can represent either advantageous tax treatment of R&D expenditure (expenditure-based provisions) or preferential treatment of incomes from licensing or asset disposal attributable to R&D or patents (income-based provisions). This section focuses on the former while the latter are discussed in a later section.

In 2015, 28 of the 34 OECD countries and a number of non-OECD economies gave preferential tax treatment to business R&D expenditures. Amongst non-OECD economies, Brazil, People's Republic of China (China hereafter), the Russian Federation and South Africa also provide tax incentives for R&D. Among OECD countries, Sweden introduced tax incentives for the first time in 2014, while Mexico and New Zealand have abolished their schemes. Finland’s was introduced on a temporary basis over 2013-14 and is no longer in place. The diversity of national R&D tax arrangements makes cross-country comparisons challenging (OECD, 2014). Some R&D tax incentive schemes explicitly target some specific types of R&D costs, activities and actors. **Table 1** in the Annex provides a summary overview of R&D tax incentives schemes across OECD and partner economies based on a set of key design features. This section provides a discussion of some of the most relevant tax support design features.

R&D and eligible activities

Definitions of R&D or other types of expenditures eligible for tax relief differ across jurisdictions and with respect to the OECD Frascati Manual definition and explanatory guidance but in general most attempt to be consistent with it.[2] Only a few countries extend tax relief beyond R&D to other innovation activities, and when they do so, it is typically under much stricter and less generous terms. R&D in the social sciences can be sometimes excluded, possibly because of the difficulty to distinguish from market research and related activities. Tax relief is more often targeted to the financial cost of R&D to the firm rather (expense), regardless of who carries out the R&D, than the cost of the R&D activity incurred within the firm. This may sometimes result in the same R&D activity generating relief for the performing firm and the firm that has contracted such services.

Some R&D tax incentive schemes explicitly target some specific **types of R&D costs**, activities and actors. Overall, based on the practices adopted by OECD countries and other major economies, there is a general preference for considering within the scope of eligible R&D those costs relating to labour and other current expenditures. Capital acquisition for use in R&D is less frequently supported as assets may be subsequently disposed of. R&D personnel costs account for the largest share of intramural R&D costs, and the focus on R&D personnel does in principle incentivise investment in human resources based in the domestic economy. Potential caveats for such a focus relate to the risks of inducing firms to depart from their optimal distribution of R&D efforts. Not all firms performing R&D require the same mix of labour and other types of inputs.[3]

Tax credits versus allowances

Any form of tax relief can be provided as an **allowance, exemption, deduction or credit**. Tax allowances, exemptions and deductions effectively subtract from the tax base before the tax liability is computed, reducing the taxable amount before assessing the tax. A tax credit is an amount subtracted directly from the tax liability due from the beneficiary unit after the liability has been computed.[4] In the case of R&D, the normal default or benchmark position is to allow R&D expenses to be fully deducted, regardless of the fact that they represent (risky) investments in knowledge assets. Therefore, the term enhanced allowance is used to identify provisions that represent a deduction rate of more than 100% over eligible expenses. [5]

Most countries provide fiscal incentives for R&D through tax credits or enhanced allowances.[6] A tax credit **becomes "payable", "non-wastable" or refundable**, when any credit excess on top of the tax liability can be paid in full or in part to the taxpayer.

Provisions for firms with insufficient profits

In principle, the scope for fully benefiting from tax relief depends on the existence of a sufficiently large tax liability. Some countries address the limited incentive effect of standard types of tax relief instruments among firms with low or no profits by providing for the carry-over of tax benefits or allowing for offsetting payments to be made by the tax authority to the firm on the relevant period. Refundability can be particularly beneficial for young, innovative firms, at the stage of investing in developing and launching their products. A potential downside of such provisions is that without additional controls they may be disproportionately used by firms with the ability to shift profits to other jurisdictions. Carry-over provisions are more common (32 out of 46 schemes) than refundability provisions, which only apply in a minority of cases (13 out for 46 schemes, 4 out of which only apply to SMEs).

Reductions in payroll taxes and social security contributions related to R&D personnel provide an alternative means of encouraging R&D investment by firms that have low or no profits (8 out of 46 schemes).[7] They act as a subsidy to upfront costs whereas tax credits for R&D expenditures generally act to enhance the profits of R&D investing companies at the point in which they incur their investments. This makes subsidies for R&D wages suitable for promoting more "speculative" and "riskier" forms of research and young firms which are more likely to be loss-making and financially constrained. In addition, they may be easier to monitor and less subject to accounting distortions than company profits. On the other hand, if the number of potential researchers (e.g. scientists and engineers) in a country is stable over time (because their supply is "inelastic"), the tax incentive would be absorbed by higher wages paid to R&D workers, instead of an increase in their numbers. This may therefore not represent an increase in the volume of research and development activities. While this "wage effect" can also arise with the more traditional R&D tax incentive schemes, the effect might be exacerbated when the only eligible R&D cost component is wages.[8]

Volume-based versus incremental schemes

R&D tax incentives may apply to all qualified R&D expenditures (volume-based credits) or only to the additional amount of R&D expenditure above a certain base amount (incremental credits). The base amount can usually take two forms:

- **Rolling average base.** The base amount is computed as the average R&D expenditure of the previous *n* years.
- **Fixed base.** The base amount equals the average R&D expenditures during a fixed reference period. This average can then be indexed to sales or inflation to stay relevant, but can be left constant over time in some countries.

In 2015, most OECD and partner economies providing tax incentives for R&D use either a tax credit (e.g. Australia, Canada, France, Ireland, Norway) or tax allowance (e.g. Brazil, China, Netherlands, United Kingdom) that is applicable on the volume of R&D expenditure undertaken. Other countries target tax credits (e.g. United States) to R&D expenditures over and above of a pre-defined baseline amount. Using a volume-based scheme has the advantage, for firms claiming incentives, of being simple, predictable and generous. However, from the government perspective, this approach might be costly as a substantial fraction of support goes to subsidise R&D that would have been performed without any R&D tax incentives. Furthermore, in the absence of any ceilings, it is likely to benefit mostly large firms.

The main reason for using only incremental R&D as the eligible base is the aim to minimise the amount of "subsidised" R&D that would have been undertaken even in the absence of support, i.e. the deadweight. However, incremental schemes also present some undesirable features.[9] Firstly, they are more complex to design and use. The complexity issue should not be underestimated as it increases transaction costs for both the government and firms, and it could even prevent some firms from applying if the application costs are, or are perceived to be, higher than the uncertain benefits. Secondly, incremental incentives are possibly less effective in stagnating economic environments or during recessions when the incremental expenditure might be zero or negative. Finally, incremental features might be associated with a strategic behaviour on the part of firms to time their R&D investments in order to maximize tax benefits, thus distorting the temporal profile of the R&D investment.

Overall, most countries have tried to increase the availability, simplicity of use and generosity of R&D tax incentives. For instance, France (in 2008), Australia (in 2010) and Ireland (in 2015) replaced their relatively complex hybrid volume and incremental-based schemes with simpler and more generous volume-based schemes. Indeed, a volume-based scheme can be more appropriate if the objective is to increase the overall level of R&D investment in a country. At the same time, an incremental-based scheme may be preferable if the objective is to support firms with high R&D growth rates. A combination of volume and incremental tax incentives (hybrid schemes) may be considered when the objective is to maintain the level of, and reward high growth of, R&D (Criscuolo et al., 2009). Korea, Portugal and Spain offer a hybrid system combining a volume and an incremental tax credit while the Czech Republic, the Slovak Republic and Turkey provide a hybrid form of tax allowance.

Ceilings and thresholds

In order to manage the overall financial burden on public finances and assure a more efficient and equitable distribution of tax benefits, several countries apply upper ceilings and thresholds to eligible R&D expenditure or tax benefits. While reducing the overall cost of support, the presence of upper ceilings may reduce the incentive effect at the intensive margin among firms with particularly high levels of R&D. Aggregation rules can play an important role, as some groups may be able to break down their R&D tax support claims across separate enterprises in order to optimise their tax bill.

Targeted relief measures

Small and medium-sized enterprises and young firms

Although tax incentives are generally seen as the more market-based, non-discretionary alternative to direct support for R&D, a number of countries target R&D tax incentives to particular types of firms, industries or activities. Targeted relief measures may be motivated by evidence or the belief that some groups of firms with observable characteristics, e.g. by size or age, can be more responsive to a given unit Also, of financial support. Expected differences in the magnitude of knowledge spillovers and overall social returns to R&D according to firm or project characteristics can also influence the choice of targeted relief support measures. The most common type of special treatment concerns SMEs, based on the notion that there is stronger market failure rationale for these firms. These firms are more likely to be credit constrained and are important drivers of job creation. However, recent research suggests that age, rather than size, is the key common feature among firms with the highest rates of net job creation (Haltiwanger *et al.*, 2012; Criscuolo *et al.*, 2014).

Only very few countries specifically target start-ups and young businesses while special provisions for SMEs are more widespread. Overall, 12 out of 28 OECD governments currently offer preferential tax treatment to SMEs, some of which specifically target young firms (e.g. France, Italy). This may include the provision of enhanced tax credit/allowance rates[10] or more generous refund conditions for those companies in the case of insufficient tax liability. In addition to explicit targeting, a number of other design considerations also implicitly shift the relative generosity for firms of different size and age. These include, most notably, the choice between incremental versus volume-based schemes and the use of carry-forward provisions, cash refunds and tax credits for R&D wages. There are some possible downsides to targeting support, as they involve additional administrative burdens. Depending on their magnitude, targeted measures could also provide incentives to firms to retain the status that warrants eligibility for targeted measures. For example, certain firms might find it advantageous to operate below a certain size threshold if the additional benefit is large enough. Furthermore, they may have incentives to break up their activities across different units able to claim preferential conditions allowed only for smaller sized firms. For this reason, business aggregation and independence rules are a necessary element of well-designed tax support measures that aim to target effectively genuine smaller-sized enterprises.

Collaborative R&D

Governments may also wish to encourage collaboration between businesses and higher education institutions (HEIs) and public research organisations (PROs). Such support is based on the idea that businesses engaging in collaborations with universities or research centres often carry out projects with closer links to basic research and, as a result, those projects are likely to provide the basis for disruptive innovations and generate spillovers. In addition, those support schemes are sometimes justified by the possible existence of imperfect information, where firms are not fully aware of the value of the knowledge generated by universities, and other potential barriers to knowledge diffusion. As of 2015, six OECD countries (Belgium, France, Iceland, Italy, Japan and Hungary) provide incentives for R&D collaboration. It is however unclear whether tax incentives are the best tool that policy makers have to deal with the market failure in this case. Evidence on their effectiveness is scarce (Criscuolo *et al.*, 2009). One possible concern is that subsidies for collaboration may shift reallocation of university and PRO resources intended for basic research to areas with more direct commercial application (Partha and David, 1994). A related concern is that university-industry collaboration might reduce broad-based knowledge spillovers from academic research. This could occur if the potential spillovers were fully appropriated within the university-business partnership, as the business partner has different incentives to share information than an academic institution. This may however attempt to maintain the spillovers from R&D within the domestic economy.

Duration and stability

The efficiency of tax incentive programmes can also be influenced by their temporary or permanent nature, as well as by how the business community expect R&D tax support to continue to be provided and under which terms. Most R&D tax support schemes initially came into being as temporary measures that the business community soon came to treat as permanent well before that was formally the case.

Some R&D projects might be undertaken just to benefit from temporary tax incentives, while other potentially more promising R&D projects might be delayed, performed abroad or cancelled if the planning horizon for those projects extends beyond the scheduled end of the tax incentive programme. In addition, not all R&D firms are affected in the same way by a temporary programme. Firms undertaking R&D projects to be completed within a year (or a few years) are less likely affected by the temporary nature of programmes than those with R&D projects covering several years (Guenther, 2008).

4. How much financial support is provided through R&D tax incentives?

Implied tax subsidy rates

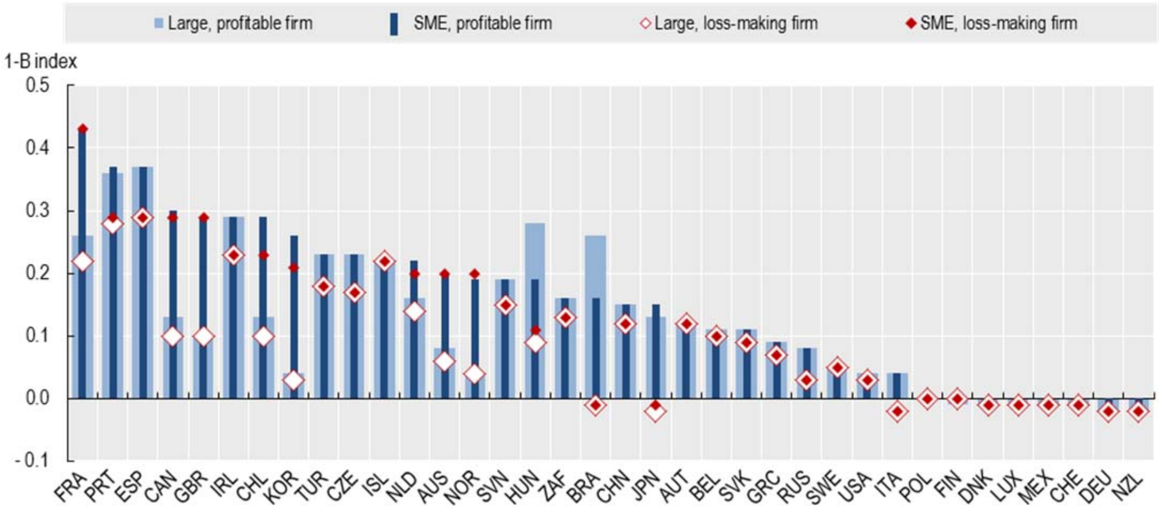
The design of R&D tax incentives such as the level of the tax credit/allowance rate and availability of refund and carry-over provisions significantly determines the “expected” tax relief per unit of R&D investment. The ***B-index***, a measure of the pre-tax income needed for a company to break even on a marginal, monetary unit of R&D outlay (OECD, 2013), takes into account tax relief provisions described in the previous section to derive implied tax subsidy rates (1 minus the *B-index*). This measure has been calculated across OECD countries and key partner economies offering tax relief for different firm size and profit scenarios. To provide a more accurate representation of different, relevant, scenarios, *B-indices* have been calculated for “representative” firms according to whether they can claim tax benefits against their tax liability in the reporting period. When credits or allowances are fully refundable, the *B-index* of a firm in such a position is identical to the one derived in the profitable scenario. Carry-forwards are modelled as discounted options to claim incentives in the future.

The B-index indicator is calculated in order to reflect the implications of investing an additional monetary unit in R&D. Whenever caps and thresholds apply to eligible R&D expenditure or the amount of R&D tax relief, an attempt was made to compute weighted marginal tax credit (allowance) rates for SMEs and large firms, using available data or proxy measures for the distribution of eligible R&D spending. Weighted marginal tax credit rates reflect the magnitude of marginal tax credit rates applicable to an extra unit of R&D spend across the firm population (e.g. SMEs or large enterprises). In the presence of thresholds and upper ceilings for relief, this measure will differ from the average subsidy rate that is relevant for firms, especially multinationals, deciding whether to invest a fixed amount of R&D in a given country. Each measure can be relevant for R&D investment decisions: the average at the extensive margin (whether to invest in a country), the marginal one at the intensive margin (how much to invest within a country). **Figure 1** presents the notional levels of tax support (before tax) per additional monetary unit of R&D outlay to which firms with defined characteristics are in principle entitled.

This level is highest, at over 40%, for SMEs in France, and it is also relatively high, at around 30-35%, for SMEs and large firms in Portugal, Spain and Ireland and for SMEs in Canada and the United Kingdom. It is, on the contrary, below 10% for firms in Greece, Russia, Sweden and the United States. The marginal tax subsidy rates for SMEs in Australia, Canada, France, Korea, the Netherlands, Norway and the United Kingdom, are markedly higher than those observed for large enterprises. Conversely, Spain, Austria, China, Czech Republic, Turkey and South Africa do not differentiate between firms of different sizes in form of enhanced tax credit/allowance rates for SMEs relative to large firms. Refunds and carry-forward provisions are sometimes used to promote R&D also in firms that would not otherwise be able to use their credits or allowances. Such provisions tend to be more generous for SMEs and young firms in France, Canada and Australia where SMEs may benefit from a refund of excess credits in the case of insufficient tax liability. In most countries, implied tax subsidy rates are lower for loss-making firms.

Figure 1. Implied tax subsidy rates on R&D expenditures, 2015

1-B-Index, by firm size and profit scenario



Source: OECD STI Scoreboard 2015, based on OECD, R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and Main Science and Technology Indicators, www.oecd.org/sti/msti.htm, June 2015. Statlink: http://dx.doi.org/10.1787/888933274335

The cost of tax incentive support for business R&D

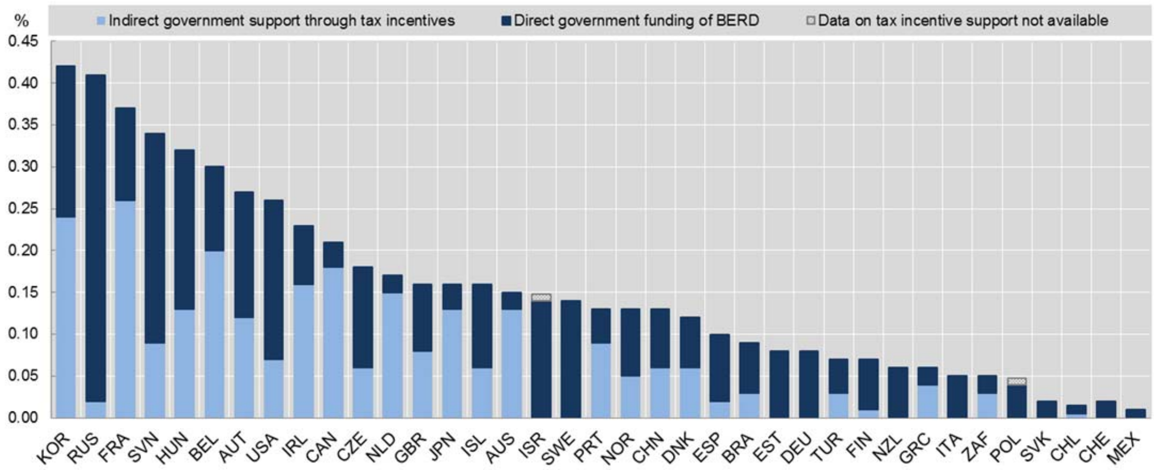
Estimated tax subsidy rates are not sufficient indicators of the financial effort made by public authorities to provide tax relief for R&D, alone or in combination with R&D statistics. There is currently no readily available, cross-country information on the distribution of R&D expenditure by type of firm and type of cost which would give rise to a distribution of "implied" tax subsidy rates, a key evidence gap the OECD is trying to address through a new project that is succinctly introduced in the concluding section of this paper. Secondly, approval and auditing mechanisms may contribute to changing the probability that any given firm decides to submit claims for R&D tax relief and is successful in this process. Expectations of onerous audits and uncertainty surrounding their outcome may discourage firms from applying for tax support. Lastly, a number of demand factors will influence the actual volume of support provided by authorities. Companies may hold back their R&D programmes under adverse credit or demand conditions, and the amounts of support they claim may depend on their profit generating capacity within the current period and their expectations for future periods.

Depending on the design and implementation of the R&D tax relief system, the cost of support can be hard to predict and accurate estimates may not be as timely as desired. There are several ways to measure the value of R&D tax relief, as tax expenditures represent deviations from a benchmark tax system. These indicators adopt a common reference framework based on full deductibility of current R&D and a country's treatment of capital investments. Estimates are typically based on tax records and calculated in terms of initial revenue loss with no or minimal adjustments for behaviour effects. The latest edition of the *Frascati Manual* summarises the guidance on reporting data on tax relief for R&D.

Figure 2 displays the cost of R&D tax incentive support (foregone revenues and refunds) as a percentage of GDP in 2013 (or closest year). Korea, the Russian Federation and France provided the most combined support for business R&D as a percentage of GDP, while France and Korea provided the largest relative volumes of R&D tax support, at approximately 0.25% of GDP. At the same time, there are countries where tax incentive support amounts to less than 0.05% of GDP (e.g. Finland, Spain and the Russian Federation) or where no R&D tax incentives was provided at all in 2013 (e.g. Germany, Mexico and Switzerland). As of 2013, approximately 6.9% of business R&D in the OECD area - i.e. close to USD 40 billion - was directly funded by governments. R&D tax incentives accounted for the equivalent of an additional 5.2% of public funding of business R&D. The largest share of R&D tax support out of all combined direct and tax R&D support was found in the Netherlands, with 87% of total government support, followed by Australia and Canada with approximately 85%.

Figure 2. Direct government funding of business R&D and tax incentives for business R&D, 2013

As a percentage of GDP



Source: OECD STI Scoreboard 2015, based on OECD, R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and Main Science and Technology Indicators, www.oecd.org/sti/msti.htm, June 2015.Statlink: http://dx.doi.org/10.1787/888933274317.

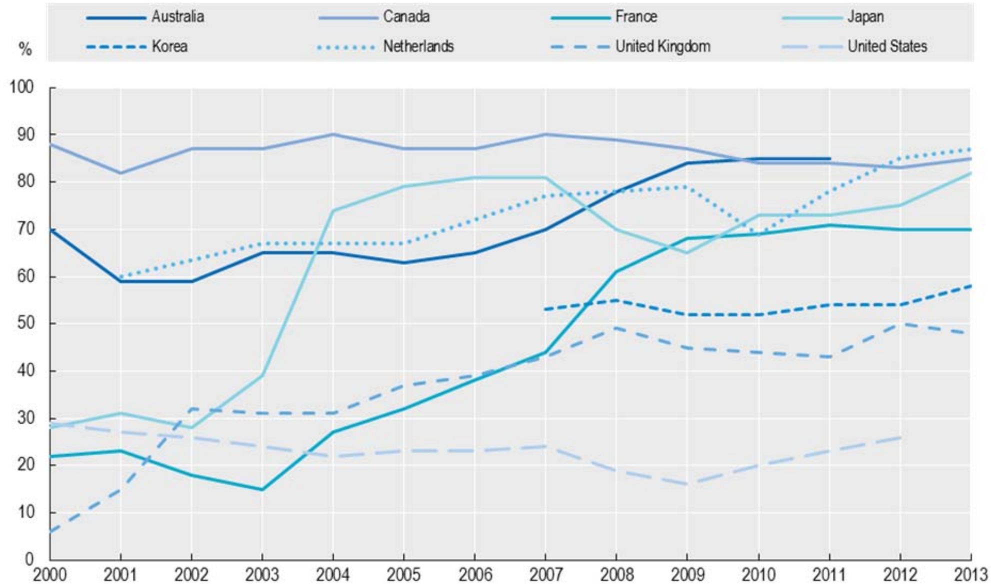
Recent trends

Since 2000,[11] several OECD countries such as France, Japan, the Netherlands and the United Kingdom have increased their reliance on R&D tax incentives as a mechanism for supporting business R&D, sometimes displacing direct forms of support (**Figure 3**).

The relative importance of tax incentives declined briefly during the crisis in many economies, reflecting the demand-led nature of tax relief and its dependence on profits. For this reason, some governments opted for direct funding to mitigate the impacts of the crisis on business R&D. In the United States, federal tax support for R&D remained fairly stable. In Canada, a review of Federal R&D support led to a small rebalancing of central government support. However, Canada continues to place significant emphasis on tax support, surpassed only by the Netherlands in 2013.

Figure 3. Trends in government tax incentive and direct support for business R&D, 2000-13

Tax support as a percentage of total (direct and tax) government support for business R&D, selected countries

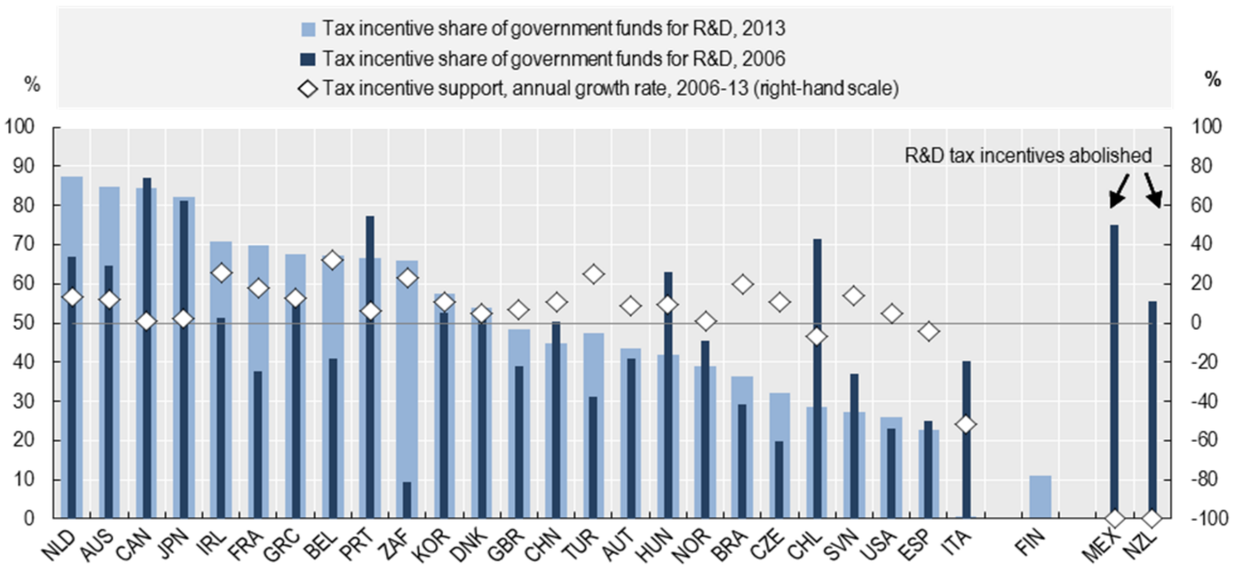


Source: OECD STI Scoreboard 2015, based on OECD, R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and Main Science and Technology Indicators, www.oecd.org/sti/msti.htm, June 2015. Statlink: http://dx.doi.org/10.1787/888933273262.

For a wider set of 28 countries for which data are available in 2013 and 2006, the indicators confirm the overall increase in the relative importance of tax incentives among a majority of them (**Figure 4**). Italy significantly reduced its level of support, however, while Mexico and New Zealand abolished their schemes. Finland had a scheme in place in 2013-14. Sweden introduced tax incentives for the first time in 2014.

Figure 4. Change in the mix of government support for business R&D, 2006-13

As a percentage of total support to business, and annualised growth rates



Source: OECD STI Scoreboard 2015, based on OECD, R&D Tax Incentive Indicators, www.oecd.org/sti/rd-tax-stats.htm and Main Science and Technology Indicators, www.oecd.org/sti/msti.htm, June 2015. Statlink: http://dx.doi.org/10.1787/888933274322.

5. The impact of government tax support for business R&D: what is the evidence?

The evidence on the effectiveness of R&D tax incentives can be organised around three central questions. Firstly, do R&D tax incentives have the intended effect on investment in R&D (inputs) and innovation and productivity (outputs)? Secondly, can the incentives lead to any unintended consequences? Thirdly, which design features, or their combinations, lead to the most desirable results?

The effectiveness of R&D tax incentives is often evaluated according to how much additional R&D investment is actually induced by the availability and use of R&D tax incentives. However, it is equally or even more important to investigate whether this increased expenditure translates into an increase in innovation output (so-called "output additionality") and to a long-run increase in economic growth and productivity. In addition, some evaluations of R&D tax incentives seek to understand the channels through which these policy instruments can have an impact. For example, how many firms, and which types of firm, which were not investing in R&D are enticed to undertake R&D efforts for the first time as a result of tax incentive support? Do differences in the provision of R&D tax incentives across countries affect the decision of firms to locate or relocate their R&D investment in a particular location?

Impacts on R&D investment

The effectiveness of R&D tax incentives in raising R&D investment can be gauged through the analysis of the private "R&D price elasticity". This represents the percentage change in R&D resulting from the tax relief for every percentage change in its after-tax price ("the user cost of R&D"), or by estimating the "incrementality ratio", which measures the change in R&D investment per dollar of foregone tax revenue that is spent on R&D fiscal incentives. Most available evaluation studies find that R&D tax incentives lead to additional R&D investment. For example, out of 17 methodologically sound evaluations on the topic (What Works Centre for Local Economic Growth, 2015), 10 indicate positive results, 5 find mixed results and only 2 report no statistically significant relationship between the incentives and R&D investment. The review also points out that the seven studies rated as being methodologically more rigorous all find positive results.

With regards to the "size" of the effect, Parsons and Phillips (2007) collect estimates from a broad range of studies undertaken between 1990-2006 in the United States, Canada and other OECD countries. They estimate a median long-run elasticity of -1.0912: a 10% reduction in the price of R&D would lead to a 10.9% increase in R&D investment. New OECD evidence is broadly consistent with these conclusions. For example, a 6% increase in the generosity of R&D tax incentives – *e.g.* from the level in the United States to the level in Japan in 2008 – is estimated to increase the level of R&D by about 6% in the long run (Westmore, 2013).

Importantly, evidence from econometric estimates suggests that the responsiveness of investment in R&D to its price is greater in the long run than in the short run.[13] This is likely due to the adjustment costs that firms have to incur when increasing their investment in R&D (e.g. to hire new scientists and engineers).

Several recent studies also look at the impact of the incentives on individual components of R&D spending: R&D wage bill, contracts and supplies. Studies looking at the effect of the incentives on the R&D wage bill find positive results (Agrawal *et al.*, 2014; Rao, 2015b).[14]

On the contrary, the effect on R&D subcontracting seems to be more mixed (Paff, 2005; Agrawal *et al.*, 2014; Rao, 2015b), which can be due to the substitution between extramural and intramural R&D.

Finally, the one study evaluating the impact of incentives on R&D supplies finds a positive effect (Rao, 2015b).

While most of the aggregate relationship between tax incentives and R&D expenditure is driven by increased R&D intensity among existing R&D performers, it is also of interest whether the incentives encourage some additional firms to hire researchers and start R&D projects.[15] The scarce empirical evidence on this issue suggests that the presence of an R&D tax incentive is associated with a higher probability of firms becoming R&D performers (Corchuelo and Martinez-Ros, 2009; Haegeland and Møen, 2007). In an ex-post evaluation of the redesigned, volume-based R&D tax credit in France, Bozio et al. (2014) document a positive effect of the credit on firms' incentives to invest in R&D among firms that began to use the tax credit scheme (extensive margin) following the 2008 reform of the tax credit scheme. However, the estimated elasticity of R&D with respect to its user cost is found to be smaller for entrants into the French tax credit system relative to those firms that had already made use of the French tax credit beforehand. Margolis and Miotti (2015) also find that the 2004, 2006 and 2008[16] reforms of the French R&D tax credit system encouraged R&D investment and the recruitment of researchers.

Impacts on innovation output

R&D tax incentives are expected to lead not only to higher R&D expenditure but also to more innovation, proxied by more product and process innovations, higher sales from innovative products, more patents or higher number of "star scientists". For several reasons, a measured increase in R&D expenditure might not translate into an increase in innovation:

- **Re-labeling of existing activities.** Following the introduction of a tax incentive, firms might re-label in their accounts and responses to statistical offices some of their ongoing activities (R&D or non R&D related) as R&D investment. This would lead to a spurious increase in measured R&D (see **Box 1**). The available evidence suggests that the incidence of this factor is relatively small, particularly in the long term.[17]
- **Input price rise.** The introduction of an R&D tax incentive may cause an increase in the wages of scientists and engineers due to their inelastic supply, in particular in the short run. Part of the measured increase in R&D expenditure would then reflect changes in prices rather than volumes of performed R&D. (See more below.)
- **Heterogeneous impacts.** The additional projects financed through R&D tax incentives might be those with the lowest marginal productivity. If there are decreasing marginal returns to R&D, the additional R&D induced by an R&D tax incentive will be less productive than the R&D that would be done even without the incentives. The broader socioeconomic impact of R&D tax incentives may further depend on the type of firm performing R&D. A recent study by Bloom et al. (2013), for instance, suggests that smaller firms generate lower social returns to R&D because they operate more in technological niches.

Box 1. R&D tax incentives and R&D statistics

In addition to published business accounting data, R&D statistics at a micro and aggregate level provide a key infrastructure for examining the impact of R&D policies and tax incentives in particular. It is therefore relevant to consider how these statistics are impacted by the availability of such schemes.

The widespread use of R&D tax incentives across many countries, with its definitions sometimes very close to the OECD Frascati Manual (OECD, 2015b), represents both an opportunity and challenge for the collection and reporting of statistical data on R&D. Rich administrative data sources are being used to improve the coverage of R&D surveys and, in some cases, may be used to effectively impute data, reducing response burdens on businesses. However, this may also result in companies reporting in surveys information that differs from what is being requested. It can be difficult to assess the direction and size of such bias. R&D statistics adopt the perspective of counting and adding up R&D carried out by firms and organisations to arrive at a meaningful aggregate. Respondents may instead report a combination of that and how much they pay others for R&D to be carried, resulting in potential double counting.

R&D tax support reform can also induce major data breaks as the presence of the R&D tax incentives may induce firms to re-consider how they describe their own product development and process improvement activities. An active tax consultancy sector does indeed engage in active marketing of tax relief claim services, sometimes with fees being charged only in the outcome of successful tax support claims.

Overall, it is important for data users and producers to bear in mind the implications of tax policy changes for data quality. Failing to do so may result in a poor assessment of the available evidence and lead to wrong inferences concerning the impact of R&D tax support.

Evaluation of output additionality is complicated by several challenges. Firstly, the available measures of innovation output are highly imperfect. Secondly, the lag between R&D investments and the resulting innovations varies widely and can be very long. Thirdly, the benefits of the incentives might spill over to firms that did not directly receive any support, complicating estimation based on comparison of recipient and non-recipient firms. Finally, innovations brought about by R&D tax incentives schemes might differ from innovations funded by firms or by government grants. For example, a Norwegian R&D tax incentive scheme has been found to increase product and process innovations that are new to the firm but not innovations that are new to the market or that can be patented (Cappelen *et al.*, 2007).[18]

With these qualifications, the available evidence predominantly suggests a positive effect of R&D tax incentives on innovative sales or the number of new products.[19]

Effects on wages

Fiscal incentives for R&D aim at increasing the volume of R&D investment. However, part of these incentives might lead to a potentially unintended increase in the wages or the costs of hiring of R&D scientists and engineers. This can be due to their inelastic supply of or due to search costs increasing as demand rises. Studies indeed tend to find a “wage affect” resulting from R&D tax incentives.[20] It should be noted, however, that most of the studies are unable to rule out the possibility that the increase in R&D wages corresponds to a change in the quality of researchers, in which case the increased expenditure would indeed reflect a real increase in the quality of innovative activities. The choice of a counterfactual also matters for identifying the presence of volume impacts in the presence of wage effects. Wage increases may be intended to retain highly mobile research personnel. There is not much evidence on the impact on the prices of other R&D inputs, although these represent a smaller fraction of total R&D costs.

Effects on firm dynamics

New OECD evidence suggests that R&D tax incentives may have the unintended consequence of protecting incumbents at the detriment of potential entrants, thus slowing down the reallocation process (Bravo-Biosca, Criscuolo, and Menon 2013). More generous R&D tax credits seem to disproportionally benefit the slowest-growing incumbent firms. As a result, they are associated with a less dynamic distribution of firm growth in R&D intensive sectors, with a higher share of stagnant firms and a lower share of shrinking firms.

On the contrary, on the basis of the available evidence, which might not be precise enough to distinguish between independent start-ups and spin-outs from incumbents and other entrants arising from M&A activity, differences in the extent of direct support do not appear to shape the distribution of firm employment growth. This paradoxically appears to suggest that such targeted policies have a more neutral impact on incumbents relative to new entrants. This is consistent with recent evidence from Finland and Germany which shows that direct support schemes do not preserve the dominance of market leaders and make small firms more likely to undertake R&D (Czarnitzki and Ebersberger, 2010). These results may ultimately reflect differences across countries in the criteria that are used to allocate direct support for R&D relative to indirect support.

Effects on the location of R&D activities

The effect of R&D tax incentives on the R&D location choice by MNEs remains a relatively unexplored issue. Estimation of this effect is complicated by a scarcity of relevant data and the complex interaction of tax regimes across and within countries. The available evidence suggests that the volume of R&D conducted in one country responds to changes in the cost of doing R&D in competing countries (Bloom and Griffith, 2001; Billings, 2003). A similar conclusion was reached in a study examining location decisions across US states (Wilson, 2009). This study found that generous incentives in one state increase R&D in that state but reduce R&D in the neighbouring states, leading to an estimated net effect of state-level incentives on national R&D that is near to zero.[21] Montmartin and Herrera (2015), using data for 25 OECD countries over the 1990-2009 period, find that the effects of national R&D tax incentives can be nullified by those introduced abroad. This finding replicates for the case of R&D tax support the results found in the general and well established tax competition literature. This substitution effect is however not found in the case of direct support.

However, surveys among multinational enterprises and econometric studies suggest that even if tax incentives might affect the location of R&D investment by MNEs (Belderbos et al., 2016), there are other factors that are more important for MNEs' decisions. These factors include access to local science and technology, proximity to frontier research at universities and other research institutions, availability of skilled workforce and strong intellectual property rights. These factors are particularly important for MNE laboratories aimed at doing basic research.[22] The location of labs engaged in development depends more strongly on access to local markets and proximity to other corporate activities.[23]

One possible way to interpret these results is to note that location-based incentives seem to play some role especially in the final stages of the decision making process, particularly when different countries are 'bidding' for the same investment (OECD, 2011), in determining the final choice of location from a list of "shortlisted" sites on the basis of economic fundamentals.

Impacts on wider economic outcomes and welfare

Ultimately, tax incentives are expected to also lead to better economic performance and increased welfare. Despite the importance of the question, the evidence on the effect of R&D tax incentives on productivity and employment growth is scarce and inconclusive. A few studies point to a positive correlation between R&D tax incentives and productivity (Brouwer *et al.*, 2005; Lokshin and Mohnen, 2007) or equity value (Berger, 1993), while a recent study by (Moretti and Wilson, 2014) suggests that the effect of tax credits on employment and wages in individual US states depends on the particular industry considered.

As discussed above, a relatively large number of studies document an effect of tax incentives on R&D investment. Recent studies by Cappelen *et al.* (2007) and Westmore (2013), among others, also establish a link between innovative activities and productivity. However, there is virtually no evidence on the direct link between R&D tax incentives and firm productivity. A recent study by Westmore (2013) fails to establish such direct link using data for 19 OECD countries.[24]

Estimates of the effect of R&D fiscal incentives on welfare require a full cost-benefit analysis. This analysis in turn must take into account the full direct and indirect effects of the policy, the implementation and compliance costs, and the impact of distortionary taxes needed to finance the incentives. Several studies have attempted such analysis and they suggest a positive net welfare gain from R&D tax incentives.[25] However, it is important to keep in mind that their results depend heavily on the assumptions made. For example, the evaluation by Parsons and Phillips (2007) separately quantifies and then combines five effects of an incentive scheme in Canada. It indicates a median increase in social welfare of 11 cents for each dollar of tax credit, but the authors observe that variations in assumptions underlying their estimates can lead to net outcomes that are either positive or negative, concluding that the "tax credit likely generates positive net economic benefits under a reasonable range of assumptions."

Evidence on the impact of tax incentives versus direct support

The first question that any governments designing support for business R&D have to consider is to what extent it will rely on indirect support through tax incentives or on direct support, such as grants. R&D tax incentives are non-discretionary and available to all potential R&D performers. Grants, on the contrary, can be directed to specific projects that the government considers to have high social returns, for example to basic research and/or in areas such as defence, health or energy.

A study for Norway (Haegeland and Møen, 2007) provides a ranking of different policy tools according to their impact on R&D investment and according to the private returns of the R&D projects that they typically fund. It finds the policy with the largest impact on the amount of R&D investment to be R&D tax incentives, followed by grants from Norway's research council, grants from government agencies and grants from the European Union. With regards to private returns, it finds that the returns to R&D projects financed by firms' own funds are on average higher than those of projects financed by R&D tax incentives, which in turn are higher than those of projects financed by grants.

The relative effectiveness of tax incentives and direct support may also depend on firm characteristics. In particular, even if R&D tax incentive schemes are refundable and contain carry-over provisions, young firms may not fully benefit from such schemes if they lack the upfront funds required to start an innovative project. Direct public funding might be more beneficial than R&D tax incentives for young financially constrained firms (Busom *et al.*, 2011) if direct support helps to certify the "good quality" of young firms and their projects. This could reduce problems associated with information asymmetry (Lerner, 1999; Blanes and Busom, 2004), which tend to be much more pronounced for radical – as opposed to incremental – innovations (Czarnitzki and Hottenrott, 2011). This would in turn lower the cost of capital for firms receiving grants when applying for external sources of financing.

As noted earlier in this paper, most governments use a combination of tax incentives and direct support. Unfortunately, the evidence base on the interaction between direct funding and tax support is comparatively scarce. Bérubé and Mohnen (2009) find that Canadian firms that benefited from both policy measures introduced more new products than their counterparts that only benefited from R&D tax incentives, made more world-first product innovations and were more successful in commercializing their innovations. Falk et al (2009) similarly identify complementary effects of both types of government support measures in Austria. These results contrast with the findings of two evaluations of federal fiscal incentives and regional subsidies in Belgium, in which evidence of a substitution effect between federal R&D tax support and regional direct subsidies is found (Dumont, 2013 and 2015). In these two studies, the positive impact of subsidies and some of the tax benefits is smaller different schemes are combined.

Montmartin and Herrera (2015), using data for 25 OECD countries over the period of 1990-2009, similarly find a substitution effect between the R&D subsidies and fiscal incentives implemented within a country. For both policy instruments Montmartin and Herrera (2015) estimate a non-linear relationship between their effect on private R&D and their level, suggesting the possibility of leveraging and crowding-out effects. Lhuillery et al. (2014) explore the impact of tax incentive support and direct subsidies on business R&D spending in France as a function of the type and amount of support provided, finding no evidence of a substitution effect. The results suggest an additionality level of EUR 1.08 of additional R&D expenditure per one EUR of financial aid, broadly in range with the rest of the literature. In the case of the French R&D tax credit, in particular, the authors observe a non-linear relationship in the R&D impact of public support, the highest effect being found for very low and very high levels of R&D tax relief.

Understanding the heterogeneity of impacts and role of design features

Despite the growing literature on the impact of different forms of support for business R&D, there is no simple, widely applicable answer to the question of what is the right volume of total support and the appropriate mix of tax incentive and direct support within countries. As previously shown, tax incentives are not equally beneficial to all types of potential R&D performers. Their heterogeneity needs to be taken into account. The impact of tax incentives may depend on the nature and structure of a country's innovation system.

Evidence on the impact on small versus large firms

Several studies directly compare the effect of R&D tax incentives on firms of different sizes. In addition, differences in the effects of the tax incentives across firms of different sizes can be gathered by comparing studies focusing on different firm size categories. Overall, smaller firms seem to be more responsive to R&D tax incentives than larger firms.[26] This is consistent with small firms being more credit constrained, as they are less likely to have collateral. Indeed, Kasahara *et al.* (2014) find that the impact of R&D incentives on small firms is stronger for firms that are more financially constrained. Kobayashi (2014) examines the effect of the Japanese R&D tax credit on SMEs and similarly finds a much stronger effect of R&D tax credits on liquidity-constrained vis-à-vis unconstrained firms. These estimates can indeed depend on the existence of and use by firms of other forms of public support. New evidence also demonstrates that the reduction in the implicit tax subsidy due to a lack of an immediate refund can indeed be substantial, limiting the effect of R&D support even in countries that provide relatively generous support at first glance. This highlights the need of cash refunds if the tax incentives are to be effective, especially for small or young firms (Elschner et al., 2009).

Regarding the potential concern about targeting measuring encouraging firms to stay or appear to be small, the limited evidence available suggests that such effects can be present but small compared to other fiscal thresholds. Dachis and Lester (2015) explore the impact of the federal R&D tax credit regime in Canada, where small businesses (Canadian Controlled Private Companies - CCPCs) are entitled to an enhanced and fully refundable SR&ED tax credit up to an expenditure limit of CAD 3 million. This expenditure limit is gradually reduced to zero as prior-year taxable income rises from CAD 500 000 to CAD 800 000 or as business assets rise from CAD 10 to CAD 50 million. While there is evidence of clustering around the R&D expenditure thresholds, this effect appears to be of an order of magnitude smaller than for thresholds relevant to the general small business deduction (SBD). Results can vary greatly by country depending on the object and magnitude of the threshold and on whether it induces a step or gradual change in the relief that firms can claim. The existence and implementation of aggregation rules can also greatly matter. In the absence of such rules, companies can organise their R&D activity across different entities in order to optimise the amount of relief received.

Evidence on volume versus incremental tax incentives

Available evidence supports the hypothesis that incremental R&D tax credits generate more R&D support per unit of taxpayers' money than volume-based schemes. In particular, it shows that while incremental credits tend to lead to additional R&D investment exceeding the public support (incrementality ratio higher than 1), the additional investment generated by volume-based tax credits tends to be smaller than the public support (incrementality ratio lower than 1) (Parsons and Phillips, 2007; Lokshin and Mohnen, 2012).[27] On the other hand, incremental credits may have the unintended effect of distorting the timing of R&D expenditure (Hollander *et al.*, 1987; Lemaire, 1996). Furthermore, the effectiveness of incremental tax incentives is linked to existence of a favourable market environment for additional R&D (Köhler et al., 2012). Based on a simulation, Lester and Warda (2014) show that at a relatively low rate of R&D growth the cost-effectiveness of incremental credits is in the same range as volume-based credits. Incremental incentives call for accelerated R&D spending which may only be feasible for firms up to a certain limit (Mohnen, 2013).[28]

Evidence on temporary schemes and predictability

There are few experiments where tax support schemes were widely perceived to be temporary that have been subject to empirical analysis. The results of a recent study on the temporary Finnish R&D tax credit, available to firms over the years 2013-2014, support earlier noted concerns about short-lived measures. Kuusi et al. (2016) find that the enhanced tax deduction for labour expenses was claimed significantly less than expected, with the actual tax loss being only 8% of the expected tax loss. The preliminary results also suggest that the impact of the tax incentive remained rather small.

More generally, given the long term nature and the sunk costs of R&D investments, stable and predictable incentives seem likely to have a stronger impact on R&D investment (Rao, 2015a). A number of studies examining the time series variability of the B-index support this view (Guellec and Van Pottelsberghe De La Potterie, 2003; Westmore, 2013).

6. Preferential tax treatment of income derived from R&D and other innovation activities

The use of income-based incentives for R&D and innovation

Governments can also incentivise business R&D by providing tax relief on incomes associated to the outputs from R&D or related activities. Preferential tax treatment may be granted to income derived from the licensing or disposal of assets attributable to R&D, such as patents or other forms of knowledge capital. This may also include, in some instances, production income derived from the internal use of knowledge capital. Relative to expenditure-based tax incentives, income-based regimes are more difficult to identify as explicitly targeted towards R&D. This poses some challenges when it comes to measurement and comparison across countries with respect to their scope, overall generosity and possible R&D and innovation impact.

Income-based incentives are currently less widely used than expenditure-based schemes but, in recent years, their adoption by countries has significantly increased. Recent examples include the "patent box" introduced in Italy, Ireland's Knowledge Development Box (KDB) regime and the "Tax Exemption for Income from Technology Acquisition" scheme introduced by Korea in 2015 as a temporary incentive for SMEs and "high potential enterprises". **Table 2** in the Annex provides a new summary overview of income-based tax incentive provisions and their key design features, as available in 15 OECD countries (e.g. Belgium, France, the Netherlands, Portugal, Spain) and two partner economies (China and the Russian Federation) in fiscal year 2015 (or closest). Key design features relate to the type of income, IP and company qualifying for tax relief in a given jurisdiction and the applicability of thresholds or ceilings that may limit the generosity of income-based tax relief. Royalties represent the most common category of income qualifying for tax relief across the given set of 17 countries[29], followed by capital gains and production income. Thresholds or caps on tax incentive benefits currently apply only in few of those countries (Belgium, China, Hungary, and Spain).

Different categories of IP also qualify for income-based tax relief across these 17 jurisdictions. Patents feature as most prominent category, but a majority of countries allow for additional categories of IP such as trademarks, designs and software copyrights to qualify for support. Countries also vary in the extent to which they allow for a preferential tax treatment of self-developed IP, existing and acquired IP and the eligibility requirements they impose on existing (e.g. date of IP development or acquisition) and acquired IP (e.g. further IP development). Furthermore, some jurisdictions impose restrictions on the location of R&D performance generating the IP related income or on the type of company qualifying for income-based tax relief (e.g. R&D Centres).

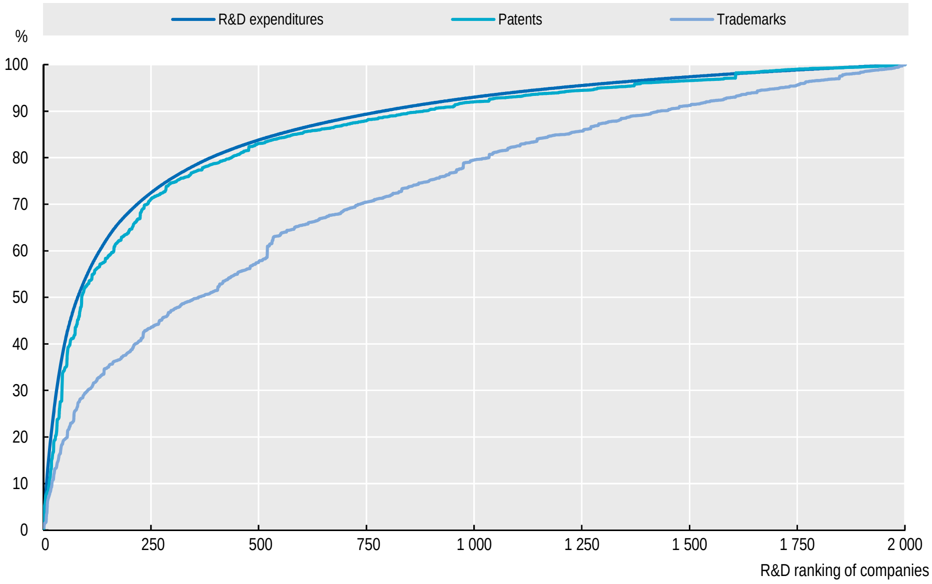
These design features, among others, affect the generosity and cost of income-based tax relief. The effective tax rate (ETR) on income derived from IP, and its magnitude relative to the statutory corporate income tax rate in a country, provides a first, indicative measure of the generosity of the income-based tax regime, assuming no ceiling or thresholds applies and that firms can make full use of the tax offset in the given period. The ETR varies across countries and type of qualifying income, ranging from 0% to 18.15% and representing a reduction in the statutory CIT rate of 50% or more in most countries.

Income-based incentives for R&D in context

The increasing adoption of income-based tax incentives deserves attention because of several issues related to the use of income-based regimes. This is particularly true for "patent boxes", one prominent example of income-based tax incentive regimes. Firstly, a large share of patents is held by a small number of large multinational corporations. In 2012, the 250 global corporations with the largest levels of R&D investment accounted for 70% of patent families filed by the top-2000 corporate R&D investors at the five largest intellectual property office worldwide (**Figure 5**) - almost 80% in the case of ICT-related patents (OECD, 2015a). This skew in the patent distribution is likely to be exacerbated when focusing on high-revenue patents. This implies that benefits of "patent boxes" and similar income-based provisions are likely to accrue mainly to multinational firms. These firms may be then able to find ways of using the income-based provisions to shift profits across jurisdictions, as emphasized by the OECD Base Erosion Profit Shifting (BEPS) Initiative (OECD, 2015c). Secondly, income-based provisions may push firms to focus on innovations that lead to outcomes that are susceptible to protection by IP rights and, therefore, distort the choice of firms to focus on more applied research (Akcigit *et al.*, 2013) or on products that are closer to being introduced to the market. Thirdly, such regimes could even distort the firm's strategy to protect its intellectual property, encouraging them to apply for patent protection when they would not have done so in the absence of the measure. Indeed, surveys reveal that many innovative firms choose not to seek any IP protection for a number of reasons.

Figure 5. R&D expenditures and the IP bundle of the top R&D companies, 2012

Cumulative percentage shares within the top 2000 R&D companies



Source: OECD STI Scoreboard 2015 (OECD, 2015a), based on OECD STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, June 2015. http://dx.doi.org/10.1787/888933273408.

In addition, two considerations cast doubt on the ability of such regimes to successfully promote investment in R&D. Importantly, credit constrained, innovative firms need the funds to conduct their research as early as possible, but benefits from a reduction of tax on IP-related incomes may materialise years after the initial investment. It is unclear how large the tax reduction has to be in order for this to become a sufficiently strong incentive to undertake R&D at the current point in time, bearing in mind the various risks and uncertainties faced by firms, especially start-ups. Without additional provisions, income deriving from R&D activity already conducted before the introduction of the incentives would be eligible for support and thus result in considerable deadweight. In addition, "patent boxes", by their very nature, give an ex-post reward only to successful innovators that already hold monopoly rights on their inventions and receive an income from it. They, therefore, do not address the key challenge with R&D – its inherent high risk of failure that risk-averse agents may be unwilling to take.

Regimes that provide for a tax preference on income relating to IP have been increasingly adopted by many countries in recent years and have been one the focus under the OECD BEPS Initiative because of their potential to have harmful effects on other countries. IP assets, such as patents, copyrights, trademarks or brands, are highly mobile and therefore can be easily located away from the activity that generated them as well as from the jurisdictions in which they are used to generative revenue. In particular, multinationals often locate their intangible assets in low-tax jurisdictions to reduce their corporate tax liabilities, thus eroding tax revenues in countries with high tax regimes.

The OECD BEPS recommendations (OECD, 2015c) require the presence of a substantial activity requirement in those IP regimes, and a so-called nexus approach has been agreed in order to determine which IP regimes have a demonstrable link between the tax relief provided and substantive, knowledge creating activity undertaken by the firm in the relevant jurisdiction. The BEPS recommendation considers within its scope a number of IP assets that are functionally equivalent to patents and qualifying expenditures characterised by novelty, non-obviousness and utility. The same principle can also be applied to other preferential regimes. However, under the nexus approach, marketing-related IP assets such as trademarks do not qualify for tax benefits under an IP regime.

Evidence on the impacts of income-based incentives

Compared to expenditure-based tax incentives, the body of empirical work and evidence on the impact of income-based tax incentives on R&D and innovation is significantly less well developed. Most of the existing literature is principally based on data reflecting the initial surge in IP regimes in the early and mid-2000s. A comprehensive assessment of the R&D and innovation impact of income-based tax incentives should ideally take into account the design features and generosity of these regimes relative to the level of corporate taxation and the interaction of such schemes with expenditure-based tax incentives which are available to firms in the majority of OECD countries and other major economies. Design features that possibly influence the overall R&D and innovation impact of income-based tax incentives, relate to the type of IP (e.g. patents, trademarks, copyrights) qualifying for tax relief and the extent to which tax relief is available for self-developed existing and acquired IP.

A number of studies on MNEs report a negative relationship between the level of corporate taxation and the attractiveness of different countries or regions as locations for IP registration and/or ownership (e.g. Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012 and Griffith et al. 2014). This appears to apply in particular in the case of high-quality patents, i.e. those with a seemingly high degree of novelty and profit potential (Ernst et al. 2014 and Böhm et al., 2015).[30] Ernst and Spengel (2011) further find that the negative effect of corporation taxation on the number of patent applications filed by MNEs is significantly larger in its magnitude in the case of large firms, inventions co-developed with foreign inventors and in countries that offer expenditure-based tax incentive support for business R&D.

Alstadsæter et al. (2015) make use of firm-level data for the top 2000 corporate R&D investors worldwide over the period 2000-2011 to gain more insights on the impacts of different IP-based relief regimes. They find that IP boxes have a strong effect on the patent location choices of top global R&D performers, and particularly so in the case of high quality patents. They also find that the effect of IP boxes on the location of patent registration increases with the scope of regimes (i.e. qualifying IP) and that such preferential tax treatment tends to reduce incentives for local innovative activities (proxied by number of resident inventors) within the country providing such qualified incentives. Local R&D performance requirements seem to have the potential to mitigate this detrimental effect.

Evers et al. (2015) incorporate IP box regimes into a theoretical model of effective tax rates to model the impact of such regimes on firms' effective tax burden. The authors show that the effect of IP regimes is also linked to the treatment of expenses relating to IP income. Negative effective average tax rates may arise under regimes that allow expenses to be deducted at the statutory corporate income tax rate rather than reduced tax rate applicable under the IP regime, which in turn may result in a subsidy to unprofitable projects. In a recent evaluation of federal tax incentives for business R&D in Belgium, including the 80% tax exemption of gross patent income (effective in Belgium as of tax year 2008), Dumont (2015) finds no evidence of additional R&D investment being induced by the patent income deduction regime.

A recent evaluation of the innovation box scheme in the Netherlands (Den Hertog et al., 2016) estimates additional R&D expenditure of 54 cents per Euro of foregone tax revenue, a positive effect but approximately half of that typically found for expenditure-based incentives. This effect is estimated at the level of individual establishments of enterprises and therefore does not include R&D impacts at the extensive margin or in other countries.

A recent analysis basis on the comparison with synthetic control group undertaken by the International Monetary Fund (IMF, 2016) also suggests a positive R&D spending effect for IP regimes in the case of Belgium and the Netherlands, while no such effect is found for France and Spain. The reasons for the differences across these countries are unclear. [31] Provisions in these countries differ with respect to the type of links that are imposed by legislation to the underlying innovation activity, in some cases just requiring a control link without the R&D having to take place in the relevant economy. The adoption of nexus-type conditions as included in the OECD BEPS Action Plan (OECD, 2015c) will provide another relevant source of policy variation that could be useful for estimating the impact of innovation boxes and the provisions therein. Any further analysis should also take into account the implications of grandfathering rights allowed by BEPS (OECD, 2015c).

7. Concluding remarks and policy implications

In recent years, there has been a considerable boost to the global evidence on the incidence and impact of R&D tax incentives. This has been based on the work of academics, policy analysts and statisticians.[32] This document sums up some of the more salient features of the available evidence on the incidence and impact of public support for R&D through tax incentives, bringing in different strands of work carried out within the OECD. The OECD has strived to distil and validate information from multiple sources in a format suitable for policy analysis and discussion, and work to integrate available sources into its policy and measurement recommendations.

With the available evidence, it is not generally possible to state unambiguously whether some tax relief design features should be recommended in favour or against as contextual elements are decisive and need to be taken into account. However, the available evidence can inform national decisions concerning the optimal balance between direct and tax support, and can also help assess the trade-offs arising from introducing certain provisions aimed at managing the less desirable features of R&D tax incentives. A number of key messages come of out this synthesis and have been noted in previous work (e.g. OECD, 2013; OECD, 2015d).

- R&D tax incentives should be carefully designed to take into account of heterogeneity among potential R&D performers and the position of ‘stand-alone’ firms without cross-border tax planning opportunities, as well as those of young, innovative firms without the profit-generating capacity on which to realise allowances or credits.

- Small or young firms react more strongly to R&D tax incentives than large firms, and they are less likely to shift their profits abroad to avoid taxes. R&D tax incentives should include carry-forward provisions, cash refunds or reductions in social security and payroll taxes, so that they fully benefit also small and young firms and projects involving basic research.

- Policymakers should consider balancing indirect support for business R&D (tax incentives) with the use of direct support measures to foster innovation where the market is less likely to deliver it on its own. They should also assess how different innovation support instrument interacts with and complement each other. In some cases, direct instruments may be more appropriate. The optimal mix will depend on very specific circumstances as well as policy preferences.

- The effectiveness of R&D tax incentives depends upon the broader regulatory environment, in particular the broad taxation regime, and its stability and predictability over time. Stable and predictable incentives are likely to have a stronger impact on R&D investment.

- Income-based incentives should be treated with caution, given the lack of evidence of their effectiveness and the risk that they will disproportionately benefit established, large firms, MNEs and innovations susceptible to protection by patents.

- Using fiscal incentives with the sole purpose of attracting potentially mobile R&D by MNEs is likely to have only limited effects, and it can lead to a dangerous "race to the bottom" among countries.

- Governments should ensure that R&D tax incentive policies provide value for money, through effective ex-post evaluation linked to the ex-ante assessment of reforms and new initiatives. Ex-ante provision for an ex-post evaluation should be an integral part of every innovation policy and this should be no exception. This should incorporate efforts to put in place the relevant data and analytical infrastructure.

In order to advance the existing evidence on the incidence and impact of public support for business R&D, the OECD Directorate for Science, Technology and Innovation just launched a new distributed micro-data project with support from the EU's Horizon 2020 Programme. This new project seeks to explore at firm-level the extent and statistical impact of public support in account of the wide heterogeneity in firms' eligibility and use of government support, direct funding and tax incentive provisions where available. The project is based on the distributed analysis of microdata through which the OECD collaborates with national experts with access to R&D and public support microdata undertaking a coordinated statistical analysis of the true incidence and impact of scheme design features and its interaction with direct forms of public R&D funding. The use of microdata enables a better understanding of the heterogeneity that underpins aggregate outcomes. It also ensures preservation of data confidentiality while addressing questions that cannot be explored through analysis within a single country or with publicly available data sources. The project will also contribute to informing country's decisions concerning the data and evidence infrastructures they need to have in place in order to monitor and evaluate their policy decisions. Efforts such as this should be complemented by comprehensive programme assessment, both quantitative and qualitative, at the level of individual countries (OECD, 2015d)

NOTES

1. The purchase of R&D services by public authorities is another form of R&D support but this represents an exchange of financial resources for economic rights to the outcome of the sponsored activity, which if undertaken under market conditions, does not represent a form of financial aid.

2. The OECD Frascati Manual defines R&D as "creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge". To qualify as such, the knowledge pursued by R&D activities must be novel, arise from creative work with uncertain outcomes, and requires a basic degree of planning as well as the possibility to have findings codified. These properties make it a unique form of asset not only those who invest in it but also to society as a whole. The manual also notes that Technology Readiness Level (TRL) classifications for projects are used in some jurisdictions and especially in some industries (e.g. systems engineering), noting that there is no single TRL definition nor correspondence table with the R&D definition that can apply in all cases.

3. More information on the eligibility status of different types of expenditures for R&D tax relief in OECD^{+} economies is available at www.oecd.org/sti/rd-tax-incentives-expenditures.pdf.

4. The credit may sometimes be taxable.

5. Countries that solely provide for the deductibility of R&D expenses are not considered in this document to provide R&D tax incentives as it is not possible to argue that observationally equivalent expenses are not R&D related. The situation can be more complex in the case that some R&D expenses can be capitalised in the firm's balance sheet.

6. The choice between credits and allowances is largely a formal one, as they can be made equivalent and converted onto the other. However, while a conversion is in principle possible, this choice has practical consequences. In the case of the allowance, the value of the support depends on the value of the corporate income tax rate (CIT) and would have to be adjusted whenever CIT rates change. Also, if CIT rates for SMEs are lower relative to those for large firms, the tax benefit to the former is lower. In some countries, CIT rates differ between SMEs and large firms.

7. Some countries impose limits to this implicit refundability so that the employee does not lose social security entitlements arising from reduced contributions from their employers.

8. The argument would apply to any R&D inputs supplied inelastically within the economy.

9. It is important to note that the association between incremental designs and additionality of support is only a very crude approximation. For example, in the absence of support, it may be argued a firm may revert to a lower level of R&D performance while support may just in some circumstances help maintain the level of R&D. The counterfactual level of R&D will vary across firms and is not necessarily the level of R&D carried out in the previous period.

10. SMEs may also benefit from enhanced tax credit rates in the case of two-level incentive rates (e.g. France) where activity thresholds (e.g. linked to the volume of R&D expenditures) are less likely to be binding for SMEs in comparison to large enterprises.

11. For a longer time perspective, see OECD (2014) and references therein to the role of the adoption of the 2000 WTO agreement on R&D subsidies, which contributed to increasing the relative attractiveness of R&D tax incentives as R&D support instruments.

12. Using panel of data on tax changes and R&D spending in nine OECD countries over a 19-year period (1979–1997) and controlling for permanent country-specific characteristics, world macro shocks and other policy influences, Bloom et al. (2002) similarly estimate the long-run price elasticity of R&D with respect to its user cost at around -1. The short-run elasticity is estimated at -0.1.

13. See, for example, B. Hall and Van Reenen (2000); Parsons and Phillips (2007); Ientile and Mairesse (2009); Lokshin and Mohnen (2012); and Rao (2015b).

14. Agrawal et al. (2014) and Rao (2015b) are recent studies that make use of confidential corporate tax return data – for Canada and the United States respectively – which allows them to calculate firm-level user cost measures reflecting the actual amount of tax support to business.

15. See Arqué-Castells and Mohnen (2015) for an analysis of the R&D inducement effects of R&D subsidies at the intensive and extensive margin and Arqué-Castells (2013) for an analysis of the state-dependence in R&D performance and the effect of R&D subsidies in encouraging sustained R&D performance.

16. In 2004, the French government introduced a 5% volume-based tax credit alongside the incremental scheme whose rate is reduced to 45%. The CIR tax relief cap is raised from EUR 6.1 million to EUR 8 million. As of 2006, the volume-based tax credit rate rises from 5% to 10%, while the incremental tax credit rate is reduced to 40%. The CIR tax relief ceiling rises from EUR 8 million to EUR 10 million per firm and year. The wages of researchers with a Ph.D. or equivalent degree and unlimited employment contract (young doctors) count twice for R&D tax credit purposes during the first 12 months following their first recruitment. Through the 2008 reform of the French R&D tax credit, the period during which the wages of young doctors count twice for tax relief purposes was extended from 12 to 24 months.

17. See, for example, Mansfield (1986) for Canada, the US and Sweden and Hall (1995) for the United States.

18. These results may, however, be driven by some of the specificities of the Norwegian scheme, which subsidises mostly SMEs and includes a cap on the total level of support available. Both of these features may hamper its ability to stimulate innovations with high social returns.

19. See De Jong and Verhoeven (2007); Czarnitzki (2011); Foreman-Peck (2012); Moretti and Wilson (2014); and Dechezleprêtre et al. (2015).

20. See Goolsbee (1998); Haegeland and Møen (2007); Lokshin and Mohnen (2012); and Lokshin and Mohnen (2013).

21. See also earlier studies by Hines (1994); and Hines and Jaffe (2000).

22. See, for instance, Thursby and Thursby (2006); OECD (2007); Alcácer and Chung (2007); Branstetter *et al.*, (2006).

23. See studies by von Zedtwitz and Gassmann (2002) and Defever (2006).

24. Cappelen et al. (2007) also estimate an impact of tax breaks on productivity, but they control for R&D investment. They, thus, effectively test if R&D investment attributable to the incentives has different effect on productivity than other R&D investment. They cannot reject the null hypothesis of no difference.

25. See Berger (1993); Russo (2004); Parsons and Phillips (2007); Lokshin and Mohnen (2012); Foreman-Peck (2012); and Dechezleprêtre *et al.* (2015).

26. See Lokshin and Mohnen (2007); Haegeland and Møen (2007); Baghana and Mohnen (2009); Azcona et al. (2014); Romero-Jordán et al. (2014); Castellacci et Lie (2015); Rao (2015b).

27. The review by the What Works Centre for Local Economic Growth (2015) concludes that available evidence does not show any systematic difference between the effectiveness of incremental and volume-based incentives. However, the review focuses only on the sign and statistical significance of the results, not considering potential differences in their magnitude.

28. Duguet (2012) estimates an incrementality ratio of slightly more than 1 for the “incremental” R&D tax credit in France over the 1993-2003 period. Mulkay and Mairesse (2013) undertake a simulation-based, ex-ante evaluation of the 2008 R&D tax credit reform in France in the course of which the incremental tax credit was replaced by a purely volume-based tax credit (applicable at a rate of 30% up to an R&D expenditure threshold of EUR 100 million and 5% above this limit). The simulation yields a positive and sizeable effect on R&D which is higher in the long run by about 12% compared to the counterfactual of no tax support. This effect corresponds to an implicit long run budget multiplier of about 0.7.

29. Some countries (e.g. Belgium, Luxembourg and the Netherlands) further include embedded royalties as a form of qualifying income. In other cases, no specific category of qualifying income may be specified, as for instance in the Russian Federation, where income is taxed at a reduced corporate income tax rate as long as it is derived from R&D and innovation activities undertaken by companies within Technical and Innovation Economic Zones.

30. Böhm et al. (2015) show that controlled foreign company rules in the parent (inventor) country, making patent income taxable at the parent company tax rate, reduce the likelihood of patent relocations from the inventor country to a foreign tax haven. Based on corporate patent applications to the European Patent Office between 1990 and 2007, the authors find that a large fraction of patents held in low-tax economies has inventors based in a foreign country. In small tax havens, this ratio is often well above 80%, but even in large and economically important low-tax countries like Ireland and Switzerland, foreign-invented patents are found to account for around 35% and 45% percent of all patent holdings. Most other European high-technology countries, in contrast, observe much smaller foreign invented patent holdings, commonly well below 10%.

31. The IMF report contains limited methodological information towards assessing the results. In the case of Netherlands, a possible concern is that the analysis might not have fully accounted for a major revision between 2010 and 2011 in the methodology for estimating business R&D. This revision led to a sudden increase in R&D performed by resident Dutch enterprises by incorporating a significant number of small R&D performers. It is therefore likely that the attributed impact is actually reflecting the unrelated impact of the R&D statistical methodological change. This appears to be consistent with the timing of the estimated impact, which coincides with the implementation of the statistical revision two years after the introduction of the IP Box.

32. It is also worth recognising the role played by tax consultancies and law firms in gathering and comparing R&D tax incentive information across different countries.

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ANNEX

Annex Table 1. Main features of R&D tax incentives provisions in selected OECD and non OECD countries, 2015

Expenditure-based R&D tax incentives			
Corporate income tax			Tax relief on wage taxes/ social contributions
R&D tax credit		R&D tax allowance	
Volume	Incremental/hybrid		
Taxable: Australia, Canada, Chile, United Kingdom (large companies) Non-taxable: Austria, Belgium (incompatible with allowance), Denmark (deficit only), France, Iceland, Ireland, New Zealand (deficit only), Norway, Hungary	Taxable: United States (credit on fixed, indexed base and incremental for simplified credit) Non-taxable: Italy (Legge di Stabilità 2015), Japan, Korea, Portugal, Spain	Non-taxable: Belgium, Brazil, China, Czech Republic (hybrid), Greece, Hungary, Netherlands, Poland (R&D Centres), Russian Federation, Slovenia, Slovak Republic (hybrid and volume-based), South Africa, Turkey (hybrid), United Kingdom	Taxable: Belgium, France, Netherlands, Hungary, Russian Federation, Spain, Sweden, Turkey
Treatment of excess claims			
Refund			
Australia (SMEs), Austria, Belgium (after five years), Canada (SMEs), Denmark, France (SMEs), Iceland, Ireland, New Zealand, Norway, United Kingdom (large companies)	Spain (reduced, payable credit optional)	United Kingdom (SMEs)	Automatic refund through wage system
Carry-forward			
Australia, Belgium, Canada, Chile, France, Ireland	Korea, Portugal, Spain (unreduced, non-payable credit), United States	Belgium, China, Czech Republic, Greece, Poland, Netherlands, Russian Federation, Slovenia, Slovak republic, South Africa, Turkey, United Kingdom	Not applicable
Enhanced tax credit/allowance rates or more favourable terms			
SMEs			
Australia, Canada, France, Norway	Italy (innovative start-ups), Japan, Korea, Portugal (start-ups)	United Kingdom	Belgium (young innovative firms), France (JEI/JEU), Netherlands (start-ups), Spain (innovative SMEs)
Collaboration			
France	Italy, Iceland, Japan	Hungary	Belgium
Limitation of benefits			
Threshold-dependent credit rates			
Canada (SMEs), France			Netherlands, Russian Federation
Ceilings on amount of eligible R&D expenditure or value of R&D tax relief			
R&D expenditure: Australia (floor and cap), Canada (SMEs), Chile, Denmark, Iceland, Norway R&D tax relief: Hungary, New Zealand (deficit only)	R&D expenditure: Italy (floor), Portugal (incremental) R&D tax relief: Italy, Japan, Korea (large firms), Spain, United States	R&D tax relief: Hungary (R&D collaboration), United Kingdom R&D expenditure and R&D tax relief: Slovak Republic (volume-based tax allowance)	R&D expenditure: Hungary R&D tax relief: France, Sweden, Turkey (five year limit)
Accelerated depreciation provisions for R&D capital			
Belgium, Brazil, Chile, China, Denmark, France, Israel (non R&D specific), Poland, Russian Federation, Spain, United Kingdom			
No expenditure-based R&D tax incentives			
Estonia, Finland, Germany, Luxembourg, Mexico, Switzerland			
Preferential tax treatment of income derived from R&D or other innovation activities			
Belgium, China, France, Greece, Hungary, Ireland, Israel, Italy, Korea, Luxembourg, Netherlands, Portugal, Russian Federation (Technology and Innovation Special Economic Zones), Spain, Switzerland (Canton of Nidwalden), Turkey (Technology Development Zones), United Kingdom			

Source: OECD, R&D Tax Incentives Database, http://oe.cd/rdtax, December 2015.

Annex Table 2. Preferential tax treatment of corporate income derived from R&D or related innovation activities – OECD and selected non OECD countries, Fiscal Year 2015 (or closest)

Country	Tax Incentive [Year enacted] Legal framework	Effective tax rate (vs. CIT)[2] in %	Type of tax relief[3]	Qualifying income					Qualifying intellectual property (IP)			Qualifying companies/ enterprises
				Type of income	Treatment of past R&D costs	Treatment of IP losses[4]	Threshold, Ceiling	Foreign tax credit[5]	Categories of IP	IP development & acquisition	Location of R&D performance	
Belgium	Patent Income Deduction [2007] Art.205^1 to 205^4 (Art. 236 bis for Belgian establishments of foreign companies) Income Revenue Tax Code 1992	6.8 (vs. 33.99)	80% deduction of qualifying income	Gross income (less cost of acquired IP, if applicable) from: Royalties, Embedded royalties, Licence fees	No recapture	Deduction against other income; excess IP losses can be carried forward and set against relevant IP profits at regular tax rate	Deduction limited to 100% of pre-tax income	Yes (lump sum)	Patents and supplementary protection certificates (protection certificates for medicinal products), certain know-how closely linked to a patent of SPC	Self-developed IP, existing IP (if granted or first used on or after 1 January 2007), acquired IP (if further developed)	Self-developed patents in Belgian or foreign "R&D" centre; acquired patents further developed in Belgian or foreign R&D centre. Part of R&D must be performed in an R&D centre in Belgium which constitutes a branch of activity; SME exempt from this requirement. (Patent income deduction Act 17 June 2013)	Belgian companies and Belgian establishment of foreign companies
China	[2008] Art. 27 Enterprise Income Tax Law of the People's Republic of China	0 or 12.5 (vs. 25)	100% (50%) exemption of qualifying income	Net income from: Royalties Embedded royalties, Capital gains	Amortisation of the cost of the intangible assets based on 150%.		RMB 5 million of qualifying income: exemption of 100% and 50% above this threshold	(Pending confirmation)	Patents, copyright of software, integrated circuits layout designs and composition rights, new plants, biological and medical variety and other authorised technology.	Self-developed IP, existing IP and acquired IP	Domestic and abroad (at least 60%of R&D must be performed domestically)	Tax residents in China
France	Patent Box introduced in 1971. Regime of Art. 39 ter Tax General Code (2001), revised in 2005 and 2010.	15 (vs. 33.33)	Reduced CIT rate of 15%	Income from royalties and capital gains (net of IP management costs, if applicable)	No recapture		None	Yes	Patents, extended patent certificates, patentable inventions and industrial fabrication processes	Self-developed IP, existing IP and acquired IP (if owned for at least two years)	Domestic and abroad (within EU)	French enterprises
Greece	[2010] Art.71 Law 3842/2010	0 (vs. 26)	100% exemption of qualifying income for 3 consecutive years (subject to tax reserve)	Net income from: Production income			None	(Pending confirmation)	Patents	Self-developed IP	Domestic; R&D performed outside of Greece should be reported to General Secretariat of Research and Technology (GSRT)	Greek tax paying entities
Hungary	50% deductibility of royalty revenues / Conditional deductibility of capital gains from sale of intangible assets embodying rights to royalties [2003 and 2012]. Act LXXXI of 1996 on Corporate and Dividend Tax	9.5 or 5 (vs. 19 or 10); 0 (vs 16)	50% exemption of royalty revenue; 100% exemption of capital gains	Royalty revenues/ Capital gains	No recapture	In the case of the capital gains IP losses are not deductible for CIT purposes / Royalty losses are deductible for CIT purposes	Deduction of royalty revenue limited to 50% of pre-tax income	Yes	Patents, know-how, trademarks, business names, business secrets, and software copyrights	Self-developed IP, existing IP and acquired IP	Domestic and abroad	Hungarian tax residents according to the Act LXXXI of 1996 on Corporate Tax and Dividend Tax

Country	Tax Incentive [Year enacted] Legal framework	Effective tax rate (vs. CIT)[2] in %	Type of tax relief[3]	Qualifying income					Qualifying intellectual property (IP)			Qualifying companies/ enterprises
				Type of income	Treatment of past R&D costs	Treatment of IP losses[4]	Threshold, Ceiling	Foreign tax credit[5]	Categories of IP	IP development & acquisition	Location of R&D performance	
Ireland	First introduced in Section 34 of the 1973 Finance Act. Knowledge Development Box (KDB) Finance Act 2015 (with effect from 1 January 2016)	6.25 (vs. 12.5)	Super expense deduction of 50% of "qualifying profit"	"Qualifying profits" calculated as "Overall Income from qualifying assets" less the expenses of the trade incurred in earning that income. "Overall income from the qualifying asset" means: (a)any royalty or other sums in respect of the use of that qualifying asset, (b)where the sales price of a product or service, excluding both duty due or payable and any amount of value-added tax charged in the sales price, includes an amount which is attributable to a qualifying asset, such portion of the income from those sales as, on a just and reasonable basis, is attributable to the value of the qualifying asset, (c)any amount for the grant of a licence to exploit that qualifying asset, and (d)any amount of insurance, damages or compensation in relation to the qualifying asset, where that amount is taken into account in computing, for the purposes of assessment to corporation tax, the profits of a trade.	N/A	Losses from a qualifying trade are allowed on a value basis against other profits	N/A	Double tax relief is calculated after taking account of the KDB deduction. Therefore, the amount of credit for foreign tax will be reduced in line with the reduction in the Irish tax arising on that income.	A qualifying asset is a: -Computer program -An invention protected by a qualifying patent (being a patent granted following substantive examination for inventive step or a patent registered before 1 January 2017 once it is certified by a patent agent as one that would have been granted following such an examination) or -IP for small companies that is the result of qualifying R&D. R&D is only qualifying R&D if it seeks to achieve a scientific or technological advancement and involves the resolution of that uncertainty. Certain supplementary certificates and plant breeders rights may also be qualifying assets.	Self-developed qualifying assets qualify for the Knowledge Development Box. Acquired IP forms part of the denominator of the KDB fraction, in line with the modified nexus approach. The cost of acquired IP therefore does not constitute qualifying expenditure, other than as part of the uplift amount.	EEA, unless tax relief is available in the EEA member state for the expenditure incurred there.	A company which is within the charge to tax in Ireland, whether tax resident here or operating here through a branch or agency.

Country	Tax Incentive [Year enacted] Legal framework	Effective tax rate (vs. CIT)[2] in %	Type of tax relief[3]	Qualifying income					Qualifying intellectual property (IP)			Qualifying companies/ enterprises
				Type of income	Treatment of past R&D costs	Treatment of IP losses[4]	Threshold, Ceiling	Foreign tax credit[5]	Categories of IP	IP development & acquisition	Location of R&D performance	
Israel	Preferred Company Regime [2011] Law 5719 - 1959 on Law for the Encouragement of Capital Investment	9 and 16 (vs. 26.5)	Reduced CIT rates of 9% (zone A) and 16% (other zones) applicable	Gross income from: Royalties, Production income		(Pending confirmation)	None	Yes	Patents, know-how, other certified IP developed in Israel	Self-developed IP	Domestic	"Preferred companies" in Zona A (priority areas) or Zone B (centre areas) with a pre-ruling agreement.
Italy	Patent box legislation: Article 1, paras 37-45, of law No 190/2014 (2015 Stability Law), Article 5 of Decree-Law No 3/2015 (Urgent Measures for the Banking System and investment) converted by law No 33/2015, and Article 1, para. 148, of law No 208/2015 (2016 Stability Law)	It depends on the ratio between qualifying R&D expenses and the overall expenses, incurred by the taxpayers to produce or to maintain the IP The effective CIT rate may be not lower than 13.75% (vs. 27.5%); Full exemption for capital gains	At full capacity, the law provides for 50% exclusion of eligible IP income from the overall income. (For FY 2015 exclusion is 30%; 40% in FY 2016); full exemption of capital gains (provided that 90% is reinvested in other IP development within 2 years); tax relief applies up to 5 years;	Royalties, embedded income, Capital gains, compensation for infringements	For the first three fiscal years of application of the Patent box legislation (2015, 2016, 2017), the taxpayers may use a three year average, calculating the nexus ratio on R&D costs incurred in the previous three years. From the third year following the entry in force on, nexus ratio should be calculated through a cumulative approach of R&D costs relevant to the IP or product embedding IPs	IP losses may be offset against ordinary income, providing for a "recapture" mechanism. The losses are recaptured inside the Patent Box decreasing the amount of qualifying income for tax relief to the extent and until the previous losses are fully absorbed	None	Yes	Software protected by copyright, industrial patents, trademarks, designs and models, as well as processes, formulas and information relating to experience acquired in the industrial, commercial or scientific field, capable of legal protection	Self-developed, existing IP (proof that the company carried out R&D activities relevant to the IP)	Domestic and abroad	Domestic and foreign companies (as Italian tax residents or through PE , provided they are, resident in countries with which an agreement to avoid double taxation is in force with Italy and with which the exchange of information has become effective)
Korea	Tax Exemption for Income from Technology Acquisition [2015] STTCL §12 (temporary incentive due to expire 31 December 2015; confirmation of extension pending)	18.15 for royalty income and 12.1 for capital gains (vs. 24.2)	Tax credit equivalent to 25% of the tax liability for leasing IP and 50% of the tax liability for transferring IP	Taxable income (Korean taxation law) from: Royalty income, Capital gains				Yes, (unused foreign tax credits can be carried forward for five years)	Patent rights, utility model rights, etc.			SMEs and High Potential Enterprises

Country	Tax Incentive [Year enacted] Legal framework	Effective tax rate (vs. CIT)[2] in %	Type of tax relief[3]	Qualifying income					Qualifying intellectual property (IP)			Qualifying companies/ enterprises
				Type of income	Treatment of past R&D costs	Treatment of IP losses[4]	Threshold, Ceiling	Foreign tax credit[5]	Categories of IP	IP development & acquisition	Location of R&D performance	
Luxembourg	[2008] Art. 50 bis Law on Income Tax	5.84 (vs. 29.22)	80% exemption of qualifying income	Net income from: Royalties, Embedded royalties, Capital gains	Recapture (capitalisation of development cost of self-developed IP incurred)	Deduction against other income; excess IP losses set against income from IP disposal at the regular tax rate	None	Yes	Patents, trademarks, designs, domain names, models, and software copyrights	Self-developed IP, existing IP (developed or acquired since 01/01/2008) and acquired IP (from non-affiliated company and since 01/01/2008)	Domestic and abroad	Domestic enterprises
Netherlands	Innovation box [2007, 2010] Art. 12b Corporation Tax Act 1969	5 (vs. 25)	5/25 of the income is taken into account as taxable base	Net income from: Royalties, Embedded royalties, Capital gains,	Recapture at the regular tax rate	Deduction against other income	None	Yes	Patents and non-patented IP with R&D declaration	Self-developed IP, (developed since 01/01/2007) and acquired IP (if further self-developed)	Self-developed by a Dutch tax payer	Dutch resident companies and Dutch permanent establishments
Portugal	[2014] Article 50a Code of Income Tax on Legal Persons	10.5 (vs.21)* *Since 01/01/2015.	50% exemption of qualifying income	Gross income from: Royalties (Capital gains on the sale/transfer of qualifying IP do not fall within the regime)	Capitalization of development costs (regular tax system)	N.A.	None	Yes	Patents, industrial designs or models (protected by IP rights)	Self-developed IP, existing IP (only IP registered as of January 1, 2014)	R&D can be performed abroad, but self-develop by the licensor and double tax relief limited to 50%	Portuguese taxable entities
Russian Federation	[2005] Federal Law No. 116-FZ/2005 on Special Economic Zones	0-13.5 (vs. 20)	Reduced CIT rate of 0-13.5% applicable, 100% exemption property tax	Income derived from R&D and innovation activities				(Pending confirmation)				Enterprises in Technical and Innovation Economic Zones
Spain	Patent box [2008, 2015] Art. 23 Corporate Income Tax Act	10 (vs 25)	60% exemption of qualifying income	Net income (gross income - expenses) from: Royalties and Capital gains (only transfers between unrelated parties)	No recapture	No special treatment		Yes	Patents, formulas, processes, plans, models, designs, and know-how	Self-developed IP and existing IP	R&D performed domestically and abroad (by IP developing enterprise and must be self-developed by the licensor in at least 25%)	

Country	Tax Incentive [Year enacted] Legal framework	Effective tax rate (vs. CIT)[2] in %	Type of tax relief[3]	Qualifying income					Qualifying intellectual property (IP)			Qualifying companies/ enterprises
				Type of income	Treatment of past R&D costs	Treatment of IP losses[4]	Threshold, Ceiling	Foreign tax credit[5]	Categories of IP	IP development & acquisition	Location of R&D performance	
Switzerland (Canton of Nidwalden)*	IP box [2011] Article 85 Corporations and Cooperatives Taxation Act In line with the BEPS Action Plan, the Canton of Nidwalden has brought this regime in line with the Nexus standard by 1st January 2016.	8.8 (vs. 12.6); ETR includes federal tax.	80% reduction of Cantonal CIT rate of currently 6%. No relief on Federal level.	Net income from: Royalties, Capital gains deriving from the sale of patents	No recapture	Expenditure surpluses from one segment / source are set off against income surpluses of the other. These recognised segment losses will be carried back to the relevant segments in subsequent years.	None	Yes (lump sum)	The definition of license income is based on art. 12 (2) of the OECD Model Convention: Patents, trademarks, designs, models, plan, secret formula or processes, artistic or literary copyrights and scientific works	Both.	R&D performed domestically and abroad	Companies resident with significant business activity in Nidwalden.
Turkey	TDZ regime [2001] Law 4691/2001 on Technology Development Zones	0 (vs. 20)	100% exemption of qualifying income until 31 Dec 2023	Net income from: Royalties, Embedded royalties, Capital gains, Production income		(Pending confirmation)	None	Not applicable under TDZ regime	Invention as a result of R&D innovation and software activities in Turkey and is patented or utility model certified. License, patent, adaptation, development, revision, deployment and plug-in derived from software or products developed in TDZ	Self-developed IP, existing IP (only for R&D in Turkey and patents certified by Turkish Patent Institute, but not for R&D in techno parks)		Enterprises in Technology Development Zones (TDZ)
	[2015] Corporate Tax Law No: 6518, Article 5/B	10 (vs. 20)	50% exemption of qualifying income	Royalties, Embedded royalties, Capital gains, Production income		(Pending confirmation)	None		Invention as a result of R&D innovation and software activities in Turkey and is patented or utility model certified.			Corporate taxpayers in Turkey, other than TDZ regime beneficiaries
United Kingdom	Patent box [2013] Incorporated in Part 8A Corporation Tax Act 2010 (CTA) 2010, sections 357A - 357GE	10 (vs. 20)	Reduced CIT rate of 10% applicable	Net income (before interest) from: Royalties, Embedded royalties, Capital gains, Production income, Infringement income	R&D expenditures allocated to patent income indirectly in line with the ratio of qualifying income to total income	Set against relevant IP profits for accounting period or carried forward and set against relevant IP profits of later periods.	None	Yes	Patents, supplementary protection certificates related to medicinal, plant, veterinary, and data protections, national security or public safety and legal right ownership	Self-developed IP, existing IP and acquired IP (if further developed by acquired company for at least 12 months)	Domestic and abroad (only for self-developed IP where active ownership applies)	UK resident and non-resident companies with permanent establishments, eligible for the patent box regime and holding qualifying IP rights

Source: OECD, R&D Tax Incentives Database, http://oe.cd/rdtax, June 2016.

Table notes

1) This table summarises the status of income based incentives for fiscal year 2015 or nearest. Changes introduced as a result of the BEPS Action Plan of 2015 are not reflected herein, unless requested by the relevant country.

2) Statutory, non-targeted corporate income tax rates, OECD Tax Database, http://www.oecd.org/tax/tax-policy/tax-database.htm, April 2015.

3) Changes in the design of income-based tax incentives arise due to the continuous development of tax policy concerning IP regimes in the OECD. In the framework of the base erosion and profit shifting (BEPS) action plan, OECD members have recently agreed to enforce rules requiring substantial R&D activities and presence. The nexus approach only allows a taxpayer to benefit from an IP regime to the extent that it can show that it itself incurred expenditures, such as R&D, which gave rise to the IP income. See http://www.oecd.org/ctp/beps-action-5-agreement-on-modified-nexus-approach-for-ip-regimes.pdf

4) Depending on national tax provisions, IP losses may be offset against current or future IP profits or non-IP related profits (subject to the regular corporate income tax rate) of the firm or other group members, if applicable. IP losses do not arise in the context of IP regimes that follow “the gross income approach”.

5) Most of the selected countries provide a credit for taxes withheld on qualified royalty income and dividends. Royalty payments for the licensing of patents and other intellectual property may be subject to withholding taxes in the country where this income is generated (residence country of the licensee) according to applicable international tax law. Withholding tax rates typically range from 5% to 15%. In order to mitigate the level of double taxation, bi- and multilateral tax treaties as well as domestic CIT regulations provide certain exemptions or deductions (see Article 23 OECD Model Convention for taxes on income and on capital). The chosen instrument depends on the applicable legal framework (Double Taxation Treaty (DTT) or domestic legislation in the absence of a DTT).

* Note from Switzerland: "The Canton of Nidwalden represents less than one percent of the Swiss territory, population and GDP. The number of beneficiaries of the IP regime is very low."

General notes

Income-based tax incentives for R&D and related innovation activities: income-based tax incentives may either reduce the tax liability directly through a preferential tax rate on income (tax credit) or indirectly through a partial or full exemption (tax allowance) of taxable income derived from R&D or other innovation activities. Preferential tax treatment provisions may apply for a defined (tax holiday) or unlimited time period to multiple categories of income such as:

- Royalties: royalty and licensing income derived from licences of knowledge assets created by R&D or other innovation activities. This includes income from patent or other IP licensing.
- Capital gains: income derived from the outright disposal of knowledge capital created by R&D or other innovation activities (e.g. sale of patent or other IP rights).
- Production income: income derived from the use of knowledge capital created by R&D or other innovation activities, other than royalty income.

Income-based tax incentives have become known under various names, including "patent box", "licence box", "innovation box" and "knowledge box". In some cases, the assets on which the incomes are based may have been developed by third, related or unrelated parties.