

## How effective are R&D tax incentives?

### New evidence from the OECD microBeRD project

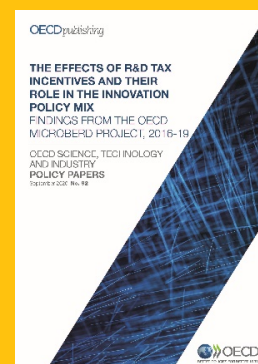
Businesses play a major role in research and development (R&D), accounting for around 70% of total R&D in OECD countries. This investment is supported by a combination of both financial and non-financial policies and interventions, including expenditure-based R&D tax incentives. OECD countries and partner economies have increasingly used tax incentives to support business innovation over the past decade – in 2017, they accounted for around 0.10% of GDP and 55% of total public support for business R&D (BERD) in the OECD area (<https://oe.cd/rdtax>). Yet so far it has been difficult for policymakers to fully gauge the impact of R&D tax incentives across different types of firms and assess whether they are more or less effective than direct funding of BERD.

#### The quick read

The **OECD microBeRD project** investigates whether R&D tax incentives and direct funding are effective in stimulating additional R&D investment (“R&D input additionality”) by business using a novel, internationally distributed method of microdata-based impact analysis. Results from this project’s Phase I (2016–19) show that the effect of such measures varies across different types of firms and R&D expenditures, and shed light on the mechanisms driving these effects (OECD, 2020). These findings, based on 20 OECD countries, have important policy implications.

**Key policy findings** from the microBeRD project include:

- Both R&D tax incentives and direct funding are effective in incentivising R&D investment by business. One monetary unit (EUR) of either tax or direct support translates into around 1.4 units of business R&D.
- R&D tax incentives help increase in R&D activity and this effect does not seem to be driven by increases in R&D wages. They increase the level of R&D activity among existing R&D performers and entice firms to start or continue investing in R&D.
- The input additionality of R&D tax incentives is larger for firms that perform less R&D. As smaller firms tend to perform less R&D than larger firms, they also show larger input additionality, on average.
- The effect of R&D tax incentives on experimental development is about twice as large as the effect on basic and applied research, while the effect of direct funding on experimental development is half as large as the effect on basic and applied research. Tax incentives and direct funding therefore complement each other.
- Firm-level results highlight a substantial variation in the R&D input additionality of R&D tax incentives and direct funding across countries. This underscores the need for a more in-depth analysis of the link between business innovation policy uptake, policy design and policy outcomes, including R&D inputs and outputs.
- Changes in R&D tax incentive policies that target smaller firms or involve ceilings or thresholds tend to have stronger effects on business R&D investment, as small R&D performers appear to be more responsive than larger firms to the availability of R&D tax subsidies.



The microBeRD project uses two complementary analytical approaches to estimate the responsiveness of business R&D expenditure and other R&D-related outcomes to changes in the magnitude of R&D tax incentive support and direct funding at different levels of aggregation:

1. **Cross-country analysis based on pooled, non-disclosive micro-aggregated data** for firms in 20 OECD countries from 2000-17. The cross-country study is centrally run but draws on harmonised, non-confidential micro-aggregates produced and shared by national experts with access to microdata.
2. **Country-specific analysis based on firm-level data** in 14 OECD countries, run in a distributed way directly on national microdata, separately within each country but following a harmonised methodology.

Both analyses are undertaken in a distributed fashion (see microBeRD project box, p. 7) and generate estimates of the gross “incrementality ratio” (IR) for R&D tax incentives and direct funding. This ratio, a measure of R&D input additionality, specifies the amount of R&D induced by one monetary unit of public funding (“bang for the buck”).

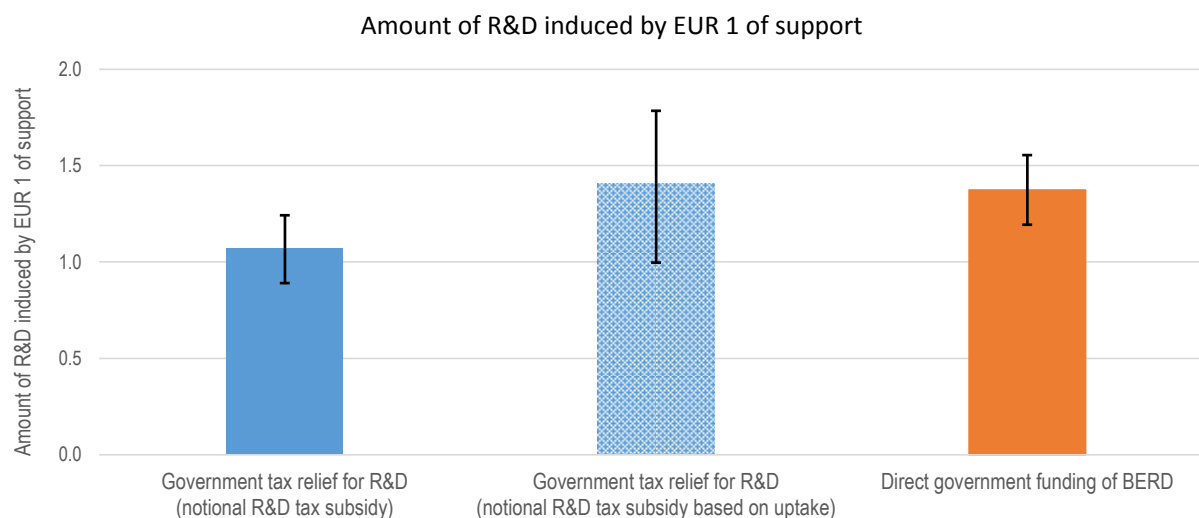
## Findings from the cross-country analysis

The cross-country analysis explores the extent to which R&D reported by companies within a country, industry and size class relates to differences and changes in R&D tax support policies applicable to these groups of firms. The purpose of the analysis is to obtain OECD-wide measures of gross incrementality.

### R&D tax incentives and direct government funding have comparable effects

The “baseline” analysis yields a gross incrementality ratio of around 1 for R&D tax incentives for the 20 OECD countries included in the study (**Figure 1**). This suggests that EUR 1 of notional support translates on average into EUR 1 of business R&D investment. However, not all eligible firms actually make use of available tax incentives. Accounting for the actual uptake of tax incentives, based on administrative records, yields an incrementality ratio of around 1.4, suggesting that EUR 1 of tax support translates into 1.4 units of R&D. This is comparable to the estimated impact of direct R&D funding.

**Figure 1. Estimated effectiveness of government support in raising business R&D**



*Note:* This figure displays the amount of R&D induced by EUR 1 of public support (gross incrementality ratio) by type of policy instrument. The whiskers mark the 90% confidence interval, which covers the “true” incrementality ratio with a probability of 90%.

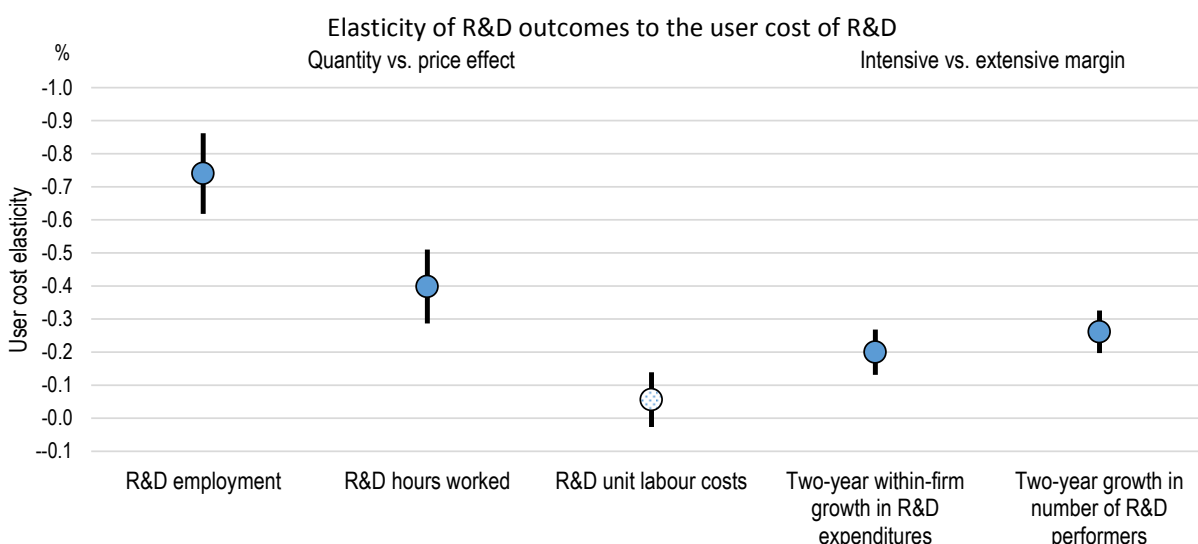
*Source:* OECD (2020), “The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBeRD project, 2016-19”, <https://doi.org/10.1787/65234003-en>.

These results suggest that both R&D tax incentives and direct funding are effective in raising business R&D investment. While incrementality ratios represent an important input into cost-benefit analysis, they are not sufficient to determine whether the benefits of a support instrument outweigh its costs. Making such a determination would require additional calculations involving assumptions about the private and public returns to the R&D induced, as well as the opportunity costs of the public funds used to support R&D.

## R&D tax incentives lead to an increase in R&D activity through multiple channels

Results of the cross-country analysis indicate that R&D tax incentives induce an increase in all types of R&D inputs – R&D labour, other current and capital expenditure – and in both intramural and extramural R&D (i.e. in both the amount of R&D that firms perform and the amount of R&D they outsource to third parties). The effect on capital and extramural R&D expenditure is larger than on current (labour and other current) R&D expenditure because firms of all sizes increase their capital and extramural expenditures, whereas only small- and medium-sized enterprises (SMEs) seem to increase their current R&D expenditure to an appreciable extent. Increased R&D expenditure in response to R&D tax incentives could partially reflect an increase in the price of R&D inputs, especially researcher wages (Goolsbee, 1998; Lokshin and Mohnen, 2013). However, the analysis does not yield evidence of an increase in R&D unit labour costs (a proxy for R&D wages) (**Figure 2**). Instead, increases in R&D labour expenditure prove to be driven by increases in the number of R&D employees in headcounts and full-time equivalents (R&D hours worked), pointing to a quantity rather than a price effect.

**Figure 2.** The effect of R&D tax incentives: impact mechanisms



*Note:* This figure displays the percentage change in R&D outcomes in response to a one percentage reduction in the user cost of R&D (B-Index) through R&D tax incentives (user cost elasticity). Vertical lines mark the 90% confidence interval which covers the “true” elasticity with a probability of 90%. Circles are shaded in light blue if estimates are not statistically different from zero.

*Source:* OECD (2020), “The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBeRD project, 2016-19”, <https://doi.org/10.1787/65234003-en>.

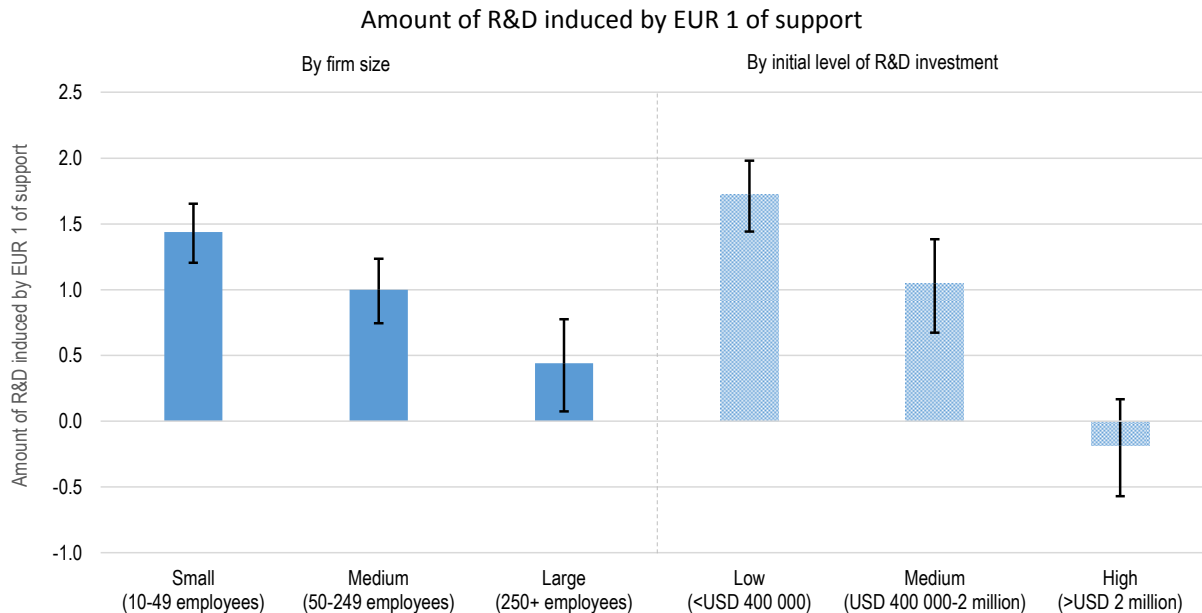
The induced increase in R&D employment seems to be more pronounced in terms of headcounts than in full-time equivalents: a 1% reduction in the cost of R&D is associated with an increase of 0.07% and 0.04% on each measure, respectively. This indicates that the additional human resources devoted to R&D projects spend on average less time on R&D than what existing R&D employees did. While this may imply that firms are hiring new staff to work on R&D on a part-time basis, they may also be re-assigning existing staff’s time away from other activities to work on R&D projects. This might be a potential indication of relabelling activity as businesses report R&D performance to National Statistical Offices collecting R&D data. In such cases, this may lead to some overstating of the actual effects of R&D tax incentives if there is no effective change in activity. Another plausible explanation is that R&D tax incentives lead to the formalisation and potential transformation of existing innovation activity within firms and their identification as actual R&D, as defined by OECD (2015). While formally separated, R&D reporting for tax support and statistical purposes may be indirectly connected in practice (e.g. through the availability of records within firms). This has implications for both the auditing of R&D tax support (ensuring that eligible R&D has effectively taken place) and the assessment of the quality of R&D statistics that is crucial for policy analysis (ensuring that official R&D statistics reflect actual business behaviour).

R&D tax incentives could increase the level of R&D expenditure reported by existing R&D performers (the so-called intensive margin of response), but they could also induce firms to start or continue investing in R&D (the extensive margin). Both of these mechanisms seem to be at play. R&D tax incentives are associated with both stronger growth of R&D expenditure among existing performers and an increased number of R&D performers (**Figure 2**).

### The effect of R&D tax incentives varies across different types of firms

The cross-country analysis also sheds light on the extent to which the impact of R&D tax incentives varies across different types of firms, including firms of different size, industry sector and initial level of R&D investment. Consistent with previous literature (OECD, 2016), the results suggest that the impact of R&D tax incentives decreases with firm size (**Figure 3**). EUR 1 of tax support corresponds to over EUR 1.4 of R&D for small firms (fewer than 50 employees), EUR 1 of R&D for medium-sized firms (50-249 employees) and only about EUR 0.4 of R&D for large firms (250 employees or more). These differences disappear, however, once the analysis accounts for the initial R&D expenditure of each firm. This suggests that R&D tax incentives boost R&D more strongly for smaller firms because these firms tend to perform less R&D, rather than because of their size alone.

**Figure 3.** Differences in the impact of R&D tax incentives across firms



*Note:* This figure displays the amount of R&D induced by EUR 1 of R&D tax support (gross incrementality ratio). The whiskers mark the 90% confidence interval, which covers the “true” incrementality ratio with a probability of 90%.

*Source:* OECD (2020), “The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBeRD project, 2016-19”, <https://doi.org/10.1787/65234003-en>.

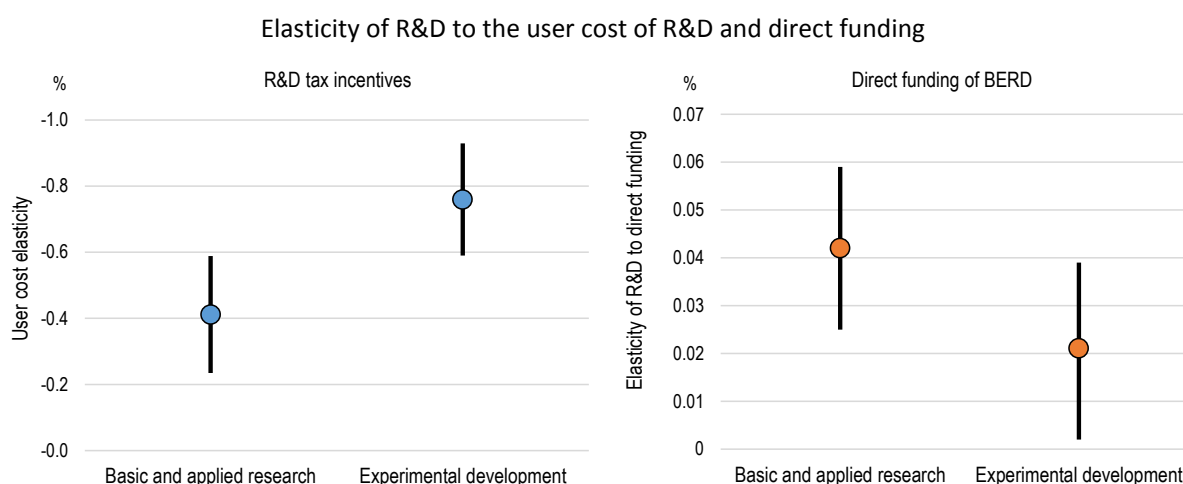
In a similar vein, the cross-country analysis finds limited input additionality for firms in high R&D-intensive industries (pharmaceuticals, computer manufacturing, scientific R&D, IR: 0.3) compared to those in less R&D-intensive sectors (IR: 1.1). This implies that R&D tax incentives are likely to show greater input additionality if they cap the amount of supported R&D expenditure or reduce the rate of R&D tax credit/allowance once a certain threshold has been reached.

### R&D support policies exhibit different strengths and complement each other

The exploratory results of the cross-country analysis suggest that R&D tax incentives and direct funding have a complementary effect on business R&D investment, with the effect of R&D tax incentives increasing with the amount of direct funding. An additional analysis of the link between R&D orientation and tax and direct support (**Figure 4**) corroborates this finding, showing that the two types of business R&D support policies are also complementary in the sense that each induces a different orientation of R&D (basic and applied research vs. experimental development). With reduced discretion on the part of authorities, R&D tax incentives appear better suited to boost R&D that is closer to market application. The elasticity of experimental development (-0.7) to changes in the user cost of R&D (through tax support) is almost twice as large as the estimated elasticity of research (-0.4).



**Figure 4. Responsiveness of research and development by type of policy instrument**



*Note:* This figure displays the percentage change in research and development in response to a one percentage reduction in the user cost of R&D (B-Index) through R&D tax incentives (user cost elasticity) and a one percentage increase in direct funding (elasticity to direct funding) respectively. Vertical lines mark the 90% confidence interval, which covers the “true” elasticity with a probability of 90%.

*Source:* OECD (2020), “The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBeRD project, 2016-19”, <https://doi.org/10.1787/65234003-en>.

In contrast, direct funding appears more conducive to promoting basic and applied research, which may reflect the way in which it is designed and prioritised. The elasticity of experimental development to direct funding (0.02) is half as large as the elasticity of research to direct funding (0.04). However, it is important to note that these estimates capture the elasticity of experimental development (or basic and applied research) with respect to the *combined* amount of direct funding for both types of project. As a result, the low elasticity of experimental development may be due to a low additionality of direct funding for experimental development projects, but it may also be due to a small share of direct funding flowing to such projects.

Overall, R&D tax incentives appear to be more suitable to encouraging experimental development activities in the business sector, while direct government funding seems to be comparatively more effective at promoting research that, while oriented towards ultimate application, is still further away from reaching the market. This finding again hints at the complementary nature of direct and indirect support mechanisms. It would be desirable in the future to count on a richer characterisation of government funding of business R&D in order to differentiate among a wide range of possible direct support instruments and requirements.

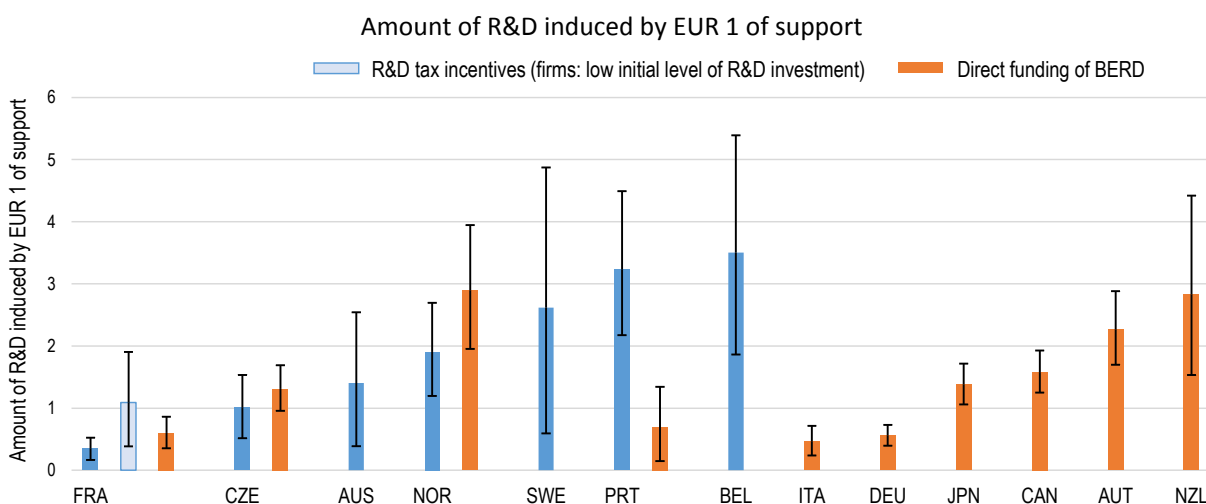
## Findings from firm-level analysis within countries

The effects of R&D tax incentives can be expected to differ across countries given the large variation in the design of such incentives and in the characteristics of firms receiving support. To estimate the effect of R&D tax incentives and direct support within individual countries, the microBeRD firm-level analysis compares R&D-performing firms that start receiving tax relief or direct support with otherwise similar firms that do not rely on such support. The firm-level analysis also investigates the effect of policy changes in the design of R&D tax incentives that focus on specific groups of firms within a country. This “quasi-experimental” approach helps corroborate the more general estimates based on firms’ uptake of R&D support policies.

### The effects of R&D tax incentives and direct funding vary across OECD countries

Although R&D tax incentives represent a market-based, non-discretionary policy tool that is, in principle, available to all R&D performing firms, not all eligible firms actually use them (e.g. due to lack of awareness, or administration and compliance costs). In the case of direct funding, not all potentially eligible firms will decide to apply for an R&D grant and only a fraction of applicants will receive an offer, which they may ultimately accept or reject. This variation can be used to compare the R&D performance of firms that receive support and those that do not (**Figure 5**). At this stage, results based on tax relief uptake are available for seven countries: Australia, Belgium, the Czech Republic, France, Norway, Portugal and Sweden. Estimates based on the receipt of direct funding are reported for ten countries: Austria, Canada, the Czech Republic, France, Germany, Italy, Japan, New Zealand, Norway and Portugal.

**Figure 5. Effectiveness of R&D tax incentives and direct support in raising business R&D**



*Note:* This figure displays the amount of R&D induced by EUR 1 of public support (gross incrementality ratio) by type of policy instrument. The whiskers mark the 90% confidence interval which covers the “true” incrementality ratio with a probability of 90%.

*Source:* OECD (2020), “The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBERD project, 2016-19”, <https://doi.org/10.1787/65234003-en>.

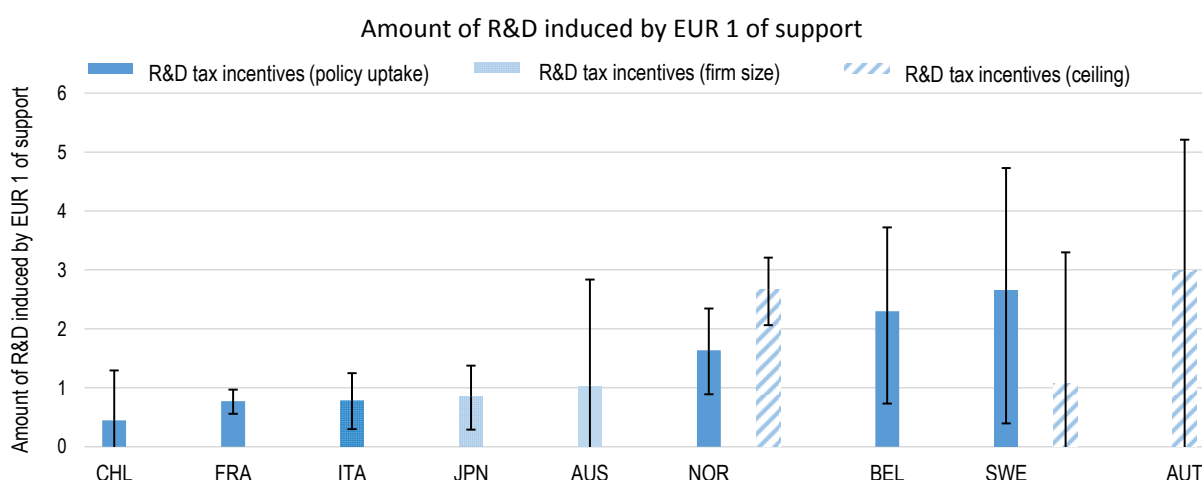
The incrementality ratios derived for R&D tax incentives are close to or greater than 1 for most countries, indicating neutral and in some cases crowding-in effects (i.e. firms increase their R&D investment by an amount greater than the amount of tax support received). A neutral effect is observable for the Czech Republic where EUR 1 of R&D tax support translates into around EUR 1 of R&D. A particularly large R&D input additionality is estimated for Belgium, Norway, Portugal and Sweden, in line with recent estimates obtained in firm-level studies for Belgium (Dumont, 2017), Canada (Agrawal et al., 2020), Norway (Benediktow et al., 2018), the United Kingdom (Dechezleprêtre et al., 2016) and the United States (Rao, 2016). The estimate of 1.4 for Australia is also similar to that obtained by Thomson and Skali (2016). France stands out as the country with the lowest incrementality ratio (IR: 0.34), which is at least partly due to the relatively large level of R&D expenditure of an average firm in the estimation sample. Restricting the sample to firms with a low initial level of R&D investment (bottom half of the R&D distribution) raises the incrementality ratio to around 1. There is likewise substantial variation in the effect of direct funding across countries. The degree of input additionality appears to be particularly high in Austria, Norway and New Zealand. This variation is at least partially related to differences in the composition of direct funding, underscoring the need for more granular data on government R&D procurement contracts and R&D grants. R&D loans and other indirect public financing mechanisms should also be incorporated into international reporting and analysis.

### Policy changes in the design of R&D tax incentives have different effects

Both compositional effects and differences in the uptake and distribution of R&D tax incentive support and direct funding likely explain some of the variability observed in the effectiveness of public support across countries. The firm-level impact analysis of R&D tax incentives based on policy changes shows variation in R&D input additionality (**Figure 6**). This estimation relies on the presence of ceilings on eligible R&D expenditure (e.g. Norway, Sweden, subcontracted R&D in Austria), which limits the availability of a newly introduced or extended R&D tax incentive to firms with R&D below this ceiling. In other cases, the analysis exploits policy changes that exclusively apply to firms in specific size groups (e.g. SMEs in Australia; large firms in Japan). Whenever tax incentives do not have any design features that imply a differential treatment for specific types of firms, information on the uptake of R&D tax incentives following (or prior to) the policy change is exploited.

It is important to bear in mind that these policy changes affect different types of firms (e.g. SMEs vs large firms) and R&D expenditure (e.g. subcontracted R&D vs. in-house R&D), and thus yield different results about the effectiveness of R&D tax incentives in stimulating R&D, both within and across countries. In line with the cross-country findings, firm-level estimation yields a higher effect for SMEs (Australia) vs. large firms (Japan) and for extramural R&D (Austria). Overall, the results based on this “quasi-experimental” approach are broadly in line with those based on policy uptake; only in the case of France is the rate somewhat higher. The estimated rate of R&D input additionality is fairly high for Belgium, Norway and Sweden.

**Figure 6. Effectiveness of R&D tax incentive policy changes in raising business R&D**



*Note:* This figure displays the amount of R&D induced by EUR 1 of R&D tax support (gross incrementality ratio). The whiskers mark the 90% confidence interval, which covers the “true” incrementality ratio with a probability of 90%.

*Source:* OECD (2020), “The effects of R&D tax incentives and their role in the innovation policy mix: Findings from the OECD microBeRD project, 2016-19”, <https://doi.org/10.1787/65234003-en>.

For Italy and Japan, the implied input additionality is slightly below 1. In the case of the Italian tax credit, available from years 2007-2009, both the estimated and actual input additionality were likely reduced by changes in the tax relief payment policy made in 2008 and 2009, which implied that some firms submitting requests to receive tax relief for R&D performed in 2008 and 2009 only received this support in 2010 or 2011. In the case of Japan, the comparatively lower additionality is likely due to the fact that the treatment group consists of large firms with capital above the SME thresholds. The median treated firm in the estimation for Japan has almost 500 employees and performs over USD 2 million of R&D, which is substantially more than in other countries.

### The OECD microBeRD project

The OECD microBeRD project is a distributed microdata project of the OECD Directorate for Science, Technology and Innovation (STI), carried out jointly by the Committee for Scientific and Technological Policy (CSTP) and Committee on Industry, Innovation and Entrepreneurship (CIIE) under the aegis of CSTP’s Working Party of National Experts of Science and Technology Indicators (NESTI). Co-funded by the European Union’s Horizon 2020 research and innovation programme, the project leverages NESTI’s expertise in producing aggregate R&D and R&D government support indicators, together with STI’s wider experience in carrying out international, distributed microdata projects such as the DynEmp (<http://oe.cd/dynemp>) and MultiProd (<http://oe.cd/multiprod>) projects.

In its initial phase (2016-19), microBeRD investigated the structure, distribution and concentration of business R&D and sources of R&D funding across countries, using a unique distributed approach to analyse the incidence and impact of public support for business R&D. This involves analysing microdata held in separate enclaves by means of a common, centrally designed routine. This routine is automated and flexible enough to run on different data sources in different countries, while accounting for their idiosyncrasies. Twenty countries have participated in this collaborative exercise – Australia, Austria, Belgium, Canada, Chile, the Czech Republic, France, Germany, Hungary, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom – and work is underway to include the United States.

The second phase of the project (microBeRD+, 2020-2023) explores the effect of R&D support policies on innovation outputs (e.g. introducing new products and services, filing patents) and economic outcomes (e.g. employment and productivity growth). It will also refine the current analysis by further exploring the relationship between tax incentive design, additionality and the innovation support policy mix over time. Additional information on this project is available at <http://oe.cd/microberd>.

## Further reading

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