

## The role of policy mix in driving business innovation



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Businesses often receive a mix of different innovation policy instruments, a *policy mix*, to support their innovation activities. For example, they may receive a mix of R&D grants and R&D tax credits. What does the evidence suggest about policy mix's role in driving business innovation? SOTA studies on the impact of different policy mixes present a complex picture. Internationally, findings range from an increase of 34 percent in business innovation associated with some policy mixes to a decrease in business innovation of 26 percent associated with other mixes.

This wide range of findings is due in part to the lack of an established empirical methodology or set of 'guiding principles' to inform best practices in evaluating the impact of policy mix on business innovation. It is also due in part to the lack of widely available business-level datasets capturing detailed information on a) the type and source of innovation policy instruments businesses receive each year and b) a range of business innovation measures, beyond R&D expenditure. This form of data is necessary to conduct, in the UK and internationally, robust evaluations with the potential to offer clear guidance on the most effective policy mix for driving business innovation.

To date, there has been an over-reliance on single policy instrument evaluations. Such evaluations risk attributing the impact of a policy mix on business innovation to one individual instrument in the mix.

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## Background

Businesses are the locus of innovation in an economy; they are where new ideas are transformed into commercially viable products and services. Business innovation is a vital engine of national competitiveness and economic growth. Yet, what role does government innovation policy play in driving business innovation?

Government innovation policy is operationalised by a suite of different innovation policy instruments, each specifically targeted at increasing business innovation. These instruments include:

- R&D tax credits that reduce the cost of conducting R&D
- R&D grants that enable governments to directly support innovation activities they perceive as having the highest social benefit
- Public procurement contracts that require new products, processes or services, creating demand for innovation
- Incentivised collaborations between business and public research institutions to enhance businesses' innovation capabilities

Evidence from the European Commission (2017, p. 38) suggests that each of these individual innovation policy instruments have “significant and large” impacts on business innovation. However, what is interesting is that 44–76 percent of businesses receiving one innovation policy instrument also receive at least one additional instrument at the same time (Dumont 2017, p. 1854). This leads Dumont (2017, p. 1852) to question “whether the different support schemes tend to reinforce or weaken one another” when businesses receive a mix?

While the policy mix concept “implies a focus on the interactions and interdependencies between different policies as they affect the extent to which intended policy outcomes are achieved” (Flanagan et al. 2011, p. 702), few empirical studies operationalise policy mix as it applies to business innovation. This is primarily due to a lack of available datasets that capture detailed information on the type and source of innovation policy instruments which businesses receive each year. Rogge & Reichardt (2016, p. 1631) suggest that accessing data with a sufficient level of detail on policy mix may pose “the greatest analytical challenge” for empirical studies.

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## Evidence

Empirical evidence on the role of innovation policy instrument mix in driving business innovation can be divided into two categories. The first category uses cross-sectional survey data; this data captures binary, aggregate measures of the type and source of innovation policy instruments that businesses receive over a period of up to 36 months (Table 1). The second category constructs more detailed panel datasets (Table 2).

Employing propensity score matching methods to control for selection bias and endogeneity associated with receiving public funding for innovation, each study estimates the impact of policy mix on business innovation relative to businesses that 1) receive no innovation policy instrument; and/or 2) receive each individual instrument in the mix.

Evidence for Germany on businesses that receive a mix of R&D subsidies from national and EU sources suggests that, while policy mix increases businesses R&D and innovation expenditure, it has no effect on patenting and only a marginal effect on new product sales. Another study, using a pan-European sample that recorded measures of the type of instruments businesses received, found that a mix comprising public procurement contracts, R&D tax credits, and direct grants increased businesses' innovation expenditure by 34 percent.

**Table 1: Aggregate measures of the innovation policy instrument mix**

Study	Data	Innovation policy instrument mix	Innovation measures	Principal empirical results
Bérubé & Mohnen (2009)	2,785 firms in Canada; cross-sectional	<ul style="list-style-type: none"> <li>•R&amp;D tax credits</li> <li>•R&amp;D grants (binary measures)</li> </ul>	Five product and process innovation indicators; sales from new products	Positive relationship between instruments. Firms are c. 4-14 percent more innovation active across all measures.
Czarnitzki & Lopes-Bento (2014)	8,734 firms in Germany; pooled cross-sectional	<ul style="list-style-type: none"> <li>•R&amp;D subsidies from national government sources</li> <li>•R&amp;D subsidies from EU sources (binary measures)</li> </ul>	R&D and innovation intensity; patents; sales from new products	Firms receiving a mix have higher R&D intensity and innovation expenditure; no effect on sales from new products; small positive effect on patent forward citations.
Neicu, Teirlinck & Kelchtermans (2015)	177 firms in Belgium; cross-sectional	<ul style="list-style-type: none"> <li>•R&amp;D tax credits</li> <li>•R&amp;D grants (binary measures)</li> </ul>	Four measures of firm's R&D/innovation behaviour	Increased the scale and speed of R&D projects by 20-24 percent; 21-26 percent more R&D projects and more research-focused R&D projects.
Radas, Anić, Tafro, Wagne (2015)	175 SMEs in Croatia; cross-sectional	<ul style="list-style-type: none"> <li>•R&amp;D tax incentive</li> <li>•R&amp;D grant (binary measures)</li> </ul>	R&D intensity and employment; R&D collaboration; number of innovations; sales from innovation; four measures of absorptive capacity	Increased innovation activity across all measures.
Guerzoni & Raiteri (2015)	5,238 firms across 29 European countries; cross-sectional	<ul style="list-style-type: none"> <li>•Public procurement for innovation</li> <li>•R&amp;D tax credits</li> <li>•Direct subsidies (binary measures)</li> </ul>	Binary measure asking whether the firm increased innovation spending	Firms receiving mix are c. 10-34 percent more likely to increase innovation spending. Not controlling for whether firms received a mix biases results and leads to over-estimation of the treatment effect of each individual instrument.
Radicic & Pugh (2017)	671 SMEs across 27 European countries; cross-sectional	<ul style="list-style-type: none"> <li>•R&amp;D subsidies from national government sources</li> <li>•R&amp;D subsidies from EU sources (binary measures)</li> </ul>	R&D expenditure and employment; patent applications; sales from new products/processes	Increased innovation activity across all measures.

While binary, aggregate measures of innovation policy instruments are a useful starting point for policy mix evaluations, they lack precise information on the specific innovation policy instrument mix businesses receive. This issue is addressed in the second category of SOTA studies (Table 2). This category merges different administrative datasets from national funding agencies and government departments with survey data from national statistical agencies. It then constructs panel datasets that capture detailed information on the innovation policy instruments businesses receive each year.

**Table 2: Detailed measures of innovation policy instrument mix**

Study	Data	Innovation policy instrument mix	Innovation measures	Principal empirical results
Marino, Lhuillery, Parrottac & Sala (2016)	12,169 firms in France; panel data (annual, 1993-2009)	<ul style="list-style-type: none"> <li>•R&amp;D grant</li> <li>•R&amp;D tax credit (split into small, medium &amp; large €-amounts)</li> </ul>	In-house R&D expenditure & growth	Mixed results. 23-61 percent higher R&D expenditure, but 14-26 percent reduction in R&D expenditure growth.
Mulligan, Lenihan & Doran (2017)	17,345 firms in Ireland; panel data (annual, 2006-2014)	<ul style="list-style-type: none"> <li>•R&amp;D tax credit</li> <li>•R&amp;D/innovation subsidies (indigenous firms)</li> <li>•R&amp;D/innovation subsidies (foreign firms)</li> <li>•Incentivised public-private research collaboration (binary measures)</li> </ul>	Total R&D intensity	Increased R&D intensity by 4-5 percent. Firms that transition from receiving an R&D tax credit in one year to receiving a mix in the next year increased R&D intensity by 2-4 percent.
Dumont (2017)	5,634 firms in Belgium; panel data (annual, 2003-2011)	<ul style="list-style-type: none"> <li>•R&amp;D subsidies from regional sources</li> <li>•R&amp;D/innovation tax credit (6 distinct types; measures in €-amounts)</li> </ul>	In-house R&D intensity	All mixes produce either no effect or a negative effect on R&D intensity

Each of these studies adopts a different empirical approach. This makes it difficult to directly compare their results. For example, one Belgian study considers all possible combinations of regional R&D subsidies with six different forms of R&D/innovation tax incentive. Applying a range of econometric approaches, it finds that the mix is either ineffective or has a negative impact on business innovation.

Using a different empirical approach, a study of businesses in Ireland directly tests for static and dynamic complementarity between different pairs of innovation policy instruments. It finds that, in most cases, the impact of the mix as a whole on business innovation is greater than the impact of individual instruments. It also shows that the sequence in which businesses receive innovation policy instruments is crucial. Businesses that receive an R&D tax credit in one year followed by an R&D tax credit and R&D/innovation subsidy in the next year outperform businesses that transition from receiving no support to receiving a mix.

Currently, there is a trade-off in SOTA studies between the available level of detail on innovation policy instrument mixes and the available breadth of innovation outcome measures. Detailed information on the policy mix is obtained through merging different administrative datasets (Table 2); however, administrative data does not usually record innovation measures beyond R&D expenditure. Dedicated innovation survey data (Table 1) usually captures a range of innovation measures, such as product and process innovation; however, it lacks precise detail on policy mix.

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## Evidence gaps

International evidence does not present a straightforward picture of the effects of policy mix on business innovation. SOTA studies using cross-sectional data and aggregate measures of innovation policy instruments generally find a positive relationship between policy mix and business innovation. However, studies using panel datasets constructed to capture precise information on the instrument type, source, and level of funding that businesses receive present a more complex picture, with results ranging from positive innovation benefits to negative effects.

Recently, Schmidt & Sewerin (2018, p. 1) suggest that “the debate about policy mixes has reached an impasse” due to the lack of empirical research operationalising the policy mix concept. To overcome this impasse, the following actions need to be taken:

1. Develop a set of best-practice ‘guiding principles’ for evaluating the impact of policy mix on business innovation.
2. Provide government administrative datasets that capture detailed information on policy mixes that businesses receive through time, as well as other data sources that capture a range of innovation measures, to researchers and policy analysts for impact evaluation.

Taking these actions will help hone the practice of policy mix evaluation and foster policy improvement.

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