Economic and Social Research Council

State of the Art Review

ERC Enterprise Research Centre

R&D tax credits verses R&D grants: effectiveness for R&D investment

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SOTA Review No 59: December 2023

The importance of Research & Development (R&D) in explaining productivity, economic growth and competitiveness is well documented in research literature. Public policies have been considered as necessary to incentivise and optimise private R&D investments.

Previous SOTA Reviews of the impact of different policy instruments on firm-level R&D provide evidence of significant positive impact of individual instruments as well as policy mixes. Direct R&D grants and indirect R&D tax incentives (R&D tax credits) are the main instruments used by most governments to promote an increase in private sector R&D activity. But how effective is R&D tax credit in promoting an increase in R&D activities verses R&D grants? What are the contextual factors which inform or moderate the relative impact of tax credits and grants? The purpose of this SOTA Review is to answer these questions drawing on the research evidence.

Very few studies consider the effectiveness of tax credits alongside grants. Evidence from these studies, most of which are 'policy mix' studies, generally suggests that both instruments significantly induce increases in firms' own investment in R&D. However, there is no consensus on their relative effectiveness. For instance, while a meta-analysis study by Dimos, Pugh, Hisarciklilar, Talam and Jackson (2022) suggests neither instrument systematically outperforms the other, other studies suggest tax credits outperform grants (Nana-Cheraa, Roper and Mole, 2023; Lenihan, Mulligan, Doran, Rammer and Ipinnaiye, 2023), while others still suggest grants outperform tax credits in promoting firms' R&D activity (Ghazinoory and Hashemi, 2021; Radas, Anić, Tafro and Wagner, 2015).

Background

Private sector R&D activities play a critical role in the creation of valuable knowledge for technological advancement and superior productivity both at the firm and national level. However, knowledge generated through R&D activities are subject to spillover, limiting

the returns for R&D performers and reducing incentives for private R&D investment. Accordingly, policy makers employ various policy interventions to provide incentives for private sector investments in R&D, in the anticipation of achieving high social return. Their commitments to ensure continuing advancement in national innovation capabilities can been seen in the huge amount of investment in private sector R&D and innovation activities. For instance, the UK government currently invests 5bn annually in support of R&D, and has over the 2012 to 2020 period increased its support for R&D from 0.16% to about 0.40% of GDP, ranking the UK third among OECD countries with the highest proportion of their GDP committed to business R&D (OECD, March 2023). The UK government's recent R&D roadmap includes a commitment to increase investment in R&D to 2.4% of GDP by 2027 and to increase public funding for R&D to £22bn per year by 2025 (DSIT, July 2020).

One fundamental concern for policy makers is the possibility of allocating public funds to substitute R&D investments which firms would otherwise undertake in the absence of public support. Policymakers would want to avoid the scenario whereby public support "crowds out" private investment in R&D. A preferable scenario would be where public funding allocations instead complement or "crowd in" private R&D by supporting firms to take on R&D projects that they would otherwise not undertake without government support. A significant number of empirical studies have addressed this concern, with most of the studies concluding that government support does indeed incentivise firms to increase their own private investments in R&D (e.g., Nana-Cheraa et al. 2023; Caloffi et al. 2022).

Behavioural models suggest that a profit maximising firm will choose to undertake the most profitable alternatives from the range of innovation opportunities available based on their associated cost, risk and returns. Firms' R&D decisions are guided by many factors, including investment opportunities in the marketplace, the market incentives for innovation, firm's own resources, the expected rate of return on investment and firms' own required rate of return. Some of these factors have underlying constraining factors including risk and uncertainties, and issues of appropriability and externalities of knowledge, which prevent the firm from optimally allocating resources to R&D activities (Nelson, 1987; Arrow, 1962). Specific characteristics of R&D grants and tax credits can lower the effect of these constraining factors. For instance, both tax credits and grants offer firms the opportunity to overcome liquidity constraints, and they reduce the cost and risk of R&D to the firms to incentivise them to take up projects that are more marginal. Grants in particular reduce the problem of information asymmetry and moral hazard on the part of the firm, allowing firms to use subsidised projects as a signalling mechanism in order to obtain complementary or future financing (Connelly et al. 2011; Bianchi et al. 2019).

Research evidence

Table 1 summarises several policy mix studies which evaluate the R&D effects of tax credits alongside grants. This includes the body of work from 2015 to 2023 considering various R&D input measures including R&D investment, R&D investment growth, R&D employment, R&D orientation. Table 1 excludes studies which investigate the output additionality or performance effects of grants and tax credits. These are covered in a separate SOTA Review titled "*A comparative review of the effectiveness of R&D tax credits and R&D grants for firm performance"*, which includes the work of Lenihan, Mulligan, Doran et al. (2023), Nana-Cheraa et al. (2023), Ghazinoory and Hashemi 2021, and Radas et al. (2015).

Table 1: Post-2014 studies on input additionality effect of tax credits and grants

Author(s)	Country and sample details	Policy instruments	Innovation input measure (s)	Key findings
Lenihan, Mulligan, Perez-Alaniz & Rammer (2023)	Panel: Administrative data and annual survey (2000-2017) Ireland	R&D grants; R&D tax credits; Academic-industry collaborative R&D support	R&D expenditure	(1) R&D grants or R&D tax credits in isolation have a positive and significant effect on R&D, although tax credit effect is larger than grant effect when support is given either once or repeated over time. (2) The impact of academic-industry R&D collaborations on R&D expenditure is insignificant albeit positive; The collaboration R&D instrument becomes significantly effective only when it precedes tax credit or when it is part of a mix over time. (3) The impact of each of the instruments is significantly larger, and in many cases more than double when firms receive them recurrently over time or as part of a sequence; Similar effect when firms receive grants followed by tax credit, but not vice versa.
Pless Jacquelyn (2022)	Panel data (2008-2017) 10,434 observations across 6,479 firms UK	R&D grants; R&D tax credits	R&D expenditure	**SMEs:** Complementary effect: receiving higher rates of tax credit doubles the impact of grant on R&D spending. **Large firms:** Substitution effect: receipt of higher rate tax credits decreases the impact of grant on R&D spending. More generous tax credits cut the effect of grants in half - Substitution effect is particularly attributed to non-capital expenditures.
Teirlinck, Spithoven & Bruneel (2022)	283 firms; Cross-sectional (2010); Belgium	R&D tax exemptions; R&D grants (modelled as a moderating factor)	R&D employment	(1) The R&D employment effect of additional financial slack created by tax credit is more pronounced among older firms than for younger firms. (2) More generous R&D tax exemptions for less-R&D-intensive firms has no additional effect on their R&D employment. (3) Firms with a high proportion of R&D tax exemptions in their policy mix increase their R&D employment less than firms with a lower proportion. The reverse is true.
Neicu Daniel (2019)	Pooled cross-section (2008, 2010, 2012) 2,650 firms, Belgium	Regional R&D grants; National R&D tax credits.	R&D expenditure Basic research Applied research Development activities.	(1) Tax credits are more effective than grants, increasing private investment in all types of R&D. (2) Grants increase research investment only when mixed with tax credits, and have no effect on development spending. (3) Policy mix has a greater additionality effect on all the types of R&D investment than the effect of tax credit and grants in isolation. (4) Policy mix users spend 4.44 times more on basic research than tax-credit-only user. (5) Policy mix is as effective as grant in promoting investment in basic research; Policy mix users spend 3.86 times more on applied research than tax-credit-only and 3.29 times more than grant-only users.
Montmartin, Herrera &	Pooled cross-sectional data	EU grants; National grants;	Amount of privately	(1) Significant crowding-in effect found only for national grants: 1% increase in national grants across all regions

Massard, 2018.	(2001-2011) France 940 observations	Regional grants; Tax credits	financed R&D investment	generates 0.071% increase in privately financed R&D investment; National grants directed toward specific regions are geographically complementary and boost firms' R&D investment; (2) Negative policy mix effect.
Dumont (2017)	Annual panel data (2003-2011); Belgium	R&D grants R&D tax credits (aggregate)	R&D expenditure (net of public support)	Significant substitution effect within mixes: The effectiveness of R & D support decreases when firms benefit from different schemes at the same time, especially when firms combine grants with several tax benefits.
Neicu, Teirlinck & Kelchtermans (2016)	177 Belgian firms; Cross-sectional (2010)	R&D grants R&D tax credits	Number of R&D projects; Scale of R&D projects; Speed of R&D projects; R&D orientation (Research vs. Development)	Policy mix is more effective than tax credits in isolation for additionalities in R&D efforts: Relative to tax-credits-only, policy mix increases the number of R&D projects by 21%, speed up R&D projects by 24%, increases the scale of projects by 20%, and orients firms more towards research-focused projects by 26%.
Marino, Lhuillery, Parrotta & Sala (2016)	12, 169 French firms; panel data (1993-2009)	R&D grants R&D tax credits	R&D expenditure; R&D investment growth	(1) Significant crowding-in effect on R&D expenditure for both policy mix and grant-only, although effect is larger for grants: Firms that received policy mix and those that received grant-only respectively invested 23% and 39% more in R&D than firms that did not receive any public support. (2) Large grant recipients invested approximately 67% more in R&D than non-publicly funded firms, 61% more than medium grant recipients, and 82% more than small grant recipients; Medium grant recipients invested on average approximately 19% more in R&D than small grants recipients. (3) In terms of R&D investment growth, there is crowding-out for all the types of treatments: e.g., Policy effect on R&D investment growth is significantly negative, both for grant only and policy mix recipients (between 10% and 26% decline in R&D investment growth).
Guerzoni & Raiteri (2015)	5238 businesses with 20 or more employees across 27 EU countries Norway and Switzerland; Cross-sectional (2008)	R&D grants; R&D tax credit; Public procurement.	R&D expenditure	A policy mix of any two or all three instruments is more effective than any of the instruments alone in promoting increase in private R&D expenditure: A mix of grant, tax credit and public procurement creates the highest effect, with mix increasing the number of treated firms who increase their private R&D expenditure by 30.3 percentage points more than the control group of firms that did not receive any public support. The effect is 9.4 percentage points for a policy mix of grant and tax credit, 21.9 percentage points for a mix of grant and public procurement, and 28.8 percentage point for a mix of public procurement and tax credits; Individually, public procurement is more effective than the other policy instruments.

Although limited, some policy mix studies have been instrumental in providing insight into the R&D performance of both supports alongside each other. Recent studies in this light include that of Nana-Cheraa et al. (2023) and Lenihan, Mulligan, Pérez and Rammer (2023). Nana-Cheraa et al's (2023) study on UK firms found grants and tax credits individually induce recipient firms to increase their private investment in R&D, although tax credits consistently outperform grants, irrespective of the type of firm. In fact, this study provides evidence to suggest that adding grant support to tax credits can sometimes weaken the effectiveness of tax credits. Similar results were found in Belgium (Neicu 2019) and results for Ireland indicate that tax credits are more effective than grants for increasing firm-level R&D expenditure when support is given either once or repeated over time (Lenihan, Mulligan, Pérez et al., 2023). Domis et al's (2022) meta-analysis of the relative effectiveness of tax credits and grants suggests neither instrument systematically outperforms each other, although grant effects tend to increase over time while tax credit effects do not. According to their study, a dollar of either tax credits or grants induces 7.5 cents of additional private R&D. The authors further conclude that tax credits are most effective under incremental schemes, delivered within a balanced policy-mix scheme, and are generally less effective for micro firms and SMEs than for large firms. R&D grants on the other hand are most effective for manufacturing firms (except high-tech firms) and are more effective than tax credits in economies predominantly using grants.

Summary and evidence gaps

Overall, the evidence shows that tax credits seem to outperform grants in increasing private R&D, indicating that market forces gear towards more R&D activities once funding restrictions are minimal. Similar sentiment is found among most of the studies which examine the output performance effect of tax credit and grants (e.g., Lenihan, Mulligan, Doran et al. 2023; Nana-Cheraa et al. 2023; Petrin and Radicic, 2021; Nilsen, Raknerud and Iancu, 2020; Pang et al. 2020). This should not lead us to conclude that grant supports should be scrapped altogether since the evidence suggests that sometimes a mix of R&D tax credits and grants offers a superior effect on additional private R&D than the individual policies in isolation (Lenihan et al. 2023), particularly among small firms (Pless, 2022). We should also note that some evidence suggests smaller interaction effects (Marino et al. 2016; Nana-Cheraa et al. 2023) and even negative interaction effects on R&D (Montmartin et al., 2018) when tax credits are mixed with grants. The implication for policy is to balance the choice between tax credits, grants or policy mix based on their relative induced returns, taking into account both firm-specific and instrument-specific characteristics. This calls for more evaluation research on the eventual impact of public supports on R&D activities, particularly sieving out both instrument-specific and firm-specific characteristics, and economic conditions under which a particular policy performs optimally. Currently, empirical research in this regard is very scarce.

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