



## RESEARCH BRIEF

# Are “Complementary Policies” Substitutes? Evidence from R&D Subsidies in the UK

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*Governments often subsidize private R&D using both direct subsidies and tax incentives. In this paper, I develop a framework for studying their interdependence, which also provides a test for detecting capital market imperfections. I implement two quasi-experimental research designs to examine firms in the United Kingdom and show that grants and tax credits are complements for small firms but substitutes for larger firms. Higher tax credit rates substantially enhance the effect of grants on R&D investment for small firms, particularly those facing financial constraints, but they reduce it for larger firms. The productivity of small firms also increases. My findings imply that the innovation policy mix should include both support mechanisms for small firms only.*

Fostering innovation is one of the longest-standing and most pressing economic challenges. In an effort to stimulate innovative activity, governments globally provide subsidies for private research and development (R&D), comprising hundreds of billions of dollars in public expenditures each year. Subsidies come in various forms—most commonly direct grants and tax incentives—and the economic case for such intervention is clear. Firms do not fully appropriate the benefits of their investments and thus competitive markets tend to under-supply innovation. There is growing evidence that various types of subsidies have positive effects on innovative activity.

In this paper, I develop a framework showing how R&D grants and tax credits can be complements or

substitutes, and I implement two quasi-experimental research designs to study their effects on R&D for firms in the United Kingdom. The model I develop shows that tax credits and grants can only be complements if firms face financing constraints, and thus it also provides a direct test for detecting capital market imperfections.

In my approach for small firms, I take a difference-in-discontinuities approach to study grants provided by Innovate UK, the UK’s largest public body that funds private R&D. This entails exploiting a sharp discontinuity in firm size that defines funding generosity, whereby different grant award rates (i.e., the proportion of proposed project costs that the funding agency subsidizes when firms win grants) apply for firms above and below a 50 employee

threshold. I then use before and after variation to estimate how increases in the tax credit rate impact the marginal effect of grant funding on R&D expenditures and productivity. I provide evidence that the assumptions for identifying the interaction effect hold.

To study larger firms, I use a different sharp discontinuity that determines the generosity of tax credits, whereby firms under a 500 employee threshold benefit from higher tax credit rates relative to those over it. To examine the tax credit policy's interaction with grants, I estimate the effect of grant funding on each side of the tax credit rate threshold, limiting the sample to firms within a narrow window around it, and calculate the difference in grant effects for firms just under versus over it. This serves as a test of complementarity that provides a causal interpretation, since the difference in grant effects is driven strictly by the exogenous variation in tax credit rates. Even though the effect of grant funding on its own is not identified, this approach identifies the interaction effect under a certain set of assumptions that I validate.

My results provide strong evidence that the subsidy schemes are complements for small firms but substitutes for larger firms and the effects are economically significant. For small firms, a 39% increase in the tax credit rate enhances the marginal effect of grant funding so much that R&D expenditures more than double. I provide three pieces of evidence to confirm that the positive effects reflect real innovative activity. First, I show that the policies have no effect on ordinary investments at all. Second, I show that firms do not pass through their subsidies to shareholders. Third, I examine the effects on firm productivity and find that both labor and capital productivity increase. Taken together, these findings indicate that the subsidy interaction effect on R&D reflects a real increase in innovative activity that results in improved productivity.

These findings also suggest that small firms face

financing constraints. I show that the interaction effects are largest for firms that appear to have binding financial constraints as measured in three ways: 1) high short-term debt, which typically reflects not having sufficient internal resources to cover unexpected costs, 2) before-tax profits, and 3) available funds for investment as measured by the sum of before-tax profits and depreciation. The subsidy interaction effects are large and positive for firms that are constrained according to all three proxies but insignificant for those that are not.

The results are entirely flipped for larger firms. Tax credit rates are, on average, 17 percentage points higher for firms under the tax credit generosity threshold relative to those over it. By estimating the difference in grant effects around the threshold, I find that higher tax credit rates dampen the effect of direct grants for larger firms. The impact is substantial: the effect of grant funding is cut in half. The negative, large, and statistically significant difference in the marginal effect of grant funding indicates that the two subsidies are substitutes and that these firms are unconstrained. Larger firms thus must be already investing in all profitable opportunities, and additional government support leads to the subsidization of infra-marginal expenditures (i.e., expenditures that would have been privately profitable even without additional subsidies).

The findings have important implications for policy. Direct grants and tax credits are the two most popular tools that policymakers use to support private investment in innovation, but when their effects are not independent, accounting for subsidy interactions in optimal R&D policy design could substantially enhance the efficiency of public spending. The key takeaway is that, in my setting, both support mechanisms must be provided to small firms for either to be effective. Only one should be provided to large firms, or else public funding subsidizes infra-marginal expenditures.

### About the Center for Energy and Environmental Policy Research (CEEPR)

Since 1977, CEEPR has been a focal point for research on energy and environmental policy at MIT. CEEPR promotes rigorous, objective research for improved decision making in government and the private sector, and secures the relevance of its work through close cooperation with industry partners from around the globe. CEEPR is jointly sponsored at MIT by the MIT Energy Initiative (MITEI), the Department of Economics, and the Sloan School of Management.

## References

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## About the Author



Jacquelyn Pless is the Fred Kayne (1960) Career Development Professor of Entrepreneurship and an Assistant Professor at the MIT Sloan School of Management. Her research interests are in the economics of innovation, energy and environmental economics, and public economics. Her research focuses on understanding how policy affects firm behavior and innovation outcomes, with a particular interest in clean energy innovation. Current projects concentrate on the role of public subsidies in driving private research and development investments and the direction of innovation. Other work examines renewable energy markets and how environmental policy impacts firm competitiveness. She holds an MS and PhD in mineral and energy economics from the Colorado School of Mines, and a BA in economics and political science from the University of Vermont.

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