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Innovation Policy and Causality

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Innovation Policy

Paul Hünermund and Dirk Czarnitzki
**Innovation Policy
 and Causality**

INTRODUCTION

A classic result in innovation economics states that firms tend to underinvest in research and development (R&D) compared to a socially optimal level. This is due to the public good character of knowledge, which prohibits firms from fully appropriating the returns to innovation (Arrow 1962). To overcome this market failure, most countries have policies in place that are supposed to increase the incentives for knowledge production. First and foremost, governments sponsor education and basic research at universities, and subsidize the supply of skilled labor in that way. More directly, the patent system is meant to improve the opportunities to appropriate gains from innovation by granting temporal monopoly rights to inventors. On the input side, tax benefits can reduce the costs for firms to engage in R&D. Lastly, R&D grants represent perhaps the most direct form of subsidizing knowledge production, because governments cover a share of the costs of a proposed innovation project.

The total amount of taxpayer money paid out as R&D grants in Europe is not negligible. Direct government support for R&D amounted to, on average, 0.64 percent of GDP in the EU28 in 2017.¹ Naturally, the question arises whether this money is well spent. Or, asked differently, are R&D grants effective at incentivizing firms to invest more in knowledge production and at stimulating growth? There are good theoretical arguments to believe that this is the case. By contrast, it is also

possible that firms simply substitute grants for what they would have anyway spent on research. If such a crowding out of private R&D occurs, grants will be nothing more than a cash transfer that will have no noteworthy effect on overall investment levels in the economy. To discriminate between these two hypotheses and check whether R&D grants achieve their goal, an econometric policy evaluation becomes necessary. Economists have developed a variety of tools for estimating the effect of grants on innovation and growth with the help of statistical analysis.

One of the challenges that need to be overcome in policy evaluation studies is that there is hardly any experimental evidence related to R&D grants. An experiment would involve randomly partitioning a population of firms into a treatment and a control group. The treatment group then receives financial support, while funding is denied to firms in the control group. Differences measured in performance between the two groups would in this case be directly attributable to the grant.

Governments are – understandably – quite reluctant to engage in this kind of experimentation. R&D grants can be large, often worth several tens of thousands of euros. Handing them out randomly, without extensive due diligence, could be met with significant resistance by taxpayers. Therefore, in the overwhelming majority of cases, evaluators have to work with ex-post observed data collected from subsidy pro-

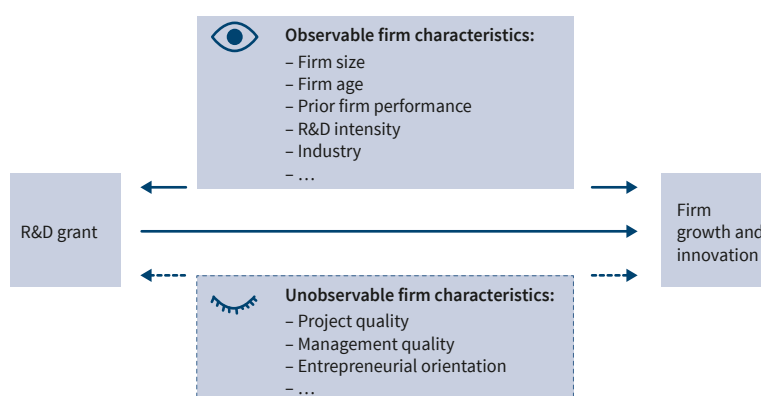


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Figure 1
Graphical Illustration of the Confounding Problem



Note: The evaluator's goal is to estimate the causal effect of R&D grants on firm growth and innovation (depicted by the solid arrow connecting the two variables). However, differences in firm characteristics between funded and non-funded firms can lead to a correlation that does not reflect any genuine causal relationship. Not all of these confounding firm characteristics might be observable to the evaluator.

Source: Authors' illustration.

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¹ Source: Rathenau Institute <https://www.rathenau.nl/en/science-figures/investments/international-perspective-rd-investments/government-support-rd-gdp>

grams where grants have not been allocated randomly, but instead a certain number of firms have been hand-selected from a list of applicants. This, as the present article argues, renders the econometric policy evaluation task much more complicated. In particular, the lack of experimental evidence makes it hard to quantify the causal effect of R&D grants on firm performance, which has to be distinguished from a positive correlation that is merely the result of picking already high-performing firms for funding. In the following, we will explain this causal inference problem in more detail and discuss a number of recent papers that have successfully tackled it.

THE CONFOUNDING PROBLEM IN POLICY EVALUATION

Causal inference lies at the heart of econometric policy evaluation. In order to assess the cost-efficiency of their interventions, policy-makers need to know whether R&D grants are effective at influencing key target metrics such as firm growth and innovation. Formulated in counterfactual language, the relevant question is: “Would firms grow slower, or be less innovative, if they had not received a public R&D grant?”. This is a causal question. The policy evaluator’s job is then to quantify this counterfactual by estimating the magnitude of the stipulated causal effect (depicted by the solid arrow connecting *R&D grants* and *Firm growth & innovation* in Figure 1) with the help of econometric methods.

Ex-post policy evaluation is plagued with several technical difficulties though. One of the most pressing is the so-called confounding problem (Bareinboim and Pearl 2016). R&D grants are rarely given out randomly. Therefore, funded firms will differ from non-funded firms along several dimensions. In the case of R&D subsidy programs, the selection process usually entails two stages. First, a firm needs to decide whether it will apply for an R&D grant. This decision depends, among other things, on whether the firm has a suitable project idea, how costly it is to apply, the availability of other funding opportunities, and the general entrepreneurial orientation of the firm’s management team (Covin and Lumpkin 2011). Second, the quality of the submitted project proposals has to be assessed, which is usually done with the help of independent technical experts. Only the best-evaluated proposals will then be chosen for funding. Selection criteria at this stage can range from general firm characteristics such as size, age, or a firm’s industry, to more specific indicators based on detailed project descriptions contained in the application files.

If left unaccounted for, differences between funded and non-funded firms resulting from the selection process can significantly affect the outcome of evaluation studies. Think of an example where evaluators systematically favor firms in industries with high average R&D intensities. These high-tech firms are likely to be more

innovative and grow faster than firms operating in less dynamic sectors. A naïve comparison of firm growth between funded and non-funded firms would then suggest higher growth rates in the former group, even if R&D grants had no causal effect whatsoever on innovative performance. This is the confounding problem. In order to tackle it, evaluators need to account for any confounding influence factors in their analysis. By assessing the effect of R&D grants separately for firms in high- and medium-tech industries, for example, sector-specific differences can be eliminated.

However, for such a strategy to work, all confounders need to be observable to the researcher. And this is rarely the case unfortunately. Firm characteristics such as size, age, and industry are relatively easy to obtain from standard firm-level databases. By contrast, many other variables relevant for the funding decision often remain unobserved (depicted by the dashed arrows in Figure 1). To overcome this problem, it is of crucial importance that program agencies collaborate with researchers and make their internal records (i.e., project descriptions, internal selection criteria, financial indicators, etc.) available for evaluation purposes. Even then, however, it is quite likely that unobservable confounders will remain. Firms with a higher entrepreneurial orientation and better management quality, for example, apply more frequently for R&D grants and are also more successful in the selection process. These variables, which are notoriously difficult to measure, will exert an effect on future performance and thus bias the results of the evaluation.

RECENT CAUSAL EVIDENCE FOR THE EFFECTIVENESS OF R&D GRANTS

Zúñiga-Vincente et al. (2014) provide a comprehensive overview of the state of the literature on R&D subsidies at the time of their writing. The systematic review includes 77 papers that empirically investigate the relationship between public financial support and company-sponsored R&D. Only very few of these studies, however, adequately take the confounding problem into account. It is therefore not surprising that in a majority of cases (60.17 percent), the researchers conclude a positive effect of grants on internal R&D expenditures. This positive correlation could simply be due to a selection of already highly innovative firms into funding and thus need not reflect a genuine causal relationship.

Since then, however, a couple of other papers have been published that provide more convincing causal evidence. Using an instrumental variable approach – an econometric technique that is able to deal with unobserved confounding – Einiö (2014) establishes a positive effect of public financial support on R&D expenditures, employment, and sales in a sample of Finnish firms. Likewise, using instrumental variable tools, Aguiar and Gagnepain (2017) find positive effects of European Framework Programme grants on the labor productiv-

ity of participating firms, while they can detect only a very limited effect on profit margins.

Two more recent papers investigate the effectiveness of R&D subsidies with the help of a so-called regression discontinuity design (RDD). This particular econometric evaluation technique relies on information about program-specific evaluation scores and compares only firms that obtained project evaluations very close to the program's minimum threshold for funding. As a result of this sample restriction, funded and non-funded firms can be assumed to be very similar with respect to the quality of their innovation projects, as well as other unobservable characteristics, which solves the confounding problem. Making use of the RDD in a sample of firms from northern Italy for the period from 2000 to 2007, Bronzini and Iachini (2014) find no effect of R&D grants on general investments (not specific to R&D). Only when they split the sample into small and large firms are they able to detect a positive effect for SMEs. By contrast, according to the evidence presented by Howell (2017), public SBIR grants in the United States had an unambiguously positive effect on a range of performance indicators, such as patents, revenue, and the likelihood of obtaining follow-up funding from private VCs.

Overall, the causal evidence presented by recent studies seems to be rather mixed. Effect estimates show a fair amount of heterogeneity across samples and outcome indicators. This calls for further research on the topic.

EVIDENCE FROM EUROPEAN JOINT PROGRAMMING

In Hünermund and Czarnitzki (2019), we present novel evidence from a European-wide subsidy program to contribute to the ongoing debate about the effectiveness of public R&D support. The program, with the name Eurostars, is an example of the newly emerging Joint Programming Initiatives, which aim to support cross-border research collaborations in Europe. It combines financial contributions from 33 countries (including five non-EU members). In our period of observation, between 2008 and 2013, the program allocated a total budget of EUR 472 million, of which 25 percent was co-funded by the European Commission.

Due to their international scope, Joint Programming Initiatives employ a rather complicated budget allocation rule – a so-called Virtual Common Pot (VCP) – that is designed to avoid cross-subsidization between countries. In Eurostars, project proposals are required to be submitted by at least two international partners and all proposals are evaluated centrally. However, each participating country funds only its respective participants. This means that in a project consortium of two firms from Belgium and Germany, the Belgian partner would receive financial contributions exclusively from the Belgian authorities, while the German firm would receive funding only from the German authori-

ties. If one of the countries involved uses up its earmarked budget, the entire project cannot be funded anymore. Due to these additional national budget constraints, the VCP partly offsets a selection of project proposals based on quality. It would, for example, be possible for another Belgian firm with a lower-ranked project to receive funding, if it teamed up with a Dutch instead of a German firm, assuming that the binding budget constraint was the German one (which is not an unrealistic example, since the German contribution to Eurostars was relatively low compared to the number of grant applications that were submitted).

In our paper, we make use of this VCP budget allocation rule to tackle the confounding problem. Our identification strategy basically consists of comparing direct neighbors in the project evaluation ranking, of which some received a grant and others were denied funding because their respective national budgets were already depleted. This is an improvement over standard regression discontinuity designs, since a VCP induces variation in funding not just at one particular threshold, but in a wider region of the evaluation ranking, which makes the results more generalizable. Our analysis shows that Eurostars grants had on average no effect on employment growth, revenue growth, and patenting. This rather disappointing result masks a large effect heterogeneity, however. For projects with relatively high evaluation scores, we find a substantial positive impact on employment and revenue growth (the effect on patenting remains insignificant throughout). Firms with low-ranked projects, by contrast, do not benefit from grants, which contributes to the relatively low average impact we find.

This effect heterogeneity has implications for the optimal design of Joint Programming Initiatives. Due to the additional national budget constraints, a VCP tends to allocate funding to projects with lower evaluation scores (since selection into funding is not based entirely on project quality anymore). Because grants have lower beneficial effects for these types of projects, a VCP thus reduces the average impact of the program. According to our estimates, this reduction can be up to 50 percent compared to a situation where there was only one single program budget.

CONCLUSION

There is a great deal of empirical literature on the relationship between direct R&D grants and firm-level variables, such as investment and performance. However, most studies fail to meet the necessary standards for causal evidence (David et al. 2000). Isolating the causal impact of grants is thereby of essential importance for assessing the cost efficiency of a policy. A positive correlation alone is not very informative, if it is merely the result of a selection process that favors higher-performing firms to begin with. Thus, without taking the problem of potentially unobserved confounding influence factors into account, econometric

evaluation studies are not able to tell whether public R&D grants are worth their money.

In recent years, a handful of papers have been published that apply more rigorous methods in order to overcome these shortcomings of the prior literature. The limited evidence that we have so far provides a mixed picture though. Overall, there seems to be a tendency towards finding positive effects. However, estimation results vary widely, not only across but even within studies. Whether R&D grants prove to be effective appears to depend a lot on particularities such as the specific performance indicator considered or the geographical and temporal context in which the data was obtained. Therefore, we are still far away from having robust, generalizable causal evidence on how well direct innovation policy measures actually work. More research will be needed. In particular, future studies should assess the circumstances under which grants are most likely to be effective. In addition, more focus should be placed on researching the optimal design of policies. Which features of an R&D subsidy program are essential for maximizing its impact? And what types of firms benefit most from receiving a grant? These kinds of questions are highly relevant for practical policy-making and academics should start to investigate them more thoroughly (Duflo 2017).

In order to facilitate this research program, however, increased cooperation from government agencies will be necessary. Recent calls for more evidence-based policy-making and evaluation plans that are already built-in at the start of a program are very welcome. Nevertheless, in order to tackle the causal inference problem, governments should also become more open to the use of experiments in R&D policy evaluations. Reservations against experimentation in this area are quite understandable. The sums of money involved are large and taxpayers might therefore not be too enthusiastic about a random allocation of grants. One way to overcome this resistance could be to use pilot studies, which would systematically test the effectiveness of design features on a smaller scale, before the program is eventually scaled up to the entire population. This is a well-established strategy, for example, in development economics (Duflo et al. 2008). Experimenting should be seen as a worthwhile investment in our knowledge of how to design more effective innovation policies. As is characteristic for investments, this might initially be associated with higher costs, which will hopefully be outweighed by larger social returns in the future though.

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