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Direct and cross scheme effects in a research and development

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ABSTRACT

Research and product or process development are two distinct, yet complementary innovation activities. Making use of a specific grant-based policy design that explicitly distinguishes between research projects, development projects, and mixed R & D projects, this study estimates the direct and cross scheme effects on both research and development investments of recipient firms. Positive cross scheme effects can be expected when research and development activities are complementary and financing constraints are more binding for research than for development projects. The results show that while research grants yield positive direct effects on net research spending as well as positive cross effects on development, development grants are less effective for stimulating development expenditures. The positive effect of development grants on overall R & D stems from cross effects of development grants on research expenditures. These results suggest a higher priority for subsidies targeting research projects.

1. Introduction

Endogenous growth theory has long singled out public subsidies as one of the main policy tools to address market failure related to research and development (R & D) investments (Aghion and Howitt, 1998; Howitt, 1999; Segerstrom, 2000). It is therefore not surprising that R & D subsidies are one of the largest and fastest-growing forms of industrial aid in developed countries (Nevo, 1998; Pretschker, 1998). A comprehensive literature has investigated the effects of public subsidies on private R & D spending. Although this literature by now provides substantial evidence that subsidies trigger additional R & D in the private sector, the cost-efficiency of providing such schemes is still under debate (Takalo et al., 2013a,b). Moreover, little is known about the responsiveness of the different activities within the R & D process to public subsidies.

R & D subsidies are often designed as direct grants and affect two related, but distinct activities, namely research ('R') and development ('D'). Research activities show fundamentally different characteristics from development activities as research typically involves more tacit knowledge, higher intangibility, greater outcome uncertainty, and larger distance to the market. These features explain the different extent of market failure associated with research versus development investments. Appropriability tends to be weaker for research investments compared to development because research typically involves early-stage activities with a wider set of possible applications and hence higher knowledge spillovers and higher expected social returns (e.g. Akcigit et al., 2013). Moreover, information asymmetries are typically more severe for such early-stage investments leading to more binding financing constraints for research than for development projects (Czarnitzki et al., 2011).

At the same time, research and development are interdependent activities. Product and process development often depends on the outcome of research activities. Firms may need to do (basic) research in order to understand how to solve problems of a more applied nature and be more effective in development activities. Quoting Rosenberg (1990, p. 171): "[…] a basic research capability is essential for evaluating the outcome of much applied research and for perceiving its possible implications."

If research and development have different characteristics that affect the wedge between their private and social returns and invoke different financial constraints, an optimal subsidy policy should be tailored to these distinct characteristics. Moreover, when different

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subsidy schemes are set for research and for development, their interdependencies should be taken into account. Although recent theoretical modelling on endogenous growth through basic and applied research advocates public policy that targets basic research directly (Akcigit et al., 2013), previous empirical studies on the impact of public R & D grants generally do not distinguish between (basic) research and applied development grants nor do they differentiate between the impact on research versus development activities. This can mainly be attributed to a lack of access to information on the nature of the project which is being subsidized as well as on how much private money is spent by firms on each of these activities. One exception is a study on Norwegian innovation policy by Clausen (2009). Clausen applies a taxonomy that distinguishes between projects that are "close to the market" and projects that are "far from the market." The author finds that while grants received for projects far from the market stimulate additional research spending, those received for projects close to the market are more likely to substitute firms' own spending on development. These results suggest that the extent to which public co-funding of R & D projects induces additional private investments depends on the type of subsidized project. However, while this taxonomy takes into consideration the stage of advancement of the R & D process, it does not unambiguously separate research and development activities. Furthermore, the classification of R & D subsidies used in this study is based on a taxonomy defined by the author rather than on the policy design of the program.

This studyinvestigates the additionality effects of targeted research and development grants on both research and development spending. This allows to measure not only the effects from the different types of grants, but also to test for any cross-effects from research grants on development spending and vice versa. The analysis presented in this paper thus addresses the research questions of whether targeted schemes induce the desired outcomes and at which stage of the R & D process public co-funding through grant-based subsidies is most effective in inducing additional investments in the recipient firms. In addition, we analyse program effectiveness by comparing targeted research and development programs to a general R & D scheme.

To address this research agenda, we investigate a project-based innovation policy implemented in the Belgian region of Flanders, which explicitly provides different schemes for research projects, development projects, and mixed R & D projects. We analyze data on the population of publicly co-financed projects over the period 2000–2011. During the first five years of that period mainly mixed-scheme projects had been co-funded, while in later years the policy shifted to primarily targeted programs for research or development. We match the subsidy data with the Belgian part of the OECD/Eurostat R & D survey, which comprises information on firms' own R & D investment, split into its research and development component in order to estimate direct and cross scheme effects.

This study contributes to the existing literature and informs the current academic and policy debate on R & D subsidies in several ways. First, the ability to distinguish research from development grants allows us to assess the direct effects of research grants on research expenditures and of development grants on development expenditures. It also allows us to test for cross scheme effects in which a research (development) grant triggers additional development (research) expenditures which may occur due the complementarity of both activities. Third, based on information about project duration and the amount received we estimate both direct and cross effects on "*net*" expenditures. Thisimplies that the following analysis not only tests for full crowding out but also for partial crowding out.

The results confirm previous studies by showing positive additionality on private R & D spending from a grant-based subsidy program. While most previous studies conclude that there is additionality when looking at gross spending, we find that also net spending increases due to the public support. More importantly, the results further clarify these insights by showing that while research grants induce additional net research spending together with significant positive cross effects on development spending, there are little direct effects of development grants on development spending. Development grants, however, do generate positive cross scheme effects on research investments. Overall, the results suggest that the impact of the R & D policy increased under the targeted schemes compared to the mixed grant scheme design.

2. The policy design: why targeted subsidy schemes?

The general rationale for government support of R & D rests on the presumption that private sector incentives (or possibilities) to invest in R & D are insufficient from a social welfare point of view. Governments typically complement private sector R & D by investing in the public research sector such as universities or by offering R & D contracts that tend to be more mission-oriented (David and Hall, 2000). Additionally, governments provide R & D funding to the private sector firms via direct grants that contribute directly to the firms' costs of an R & D project. In most OECD countries, this is a major instrument to stimulate private innovation activities. While such grants typically do not distinguish between research and development, this section discusses why it may be optimal to target grant-based subsidy schemes towards certain project types.

R & D projects comprise different types of activities. Following the definition of the OECD's Frascati Manual, basic research primarily aims at acquiring new knowledge not necessarily with applications in mind, while applied research is an activity directed toward a specific objective. Research projects can be characterized by a high degree of outcome uncertainty and by being 'far from the market' without directly targeting commercialization opportunities. Yet, they typically create the foundation for future product or process development projects (see e.g., Mansfield et al., 1971). As research involves early-stage technologies, the new knowledge is often tacit and therefore more difficult to appropriate by the creator (Arrow, 1962; Usher, 1964). Because of the higher spillovers, economic theory suggests a larger gap between the social and private rates of returns for research activities compared to development activities. Development projects, on the other hand, aim at commercializing inventions. As the development trajectory is often more focused and builds on earlier research investments, it is less prone to spillovers when compared to research. In addition, because development projects are closer to the actual implementation of an invention or the introduction of a new product to the market, firms will typically protect their "close-to-the-market" innovations through formal and informal IP strategies (Cassiman and Veugelers, 2002).

Beyond differences in spillovers and appropriability, research and development activities are different in their risk and uncertainty profile. Karlsson et al. (2004) promote the idea that research is a more discontinuous process, which may or may not result in solutions, whereas development is a more continuous search for solutions within an existing set of ideas. Such differences in risk and uncertainty translate into different sensitivities of research versus development investments to imperfections in the financial markets. Czarnitzki et al. (2011) find in a sample of Flemish firms that research investments depend more on firms' internal financial resources than development projects, pointing to more binding financing constraints for research.

Given this heterogeneity of activities within the R & D process, it seems reasonable for policy makers to consider these specificities when designing innovation policy tools. With more difficult appropriability conditions and higher outgoing spillovers, costly or even constrained access to external finance for research activities, market failure is likely to be larger for research than for development activities. The optimal subsidy rate for research projects should consequently be higher than for development projects and the expected additionality effects from subsidizing both type of activities may differ.