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The effectiveness of R&D subsidies: A meta-regression analysis of the evaluation literature

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ABSTRACT

Widespread and increasing public subsidy for research and development (R&D) has given rise to a large and growing number of evaluation studies. While economic theory identifies market failures that justify public support, theory also suggests reasons why returns might be disappointing. Similarly, the empirical literature investigated – 52 micro-level studies published since 2000 on either input or output R&D – reports a wide range of findings. The lack of conclusiveness both of theory and of the evaluation literature motivate this Meta-Regression Analysis (MRA). This study contributes to policy debate by identifying a representative subsidy effect: after controlling for publication selection bias and for a wide range of sample and study heterogeneities, MRA findings reject crowding out of private investment by public subsidy but reveal no evidence of substantial additionality. In addition, among the research practices explaining the heterogeneous effects reported in this literature, those related to the treatment of unobservable firm heterogeneity are particularly important.

1. Introduction

In the Schumpeterian tradition, innovation determines growth through "creative destruction" (Schumpeter, 1942). Similarly, neoclassical growth theory identified technical progress as the only source of sustainable per capita income growth (Solow, 1956). Yet, according to other developments in neoclassical theory in the 1950s and 1960s (Nelson, 1959; Arrow, 1962; Usher, 1964), firms tend to underinvest in innovation due to market failures. Influenced by these theories, policy makers embraced innovation as the means to achieve higher and sustainable growth rates and, correspondingly, governments introduced a variety of policy instruments to promote private innovation, including public subsidies – grants and/or (low-interest) loans – to incentivise private firms to perform research and development (R&D). This study is a contribution to assessing the effectiveness of R&D subsidies[1].

Public subsidies constitute a direct support measure in contrast to indirect fiscal support for R&D (e.g. tax credits) and are widely implemented by public authorities. Fig. 1 indicates the share of product and/or process innovative firms that received public subsidies for R&D and related activities in 28 countries during the periods 2006–2008 and 2008–2010. Previous data from the same source shows that R&D subsidies are also important in the US (not included in Fig. 1).

There is neither theoretically nor empirically definitive guidance on the effectiveness of public R&D subsidies in stimulating private R&D. Public support of private R&D decreases unit costs and increases the expected profitability of funded R&D projects thus giving an incentive for subsidised firms to invest in R&D activities over and above the counter-factual levels that firms would have undertaken without public support, leading to additionality. On the other hand, firms may substitute public funds for private funds that would have been committed in any case, leading to crowding out.

This paper provides a meta-regression analysis (MRA) of the quantitative microeconomic literature on the effectiveness of public R&D subsidies in triggering private R&D. Together, the primary studies, in their attempt to investigate the existence of a causal relationship between public R&D funding and private R&D, offer conflicting findings. Public subsidies are found to complement private R&D; to have no effect at all; or even to crowd-out private R&D. All three possible outcomes are well reported in the literature. In line with meta-regression studies of other literatures, we investigate this literature to determine:

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[1] In the introductory paragraph and in Section 2 below, we refer only to the intellectual and policy context most directly relevant to the introduction and subsequent use of R&D subsidies. Hence, we make no reference to later – e.g. evolutionary, behavioural and systems – models of innovation and approaches to public intervention.

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0048-7333/

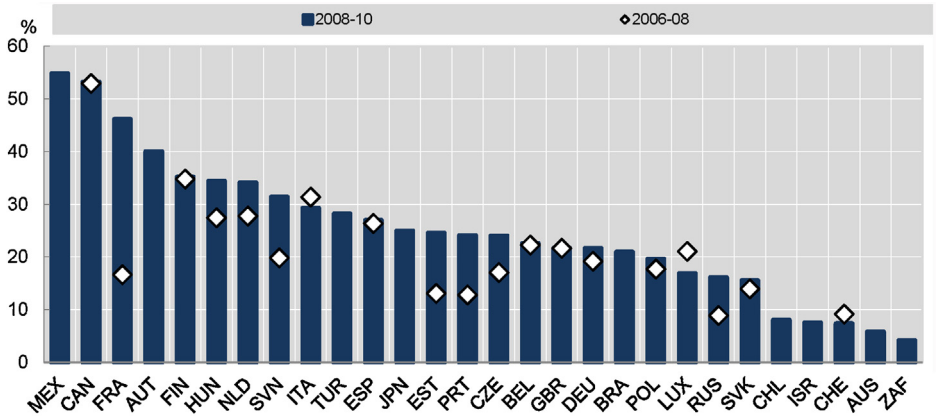

Fig. 1. Percentage of product and/or process innovative firms receiving public subsidies for innovation, 2006–08 and 2008–10 *. *Source:* Adapted from OECD (2013, p.185).
* Subsidies for innovation refer to 'various financial incentives to encourage firms to engage in innovation activities (R&D and other)' and exclude 'indirect support (such as foregone revenue from R&D tax credits)' OECD (2013, pp.184–185).

(a) the extent to which heterogeneous findings in this literature can be explained by the heterogeneity of samples and empirical methodologies;
(b) the degree – if any – to which this literature is infected by publication selection bias; and
(c) the genuine representative effect – if any – established by this literature after controlling for possible publication bias and sources of heterogeneity.

Previously, a meta-analysis (García-Quevedo, 2004) investigated the first of these concerns for studies published before or during 2002, concluding that no research dimensions, controlled for in the meta-analysis, can explain the heterogeneity in the empirical findings. The present study investigates studies published in or after 2000 and, in addition, investigates the second and third of these concerns. The estimation, controlling for publication bias, of a representative effect of public R&D subsidies on private R&D provides evidence on the effectiveness of public subsidies. Another distinguishing feature of this meta-regression analysis is the inclusion of studies not only on input additionality (i.e. additionality measured on R&D inputs like R&D expenditure and the number of employees committed to R&D activities) but also of studies on output additionality (i.e. additionality measured on R&D outputs like patents and new products).

2. Theoretical context: Competing perspectives

Different theories suggest contrasting outcomes. The mainstream perspective is that R&D has public good characteristics, namely non-rivalry and non-excludability. Consequently, the appropriability of private R&D outputs is not perfect, the corollary of which is lower private than social returns and a socially suboptimal level of R&D (Nelson, 1959; Arrow, 1962; Usher, 1964; Bloom et al., 2013). Moreover, due to inherent high risk in R&D investments, to the nature of R&D activities, which cannot be used as collateral in loan contracts, and to information asymmetry between creditors/investors and R&D performing firms, insufficient or too costly external capital is available to firms for financing R&D activities (Hall, 2002a,b). Both the public good characteristics of R&D and capital market imperfections constitute market failures, which provide the theoretical rationale for public intervention. Subsidies can mitigate these market failures by decreasing R&D unit costs and increasing the expected profitability of funded R&D projects, which incentivises greater private R&D spending; i.e. additionality. In other words, the effectiveness of subsidy in raising private R&D towards the socially optimum level precludes full crowding out. Yet, other theoretical perspectives suggest that intervention may lead to full crowding out: both self-interested selection procedures on the part of public bureaucracies and firms exploiting information asymmetries may reduce the effectiveness of subsidies.

From the perspective of public choice theory, public agencies may adopt opportunistic behaviour[2]. In particular, it may be in their interests to support firms with R&D projects that are likely to succeed irrespective of public support. This "cherry-picking" strategy will result in apparent effectiveness, which will give credit to the agency's managers, will justify the role of the agency itself and thus perpetuate its existence. Opportunistic bureaucrats may also support such a strategy in order to gain short-term reputation for the "effectiveness" of their programmes. Funding such projects, which are the ones most likely to be privately financed in the absence of public support, may also constitute a source of crowding out. Given that R&D subsidies may significantly increase the probability of a firm conducting R&D (Czarnitzki, 2006), cherry-picking may also contribute to the reinforcement of the already competent firms, without inducing new firms to undertake R&D[3].

According to Aschhoff (2009), firms may view public funds as a relatively cheap way to finance their R&D projects, especially when application costs are low and the probability of selection is high compared to alternative financing sources. In addition, as is the case for many outputs of public policy (Butler, 2012, p.89), difficulties in measuring the private and social returns of R&D projects give rise to information asymmetry between public agencies and private firms. While Aschhoff (2009) points to the incentive for firms to hide private information from public agencies, asymmetric information enables firms to do so. Accordingly, we conjecture that, together, incentive and means render likely the suboptimal allocation of public funds. Between firms, hidden information potentially diverts public support to projects that would have proceeded in any case; while, within supported firms, hidden actions may include the diversion of allocated resources to uses other than those agreed.

In conclusion, theory alone cannot be conclusive regarding the size or even the direction of the effect of public R&D funding on private R&D. Hence, we turn to the corresponding empirical evidence. Yet, the extensive literature on the effects of public R&D subsidies on private R&D also yields ambiguous findings. Hence,

[2] Public choice theory is the subset of positive political theory that models voters, politicians, and bureaucrats as making self-interested rational choices in an environment where outcomes are hard to measure or even define. A useful "primer" is Butler (2012; in relation to the following two paragraphs, see pp.36 and 88-94).
[3] For discussion of the practice of cherry-picking and evidence of its adverse effects, see Radicic et al. (2014, 2015).