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Internal and external effects of R&D subsidies and fiscal incentives: Empirical evidence using spatial dynamic panel models

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ABSTRACT

Most studies evaluating the macroeconomic effects of financial support policies on business-funded R&D use econometric methods that do not consider the existence of spatial effects, and generate biased estimates. In this paper, we discus and address this problem using spatial dynamic panel data methods. This allow us to provide new insights on the internal (in-country) and external (out-of-country) effects of both Research and Development (R&D) subsidies and fiscal incentives. We use a database of 25 OECD countries for the period 1990–2009. In relation to internal effects, for both instruments, we find a non-linear relationship between their effect on private R&D and their level (suggesting the possibility of leveraging and crowding-out effects). We also find a substitution effect between the R&D subsidies and fiscal incentives implemented within a country. Concerning the spatial component, we find evidence of positive spatial spillovers among private R&D investments. However, our results suggest the existence of competition/substitution effects between national R&D policies.

1. Introduction

The European Commission has set an R&D investment objective for the "2020 European Strategy" at 3% of GDP, two-thirds of which should be financed by the private sector. In 2012, the EU's R&D investment is estimated at 2.06% of GDP, financed 55% by the private sector (source: Eurostat). Thus, the public sector investment objective (0.93% vs. 1%) has almost been achieved but, the private sector contribution is lagging (1.13% vs. 2%). The rationale for these objectives and public support for private R&D, is the common belief that R&D specificities generate numerous market failures[1] leading to a sub-optimal equilibrium and private under-investment in R&D.

A growing literature[2] discusses and evaluates the capacity of financial support policies to increase private investment in R&D through two main instruments: tax incentives (indirect support) and direct subsidies (direct support). This topic is especially important in a context of public budget pressure that requires all public expenditure to be justified and effective. In the context of financial support for R&D, although most macroeconometric studies provide evidence on the effectiveness of such measures to increase private investment in R&D, some basic questions remain unaddressed. These are related to crowding-out effects and distortions between firms and sectors that can be generated by direct and indirect support. In an empirical context, while the cost of financial support for R&D has increased significantly in European countries, the evolution of privately financed R&D has been relatively flat.[3] Also, in EU countries with the highest level of private investment in R&D (Denmark, Germany, Finland, Sweden) support for R&D – either, direct (subsidies) or indirect (fiscal incentives) – is less than the EU and OECD averages.

The economic literature distinguishes tax incentives and direct subsidies according to their design, timing, cost and potential welfare impact. Obviously, the main difference between direct and

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[1] Such as knowledge spillovers, duplications, see Montmartin and Massard (2014) for a review.

[2] See reviews by David et al. (2000), Hall and Van Reenen (2000), Lentile and Mairesse (2009) and Lokshin and Mohnen (2009).

[3] Privately financed R&D increased from 1.03% of GDP in 1999 to 1.13% in 2012.

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Table 1
Advantages and disadvantages of support.

Advantages	Disadvantages
Direct support	
• Adapted to target upon activities and projects where there is a significant gap between private and social returns to R&D.	• High administrative costs for both firms and public authorities.
• Theoretically, competition between firms ensures that public funds are used for the best R&D projects.	• Impossible to put into practice for a large number of projects.
• May be used to reduce the effects of economic cycles on firms' R&D investments.	• Causes distortions on the markets for the allocation of resources between different R&D fields and firms.
• May encourage cooperation and the transferal of technology thereby reinforcing knowledge externalities	• Project selection tends to reward lobbies. The pressure related to the result objectives of the established policies entails the risk of projects being selected due to their high success potential, i.e., projects with high private productivity carried out without any public funding.
• Allows the verification of costs entailed by measures.	
• May enhance the reputation of firms who have received financing thereby reducing their capital cost (SMEs).	• Numerous potential eviction sources, due to the fact that direct measures are targeted and affect returns to R&D.
Indirect support	
• Measures are more neutral as they encourage investment in R&D for all firms, particularly SMEs (although specific sectors may also be targeted).	• It is difficult to control the cost of financial measures.
• The firms themselves decide which projects they wish to invest in.	• The effects are limited for firms who do make sufficient profit or which invest heavily in R&D (large companies) because they do not reap the maximum benefit from the financial measures.
• Reduces the risk of public markets being rigged.	• Non-neglectable risk of eviction as these measures can reduce the cost of projects which would have been carried through anyway (particularly in the case of a large tax credit).
• Does not require a specific budget line as the cost is only expressed in terms of a loss of financial income.	• Financial incentives favor R&D projects with the highest short-term returns. Hence, projects with high social returns to R&D will not be favored by this type of measure.
• Implementation and management costs are relatively low.	
• Financial measures reduce the cost of R&D directly which theoretically reduces the potential eviction sources.	• Few knowledge externalities are generated as the firms choose the projects and cooperation is rarely a factor for eligibility.

Notes: Adapted of Carvalho (2011).

indirect support is that the former typically allows firms to choose projects, while the latter usually is related to a public authority project choice. Concerning timing, R&D subsidies do not always require an initial R&D investment from the firm, and thus can be used to finance a current R&D project. However, to benefit from fiscal incentives firms must first conduct and finance R&D. In relation to relative cost, it is often argued that direct support implies heavier administrative costs than indirect support, and in terms of welfare impact, many economists highlight the risk that indirect support favors projects with high private returns not high social returns while direct support seems to be linked to projects with considerable social returns.[4] Table 1 presents an overall view of the main advantages and disadvantages of each instrument in terms of its cost, efficiency and welfare impact.

The extensive empirical literature evaluating the impact of financial support on private investment in R&D mostly (1) evaluates the capacity of a specific measure to increase private R&D investment and (2) is at a microeconomic level. Only four studies analyze the impact of both direct and indirect support at the macroeconomic level.[5] However, macroeconomic investigation of financial support would seem very useful in many respects: to evaluate the global effect of R&D policies, to discuss the complementarity of instruments and the pertinence of the policy mix, and to understand their cross-border effects. The small number of macroeconometric works mean much remains to be done.

The literature mostly ignores the possibility of an external (out-of-country) impact of R&D policies, i.e, a country's R&D investment is considered only to be affected by the home country environment and R&D policies. However, (Tobler, 1970, p.234) first law of geography reminds us that "everything is related to everything else, but near things are more related than distant things", i.e, a country's R&D investment may well be affected by the environment and policy decisions of other countries (and vice-versa). Distance is understood as proximity, not necessarily geographical distance, such as the intensity of trade or scientific collaboration for instance. Given the nature of knowledge creating activities and the existence of localized knowledge externalities, it might be expected that private R&D investment in country *i* could be affected by private R&D investment and the R&D policy incentives of other countries.

The main objective of this paper is to investigate more comprehensively the global effects of direct and indirect support policies by considering both temporal and spatial dependence of R&D activities. Although temporal dependence[6] has been modeled in previous works, spatial dependence has been ignored. The presence of spatial dynamics in panel data models generates important spatial spillovers effects that condition the standard results. We provide new empirical evidence based on data for 25 OECD countries in the period 1990–2009. In terms of internal effects, we show that, for both instruments, there exists a non-linear relationship between their effect on the business-funded R&D intensity (hereafter "private R&D intensity") and their level of use. This suggest the possibility of both leveraging and crowding-out effects of these policies according to their exploitation by countries. The spatial component of our work provides evidence that private R&D intensity generates positive spatial spillovers. However, it appears that policies implemented by "neighboring" countries have the opposite impact to national policies. In other words, R&D policies implemented by different countries could be substitutes.

The paper is organized as follows. In Section 2, we present the theoretical macroeconomic effects of financial support policies; Section 3 investigates and briefly reviews the empirical literature

[4] Although the allocations made by public authorities are often questioned for their efficiency.

[5] Guellec and Van Pottelsberghe de la Potterie (2003), Shin (2006), Falk (2006) and Montmartin (2013).

[6] The introduction of temporal dependence in empirical works is related to the strong adjustments costs of R&D investment that do not allow firms to react fully to environmental changes within a period.