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SPECIAL ISSUE

ON THE ROLE OF PUBLIC R&D SUPPORT IN FOSTERING PRIVATE R&D INVESTMENT, INNOVATION and GROWTH

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1. Public R&D policies and private R&D investment: a survey of the empirical evidence

Becker B (2015). Public R&D policies and private R&D investment: a survey of the empirical evidence. *Journal of Economic Surveys* 29(5): 917-942.

- The paper reviews the most recent literature on the role of public R&D policies in increasing private R&D investment. Three types of policies are studied: tax incentives and subsidies; public research and education; public support to cooperation.
- The latest findings suggest that tax incentives and subsidies have a positive impact on firms' investments in R&D. The former are found to have short term returns.
- Private R&D benefits from geographically localised knowledge spillovers from university research.
- Public policies incentivising R&D cooperation may impact positively on private R&D investment.

Acknowledging the pivotal role of R&D investment in economic growth, the paper provides a survey of the empirical evidence on the effects of public R&D policies on private R&D investment. The study presents the main findings of the recent literature in three domains of public R&D policy, reporting evidence of an overall positive role of public R&D policies. First, the latest empirical evidence supports unambiguously the positive effects of tax incentives and subsidies on private R&D spending. Tax incentives are effective since they reduce the user cost of private R&D investment, despite the risk of "relabelling" different expenditure as R&D. A positive impact is also found for subsidies, with additionality prevailing over the risk of partial crowding out. The effect is particularly relevant for financially constrained small firms, even though current policies tend to favour larger companies, implying a need for a better targeting. Secondly, international evidence suggests that public academic research is beneficial to firms' R&D investments and that geographically localised knowledge spillovers exist and affect the location of companies. This is also true for the education side, since firms can benefit from higher shares of high-skilled workers. These findings call for public policies supporting regional clusters of university and private R&D activities to exploit agglomeration economies. Finally, a similar argument applies for R&D cooperation between firms and public research centers and universities. Incoming knowledge spillovers have indeed a positive effect on private R&D spending.

2. Getting the most from public R&D spending in times of budgetary austerity

Veugelers, R. (2016). Getting the most from public R&D spending in times of budgetary austerity. Bruegel.

- The paper reviews the evidence of the impact of public R&D spending both at the micro and at the macro level.
- The focus is on the evidence from cross-country micro-research and from using the NEMESIS macro-economic model, resulting from the SIMPATIC project.
- Results at the micro level show that public R&D support has positive effects, even though participation rates of firms are low and there is a selection bias towards large companies.
- Macro-evidence from the NEMESIS model suggests that there is potential for considerable impact in terms of GDP and job creation, with positive effects materialising over the long run.

The difference between private and social rates of return from R&D investment, together with the relevance of knowledge spillovers, advocates for public support to private R&D activities. However, the positive impact of policies depends on several factors which are heterogeneous among countries, firms and R&D programmes. The paper reviews empirical evidence obtained through the EU-funded SIMPATIC project, the objective of which was to provide a better assessment of the impact of research and innovation policies across Europe. Overall, despite the heterogeneity among countries and firm characteristics, micro-evidence suggests that R&D grants and tax credits have scope for positive effects, especially if targeted towards small and credit-constrained firms, for which social rates of return exceed private returns. However, results from the SIMPATIC project also show that, despite these findings, governments tend to act in line with the market, i.e. focusing on private rates of return. Ex-ante evaluations performed with the NEMESIS macro-economic model suggest that R&D policies have a positive impact in the long term, both in terms of GDP and job creation. In particular, simulations for the FP7 programme estimate a GDP multiplier around 10, while 38.000 new jobs each year are estimated to be created over a period of 15 years. Larger figures are expected for the Horizon 2020 programme.

3. Evaluation of public R&D policies: A cross-country comparison

Czarnitzki, D., Lopes Bento, C. (2012). Evaluation of public R&D policies: A cross-country comparison. *World Review of Science, Technology and Sustainable Development* 9(2-4): 254-282.

- The paper evaluates the impact of R&D subsidies on private R&D and innovation intensity for a sample of firms belonging to 5 different countries.
- The study uses a matching method which allows to identify the "treatment effect" of the subsidy, i.e. to find whether the subsidy has an additionality effect.
- Results indicate that on average firms would have invested significantly less without government subsidies.
- The study also suggests that governments in the sample would benefit from an extension of their subsidy policies.
- No systematic misallocation of public funds is detected

Technological change is acknowledged as the main driver of long run growth, fundamental booster for the competitiveness of firms and the entire economy. The study considers market failures and private underinvestment as the rationale of public intervention with R&D policies. Therefore the scope of the study is to assess whether government subsidies have a positive impact on R&D and innovation expenditures by firms. The main contribution to the literature consists in i) providing an international comparison by including Flemish, German, Luxembourgish, South African and Spanish firms, ii) investigating the "treatment effect on the untreated", i.e. to assess whether governments could further foster R&D activities by extending innovation policies to currently not supported firms. The econometric analysis controls for relevant characteristics of firms, including size, exports and previous R&D activities. The latter are found to be significantly higher for subsidised firms, suggesting that selected countries could be biased towards a "picking the winner" policy, with the exclusion of Luxembourg which could be favouring either the laggards or the national firms. Results

reveal a clear additionality effect of subsidies for both private R&D and innovation expenditure. Furthermore, extending the subsidies may improve R&D investment of the non-picked firms, while no misallocation of funds is uncovered.

4. Linking public support, R&D, innovation and productivity: New evidence from the Spanish food industry

Acosta, M., Coronado, D., Romero, C. (2015). Linking public support, R&D, innovation and productivity: New evidence from the Spanish food industry. *Food Policy* 57: 50-61.

- The paper investigates the links between public support, R&D, innovation and productivity for firms in a low-tech industry in Spain.
- The methodology builds on the Crépon-Duguet-Mairesse (CDM) model which departs from the standard production function approach by linking R&D to innovation output, instead of directly to productivity or value added.
- Public national funding has a positive impact on both R&D investment decisions and intensity, while EU funding is relevant only for the latter.
- R&D intensity is relevant for product and organisational innovation, while no significant effect is found for process innovation.
- Undergoing the three different types of innovations all together is positively correlated with labour productivity, while process innovation alone is insignificant.

The link between R&D investment and labour productivity of Spanish food&beverage firms is investigated by departing from the standard simple production function. Instead the CDM approach is used and the model makes use of three different steps. First the determinants of R&D investment decisions and intensity are analysed. Second, the predicted R&D intensity is used as explanatory variable together (with other control variables) for innovation output in terms of process, product and organisational. Finally, the effect of innovation on labour productivity is estimated. The methodology allows to trace the relationship behind the theoretical argument linking R&D investment and economic growth, accounting also for framework conditions, firm and industry characteristics. Results highlight the positive role of public support in fostering firms R&D investment decisions, with a particular emphasis on national policies. Moreover, the higher the R&D intensity of firms, the higher the probability to innovate, even though the effect is lower than in high-tech sectors, suggesting that sectoral characteristics should be accounted for. Finally, the positive link between innovation and labour productivity is confirmed, together with the role of investment intensity and foreign capital participation in firms' capital.

5. The effects of public supports on business R&D: firm-level evidence across EU countries

Aristei, D., Sterlacchini, A., Venturini, F. (2015). The effects of public supports on business R&D: firm-level evidence across EU countries. *University Library of Munich No. 64611*.

- The paper analyses the impact of public support on business R&D across 5 EU countries: Italy, Spain, France, Germany, UK.
- Results from two alternative empirical methodologies reject the hypothesis of crowding-out for every country, with the partial exception of Spain.
- No support for an additionality effect (crowding-in) is found.
- The study also provides estimates of the multiplier of fiscal incentives for France and Spain, which are between 1.08 and 0.91.

Exploiting the EU-EFIGE dataset (project supported by DG RTD through the FP7 programme), the paper provides a cross country analysis of the effects of public support on firms' private R&D between 2007 and 2009. The analysis draws on companies from Italy, Spain, France, Germany, UK and, as such, account for conditional factors both at the firm (size, age, credit constraint) and at the regional level (regional R&D intensity, regional TFP, industry, belonging to convergence regions). Using both a propensity score matching approach and simultaneous system estimates, they find neither evidence of crowding-out of private investment, nor an additionality effect. The latter can be explained considering that the time period includes the advent of the crisis, hence

firms could have diverted their own resources to other activities. Moreover, for France and Spain, the authors estimate the effect of tax credits on R&D intensity, finding a positive impact for France and no significant effect for Spanish firms. Finally, in the French case, the paper quantifies the fiscal multiplier using a cost-benefit analysis and fitting the estimates with official data from national sources. Results suggest a fiscal multiplier of around 1.

6. Radical or incremental: Where does R&D policy hit?

Beck, M., Lopes Bento, C., Schenker-Wicki, A. (2016). Radical or incremental: Where does R&D policy hit?. *Research Policy* 45: 869-883.

- The article investigates the impact of public R&D support to private investment for a sample of Swiss firms.
- The scope of the analysis is twofold: assessing i) whether public intervention fosters additionality and ii) whether publicly supported private investment positively affects either radical or incremental innovation.
- Results support the additionality hypothesis, while only radical – i.e. the riskiest – innovation is positively related to public support.

An increasing empirical literature focuses on the role of public R&D support in fostering private R&D investment and firms' innovation. This study contributes to the literature by providing evidence of the role of public R&D policy in fostering radical innovation, i.e. the case when the risk of investment is higher. As stated by the market failure hypothesis, the contribution of the State should be higher in those sectors in which firms invest less due to higher uncertainty on appropriability of returns and final outcomes. Using a sample of Swiss firms from 1999 to 2011, the paper uses an impact evaluation empirical framework to investigate the additionality of public support and the role of the latter in fostering radical and incremental innovation. Results confirm the rejection of the crowding out hypothesis and confirm the pivotal role of public support in the case of radical innovations. No significant effect is found for incremental innovation, nor for the role of industry-science collaboration.

7. Regional innovation system (in)efficiency and its determinants: an empirical evidence from Italian regions

Barra, C., Zotti, R. (2015). Regional innovation system (in)efficiency and its determinants: an empirical evidence from Italian regions. *MPRA Working Paper*.

- The paper investigates the determinants of innovation and inefficiency of Regional Innovation Systems (RIS) in Italy.
- Using a stochastic frontier analysis (SFA), the study is able to assess the influence of exogenous characteristics of the regional environment on RIS efficiency.
- The paper finds that R&D expenditure in the public sector, in education institutions and in the private sector positively affects innovation output.
- Regional framework conditions are found to affect RIS efficiencies in different ways. Urbanisation economies and manufacturing activities are associated with lower system inefficiency. Southern regions are systematically outperformed by Northern Regions confirming the North-South divide.

Research and development activities determine the innovation output of RIS. However, the latter is also affected by framework conditions which are not strictly related to the production of knowledge. The study analyses the impact of public and private R&D expenditure on innovation for Italian regions from 2000 to 2009, adopting a stochastic frontier analysis approach based on the estimation of a knowledge production function. R&D is decomposed in public, higher education and private expenditure. The methodology used allows to assess RIS efficiency in producing knowledge, by accounting for the role of exogenous characteristics of the regional environment, in particular labour market characteristics and the sectoral composition. Findings reveal that R&D expenditure in the higher education sector and private R&D spending are positively related to innovation (measured as patent applications). Higher unemployment rates are detrimental to the efficiency of innovation production, while higher shares of services and manufacturing employment, as well as

larger exports shares in GDP, are found to be beneficial. The Italian North-South dualism is confirmed, with northern regions being systematically more efficient than southern ones.

8. R&D Policy and Schumpeterian Growth

Minniti, A., Venturini, F. (2016). R&D Policy and Schumpeterian Growth. DSE Working Papers, University of Bologna.

- The paper assesses the long-run impact of public R&D support to firms.
- The analysis is also an empirical test of the fully-endogenous growth model.
- Using data for twenty US manufacturing industries from 1975 to 2000, the authors find a positive impact of public R&D support in the form of tax credits on economic growth.
- The result is robust to different econometric methods and to economic and industry controls

Two main strands of no-scale effects endogenous growth models can be distinguished. The first states that the amount of R&D in the economy does not affect long run growth of GDP, but just its level. The second instead states that long run growth depends on the R&D intensity of the economy. Accordingly, R&D policies fostering R&D intensity in the economy have an effect on economic growth. The paper empirically verifies the fully-endogenous (Schumpeterian) model for a sample of twenty US manufacturing industries from 1975 to 2000. Estimates suggest that R&D intensity has a persistent effect on economic growth. Similarly, a positive relationship is found for tax incentives, while no significant effect arises from public subsidies. Results are consistent across specifications, also when accounting for industry-wide characteristics – e.g. technological concentration of industries – and tax controls – e.g. corporate or income tax.

9. Innovation systems: from fixing market failures to creating markets¹

Mazzucato, M. (2015). Innovation systems: from fixing market failures to creating markets. *Revista do Serviço Público* 66(4): 627-640.

- The paper presents a critique of the market failure theory usually used to justify State R&D policies.
- The concept that the State should intervene in markets where private R&D investment is low due to innovation and knowledge being quasi-public goods is challenged.
- Government is proposed as the main actor of innovation which should shape and create new markets and ensuring distribution of both risks and rewards of innovation activities.

Economic studies assessing the impact of public support to private R&D investment assume that government intervention is needed because of the quasi-public good nature of innovation. Firms are not able to internalise all the positive externalities of R&D activities and therefore they set a level of investment which is lower than the socially desirable level. Public intervention should address this issue by either improving private appropriability (i.e. patent protection) or by providing economic support to firms. The paper suggests that such an approach is limiting since it reduces the analysis to an ideal steady state scenario. It is less useful when markets need to be shaped or created dynamically, as the nature of innovation itself implies. It is suggested that governments should be the main actor leading the process, by acting as venture capitalists, i.e. investigating innovation opportunities and mobilising resources towards new technological challenges. Such a vision is consistent with the concept of "smart growth and specialisation". This also implies that both risks and rewards from public R&D investment should be socialised, beyond the concept of tax returns (portfolio approach to public investment in innovation).

¹ See also Mazzucato, M. (2015). *The entrepreneurial state: Debunking public vs. private sector myths*. Anthem Press and Mazzucato, M. (2015). *Building the Entrepreneurial State: A New Framework for Envisioning and Evaluating a Mission-oriented Public Sector*. Levy Economics Institute of Bard College Working Paper, (824).