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Sowing the seeds of the future: Policies for financing tomorrow's innovations

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ABSTRACT

In this paper, we discuss the state of the art in research and policy making related to the dynamics of financing innovation, highlighting gaps in the literature and setting up the objectives of this Special Issue. We also provide a discussion of methodological issues and future directions for the stream of studies aiming at the evaluation of the effectiveness and impact of policies to finance innovation. Finally, we discuss how the articles in this collection contribute to improve our understanding of the financing of innovation along different perspectives.

1. Introduction

Science, technology, and innovation (STI) are key pillars for economic growth and competitiveness at the firm, industry, and national levels (Lundvall and Borrás, 2005). While their importance has been highlighted in the literature, and is likely to only increase (Colombo et al., 2011), there are still important issues which remain unresolved. Firstly, the qualitative and analytical models using market failure theory to justify STI policy are potentially limited when the innovations in question are related to transformational shifts and grand challenges (Mazzucato, 2013a; Nelson, 1994); and secondly, solid quantitative and empirical models to support the design of policies promoting technological breakthrough innovation are still scarce (Vilkkumaa et al., 2015).

Countries' and firms' continuous need for increasing investments in knowledge activities underlines the search for competitive advantages (Aghion et al., 2009), and has rendered scientific advancements and the development of new technologies the panacea to the many challenges that current society faces (European Commission, 2010). Living standards and general socio-economic development are seen to be directly related by advances in information and communication technologies (ICTs), broadband technologies, and next-generation networks. Furthermore, grand challenges around climate change, health and inequality, have caused new types of 'mission oriented' goals around new energy sources which can decrease carbon and greenhouse emissions (Mazzucato and Semieniuk, 2017). Similar mission oriented goals around health mean that genetics and biotechnology are being used to tackle different diseases and famine, as well as increasing the quality and sustainability of our health systems that interact with information technology (Eckardt et al., 2009). Of course, future achievements in terms of growth, production and consumption, crucially depend upon, and are unavoidably shaped by, the decisions, consequent actions and investments made today (Morlacchi and Martin, 2009; Weber and Rohracher, 2012). Such decisions, actions, and investments might be supported by research and innovation policies that must be put in place in economic and institutional contexts that are more intricate than ever before. And yet, while these areas have been well studied, there are three key areas which require further attention. First, while science and technology are increasingly important prerequisites for producing many of today's most valuable long-term innovations (Mazzucato, 2013b), the trio of areas S, T, and I is becoming more intertwined, as seen by the rise in the number of references to scientific literature in patent applications (OECD, 2009). Second, innovation increasingly requires large long-term and the joint endeavours of a large number of stakeholders, including public research institutions, private firms, third sector actors, and dynamic users which may be scattered around the globe (Lange et al., 2013). Consequently, the *governance* of innovation activities is becoming more challenging. Third, and probably most importantly, the financial crisis has reduced companies' propensity to invest in long-term, high risk innovation projects (Paunov, 2012) and significantly decreased financial capital invested in STI, with a considerable risk of short-termism by all stakeholders in the process of allocation of financial resources (Mazzucato, 2013b; Mazzucato, 2016). Immediately after the financial crisis governments were required to not

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only intervene through bailout funds and financial reforms (Wu et al., 2015), but also to lend to those firms (especially SMEs) that were being penalised by the credit crunch. Some studies found that more than a lack of credit there was a differential treatment on the price of credit, with innovative firms being penalised the most (Hughes and Mina, 2012).

These traits, make the nature of the current international STI landscape more complex, and call for improved research approaches in the field of innovation policies for the support to financing STI activities. Policy interventions in the STI domain require new rationales than those typically advocated and confined to market failures in the presence of relevant knowledge spill-overs and capital market imperfections (Mazzucato, 2016). This modified global scenario calls for new methods and mechanisms for financing scientific and innovation activities all along the global value chains; a re-consideration of the traditional funding tools; and a more granular understanding of the role of the public sector (and of supra-national, national, regional, and local industrial and innovation policy initiatives) for financing STI activities that goes beyond the notion of simply fixing failures.

The issue of financing STI has been addressed in the past two decades by both the finance literature and the literature on innovation studies. However, the former was primarily interested with identifying significant financial barriers and constraints on (firms') investments in R&D and intangible assets. The latter devoted considerable effort to evaluating those specific policy mechanisms implemented for alleviating (firms') financial constraints and favoring the access of innovative firms to equity markets. There are several contributions in the innovation literature related to financial issues, including studies analyzing the effects of different financing sources on firms' R&D activities or evaluation exercises on specific policy instruments for (firms') innovation performance. Indeed, there are several attempts to look at innovation issues in the finance literature, ranging from the effects of financial constraints on innovation activities to the consequences of public financing in terms of crowding-in/-out effects.

Still, the recent evidence on the dynamics of capital markets (especially after the start of the global financial crisis) suggests how these partial contaminations, although relevant, are unlikely to find comprehensive solutions to the risk of underfinancing STI. A more complete and inclusive approach that looks at the whole science and innovation "supply chain" (not just its downstream stages) is needed, together with new policy rationales and tools, especially in science-based areas. During the last decade, much progress has been made in the finance and innovation literature on STI policies and innovation financing, but many questions remain unsolved, and these require for the reasons stated above a more comprehensive approach. In particular, more attention must be placed on institutional features, and the dynamic interaction between heterogeneous financial and policy instruments. Starting to address this gap is the ambitious goal of this special issue. Our rationale is to provide an opportunity for researchers to create a bridge between these different streams of finance and innovation literatures that, while connected, have not been integrated and thus continue to ignore some of the most pressing questions in the complex global landscape.

A key theme across all the papers in the special issue is the need to better understand how policies can stimulate private investment. We thus use the next section of our introduction, before summarizing the papers in Section 3, to explore in depth recent advances in the assessment of the effectiveness and actual impact of different typologies of public aid, specifically R&D subsidies and their evaluation. In particular, we highlight a series of key methodological issues on research-design which are key for policy makers to understand the consequences of R&D subsidies which they implement.

2. Evaluation of R&D subsidies: a research mind map

The importance of R&D activities to foster economic growth has solid theoretical roots, embracing the work of Schumpeter (1912, 1942), passing through Solow (1956, 1957), arriving to the first (Romer, 1986) and subsequent (Aghion and Howitt, 1992, 1998; Romer, 1990) waves of endogenous growth theory models. Albeit not unanimous, the relationship between R&D expenditure and economic performance has also found important empirical validation in the scientific literature (e.g. Griffith et al., 2004). Accordingly, achieving an adequate level of R&D expenditure has become a key policy statement in virtually all the advanced economies in the world. The pressure on increasing R&D expenditure is particularly high in the European Union (EU), given the gap suffered in this dimension with respect to international competitors. Allegedly, the increase in R&D expenditure constitutes the pillar of the most important recent policy actions at the EU level, e.g. the Lisbon strategy in 2000 and the more recent Europe 2020 agenda (see European Commission, 2010). In this domain, the main area on which Europe needs to progress is to incentive innovative activities by the private sector. The fact is explicitly acknowledged by the own words of the European Commission (2010, p. 10, *our emphasis*): "Europe needs to focus on the impact and composition of research spending and to *improve the conditions for private sector R&D* in the EU. *Our smaller share of high-tech firms* explains half of our gap with the US". But given the relevance of the objective, a question arises: can public policy play a role in helping these dynamics to unfold?

From one side, the entrepreneurial and innovative activities in modern economies are strongly influenced by several forces ranging from competition policy, the development and functioning of financial markets, to regulatory and law regimes, passing through the patent system and its enforcement. All these dimensions (among others) contribute to shape the interested dynamics. And all these dimensions (including also the institutional and cultural context) may be strongly influenced and shaped by the public actor. Indeed, the ability of 'mission oriented' policies to *directly* create new technological landscapes which 'crowd in' business by raising the expectations about future growth rates (endogenously creating animal spirits) is one of the most promising areas of research. On the other side, it is also generally accepted that public policy may play a more direct and immediate function in order to *improve the conditions for private sector R&D* and *increase the share of high-tech firms*: in this area, the implementation of R&D policy subsidies to private firms carves out a major role.

Policy makers tend to justify direct and pro-active types of schemes in the economy in two different ways. A first argumentation revolves around the likely existence of asymmetric information between the firm and the potential external investors (e.g. banks) on the nature of R&D activities (Hall and Lerner, 2010). This asymmetry could lead to moral hazard and adverse selection problems and in general to capital market imperfections that may prevent also good R&D projects to obtain the financing resources they need. A second motive resides in the presence of important knowledge spillovers in R&D activities. To the extent that the returns from innovation investments cannot be fully appropriated by the firm we expect an ex ante decrease in R&D incentives: investors will be reluctant to invest in that specific activity, leading to the under provision of R&D expenditure in the economy. Both the "capital market imperfection" and the "spillover" arguments are reputed to hold particularly for high-tech start-ups (see Revest and Sapio, 2012; Storey and Tether, 1998; Teece, 1986).

Consequently, this type of policy scheme, i.e. R&D public grants to private firms, was in the past and still it is nowadays extremely widespread across nations (and at different governmental levels) to such an extent that is practically impossible to have a record at global level of all these policy interventions.

However, there is limited scientific knowledge about the efficacy of such interventions. Are they successful in raising the level of private R&D expenditure (i.e. crowding-in effect) or simply (partly or totally) substitute private resources devoted to innovative activities (i.e. partial or full crowding-out), with the result that global R&D activities remain unchanged or grows less than proportionally?