Sectors and the additionality effects of R&D tax credits: A cross-country microeconometric analysis

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\textbf{A B S T R A C T}

Do the additionality effects of R&D tax credits vary across sectors? The paper presents a micro- econometric analysis of this question for three countries: Norway, Italy and France. We use a panel of firm-level data from three waves of the Innovation Surveys carried out in these countries for 2004, 2006 and 2008. The study estimates input and output additionality effects of R&D tax credits in each of these economies, and it investigates how these effects differ across sectors characterized by different R&D orientation and competition conditions. The results point out that firms in industries with high R&D orientation have on average higher propensity to apply to R&D fiscal incentives schemes and stronger input and output additionality effects. Output additionality is found to differ among the three examined countries.

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http://dx.doi.org/10.1016/j.respol.2016.10.002

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1. Introduction

More than 20 OECD countries currently support private R&D investments through R&D tax credits. In the presence of a R&D tax credit program, firms that are engaged in R&D activities can apply for direct reductions on the amount of tax to be paid, and in this way significantly reduce the costs of their existing R&D projects and/or expand their scale (OECD, 2010).

A large stream of applied research has investigated the effects of tax credits on firms’ R&D expenditures by employing firm-level data (Hall and Van Reenen, 2000; Parsons and Phillips, 2007; Arvanitis, 2013). This literature has mostly focused on the estimation of the input additionality effect, namely the increase in R&D expenditures caused by a tax incentive scheme vis-à-vis the counterfactual situation in which the firm does not receive any public support (Yang et al., 2012; Yohei, 2013). Only a very limited number of studies has so far attempted to estimate the output additionality effect, which measures the extent to which a given increase in a firm’s R&D expenditures (generated by a tax credit) leads to an increase in a firm’s innovation output (Czarnitzki et al., 2011; Cappelen et al., 2012; Takalo et al., 2013).

A general characteristic of the R&D tax credits literature is that most studies have estimated the average additionality parameter within a given national economy. However, while the average additionality parameter provides a general indication about the effectiveness of R&D tax credits programs, this figure per-se provides policy-makers with limited insights on its real effectiveness within an economy. The effects of R&D policy may in fact be heterogeneous. Academic research should uncover the sources of heterogeneity in order to provide innovation policy-makers with a more thorough understanding for the formulation and revision of R&D tax credit programs in the future.
In this paper we focus on one specific source of heterogeneity: industrial sectors. The extant research on R&D tax credits has paid relatively little attention to whether, and to what extent, additionality effects differ across sectors. Castellacci and Lie (2015) have recently carried out a meta-regression analysis of the R&D tax credits literature, pointing out that the size of the estimated additionality effects also depends on whether or not the studies controlled for industry-level differences. This suggests that the analysis of sectoral differences in the additionality effects of R&D tax credits does indeed represent an important aspect that deserves further investigation.

One reason to expect cross-sectoral variation is that, as it has convincingly been shown in the field of innovation studies, sectors matter (Malerba, 2002). The sectoral context provides firms with a different set of technological and market opportunities and constraints that greatly shape the way in which firms organize their innovative activities, choose innovative strategies, and perform (Dosi, 1988). More specifically, as shown by Pavitt (1984), industries differ substantially in terms of the dominant innovation strategy adopted by firms, and in particular with respect to their R&D orientation, i.e. the extent to which formal R&D activities represent the main innovation strategy adopted by innovative companies (Castellacci, 2008). In addition to this, the literature on competition and innovation has for a long time studied the relationships between the degree of market competition and innovation and shown the importance of cross-industry differences in this respect (Breschi et al., 2000).

Building upon this literature, the present paper tackles two research questions related to cross industry differences. The first is whether or not the input and the output additionality of R&D tax credits vary with an industry's R&D orientation. The second question is whether sector-specific competition conditions (and in particular the degree of market concentration) affect the input and the output additionality effects of R&D tax credits.

To answer these questions, we perform a micro-econometric analysis for three countries: Norway, Italy and France. We use panel data on manufacturing firms from three waves of the Innovation Surveys carried out in these countries (referring to the years 2004, 2006 and 2008 respectively). The study estimates additionality effects of R&D tax credits in each of these economies by using a three-step estimation procedure previously employed by Czarnitzki and Hussinger (2004) and Cerulli and Poti (2012) (see also Czarnitzki and Delanoë, 2014). In a nutshell, our results suggest that firms in industries with high R&D orientation (and in particular in science-based and specialized suppliers) are on average more responsive to fiscal incentives to R&D, especially in using these incentives and in increasing their R&D expenditures. We also find that output additionality differs considerably among the three examined countries.

The paper contributes to the literature in four respects. First and foremost, by explicitly investigating the role of the sectoral dimension, this paper creates a bridge between the R&D policy literature and the literature on sectoral patterns of innovation. Second, the study considers both the input additionality and the output additionality effects (the latter have typically been neglected in previous research on R&D tax credits). Third, while most prior studies have focused on firm-level samples for a single economy, the present work combines micro-econometric evidence for three countries. Cross-country comparisons may shed light on the role of country-specific aspects (and particularly the design of national R&D policies) on the effects of fiscal incentives to R&D. Finally, this paper suggests that R&D tax credit programs, although usually horizontally defined (i.e. providing the same fiscal incentives to firms in all sectors of the economy), tend to benefit companies in different industries differently.

The paper is organized as follows: Section 2 presents the main theoretical framework and develops the hypotheses; Section 3 introduces the model specification, data and econometric methods; Section 4 discusses the results; Section 5 concludes the work and points out implications for policy and future research.

2. Theoretical framework and hypotheses development

Most of the literature that investigates the effects of tax credits on firms’ R&D expenditures has so far focused on input additionality effects. Input additionality is the extent to which a given amount of tax credits leads to an increase in a firm’s R&D expenditures, as compared to the situation in which a company does not receive any fiscal incentive (Wilson, 2009).

Only a very limited number of studies in the R&D tax credit literature have so far tried to estimate the output additionality effects (Takalo et al., 2013). The latter is the extent to which a given increase in a firm’s R&D expenditures generated by a tax credit leads to an increase in the firm’s innovation output. Among the few studies that have examined output additionality, Czarnitzki et al. (2011) presented an empirical analysis focused on the new product performance of Canadian firms, and Cappelen et al. (2012) studied the innovation and patenting activity of Norwegian firms and their relation to the Norwegian tax credit scheme (SkatteFUNN).

A general limitation of the existing literature on R&D tax credits is that most studies have estimated regression models for the whole sample of observations, and have seldom investigated differences in the additionality effects across sectors. Only a limited number of studies have presented estimations for sub-samples of high- and low-tech industries, mostly done as robustness checks. For instance, Wang and Tsai (1998), Huang (2009) and Yang et al. (2012) focused on Taiwanese companies: they found that enterprises in the electronics sector are more responsive to fiscal incentives than firms in other manufacturing industries. Patf (2004, 2005), Ho (2006) and Rao (2013) investigated the effects of the standard tax credit and the alternate incremental credit (AIC) in the US, highlighting substantial differences between high-tech and low-tech sectors. However, these studies have mostly treated sectoral differences as a secondary aspect: they have not investigated whether there is a systematic effect, and what sector-specific factors may explain these patterns (Castellacci and Lie, 2015). This is the research question that this paper intends to explore.

2.1. Additionality effects and sectoral patterns of innovation

Why should we expect the additionality effects of R&D tax credits to differ across industries? To answer this question we draw upon two related branches of literature: one on technological trajectories and sectoral taxonomies, and the other on competition and innovation.

The literature on technological trajectories and sectoral taxonomies has its origins in the work of Pavitt (1984). In this seminal paper, Pavitt identified three dimensions which characterize innovative activity: the main locus and source of innovation (i.e. where innovation takes place); which type of innovation is paramount and what is needed to innovate; the structure of the industry (i.e. concentration, size of firms and entry barriers). Pavitt’s taxonomy uses these dimensions to identify four major clusters of sectors that display similar patterns of innovation: science-based, specialized suppliers, scale intensive, and supplier-dominated sectors.

Firms in science-based industries are typically large in size. They rely upon formal R&D to source technology and innovate. Their knowledge base is complex and heavily dependent on scientific advances, so that the interactions between private firms and the science system is a major source of technological change.
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