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The effects of R&D tax credits on patenting and innovations

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ABSTRACT

Norwegian business spending on R&D is low by OECD standards. To stimulate business R&D, in 2002 the Norwegian government introduced a tax-based incentive, SkatteFUNN. We analyze the effects of SkatteFUNN on the likelihood of innovating and patenting. Using a rich database for Norwegian firms, we find that projects receiving tax credits result in the development of new production processes and to some extent the development of new products for the firm. Firms that collaborate with other firms are more likely to be successful in their innovation activities. However, the scheme does not appear to contribute to innovations in the form of new products for the market or patenting.

1. Introduction

Both economic theory and empirical evidence support the view that R&D plays a vital role in raising productivity on a sustainable basis (see, e.g., Griliches, 1992; Romer, 1990). The social return on R&D investment is often higher than the private return to the investing firm. Thus, one can justify policy interventions if a well-designed intervention scheme can be implemented. Since the 1990s, OECD countries have tended to rely on fiscal policy incentives to promote R&D spending in the business sector. In 1996, 12 OECD countries offered tax incentives for R&D expenses; by 2004 this number had increased to 18, with Norway as one of the newcomers.

R&D incentives are designed in many different ways. Some countries offer incremental schemes targeting only increases in R&D expenses, while others have volume-based incentives. A few countries have both. Although more countries have introduced tax incentives over time, no consensus exists as to what is best practice. Evaluation of the incentives in various countries may help determine which policies or policy mixes work well.

R&D spending in the Norwegian business sector as a share of GDP is below the OECD average. To stimulate private R&D investment, the Norwegian government has traditionally used direct R&D subsidies. In 2002 this policy was supplemented with an R&D tax credit scheme – SkatteFUNN – for small and medium-sized enterprises (SMEs), which by 2003 became available to all firms. SkatteFUNN provides a volume-based tax credit to firms with an R&D project that the Research Council of Norway (RCN) has approved. A tax credit of 18% (20% for SMEs) of R&D costs for the approved project is deductible from the firm's income tax, with a project cost cap roughly equal to half a million Euros. If the firm does not pay any tax or pays less tax than the tax credit, the credit is paid to the firm as if it were a grant.

The SkatteFUNN scheme is one of the most generous tax credit systems among OECD countries according to OECD (2007, cf. Figure 5.1). The tax credit contains no sector or regional bias and is neutral between qualifying projects, region, sectors and the tax position of qualifying firms. However, the scheme provides an incentive for increased R&D mainly to firms with small R&D projects for which the cap in the tax credit is not binding.[1] That is, it lowers the *marginal* cost of R&D for low spenders more than for firms with large R&D expenditures. A summary of main findings from the evaluation of the scheme is given in Cappelen et al. (2010).

In this paper we study the effects of SkatteFUNN on firms' innovation activities and patenting. We analyze three types of

[1] Even if SkatteFUNN is available to all firms, it induced a significant increase of R&D subsidies to small firms. The official R&D statistics show that the Norwegian government spent 2.1 billion NOK (250 million Euro) on public subsidies to R&D in 2008 (cf. RCN, 2010). About 1 billion was given as tax subsidies through the SkatteFUNN scheme, the rest, 1.1 billion, was given as direct grants. About 40% of the SkatteFUNN subsidies (400 million NOK) were given to firms with less than 5 employees in 2008.

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innovations: a new (or improved) product for the firm, a new (or improved) product for the market, and a new (or improved) production process. We also have information on patent applications. We focus on the following three questions which are of general interest for research policy.

First, how is the introduction of innovations related to R&D? While R&D obviously is an important factor behind innovation, it is not the only one. The availability of high-skilled workers is another important factor. Our data reveal that formal R&D is not a necessary condition for innovation.

Second, does SkatteFUNN lead to more innovations? Hægeland and Møen (2007) find that firms receiving support through SkatteFUNN are more likely to increase their R&D investments than other firms. The question remains whether there is a causal relation between SkatteFUNN and firms' innovations.

Third, does the answer to the third question depend on type of innovation? One important reason for government intervention in the market for R&D is to create spillovers. If firms receiving subsidies mainly innovate in the form of products that are new for the firm, but not for the market (i.e., imitate other firms), it is not clear that the scheme will reach those R&D activities with the largest potential for spillovers. Thus, to assess the impact of tax credits on innovation is important from the point of view of research policy. To our knowledge, the existing literature has addressed this issue only to a limited degree.

For the analysis, we use Norwegian micro data covering firms included in the 2001 and 2004 innovation surveys (CIS3 and CIS4). These surveys contain information on the inputs and outputs of firms' innovative activities, e.g., whether firms have introduced product or process innovations and whether they have applied for a patent over the three-year period before each survey. The 2001 survey covers the three years before the introduction of SkatteFUNN (1999–2001), while the 2004 survey covers the three years following the introduction of SkatteFUNN (2002–2004). Since about 2/3 of the firms are included in both surveys (see Section 3), we are able to obtain a panel data set from these survey data. By supplementing the data with information from the (annual) R&D survey and different registers, we obtain two three-year periods with data on the innovation variables and six years of observations on R&D and other variables.

Our modeling framework is influenced by Griliches (1990), Crepon et al. (1998) and Parisi et al. (2006). The main idea in this literature is that by investing in R&D, the firm accumulates R&D capital, which plays an important role in its innovation activities. Using binary regression models, we model the probability of innovating and patenting as a function of the firm's R&D capital stock at the *beginning* of each three year period, whether it participated in SkatteFUNN or not, and different firm characteristics (size, industry, share of high-skilled workers, etc.). Even if R&D *investments* are simultaneously determined with innovation activities, the timing of our R&D variable allows us to consider the R&D capital *stock* as predetermined. Moreover, access to panel data and not just repeated cross-sections gives us an opportunity to estimate models that explicitly take into account the persistence of innovation activities within firms by conditioning on past innovation and patenting activities. To identify causal effects of SkatteFUNN, we model the probability of obtaining SkatteFUNN and the probability of innovations simultaneously. We also examine the validity of identifying restrictions.

Our results show that the SkatteFUNN scheme contributes to the development of new production processes and, to some extent, to the development of new products for the firm. Firms that collaborate with other firms in their R&D activities are more likely to innovate. However, the scheme does not appear to contribute to innovations in the form of new products for the market or more patenting.

The structure of our paper is as follows. Section 2 describes our study in the context of the existing literature. Section 3 presents the data and provides descriptive statistics on R&D, innovations and patent applications. Section 4 discusses our identification strategy and describes the model framework, while Section 5 presents the results. Finally, Section 6 concludes and raises policy issues that are relevant for the design of tax credit schemes in general.

2. Our study in the context of the existing literature

There exists a relatively large literature evaluating the effects of public R&D subsidy programs on firms' R&D investment. The early literature is surveyed in Hall and van Reenen (2000) while Mairesse and Mohnen (2010) give an overview of later contributions. Some examples include Wallsten (2000), who examined the U.S. Small Business Innovation Research program, Lach (2002), who studied an Israeli scheme of R&D subsidies for manufacturing firms, and Almus and Czarnitzki (2003), who studied a German R&D subsidy program and Lokshin and Mohnen (2007), who analyzed a tax credit scheme in the Netherlands. Most of these studies focus on possible crowding-out effects; i.e., whether the firms substitute their private R&D investments with public R&D funding. This question has been examined in the context of the Norwegian SkatteFUNN scheme by Hægeland and Møen (2007), and the main findings are summarized in Cappelen et al. (2010). Few researchers have examined the effects on output measures, such as patents and innovations. One exception is the evaluation of the Dutch R&D subsidy program (WBSO); cf. De Jong and Verhoeven (2007), who analyzed how WBSO has influenced the proportion of turnover from sales of new products and services. They reported a significant positive effect of WBSO on their output measure but, like most other studies in this area, they ignored selection problems. As pointed out by, for instance, Klette et al. (2000) and David et al. (2000), controlling for self-selection is a prerequisite for valid inference.

In general, when evaluating the treatment effects of a public policy program, one must address a counterfactual question: what is the change in the outcome variable given treatment, say $Y(1)$, compared to the potential outcome in the case of non-treatment, $Y(0)$? We cannot answer this question just by regressing the observed outcome, Y (e.g., the number of patent applications), on a dummy for whether the unit is treated ($D=1$) or non-treated ($D=0$). The reason is that observed and unobserved variables that affect the dependent variable, Y, may also affect the outcome of D; i.e., we may have a case of self-selection into the program. In the example with SkatteFUNN, firms that already are engaged in R&D activities have a larger probability of applying for R&D subsidies than other firms; i.e., there is "selection based on observables". There may also be "selection based on unobservables". For example, the decision to apply for SkatteFUNN may be based on the (unobserved) probability of success for already ongoing projects. Ignoring selection problems may lead to seriously biased estimates of causal effects. As our study reveals, the way we control for self-selection has a major impact on the results.

One approach to the self-selection problem is propensity score matching, which is based on the assumption that there exists a vector of exogenous covariates, X, such that $Y(0)$ and $Y(1)$ are independent of D given X (conditional independence). According to a result in Rosenbaum and Rubin (1983), a *treated* firm and a *non-treated* firm can be matched if they have identical probability of participating in the program, given X. That is, they can be considered as if they were equal in all other respects, except for an additive error term. The difference in Y can then be calculated for all *matched pairs* and the average value of these differences is a valid estimator of the average treatment effect among the treated. This idea was applied by Almus and Czarnitzki (2003). However,