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***Documents de travail GREDEG***
***GREDEG Working Papers Series***

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**GREDEG WP No. 2020-09**
**https://ideas.repec.org/s/gre/wpaper.html**

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# Can direct innovation subsidies relax SMEs' credit constraints?

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## Abstract

Credit constraints hamper the ability of SMEs to undertake innovative activities. Promoting access to external funding for SMEs represents therefore an important challenge for policymakers. This paper investigates whether innovation subsidies provided by the French public investment bank to SMEs have translated into better access to bank and other external financing through an indirect certification effect. We exploit a unique database covering the period 2000-2010 to construct a quasi-natural experiment and evaluate the causal impact of these subsidies on SMEs' financial constraints. If we find a significant improvement in the access to bank financing for subsidized firms, the effect is heterogeneous and mainly concentrated on small firms operating in high-tech sectors. Moreover, such public support does not seem to improve the access to other external sources of financing which can be explained by the low development risk-capital markets in France.

**Keywords:** Credit constraints, innovation policy, certification effect, Mahalanobis distance matching, difference-in difference

**JEL classification:** O33, O38

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# 1. Introduction

Credit constraints are one of the most important issues that innovative firms face in the market (Hall, 2002; Hall and Lerner, 2010, Blanchard *et al*., 2013), whatever countries' level of development (Gorodnichenko and Schnitzer, 2013). Indeed, research and development (R&D) and innovation are specific activities that induce particular market failures. Among the market failures that impact the cost of undertaking R&D activities[1], the most commonly known are related to external funding access. While it is, in general, difficult and expensive for firms to access funding from external sources, this problem is more important when R&D activities are concerned. Hall (2002) compares the market for external funding for R&D with Akerlof's famous "market for lemons" (1970) due to the existence of a strong adverse selection problem. Indeed, the firm has a better knowledge about the project and its probability of success than an external investor, but it is not in the interest of the firm to disclose all information about its innovative project because of the risk of leaks. Thus, the risk premium charged by external investors will be higher for R&D investment than for physical investment because they have more difficulty distinguishing good projects from bad given that they have much less objective information to differentiate projects' true quality. From an empirical point of view, several studies highlight the link between funding access and the level of R&D and innovation activities. For example, the study of Himmelberg and Petersen (1994) on a large sample of U.S. firms highlights the strong causal link between the level of R&D investment and internal financing capacity. Similar conclusions are found for German (Czarnitzki and Hottenrot, 2011), British (Mina *et al*., 2013), and Spanish (Manez *et al*., 2015) firms, as well as European firms overall (Tiwari *et al*., 2008; Brown *et al*., 2012).

Moreover, it seems that those market failures are more important for innovative small and medium-sized enterprises (SMEs). In particular, Mancusi and Vezzuli (2014), relying on a sample of Italian manufacturing SMEs, show that credit rationing significantly reduces both the probability of doing R&D and the level of R&D investment. More interestingly, it appears that credit rationing primarily affects the proportion of firms doing R&D rather than the expected level of R&D investment for firms already doing R&D. This suggests that R&D effort from young and small firms is even more discouraged by the difficulty of accessing external funding. Consequently, empirical evidence clearly indicates that SMEs' R&D investment would be significantly higher if they had greater access to external funding (Hall and Lerner, 2010). SMEs are important for economic growth because they drive technological change by bringing radically new innovations to market (Veugelers, 2008; Schneider and Veugelers, 2010, Czarnitzki and Delanote, 2015). Consequently, the stronger impact of market failures on this category of firms and notably those related to access to external funding raises concerns of an important underinvestment in R&D by SMEs (see Mohnen *et al*., 2008). This is a central point for policymakers, as it constitutes a serious obstacle to the process of creative destruction and to the realization of the social benefits from breakthrough innovations that small and young firms might introduce. This clearly justifies the implementation of specific public policies to foster R&D and innovation activities within SMEs.

Public schemes aiming at alleviating financial constraints for SMEs and young firms have been implemented for years, especially in France. Such programmes are diverse and include tax incentives, subsidies, zero interest rate loans and loan guarantees. While the direct effects of such programmes on R&D have been widely investigated in the empirical literature, the

[1] See Montmartin and Massard (2015) for a detailed discussion of specific market failures faced by innovative firms.

literature has paid less attention to the indirect effect of public schemes through R&D subsidies on SMEs' financial constraints, especially in the French case. Indeed, firms that receive subsidies from the government benefit not only from the amount of the grant but also from an indirect certification effect that helps attract external sources of financing (Lerner, 1999; Meuleman and De Maeseneire, 2012).

In this paper, we examine this important question by exploiting a unique dataset provided by the French Public Investment Bank (Banque Publique d'Investissement (Bpifrance)). The dataset contains information on innovation subsidies allocated by ANVAR, OSEO and Bpifrance[2] to French SMEs between 2000 and 2014 to more than 1000 firms per year. We combine this dataset with information provided by the INSEE (French Statistical Office) on the accounting and performance of French firms, allowing us to evaluate the causal effect of innovation subsidies on SMEs' financial constraints through a quasi-natural experiment. We use Mahalanobis distance matching (MDM) to construct a control group and end up with a panel of nearly 400 targeted firms and 400 control firms per year over the period 2000-2010. Finally, we combine MDM with a difference-in-difference (DiD) regression to assess the causal impact of public subsidies on firms' financial constraint measures. We consider two measures of financial constraints related to two different sources of financing: financial leverage, which measures the importance of credit constraints (bank financing), and the external equity ratio, which measures equity constraints (business angels and venture capital financing, among others). The unique final dataset allow us to investigate several important sources of heterogeneous effects among SMEs according to size, age and industry.

Three main results are highlighted in this study. First, we confirm that innovation subsidies increased the financial leverage of targeted firms and, therefore, allowed them better access to bank financing through an indirect certification effect. However, the effect is heterogeneous. Indeed, it seems concentrated on firms between 5 and 8 years old and on micro and small firms. We do not find evidence of a significant effect for "new" firms and for medium-sized firms. The effect is also stronger for manufacturing firms that belong to high-tech industries. Second, we do not find evidence of a certification effect for other external investors such as business angels or venture capitalists. According to us, this result reflects the weak development of business angels and risk-capital markets in France over the studied period. Third, we highlight the presence of a significant break in the effect of innovation subsidies on the access to bank financing in 2005, which corresponds to the transformation of ANVAR into OSEO. It seems that the overall positive certification effect of subsidies is concentrated in the first sub-period (2000-2005) but is not significant in the second sub-period (2006-2010). Thus, the institutional changes (and, notably, an increase in the amounts of subsidies provided by OSEO compared to ANVAR) seem to have lowered the certification effect for banks, suggesting that restrictive selection of firms is of high importance in generating such an effect.

The remainder of the paper is organized as follows. Section 2 presents a short summary of the literature on signalling effects and access to external sources of funding. Section 3 describes the institutional framework. Section 4 describes the database used and the characteristics of our final sample. Section 5 introduces our empirical strategy. In Section 6, we present our main results, and Section 7 concludes.

[2] ANVAR and OSEO are the names of the previous institutions in charge of the allocation of these subsidies before the creation of the French Public Investment Bank in 2012.

## 2. Background

### *2.1 The indirect effect of public subsidies: signalling effects*

As seen in the introduction, information asymmetry between firms and lenders and the riskiness of R&D projects entails poor access to external sources of finance for of SMEs (Freel, 2007). This is especially the case for young firms in emerging sectors (Howell, 2017). Indeed, due to their more established track records, older firms have better access to bank loans than do younger ones (Storey and Frankish, 2016). The agency and asymmetric information problems are also generally more pronounced for small firms than for large ones (Lerner, 1999; Meuleman and De Maeseneire, 2012). In a similar vein, high-tech companies (in both services and manufacturing sectors) are more prone to suffering information asymmetries than are low-tech companies (Carpenter and Petersen, 2002), and this information problem can be even stronger in the services than in the manufacturing sector (Hottenrott *et al*., 2017). In addition, the returns to small high-tech companies are highly uncertain, and their assets have low collateral value because they are largely intangible (Carpenter and Petersen, 2002). For these reasons, high-tech companies are more likely to face financing constraints than are low-tech companies.

As suggested by Bond *et al*. (2005), this financial constraint problem discourages firms from investing in R&D activities. However, to resolve this market failure, governments set up public innovation support programmes such as R&D subsidies, concessional loans and R&D tax credits. While the magnitude of the direct effect of these public policies on additional R&D expenditures in recipient firms has been widely investigated in the literature[3], less attention has been devoted to the indirect effects of such policies.

Usually, public grants only finance a share of total project costs, and firms still need to seek external funds. As a consequence, public support can also generate an indirect effect *via* better firm access to external financing through quality certification. As suggested by the signal theory (Spence, 1973), to deliver a signal to external investors, the signal must meet two main criteria. First, it has to be observable. Second, it must be credible to external investors as indicative of high costs undertaken by firms in terms of the effort and time required to obtain the subsidy. These two criteria are satisfied by government grants. Indeed, the status of grant recipients from the government is easily observable for external investors, and the selection of beneficiary firms for the subsidies is usually subject to tough ex ante screening (Takalo and Tanayama, 2010; Meuleman and De Maeseneire, 2012). Therefore, a growing strand of the literature has focused on investigating the symbolic effect of the certification of firms' quality when governments subsidize firms' financial constraints.

Lerner (1999) supports this hypothesis in his study of the U.S. Small Business Innovation Research (SBIR) programme. He shows that the grants have allowed beneficiary firms to attract private venture financing, the effect being greater for firms in high-tech industries. Moreover, Feldman and Kelley (2006) put forth evidence that firms involved in the Advanced

[3] See Becker (2015) for a survey of the literature on this topic.

Technology Program (ATP) in the U.S. are more likely to raise external funding from other sources. Meuleman and De Maeseneire (2012), relying on data on 1107 approved requests for Belgium-specific R&D grants and a control group of denied requests, provide evidence that R&D subsidies deliver a positive signal and allow small firms to have better access to long-term debt.

More recent studies also provide evidence of a positive effect of government subsidies on firms' financial constraints. Demeulemeester and Hottenrott (2017) indicate, using an R&D subsidies programme in Flanders, that the beneficiaries of R&D grants face lower interest rates thanks to the quality certification of the Belgian government. Marti and Quas (2018) also investigate the role of the certification effect on the access to external finance of 488 Spanish SMEs that received participative loans from the government. Using a matching procedure to select 719 "twin" firms as a control group, these authors show that recipient firms have higher external financial debt and that the effect is significantly stronger for small firms or firms in high-technology industries, as in the findings of Lerner (1999). Hottenrot *et al*. (2017) complete this conclusion using German firm-level data and put forth evidence of a stronger effect in highly information-opaque sectors. This highlights the fact that the grant strongly reduces information asymmetries, which is relevant for banks in selecting firms for a loan application. More recently, Chen *et al*. (2018) investigate the distinct effect of R&D subsidies on initial public offerings (IPOs) using a sample of 269 Chinese information technology firms. They highlight a U-shaped effect of R&D grants on IPO performance, while the effect is linear and positive for firms that did not receive R&D grants.

Nevertheless, the study of Howell (2017) tempers these positive outcomes. Indeed, her results on SBIR grants in the energy sector in the U.S. provide evidence that the positive impact of grants on venture capital funding comes from the financing of prototyping rather than from a certification signal from the government. She argues that the grant allows firms to engage in proof-of-concept work that the firm cannot finance without the grant. This proof-of-concept work resulting in a tangible outcome (a prototype) then increases the probability that venture capitalists invest in the project. Therefore, there exists a delay between the receipt of the grant and the effect on venture capital.

### *2.2 Access to bank vs access to external investors*

Innovative SMEs face both financial and technological risks that exacerbate, in turn, the presence of severe information asymmetries. First, the financial prospects are very uncertain for small innovative firms, and thus it is very difficult for banks to select these firms *ex ante*. Due to the lack of sufficient information, it is also very difficult for banks to monitor these firms *ex post* and to obtain a guarantee because the firms hold assets with low collateral value. Indeed, small innovative firms are characterized by a high proportion of intangible assets such as patents, licenses, brands, *etc*. Access to bank credit for small innovative firms is thus difficult. Consequently**,** these firms would choose to rely more on external equity capital to finance their activities.

It is often argued that external equity capital provided by business angels and especially venture capital firms offers several advantages over debt (Colombo and Grilli, 2007). Indeed, according to Hellman and Puri (2002) and Amit *et al*. (1998), venture capitalist firms play roles over and beyond those of traditional financial intermediaries. For instance, Admati and Peiderer (1994) show that venture capitalists are better able to solve agency problems than traditional investors

such as banks are. Indeed, these investors are specialized in the selection and monitoring of high-tech start-ups and thus are able to reduce the risks inherent to these firms (Gompers and Lerner, 2004).These financial investors engage in face-to-face interactions with managers and are involved on the boards of their portfolio companies (Sapienza and Gupta, 1994; Fried *et al*., 1998), in the recruitment of top managers, and in strategy development (Hellman and Puri, 2002). In addition, since their investment process is extremely selective (Sahlman, 1990), the receipt of venture capital funding should convey positive information about the invested company, which, in turn, provides access to cheaper sources of financing (Manigart *et al*., 2002). Venture capital firms can also provide value-adding effects to their portfolio companies though their monitoring, management support and professional networks (Sapienza et al., 1996; Fitza *et al*., 2009). For instance, Kortum and Lerner (2000) show for the U.S. that venture capital fundraising in an industry is positively associated with higher patenting rates. The empirical literature also shows that venture capitalists play a positive role in employment (Bertoni *et al.* 2007) and productivity (Chemmanur *et al*. 2011).

Nevertheless, in France and in continental European countries overall, the story is not as simple as that in the U.S. The number of business angels in France is far from being sufficient to meet the financial needs of small innovative firms (OECD, 2014; Ekeland *et al*., 2016). In addition, in contrast with the U.S., venture capitalists in France offer much more financing of the later stages of firm developments than of the seed stage (OECD, 2014; Ekeland *et al*., 2016; EVCA, 2016; NVCA, 2016). In 2016, for example, only 7% (874 million euros) of the funds invested by the private equity sector in France was dedicated to companies' early stage development. Thus, access to external finance (in the form of external equity capital) for small innovative firms at the seed stage remains a problem in France. For that reason, Colombo and Grilli (2007) explain that in a bank-based financial system similar to those of Italy, France and Germany (Rajan and Zingales, 2003), bank loans are still the most important source of outside financing for new high-tech ventures, even if this form of financing is not adequate to the financing needs of such firms (Ekeland *et al*., 2016).

Therefore, it is important to understand to what extent direct support for innovation helps alleviate small innovative firms' financing constraints by reducing both their credit constraint and attracting more external equity.

## 3. Institutional framework: direct support for innovative SMEs

The first French institution to support innovation was set up in 1967 under the name ANVAR. When it was created, ANVAR's role was to help transfer knowledge and research results from public institutions to private companies. From the early 1980s, ANVAR devoted its efforts to supporting SMEs, which represent a great reservoir of wealth creation (Reinhart, 2014). ANVAR had two main missions: to develop the link between economic growth and public research (research laboratories) but also to support the transfer of public research to companies by granting subsidies and repayable advances. Its objectives then evolved to directly promote innovation in French companies. In 2005, this institution was transformed into OSEO with the aim of providing financing support for SMEs' growth. Indeed, market failures decrease the growth of small innovative firms and thus justify government intervention. In addition, OSEO played a countercyclical role, compensating, in particular, for the lack of funding during crises (Riedinger *et al*., 2011). Following the financial crisis of 2008, one of the French government's priorities was to optimize company financing, and in this context, a re-foundation and simplification of existing structures was undertaken. This resulted in 2012 in the creation of

Bpifrance. This public investment bank was the result of a merger of OSEO, CDC Entreprises and the Fonds Stratégique d'Investissement (FSI)[4]. The mandate of Bpifrance fully absorbed that of OSEO. Bpifrance provides, among other types of support (i.e., for exportation), bank loans, project co-financing, loan guarantees, and innovation subsidies.

Given the period under study in our research (2000 to 2010), we evaluate the effects of innovation subsidies distributed by ANVAR (2000 to 2004) and then OSEO (2005 to 2010). ANVAR and OSEO offered a wide range of financing aids to innovative SMEs. In brief, ANVAR and OSEO offered three different tools for supporting French SMEs: innovation grants, repayable advances and many management services to companies. Subsidies generally allow the financing of part of a project. They are intended for the earliest and riskiest development stages, namely, the "creation and feasibility of projects", "support for innovative business creation" or "creative competition assistance of innovative technology companies" (Riedinger *et al*, 2011). A repayable advance corresponds to a non-bank loan at a zero interest rate, without any guarantee requirement, granted to a SME. They are mainly granted to promote the development of projects with a commercial purpose and offer companies the double service of interest-free financing and coverage against risk. Indeed, repayment of the principal is only due if the project is technically or commercially successful. The terms of repayment of the advance take into account the success of the project; even in the event of failure, a flat-rate reimbursement is provided (Riedinger *et al*, 2011). According to Dufourcq (2014), these systems have proved to be effective: R&D expenditure supported by ANVAR and OSEO led to the award of around three times as many patents as the number awarded to projects not supported by such aid in the past.

ANVAR and OSEO gave priority to financing innovative SMEs, regardless of their sector. This promotion of innovation aimed to overcome two market dysfunctions that weaken innovation: externalities related to the diffusion of knowledge (risks of losing part of the benefits of innovation despite patenting) and information asymmetries (commercial risks related to innovation and the illiquidity of investments).

## 4. Data and sample selection

### *4.1 Data*

In this paper, we combine three different databases. The first is a unique database of French innovative SMEs that has been made available by Bpifrance for the first time to university researchers. The database contains information on French innovative firms that received subsidies and other financial support from 2000 to 2014. The information available through this database includes (i) the year(s) a firm received financial support, (ii) the amount(s) of financial support, (iii) the amount and type of financial support (subsidy, zero-interest rate loan, repayable advances) granted to a project.

In this study, we have chosen to concentrate on a single type of financial support, namely, innovation subsidies. Several reasons justify this focus. First, subsidies are an uncompromising support from the company's point of view. Second, they are intended for the most upstream and riskiest phases of the innovation process in programmes such as "support for the creation and feasibility of projects" and "assistance for the creation of innovative enterprises". Third, the

[4] CDC Entreprises is the venture capital activity of the CDC (State bank handling official deposits) and the FSI is the French Strategic Investment Fund.

effect of the two other forms of financial support – repayable advances and zero-rate loans – on firms' financial constraints is hard to evaluate. Indeed, these types of financial support imply an automatic variation in firms' financial debt[5], which could bias the empirical results.

This original database is then merged with the FICUS and FARE databases, which are provided by the French National Institute of Statistics (INSEE). These databases gather accounting and performance variables at the firm level and cover all French firms, with the exception of firms with no employees and firms in the agricultural and finance sectors. Specifically, the database contains information about firm value added, nominal gross output, number of employees, intermediate inputs, tangible and intangible capital, investment goods and date of creation. These variables are used to compute the labour productivity, size and age of French firms. These databases allow us to obtain the financial information for (i) firms that received a subsidy from Bpifrance and (ii) firms that did not receive financial support from Bpifrance (the counterfactual). It should be noted that merging these two databases requires us to standardize the data because of different developments concerning sectoral classifications and the denomination of variables[6].

*4.2 Sample selection*

We restrict the period of analysis from 2000 to 2010 to be able to follow firms two years before and 3 years after they received the subsidy. This constraint is imposed by the availability of data from the FICUS and FARE databases. We merge the three databases (Bpifrance and FICUS/FARE) to obtain a final sample of French companies for which the financial variables were available for a period of the 2 years before the year the firm obtained the subsidy to the third year after the firm obtained it. The FICUS/FARE databases allow us to obtain a sample of companies that did not receive financial support from a public organization and, thus, to constitute our control sample (by considering the same time period for the availability of the data).

In this paper, we focus on SMEs and intermediate-sized enterprises, which are defined according to INSEE as firms with less than 5000 employees and a turnover lower than 1.5 billion euros. Consequently, in our sample, we have four main categories of firms, as described in Table 1.

**Table 1: Sample selection based on firms' size**

| Company category | Staff headcount | Turnover |
|---|---|---|
| Intermediate-Sized | < 5000 | ≤ 1.5 billion |
| Medium-Sized | < 250 | ≤ 50 million |
| Small | < 50 | ≤ 10 million |
| Micro | < 10 | ≤ 2 million |

There are two main reasons to exclude large firms from our sample. First, the aim of this research is to question the ability of public subsidies to relax financing constraints. However,

[5] It is hard to subtract the outstanding amount of the repayable advance or a zero-rate loan from the final amount of debt. Indeed, for instance, a repayable advance has to be reimbursed after a certain period of time that varies depending on the sector of the company.

[6] We thank our colleague Lionel Nesta for making available to us his files allowing for the standardization of the two databases.

the empirical literature has stressed that large firms are less financially constrained than smaller firms. Specifically, Beck *et al*. (2008) show that it is easier for large firms to expand external financing when they are constrained than it is for small firms. Second, the innovation subsidies distributed by ANVAR and OSEO specifically targeted SMEs and intermediate-sized companies (Riedinger *et al*., 2011).

Table 2 summarizes the sample we selected from the original database. Considering the data on innovation subsidies, we see that the successive public organizations provided, on average, support for 2,366 firms annually. The number of firms that received subsidies represents nearly 2/3 of the sample. Due to the numerous exclusions of observations linked to the merger of the three databases, the sample of firms retained for this paper represents approximately 25% of firms receiving innovation subsidies during the period of analysis.

**Table 2: Data from the Bpifrance database and sample selection**

| Year | BPI Innovation nb of firms (1) | Innovation subsidies nb of firms (2) | Sample used (3) | Ratio (3)/(2) |
|---|---|---|---|---|
| 2000 | 2231 | 1568 | 430 | 27.4% |
| 2001 | 2117 | 1470 | 361 | 24.6% |
| 2002 | 2414 | 1655 | 359 | 21.7% |
| 2003 | 2028 | 1067 | 226 | 21.2% |
| 2004 | 2069 | 1241 | 281 | 22.6% |
| 2005 | 2067 | 1261 | 313 | 24.8% |
| 2006 | 2379 | 1575 | 395 | 25.1% |
| 2007 | 2901 | 1918 | 473 | 24.7% |
| 2008 | 2888 | 1855 | 575 | 31.0% |
| 2009 | 2435 | 1478 | 362 | 24.5% |
| 2010 | 2496 | 1666 | 462 | 27.7% |
| **Average 2000-2010** | **2366** | **1523** | **385** | **25%** |

Table 2 also highlights a relatively stable number of firms receiving innovation subsidies over the period 2000-2010, although it seems that the transformation of ANVAR into OSEO in 2005 drove a relative increase. Indeed, the number of firms benefiting from innovative subsidies is significantly above the mean for years 2007, 2008, 2009 and 2010. The same finding appears in our restricted sample.

In Figures 1a and 1b, we present the total amount of innovation subsidies allocated to firms during the period 2000-2010 and the corresponding amount on our restricted sample.

**Figure 1: Total amount of innovation subsidies (million euros)***

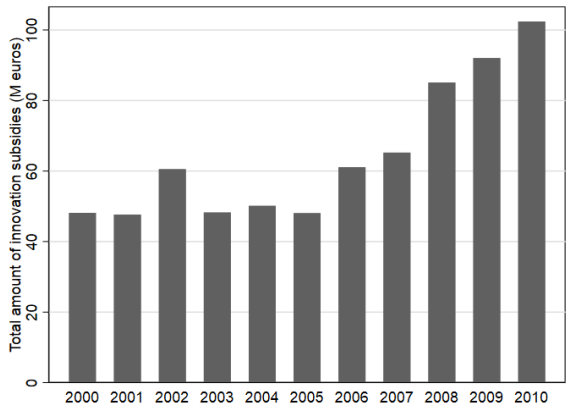


**Figure 1a: Innovation table sample**

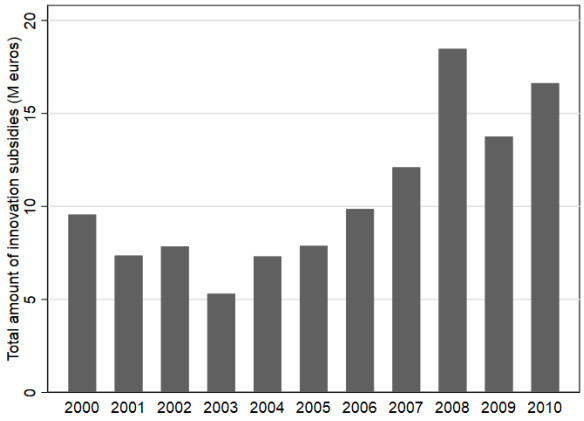


**Figure 1b: Sample used**

Figure 1a highlights an important increase in innovation subsidies allocated to firms over the whole studied period. Indeed, total subsidies increased more than twofold between 2000 and 2010 to more than 100 million euros in 2010. Nevertheless, this dynamic has not been linear. Indeed, the total amount of subsidies remained relatively stable at nearly 50 million euros over the period 2000-2005. The transformation of ANVAR into OSEO in 2005 dramatically changed these dynamics, as highlighted in Figure 1a. Concerning our restricted sample, the dynamic is a little bit different for the last three years of the study. We see here that the total amount of subsidies reached its maximum in 2008 at nearly 19 million euros but decreased in 2009 and 2010. Nevertheless, Figure 1b also highlights a structural change in the importance of innovation subsidies allocated since the creation of OSEO in 2005.

Figures 2a and 2b represent the average amount received over the period by firms in both the whole sample and the restricted sample. We can see that this amount is relatively stable between 2000 and 2007 at approximately 20 000 euros before recording a strong increase. There is no significant difference between the data from the full database provided by Bpifrance and the restricted sample.

**Figure 2: Average innovation subsidy amount (euros)**

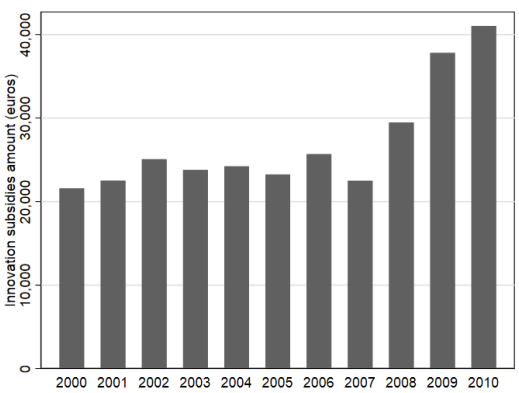


**Figure 2a: Innovation table**

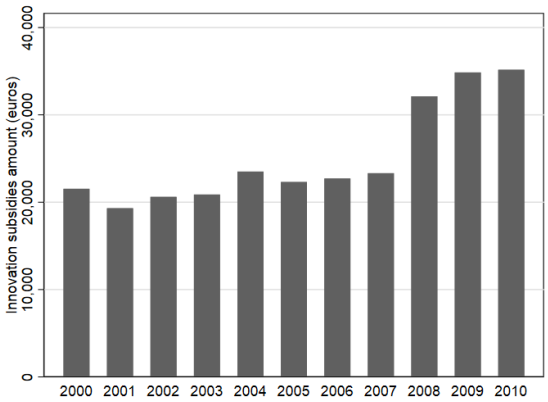


**Figure 2b: Sample used**

Both figures highlight a significant jump after 2007 in the average subsidy amount provided to firms. Indeed, for the full sample the average amount in 2010 is nearly two times higher compared to the 2000-2007 period. This clearly highlights a new strategy of OSEO compared to that of ANVAR.

The logic of these innovation subsidies is to co-finance innovative projects, that is, the subsidy amount only covers a portion of the project cost. Thus, it is important to see how the funded proportion of projects evolved over the period (Figures 3a and 3b).

Figures 3a and 3b highlight important differences in terms of dynamics between the full sample and our final sample. Indeed, while the average share of a project financed by subsidies is slightly increasing over time, the opposite occurs in our restricted sample. This difference can partially explain why the average amount of subsidies differs slightly between the two samples. Nevertheless, this share remains more stable in the sample used (range 34-40%) compared to that of the full sample (range 32-40%). These two figures combined with Figures 2a and 2b suggest that the average number of projects financed by the ANVAR/OSEO increased over time, and this is especially true for our restricted sample.

**Figure 3: Share of innovative project financed (average per firm)**

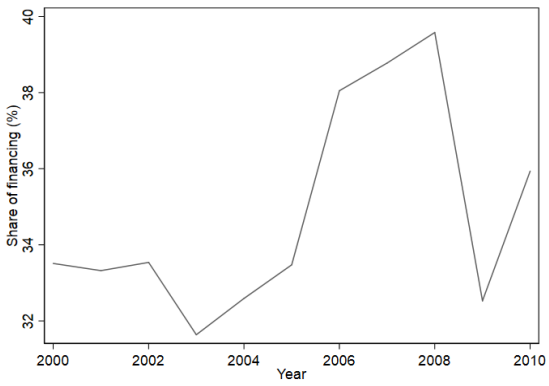


**Figure 3a: Innovation table sample**

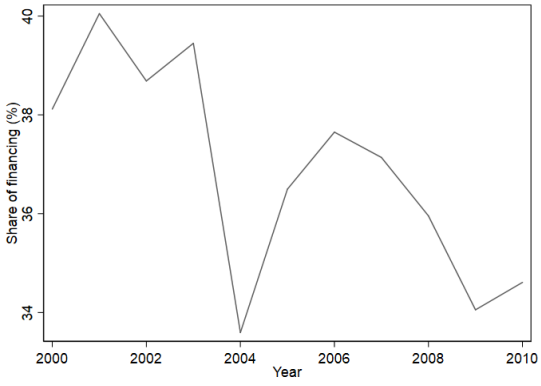


**Figure 3b: Sample used**

Finally, Table 3 shows the distribution of firms that received a subsidy by size in our final sample. We can remark that the successive public organizations concentrated their financial support on SMEs and, more specifically, on firms with less than 50 employees.

**Table 3: Distribution of firms in the restricted sample by size**

| | 2000-2005 | 2006-2010 |
|---|---|---|
| Small <10 | 689 | 900 |
| 10-49 | 872 | 994 |
| 50-249 | 355 | 334 |
| = >250 | 54 | 39 |

*4.3 Dependent variables*

In this study, the dependent variables are two relative measures of financial constraints: financial (debt) leverage and the external equity ratio. Financial leverage is measured as the ratio between short- and long-term financial debt (bank debt) and total assets. The external equity ratio is measured as the ratio between the value of the external equity of the firm and its total assets. Our data do not allow us to distinguish between equity raised from existing or new shareholders. Thus, here, equity can be raised from either existing or new shareholders. To control for the fact that, by definition, total firm equity *de facto* increases when the firm receives a subsidy, we consider here only the value of the share capital (not the value of other equity capital).
When analysing the descriptive statistics (see Table A1 in Appendix 1) for our two dependent variables, we can see that the mean for the leverage ratio is 17.4%, with a minimum below 0 and a maximum above 100%. The mean value for the external equity ratio is 13.3%, with a minimum again below 0 and a maximum above 100%. We are aware from this fact that debt on total assets and external equity on total assets should be (except in very specific cases) between 0 and 100%. These outlier values, which represent less than 20 observations in our sample, may also be the result of measurement errors. Instead of dropping those observations (and consequently the corresponding firms) with a financial leverage or an external equity ratio that is not between 0 and 100%, we decide to control for them by including a dummy for each outlier's value.

## 5. Econometric strategy

In this paper, we are interested in assessing the effect of innovation subsidies on SMEs' financial constraints, which requires a quasi-experimental framework. The main problem to control for is the potential endogeneity bias in our analysis, as selection of firms by the public institution may be not random and may be linked to better performance in terms of productivity or to firms' specific characteristics. For this reason, as in Sissoko (2011) and Ben Abdesslem and Chiappini (2019), we combine a matching method with a difference-in-difference (DiD) regression to evaluate the causal impact of public subsidies on firms' financial constraint measures, as we aim to replicate a randomized experiment as closely as possible.

*5.1 Matching*

The main purpose of relying on matching procedures is to reduce the imbalance in the distribution of pre-treatment confounders between the control and treated groups (Stuart, 2010). The most common matching method used in the empirical literature is propensity score matching (PSM), first developed by Rosenbaum and Rubin (1983). PSM consists of estimating each individual's propensity to receive a given treatment (here, the subsidy) based on observable covariates, $e_j(X_j) = P(T_j = 1|X_j)$, and then matching each treated individual with a non-treated individual with similar propensities. The method permits the creation of a counterfactual group that shares similar observable characteristics to those of the treated firms, which controls for selection bias (Rosenbaum and Rubin, 1983; Lechner, 2002).

Generally, implementation of the PSM method is based on a logit model estimating the probability that each individual *i* will receive a specific treatment based on different covariates (Caliendo and Kopeinig, 2008). The propensity score is, then, defined as the likelihood of obtaining the treatment, conditional on the common observed covariates. The score therefore fulfils the unconfoundedness assumption. The most common practice is to use one-to-one

nearest-neighbour matching without replacement. This method selects for each treated individual *i* the control individual with the smallest distance in terms of propensity score. In this case, individuals from the counterfactual group are only paired once with a treated individual. Finally, the propensity score distributions of both groups (treated and non-treated) overlap (Caliendo and Kopeinig, 2008), as the violation of this assumption entails an important evaluation bias (Heckman *et a*l., 1997). Indeed, it ensures that individuals with the same covariate values have a positive probability of being either treated or non-treated (Caliendo and Kopeinig, 2008). Therefore, as suggested by Bryson *et al*. (2002), the common support condition has to be imposed as it ensures that each characteristic observed in the treated sample is also observed in the counterfactual sample.

While PSM is commonly used to match individuals, the empirical literature has emphasized some important shortcomings of this method. In a seminal paper, King and Nielsen (2019) show that PSM often increases imbalance rather than reducing it and therefore increases bias in matching. They argue that this important shortcoming of the method is linked to the fact that PSM often approximates random matching. Indeed, in more balanced data, PSM tends to approximate a completely randomized experiment and therefore engages in random pruning (deleting observations at random), which turns out to increase imbalance, as the sample size decreases so that variance increases. King and Nielsen (2019) argue that matching approaches that approximate fully blocked randomization, such as Mahalanobis distance matching (MDM), should be used because complete randomization is less efficient than fully blocked randomization. Exact matching could be another way to overcome this problem. However, as suggested by Rosenbaum and Rubin (1985), this method does not work very well when the number of covariates is high-dimensional. Indeed, this method often leads to individuals not being matched, which increases the bias linked to the matching procedure (Stuart, 2010). Therefore, MDM is our preferred matching method, although we also present results from the PSM one-to-one matching.

In the MDM approach, the distance $D_{ij}$ between individuals *i* and *j* used for matching is expressed as follows:

$$D_{ij} = (X_i - X_j)' \sum\nolimits_{-1} (X_i - X_j)$$

where $X$ are the covariates. Rubin (1979) and Zhao (2004) argue that MDM performs well as long as the number of covariates is fewer than 8.

In our analysis, we rely on 6 covariates for the probability that a firm *i* received an innovation subsidy in year *t*. We retain variables that are widely used in the empirical evaluations of public policy (Bérubé and Mohnen, 2009; Martin *et al*., 2011; Vanino *et al*., 2019; Ben Abdesslem and Chiappini, 2019) and that have been found to be significant in influencing the probability that a firm obtain a subsidy. This includes covariates such as productivity, employment, age and intangible assets. Namely, the covariates are the following: the average labour productivity between year *t-1* and year *t-2*, $((LabProd_i)_{t-1;t-2})$, measured as the ratio between the value added of firm *I* and its number of employees; the average number of employees of firm *i* between year *t-1* and year *t-2*, $((Emp_i)_{t-1;t-2})$; the average age of firm *i* between year *t-1* and year *t-2*, $((Age_i)_{t-1;t-2})$; the average share of intangible assets in total net assets of firm *I* between year *t-1* and year *t-2*, $(Intangible)_{t-1;t-2}$); the squared value of the average number of employees of firm *i* between year *t-1* and year *t-2*, $((Emp_i)^2_{t-1;t-2})$; and the squared value

of the average age of firm *i* between year *t-1* and year *t-2*, $((Age_i)^2{}_{t-1;t-2})$. All variables are used in their logarithmic form. Descriptive statistics for these selected covariates are presented in Table A1 (Appendix 1). Note that MDM is performed for each year of the sample (2000 to 2010) using cross-sectional data[7].

To check the quality and robustness of the matching procedure, we next perform balancing tests that assess if the propensity score adequately balances the characteristics between treated and control firms. We rely on two types of tests. First, we construct univariate *t*-tests of equality of means between the groups of treated and matched firms for each covariate used. Second, we rely on Hotelling's $T^2$ multivariate test, which is argued to be more efficient than the univariate *t*-test (Sissoko, 2011), to analyse if a set of means is zero or, alternatively, equal between the two groups. Results of the tests are reported in Table A3 (Appendix 2) and provide evidence of the accuracy of the MDM matching procedure. Indeed, all tests strongly support the null hypothesis of means equality between treated and matched firms.

### *5.2 Difference-in-Difference regression*

As our last step, we supplement the MDM with a DiD model to get rid of unobserved heterogeneity and time trends that are still present after the implementation of the MDM. The DiD model is expressed as follows:

$$\varphi_{it} = \gamma SUB_{it} + \delta_t + \mu_i + \varepsilon_{it}$$

where $\varphi_{it}$ indicates the measure of financial constraint, $SUB_{it}$ is a dummy variable that equals 1 for subsidized firms at one year and three years after the grant date, $\delta_t$ are time fixed effects, $\mu_i$ controls for unobserved firm heterogeneity, and $\varepsilon_{it}$ indicates the error term. The coefficient $\gamma$ represents the causal effect of the innovation subsidy on firms' financial constraints provided that $\varepsilon_{it}$ is orthogonal to the regressors (Martin *et al.*, 2011). Note that this model is estimated on the whole sample of treated and non-treated firms over the entire period of study (2000-2010).

To evaluate more precisely the impact of those subsidies given the huge heterogeneity of SMEs, we also perform analysis on different sub-samples depending on the age, the size, the sector and the period.

## 6. Empirical results

### *6.1 Results on the full selected sample*

Tables 4a and 4b present the effect of innovation subsidies on financial leverage and the external equity ratio of firms subsidized by ANVAR (2000-2005) and OSEO (2005-2010) at one and three years after the treatment. Table 4a displays the estimation results for financial leverage, while Table 4b presents the estimation results for the external equity ratio. We present the results obtained with the Mahalanobis distance matching (MDM) approach and the

[7] The estimation is carried out 11 times. We use the Stata command psmatch2. Results are provided in Table A2 (Appendix 2).

propensity score matching (PSM (1,1)) procedure. As previously discussed, we are more confident with the DiD results obtained using Mahalanobis distance matching (MDM) but we also present results from the propensity score matching (PSM (1,1)) for robustness purposes.
Table 4a highlights a significant positive effect of innovation subsidies on the financial leverage of targeted firms at both one year and three years after the subsidization. The MDM results highlight a slightly higher effect after three years than after one year. We estimate that firms receiving an innovation subsidy from ANVAR/OSEO increase their leverage ratio by 117 base points after one year and 135 base points after three years. The PSM results are in line with these results.

**Table 4a:** Innovation subsidies and access to external financing

| | Financial leverage | | | |
|---|---|---|---|---|
| | MDM | | PSM (1,1) | |
| | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.0117*** | 0.0135*** | 0.0143*** | 0.0124*** |
| | (0.00397) | (0.00454) | (0.00264) | (0.00348) |
| Intercept | 0.173*** | 0.171*** | 0.146*** | 0.156*** |
| | (0.00512) | (0.00474) | (0.00846) | (0.00570) |
| Obs. | 41025 | 45335 | 30342 | 45715 |
| R-squared | 0.538 | 0.503 | 0.955 | 0.909 |
| Number of firms | 7762 | 7762 | 7739 | 7739 |
| Firm FE | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table 4b:** Innovation subsidies and access to external financing

| | External equity | | | |
|---|---|---|---|---|
| | MDM | | PSM (1,1) | |
| | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | -0.000274 | -0.00359 | -0.00751** | -0.00977*** |
| | (0.00506) | (0.00543) | (0.00308) | (0.00320) |
| Intercept | 0.140*** | 0.139*** | 0.151*** | 0.163*** |
| | (0.00429) | (0.00405) | (0.00914) | (0.00563) |
| Obs. | 41414 | 45728 | 30342 | 45715 |
| R-squared | 0.787 | 0.750 | 0.351 | 0.761 |
| Number of firms | 7762 | 7762 | 7739 | 7739 |
| Firm FE | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level respectively.

In contrast, Table 4b shows that innovation subsidies do not significantly influence the external equity ratio of targeted firms at either one or three years post-subsidization. The PSM results provide a more negative view, as we detect a slight (but significant) negative effect of ANVAR/OSEO support on the external equity ratio. Nevertheless, as we explained previously, we are cautious in interpreting the PSM results.

To summarize, our global results indicate that firms benefiting from ANVAR/OSEO innovation subsidies are able to significantly increase their financial leverage but not their external equity ratio. These results tend to imply that such public support acts as a positive signal that bestows access to more debt from banking institutions. Nevertheless, it also indicates that such subsidies do not allow the targeted firms to attract more capital from other investors such as business angels or venture capitalists.

In what follows, we only present the estimation results from MDM, as it constitutes our preferred matching method. Note that the estimation results from using the PSM (1,1) are presented in Tables A4 to A8 (Appendix 3).

*6.2 Age and size results*

As mentioned previously, young and small firms are more prone to suffering from information asymmetries. Consequently, the signal delivered by public subsidies for those firms can be fundamental for obtaining outside financing from both banks and private external investors.
The objective of this sub-section is to evaluate if ANVAR/OSEO public subsidies facilitate access to additional financing for young and small firms.

Concerning firm age, we test the impact of ANVAR/OSEO innovation subsidies on four different sub-samples. The first is built by following the definition of Hottenrott *et al*. (2017) of "new" companies, that is, firms that are up to 5 years old. At this stage of development, the early stage, a firm may still be unprofitable (Mayer, 2002), and public intervention at this stage can be crucial to reducing the financing gap (Wilson, 2015). We build a second and larger sub-sample by including companies that are up to 8 years old. The main reason behind this extension of the sample is the existence of a French-specific label, *Jeune Entreprise Innovante* (Young Innovative Companies), given to young, innovative firms. This label can be obtained by companies until their 8$^{th}$ anniversary[10]. This threshold of 8 years allows us to have a better understanding of the role played by innovation subsidies in the ability of companies to raise equity finance. Indeed, according to Bertoni *et al*. (2011), the probability of obtaining VC financing decreases with firm age to a maximum of 10 years old. To have a more granular understanding of our results, we define a third sample containing companies between 5 and 8 years old. Finally, the last sub-sample can be seen as a benchmark in the sense that we include all firms that are over 8 years old, which represent the older companies in our sample.

Concerning firm size, we split our sample into four sub-samples of companies according to the INSEE definition (see Section 4.2). Consequently, we evaluate the effect of ANVAR/OSEO subsidies on four types of SMEs: micro, small, medium-sized and intermediate-sized companies.

Tables 5a and 5b present our results by company age. Concerning the impact of ANVAR/OSEO subsidies on the financial leverage of targeted firms (Table 5a), we highlight a significant difference between new firms (up to 5 years old) and the others. Indeed, we detect (at 1 and 3 years) a significant positive effect of innovation subsidies on the financial leverage of firms between 5 and 8 years old and (to a lesser extent) firms that are over 8 years old. The effect on firms between 5 and 8 years is estimated at approximately 220 bp (at both 1 and 3 years), which is nearly double the estimated impact for the whole sample. Conversely, we do not detect any positive or negative effect for "new" firms.

[10] For more information, please refer to http://www.enseignementsup-recherche.gouv.fr/cid5738/la-jeune-entreprise-innovante-j.e.i.html.

Concerning the impact of ANVAR/OSEO subsidies on the external equity ratio of targeted firms (Table 5b), we do not detect any specific impact related to the companies' age. In line with our overall results, no influence of ANVAR/OSEO subsidies at either one or three years is detected.

**Table 5a:** Innovation subsidies and access to external financing by age of firms

| | Financial leverage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | | 8 | | 5-8 | | >8 | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.0410 | 0.0377 | 0.0240** | 0.0275** | 0.0226* | 0.0221** | 0.00728* | 0.00927* |
| | (0.0375) | (0.0358) | (0.0116) | (0.0126) | (0.0117) | (0.0112) | (0.0042) | (0.0051) |
| Intercept | 0.246*** | 0.244*** | 0.173*** | 0.182*** | 0.159*** | 0.170*** | 0.174*** | 0.172*** |
| | (0.0503) | (0.0504) | (0.0167) | (0.0175) | (0.0168) | (0.0178) | (0.0049) | (0.0049) |
| Obs. | 4320 | 4312 | 10755 | 10368 | 8125 | 7738 | 34580 | 30657 |
| R-squared | 0.055 | 0.056 | 0.776 | 0.782 | 0.851 | 0.857 | 0.166 | 0.191 |
| Number of firms | 1829 | 1829 | 2833 | 2833 | 2800 | 2792 | 7004 | 6744 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table 5b:** Innovation subsidies and access to external financing by age of firms

| | External equity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | | 8 | | 5-8 | | >8 | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | -0.00082 | -0.00097 | -0.00082 | 0.0096 | 0.0105 | 0.0071 | 0.0016 | -0.00050 |
| | (0.0263) | (0.0248) | (0.0263) | (0.0118) | (0.0146) | (0.0135) | (0.0053) | (0.0055) |
| Intercept | 0.124*** | 0.124*** | 0.150*** | 0.149*** | 0.164*** | 0.164*** | 0.136*** | 0.137*** |
| | (0.0316) | (0.0317) | (0.0131) | (0.0139) | (0.0132) | (0.0140) | (0.0036) | (0.0039) |
| Obs. | 4369 | 4361 | 10868 | 10481 | 8224 | 7837 | 34860 | 30933 |
| R-squared | 0.838 | 0.838 | 0.880 | 0.883 | 0.922 | 0.925 | 0.558 | 0.627 |
| Number of firms | 1829 | 1829 | 2833 | 2833 | 2800 | 2792 | 7004 | 6744 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

To summarize, for "new" companies (those younger than five years old), obtaining an ANVAR/OSEO subsidy did not seem to serve as a signal for banks and/or other external investors. Older companies and especially those between 5 and 8 years old benefit more from these grants, as we clearly detect a positive impact of receiving an innovation subsidy on access to bank financing. However, if the signalling effect of ANVAR/OSEO grants seems to be valid for banks, this is not the case for external investors. Indeed, obtaining an innovation subsidy does not impact the level of external equity (as a share of total assets) for companies, whatever their age.

Our analysis by size also provides interesting results on the heterogeneous effects of ANVAR/OSEO grants on financial constraints (Tables 6a and 6b). Indeed, it seems that the

positive effect of those subsidies on financial leverage only concerns micro and small companies. Indeed, we did find no significant effects for medium- and intermediate-sized companies. The positive signalling effect of ANVAR/OSEO subsidies is more important for micro businesses and intensifies over time. We estimate that receiving a grant increases financial leverage of micro companies by 146 bp at one year and by 191 bp at 3 years post-subsidization. The effects are lower and less significant for small companies with 107 and 133 bp, respectively. Concerning the impact on external equity, we obtain unexpected results, as ANVAR/OSEO subsidies seems to reduce the external equity ratio of small and intermediate-sized firms after three years. For the other size group, we find no significant effect. Because our dependent variable is the ratio of external equity over total assets, we can imagine that the positive access to bank financing induced by ANVAR/OSEO subsidies allows recipient firms to significantly increase their total assets (well above the increase in the share of equity). This is especially true for small firms, for which the financial leverage effect of ANVAR/OSEO subsidies is the strongest.

**Table 6a:** Innovation subsidies and access to external financing by size of firms (number of employees)

| | Financial leverage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <10 | | 10-49 | | 50-249 | | >=250 | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.0146* | 0.0191** | 0.0107* | 0.0133* | 0.00740 | 0.0121 | 0.0159 | 0.0202 |
| | (0.00806) | (0.00863) | (0.00567) | (0.00715) | (0.00856) | (0.00798) | (0.0140) | (0.0154) |
| Intercept | 0.173*** | 0.174*** | 0.175*** | 0.169*** | 0.162*** | 0.157*** | 0.137*** | 0.135*** |
| | (0.00901) | (0.00839) | (0.00608) | (0.00578) | (0.0118) | (0.0102) | (0.0148) | (0.0145) |
| Obs. | 14711 | 16032 | 18318 | 20364 | 7056 | 7873 | 940 | 1068 |
| R-squared | 0.667 | 0.641 | 0.044 | 0.037 | 0.062 | 0.056 | 0.080 | 0.066 |
| Number of firms | 3440 | 3476 | 4390 | 4453 | 1680 | 1713 | 219 | 228 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table 6b:** Innovation subsidies and access to external financing by size of firms

| | External equity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <10 | | 10-49 | | 50-249 | | >=250 | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.00813 | 0.00543 | -0.00893* | -0.00969** | 0.00506 | -0.000595 | -0.0146 | -0.0223** |
| | (0.00882) | (0.0100) | (0.00518) | (0.00450) | (0.0169) | (0.0128) | (0.0101) | (0.0104) |
| Intercept | 0.154*** | 0.154*** | 0.126*** | 0.127*** | 0.154*** | 0.152*** | 0.163*** | 0.155*** |
| | (0.00657) | (0.00647) | (0.00415) | (0.00365) | (0.00955) | (0.00888) | (0.0218) | (0.0189) |
| Obs. | 14882 | 16205 | 18475 | 20522 | 7115 | 7933 | 942 | 1070 |
| R-squared | 0.900 | 0.866 | 0.628 | 0.619 | 0.003 | 0.003 | 0.025 | 0.024 |
| Number of firms | 3442 | 3476 | 4393 | 4456 | 1680 | 1713 | 219 | 228 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

Our results support the idea that the ANVAR/OSEO financing strategy is able to reduce the financing constraints for SMEs in the context of bank financing but not in their earliest stage of development. However, the public subsidies do not play the role of catalyst for attracting external professional investors. Thus, these public subsidies do not seem to help here to close the equity gap for SMEs in the early stage of development.

*6.3 Sector: high-tech versus low-tech*

Another important source of heterogeneity among firms concerns their activity. We thus evaluate the effects of ANVAR/OSEO subsidies by comparing manufacturing and services firms, on the one hand, and high-tech and low-tech manufacturing, on the other hand. For the sectoral classification, by using the 4-digit codes based on NAF (*nomenclature d'activités française*) revision 1 2003 from INSEE, we first categorize the companies into two groups: firms that belong to manufacturing sectors and firms that belong to service sectors. Following the OECD categorization for the definition of high-tech manufacturing, low-tech manufacturing, knowledge-intensive services and other services, we divide our sample into three groups of firms: high-tech manufacturing, low-tech manufacturing and services[12]. We do not distinguish between knowledge-intensive services (R&D services here) and non-knowledge-intensive services because less than 2.5% of the firms located in services are classified in knowledge-intensive services. In our final sample, 21.72% and 14.94% of firms are located in low-tech and high-tech manufacturing sectors, respectively, while 61.77% are located in non-knowledge-intensive services and 1.58% in knowledge-intensive services[13].

Table 7 presents the results for manufacturing and services companies and highlights an important difference: ANVAR/OSEO subsidies do not seem to reduce financing constraints for manufacturing firms but do improve access to bank financing for services firms. Indeed, we estimate that receiving ANVAR/OSEO subsidies allows services firms to increase their

[12] We rely on the classification provided by the OECD in 1997, which has been revised as presented in Table 1 in Galiendo-Rueda and Verger (2016).
[13] Table A1 presents all the variables used in the empirical model and the descriptive statistics.

leverage ratio by 117 bp after one year and 135 bp after three years. However, those public subsidies do not influence the external equity ratio for either manufacturing or services firms.

Table 8 presents the results for high-tech and low-tech manufacturing firms. We use the OECD classification to distinguish between low-tech and high-tech manufacturing sectors[14]. We again highlight an important heterogeneity of the impact of OSEO/ANVAR subsidies. Indeed, high-tech manufacturing firms seem to significantly benefit from those subsidies in terms of obtaining more access to bank debt. We estimate that following receipt of OSEO/ANVAR subsidies, high-tech manufacturing firms increase their financial leverage by nearly 150 bp (after both one and three years). We do not detect any effect on the external equity ratio. Concerning low-tech manufacturing, it seems that ANVAR/OSEO subsidies are not able to reduce these firms' credit constraints.

This positive result suggests that the additional information conveyed by public authorities is valuable and thus informative for banks when the firms are located in more opaque sectors. However, our analysis by sector and technological level suggests that the additional information conveyed by ANVAR/OSEO subsidies (in terms of signal) is valued only by banks. Receiving a subsidy from this public institution does not play a catalysing role in terms of funding from professional external equity investors.

[14] See Galindo-Rueva and Verger (2016) for further details on the classification of manufacturing sectors according to their technological intensity.

**Table 7:** Manufacturing versus services sectors

| | Manufacturing | | | | Services | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial leverage | | External equity | | Financial leverage | | External equity | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.00882 | 0.0103 | -0.00250 | -0.00226 | 0.0117** | 0.0135** | 0.00283 | -0.00458 |
| | (0.00537) | (0.00653) | (0.00297) | (0.00386) | (0.00576) | (0.00609) | (0.0102) | (0.0107) |
| Intercept | 0.172*** | 0.171*** | 0.141*** | 0.140*** | 0.174*** | 0.172*** | 0.139*** | 0.138*** |
| | (0.00715) | (0.00684) | (0.00515) | (0.00495) | (0.00677) | (0.00621) | (0.00587) | (0.00554) |
| Obs. | 14944 | 16590 | 15060 | 16708 | 25942 | 28595 | 26215 | 28870 |
| R-squared | 0.085 | 0.069 | 0.099 | 0.086 | 0.596 | 0.570 | 0.793 | 0.759 |
| Number of firms | 2795 | 2795 | 2795 | 2795 | 4939 | 4939 | 4939 | 4939 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation. *, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table 8:** Low-tech manufacturing versus high-tech manufacturing

| | Low-tech sectors | | | | High-tech sectors | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial leverage | | External equity | | Financial leverage | | External equity | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.00361 | 0.00698 | -0.00297 | -0.00371 | 0.0153** | 0.0148** | -0.00122 | 0.000996 |
| | (0.00860) | (0.0112) | (0.00455) | (0.00595) | (0.00621) | (0.00657) | (0.00372) | (0.00475) |
| Intercept | 0.191*** | 0.191*** | 0.137*** | 0.142*** | 0.144*** | 0.140*** | 0.148*** | 0.137*** |
| | (0.00961) | (0.00935) | (0.00624) | (0.00576) | (0.0103) | (0.00957) | (0.00895) | (0.00900) |
| Obs. | 8890 | 9817 | 8970 | 9897 | 6054 | 6773 | 6090 | 6811 |
| R-squared | 0.106 | 0.083 | 0.109 | 0.106 | 0.047 | 0.042 | 0.087 | 0.061 |
| Number of firms | 1682 | 1682 | 1682 | 1682 | 1113 | 1113 | 1113 | 1113 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation. Low-tech sectors refer to the aggregation of the low-tech and middle-low-tech categories, and high-tech sectors to the aggregation of the high-tech and middle-high-tech categories of the OECD classification. *, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

*6.4 Structural change in the effect of the policy*

In this section, we try to identify if the effect of OSEO/ANVAR subsidies on firms' financial leverage and external equity ratio changed over time. More precisely, we test if institutional change from ANVAR to OSEO could be associated with a different level of effectiveness in the allocation of subsidies. Until 2005, BPI was named ANVAR and became OSEO in 2005. This was not only a question of name changes but also important changes in terms of total amount of subsidies, as described in the descriptive statistics section. We thus decide to test for the presence of a break in the effect of innovation subsidies in 2005. Table 9 summarizes these estimation results.

**Table 9:** Structural break (in 2005) in the effect of innovation subsidies

| | Financial leverage<br>After 3 years | External equity<br>After 3 years |
|---|---|---|
| $SUB_{it}$ | 0.0284*** | 0.00673 |
| | (0.00925) | (0.00797) |
| $Break$ | 0.00663 | 0.00208 |
| | (0.00543) | (0.00512) |
| $SUB_{it} * break$ | -0.0215** | -0.0149 |
| | (0.00968) | (0.00962) |
| Intercept | 0.167*** | 0.139*** |
| | (0.00246) | (0.00228) |
| Obs. | 45335 | 45728 |
| R-squared | 0.503 | 0.750 |
| Number of firms | 7762 | 7762 |
| Firm FE | YES | YES |
| Time FE | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation. The structural break is tested in 2005.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

Our results highlight a significant (negative) break in the effect of innovation subsidies on financial leverage after 2005. More precisely, it seems that while ANVAR subsidies were able to significantly increase the financial leverage of targeted firms (+284 bp at 3 years) during the first period (2000-2005), this effect disappeared during the second period (2006-2010). Indeed, the net effect of OSEO subsidies for the second period is estimated at +69 bp (0,0284-0,0215) but is insignificant.

Concerning the effect of OSEO/ANVAR subsidies on external equity, we do not detect a significant change between the two periods. In line with previous results, it seems that the innovation support provided by those institutions was not able to significantly influence the level of external equity of targeted firms.

This result is particularly interesting in the sense that it highlights a link between institutional change and the effectiveness of public support. Moreover, as the total amount (and amount per firm) of innovation subsidies increased significantly under OSEO compared to ANVAR, the results also suggest that more does not imply better. More specifically, we may surmise that the selection process of firms made by OSEO has been less restrictive than the one implemented by ANVAR, lowering the positive signal effect for banks accordingly.

## 7. Concluding remarks

The long-term growth of economies is largely dependent on the capacity of firms to innovate. An increasing number of studies, such as Veugelers (2008), Schneider and Veugelers (2010) and Czarnitzki and Delanote (2015), highlight the key role played by innovative SMEs in driving technological change by bringing radically new innovations to market. Nevertheless, the specificities of innovative activities require important risky investments and sources of funding.

While large companies are able to self-finance most of their innovative projects, this is not the case for SMEs, which need external funding to develop their innovative pipeline. As highlighted by Mohnen *et al*. (2008), the low availability of external funding for SMEs, especially in Europe, raises the fear of important underinvestment in R&D by SMEs. In view of this concern, most European countries have implemented specific policy tools to help SMEs finance their innovative projects. In this respect, France constitutes an interesting case to study, as the government created a specific agency (ANVAR) in the end of the 1960s to foster innovation within SMEs using specific policy tools. Now renamed Bpifrance, this agency is the main financing tool for innovative SMEs in France.

Using a unique database, this paper evaluates whether innovation subsidies granted by ANVAR/OSEO to SMEs during the 2000-2010 period helped alleviate targeted firms' credit constraints. More specifically, we test the indirect signalling/certification effect for recipient firms through two different channels: better access to bank financing, on the one hand, and better access to external investor (such as business angel and venture capital) funding, on the other hand.

Our results suggest that recipient firms benefited from a significant improvement in bank financing after receiving an ANVAR/OSEO subsidy. Nevertheless, this effect is heterogeneous and mainly concentrated on small firms between 5 and 8 years old operating in high-tech sectors. In contrast, we find no signalling effect of ANVAR/OSEO grants in terms of access to other external sources of financing (such as through business angels and venture capitalists). In a sense, it is not a very surprising result, as many studies highlight the lack of this type of investors (for the seed and start-up stages) in France (Ekeland *et al*., 2016). Indeed, in France, as in other continental European countries, accessing outside seed and start-up equity capital is still relatively complicated for young, innovative companies.

Finally, we also highlight a significant (and negative) change in the effect of ANVAR/OSEO subsidies on bank financing access after the transformation of ANVAR into OSEO in 2005. This suggest the importance of institutional change on the certification effect/efficiency of public agencies.

Our results provide interesting evidence for policymakers and agencies supporting innovative SMEs. First, it seems that public agencies such as ANVAR/OSEO can play a very important role in helping SMEs finance their innovative activities through both direct and indirect effects. The direct effect is driven by the allocation of subsidies, and the indirect effect materializes through a certification effect for other external investors. Nevertheless, this certification effect is highly dependent on the availability of different sources of external financing sources. Indeed, in France, SMEs are mainly financed by banks, and other external investors are almost non-existent. Consequently, the positive certification effect of ANVAR/OSEO grants is limited

to the banking sector. One way to increase this certification effect could be to develop and attract business angels and venture capital firms.
Another interesting piece of evidence concerns the evolution of the certification effect related to the institutional change whereby ANVAR was transformed into OSEO, accompanied with a change in budget and missions. Indeed, the budget and average grant amount during the OSEO period (2005-2010) was significantly higher compared to the ANVAR period (2000-2005). Nevertheless, we find a strong decrease in the effectiveness of grants allocated by OSEO compared to ANVAR, suggesting the importance of institutional change for the effectiveness of public agencies. This suggests that avoiding too many institutional changes for public agencies in charge of support to SMEs could also help to improve their global certification effect for external investors. Inertia in terms of teams, procedure and allocation can sometimes be beneficial.

## Acknowledgement

We wish to thank Lionel Nesta for helping us to merge FICUS and FARE databases. We sincerely acknowledge BPI France for its financial support (FIPE project) and access to the data. This work has also been supported by a public grant overseen by the French National Research Agency (ANR) as part of the « Investissements d'avenir » program (reference: ANR-10-EQPX-17 – Centre d'accès sécurisé aux données – CASD). Any subsequent errors or omissions are the responsibility of the authors alone.

**Appendix 1:** Descriptive statistics

**Table A1:** Definitions of variables and descriptive statistics

| Variable | Definition | Mean | sd | Min | Max |
|---|---|---|---|---|---|
| Age (ln) | Measured as the difference between the year the firm received the subsidy and the year of firm creation | 2.7745 | 0.854 | 0 | 4.727 |
| Age $(ln)^2$ | Measured as the squared term of Age (ln) | 8.431 | 4.933 | 0 | 22.348 |
| Emp (ln) | Measured as the number of employees | 2.8267 | 1.340 | 0 | 8.186 |
| Emp $(ln)^2$ | Measured as the squared term of Emp (ln) | 9.787 | 9.786 | 0 | 67.014 |
| Intangible | Measured as the ratio between the firm's intangible assets and total assets | 0.1241 | 0.484 | 0 | 58.153 |
| LabProd (ln) | Measured as the ratio between firm value added and number of employees | 3.897 | 0.541 | -4.710 | 10.303 |
| Financial leverage | Measured as the ratio between short- and long-term financial debts and total assets | 0.174 | 0.272 | -2.067 | 27.197 |
| External equity financing | Measured as the ratio between the value of the firm's external equity (raised from external or existing shareholders) and total assets | 0.133 | 0.316 | -14.369 | 29.792 |

**Appendix 2:** Logit model for the PSM matching and results of balancing tests

**Table A2:** Results of logit models for the probability of obtaining an innovation subsidy

| | (1) 2000 | (2) 2001 | (3) 2002 | (4) 2003 | (5) 2004 | (6) 2005 | (7) 2006 | (8) 2007 | (9) 2008 | (10) 2009 | (11) 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Ln(LabProd_i)_{t-1;t-2}$ | -0.0110 | 0.0662 | 0.0967 | 0.0736 | -0.0384 | -0.0739 | 0.0814 | 0.135 | -0.176** | -0.457*** | -0.420*** |
| | (0.0973) | (0.105) | (0.0955) | (0.134) | (0.111) | (0.104) | (0.102) | (0.0850) | (0.0754) | (0.0918) | (0.0776) |
| $Ln(Emp_i)_{t-1;t-2}$ | 1.966*** | 1.625*** | 1.394*** | 1.591*** | 1.570*** | 1.119*** | 1.384*** | 1.373*** | 1.260*** | 1.729*** | 1.308*** |
| | (0.171) | (0.163) | (0.154) | (0.179) | (0.184) | (0.150) | (0.152) | (0.136) | (0.102) | (0.165) | (0.135) |
| $Ln(Emp_i)_{t-1;t-2}{}^2$ | -0.217*** | -0.167*** | -0.137*** | -0.166*** | -0.183*** | -0.107*** | -0.148*** | -0.136*** | -0.136*** | -0.212*** | -0.150*** |
| | (0.0257) | (0.0227) | (0.0220) | (0.0251) | (0.0284) | (0.0218) | (0.0228) | (0.0195) | (0.0154) | (0.0263) | (0.0218) |
| $Ln(Age_i)_{t-1;t-2}$ | -0.761*** | -0.924*** | -0.872*** | -0.863*** | -0.954*** | -0.680*** | -0.708*** | -0.928*** | -0.629*** | -1.249*** | -1.149*** |
| | (0.213) | (0.234) | (0.244) | (0.298) | (0.260) | (0.258) | (0.235) | (0.199) | (0.195) | (0.321) | (0.189) |
| $Ln(Age_i)_{t-1;t-2}{}^2$ | 0.121*** | 0.134*** | 0.124*** | 0.120** | 0.123** | 0.0784 | 0.0741* | 0.120*** | 0.0672* | 0.184*** | 0.198*** |
| | (0.0395) | (0.0438) | (0.0455) | (0.0550) | (0.0504) | (0.0485) | (0.0448) | (0.0377) | (0.0371) | (0.0618) | (0.0400) |
| $(Intangible\ assets_i)_{t-1;t-2}$ | 0.459*** | 0.0982 | 0.216*** | 0.473** | 0.107 | 0.0805 | 0.0482 | 0.113 | 0.0412 | 0.0520*** | 0.0755*** |
| | (0.101) | (0.217) | (0.0682) | (0.199) | (0.0827) | (0.0640) | (0.114) | (0.162) | (0.0434) | (0.0143) | (0.0200) |
| Intercept | -10.59*** | -9.433*** | -10.15*** | -9.691*** | -9.516*** | -7.614*** | -8.477*** | -10.04*** | -7.364*** | -4.797*** | -6.623*** |
| | (1.350) | (0.866) | (1.354) | (1.123) | (1.189) | (0.761) | (0.800) | (1.144) | (1.039) | (1.067) | (1.059) |
| Obs. | 369165 | 337275 | 332747 | 335251 | 267333 | 385450 | 364698 | 403136 | 578848 | 382259 | 598458 |
| Sector FE | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
Logit models are estimated year by year (cross-section).
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A3:** MDM matching procedure tests

| | 2000 | | | | 2001 | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | Control (N=429) | Treated (N=430) | T-Stat | P-value | Control (N=359) | Treated (N=361) | T-Stat | P-value |
| $Ln(LabProd_i)$ | 3.753 | 3.755 | -0.074 | 0.941 | 3.781 | 3.787 | -0.190 | 0.849 |
| $Ln(Emp_i)$ | 2.990 | 2.993 | -0.037 | 0.970 | 2.973 | 2.977 | -0.039 | 0.969 |
| $Ln(Emp_i)^2$ | 10.426 | 10.449 | -0.040 | 0.968 | 10.599 | 10.622 | -0.037 | 0.970 |
| $Ln(Age_i)$ | 2.779 | 2.776 | 0.053 | 0.958 | 2.664 | 2.668 | -0.044 | 0.965 |
| $Ln(Age_i)^2$ | 8.659 | 8.637 | 0.058 | 0.954 | 8.061 | 8.088 | -0.065 | 0.948 |
| $(Intangible\ assets_i)$ | 0.111 | 0.113 | -0.142 | 0.887 | 0.079 | 0.082 | -0.276 | 0.782 |
| | | **Hotelling $T^2$-test** | 0.034 | 1.000 | | **Hotelling $T^2$-test** | 0.122 | 0.994 |
| | **2002** | | | | **2003** | | | |
| **Variable** | Control (N=359) | Treated (N=359) | T-Stat | P-value | Control (N=226) | Treated (N=226) | T-Stat | P-value |
| $Ln(LabProd_i)$ | 3.828 | 3.830 | -0.052 | 0.959 | 3.859 | 3.856 | 0.063 | 0.950 |
| $Ln(Emp_i)$ | 2.875 | 2.881 | -0.061 | 0.952 | 2.951 | 2.952 | -0.003 | 0.998 |
| $Ln(Emp_i)^2$ | 10.163 | 10.192 | -0.046 | 0.964 | 10.512 | 10.532 | -0.024 | 0.981 |
| $Ln(Age_i)$ | 2.619 | 2.620 | -0.003 | 0.997 | 2.641 | 2.635 | 0.056 | 0.955 |
| $Ln(Age_i)^2$ | 7.827 | 7.834 | -0.016 | 0.988 | 7.937 | 7.913 | 0.046 | 0.964 |
| $(Intangible\ assets_i)$ | 0.101 | 0.105 | -0.256 | 0.798 | 0.102 | 0.105 | -0.148 | 0.882 |
| | | **Hotelling $T^2$-test** | 0.091 | 0.997 | | **Hotelling $T^2$-test** | 0.038 | 1.000 |
| | **2004** | | | | **2005** | | | |
| **Variable** | Control (N=281) | Treated (N=281) | T-Stat | P-value | Control (N=313) | Treated (N=313) | T-Stat | P-value |
| $Ln(LabProd_i)$ | 3.810 | 3.809 | 0.040 | 0.968 | 3.836 | 3.835 | 0.020 | 0.984 |
| $Ln(Emp_i)$ | 2.694 | 2.694 | -0.001 | 0.999 | 2.781 | 2.785 | -0.034 | 0.973 |
| $Ln(Emp_i)^2$ | 8.816 | 8.826 | -0.017 | 0.987 | 9.689 | 9.711 | -0.031 | 0.975 |
| $Ln(Age_i)$ | 2.554 | 2.553 | 0.014 | 0.989 | 2.593 | 2.593 | 0.005 | 0.996 |
| $Ln(Age_i)^2$ | 7.460 | 7.455 | 0.013 | 0.990 | 7.621 | 7.613 | 0.019 | 0.984 |
| $(Intangible\ assets_i)$ | 0.098 | 0.101 | -0.213 | 0.831 | 0.102 | 0.107 | -0.330 | 0.742 |
| | | **Hotelling $T^2$-test** | 0.052 | 0.999 | | **Hotelling $T^2$-test** | 0.132 | 0.992 |

| | 2006 | | | | 2007 | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | Control (N=394) | Treated (N=394) | T-Stat | P-value | Control (N=471) | Treated (N=473) | T-Stat | P-value |
| $Ln(LabProd_i)$ | 3.911 | 3.910 | 0.031 | 0.975 | 3.967 | 3.970 | -0.100 | 0.920 |
| $Ln(Emp_i)$ | 2.768 | 2.771 | -0.038 | 0.970 | 2.873 | 2.879 | -0.064 | 0.949 |
| $Ln(Emp_i)^2$ | 9.344 | 9.356 | -0.022 | 0.982 | 10.085 | 10.115 | -0.054 | 0.957 |
| $Ln(Age_i)$ | 2.571 | 2.572 | -0.011 | 0.991 | 2.593 | 2.597 | -0.070 | 0.944 |
| $Ln(Age_i)^2$ | 7.472 | 7.472 | 0.000 | 1.000 | 7.634 | 7.659 | -0.073 | 0.941 |
| $(Intangible\ assets_i)$ | 0.099 | 0.100 | -0.113 | 0.910 | 0.103 | 0.105 | -0.165 | 0.869 |
| | | **Hotelling $T^2$-test** | 0.022 | 1.000 | | **Hotelling $T^2$-test** | 0.048 | 1.000 |

| | 2008 | | | | 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| **Variable** | Control (N=575) | Treated (N=575) | T-Stat | P-value | Control (N=359) | Treated (N=359) | T-Stat | P-value |
| $Ln(LabProd_i)$ | 3.900 | 3.901 | -0.030 | 0.976 | 3.895 | 3.896 | -0.018 | 0.986 |
| $Ln(Emp_i)$ | 2.554 | 2.555 | -0.015 | 0.988 | 2.688 | 2.702 | -0.157 | 0.875 |
| $Ln(Emp_i)^2$ | 8.339 | 8.351 | -0.027 | 0.978 | 8.580 | 8.659 | -0.152 | 0.879 |
| $Ln(Age_i)$ | 2.561 | 2.561 | 0.007 | 0.995 | 2.648 | 2.660 | -0.182 | 0.856 |
| $Ln(Age_i)^2$ | 7.442 | 7.440 | 0.007 | 0.994 | 7.785 | 7.868 | -0.225 | 0.822 |
| $(Intangible\ assets_i)$ | 0.103 | 0.108 | -0.390 | 0.697 | 0.128 | 0.132 | -0.174 | 0.862 |
| | | **Hotelling $T^2$-test** | 0.162 | 0.987 | | **Hotelling $T^2$-test** | 0.070 | 0.999 |

| | 2010 | | | |
|---|---|---|---|---|
| **Variable** | Control (N=459) | Treated (N=459) | T-Stat | P-value |
| $Ln(LabProd_i)$ | 3.837 | 3.838 | -0.018 | 0.985 |
| $Ln(Emp_i)$ | 2.598 | 2.606 | -0.095 | 0.925 |
| $Ln(Emp_i)^2$ | 8.396 | 8.431 | -0.070 | 0.944 |
| $Ln(Age_i)$ | 2.540 | 2.547 | -0.100 | 0.920 |
| $Ln(Age_i)^2$ | 7.444 | 7.486 | -0.124 | 0.901 |
| $(Intangible\ assets_i)$ | 0.191 | 0.204 | -0.192 | 0.848 |
| | | **Hotelling $T^2$-test** | 0.070 | 0.999 |

## Appendix 3: PSM 1:1 estimation result

**Table A4a:** Innovation subsidies and access to external financing by age of firms (using PSM one-to-one matching)

| | Financial leverage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | | 8 | | 5-8 | | >8 | |
| | After 1 year | | After 3 years | | After 1 year | | After 3 years | |
| $SUB_{it}$ | 0.0263* | 0.0259* | 0.0205*** | 0.0102 | 0.0149** | 0.00220 | 0.0113*** | 0.0121*** |
| | (0.0140) | (0.0137) | (0.00588) | (0.00900) | (0.00607) | (0.00928) | (0.00294) | (0.00340) |
| Intercept | 0.121*** | 0.132*** | 0.114*** | 0.156*** | 0.157*** | 0.169*** | 0.158*** | 0.157*** |
| | (0.0327) | (0.0320) | (0.0181) | (0.0210) | (0.0228) | (0.0227) | (0.00989) | (0.00568) |
| Obs. | 4358 | 4409 | 8876 | 10664 | 6132 | 7916 | 21466 | 35051 |
| R-squared | 0.973 | 0.972 | 0.985 | 0.973 | 0.967 | 0.981 | 0.043 | 0.059 |
| Number of firms | 1774 | 1775 | 2751 | 2753 | 2656 | 2716 | 6006 | 6941 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A4b:** Innovation subsidies and access to external financing by age of firms (using PSM one-to-one matching)

| | External equity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5 | | 8 | | 5-8 | | >8 | |
| | After 1 year | | After 3 years | | After 1 year | | After 3 years | |
| $SUB_{it}$ | 0.0162 | 0.0154 | -0.00302 | -0.00849 | 0.00288 | -0.00823 | -0.00553** | -0.00678** |
| | (0.0137) | (0.0135) | (0.00803) | (0.00818) | (0.0103) | (0.00937) | (0.00252) | (0.00285) |
| Intercept | 0.110*** | 0.108*** | 0.137*** | 0.178*** | 0.123*** | 0.185*** | 0.153*** | 0.159*** |
| | (0.0275) | (0.0263) | (0.0216) | (0.0148) | (0.0350) | (0.0206) | (0.00826) | (0.00554) |
| Obs. | 4358 | 4409 | 8876 | 10664 | 6132 | 7916 | 21466 | 35051 |
| R-squared | 0.084 | 0.084 | 0.039 | 0.767 | 0.025 | 0.845 | 0.621 | 0.755 |
| Number of firms | 1774 | 1775 | 2751 | 2753 | 2656 | 2716 | 6006 | 6941 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A5a:** Innovation subsidies and access to external financing by size of firms (using PSM one-to-one matching)

| | Financial leverage | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <10 | | 10-49 | | 50-249 | | >=250 | |
| | After 1 year | | After 3 years | | After 1 year | | After 3 years | |
| $SUB_{it}$ | 0.0138*** | 0.0164*** | 0.0120*** | 0.00807 | 0.0167*** | 0.0145** | 0.00580 | -0.000389 |
| | (0.00482) | (0.00632) | (0.00384) | (0.00556) | (0.00554) | (0.00596) | (0.0105) | (0.0147) |
| Intercept | 0.153*** | 0.156*** | 0.152*** | 0.165*** | 0.110*** | 0.136*** | 0.147*** | 0.153*** |
| | (0.0150) | (0.0106) | (0.0121) | (0.00816) | (0.0176) | (0.0102) | (0.0201) | (0.0165) |
| Obs. | 11451 | 16593 | 13114 | 19999 | 4830 | 7641 | 948 | 1484 |
| R-squared | 0.977 | 0.955 | 0.401 | 0.144 | 0.063 | 0.045 | 0.038 | 0.024 |
| Number of firms | 3452 | 3578 | 4073 | 4398 | 1495 | 1668 | 286 | 323 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A5b:** Innovation subsidies and access to external financing by size of firms (using PSM one-to-one matching)

| | External equity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <10 | | 10-49 | | 50-249 | | >=250 | |
| | After 1 year | | After 3 years | | After 1 year | | After 3 years | |
| $SUB_{it}$ | -0.0100* | -0.00971* | -0.00518 | -0.00545 | -0.0105* | -0.0114* | 0.00674 | -0.000249 |
| | (0.00569) | (0.00535) | (0.00474) | (0.00409) | (0.00540) | (0.00663) | (0.00752) | (0.00864) |
| Intercept | 0.160*** | 0.177*** | 0.141*** | 0.141*** | 0.184*** | 0.190*** | 0.164*** | 0.180*** |
| | (0.0142) | (0.00745) | (0.0144) | (0.00744) | (0.0200) | (0.0120) | (0.0299) | (0.0138) |
| Obs. | 11451 | 16593 | 13114 | 19999 | 4830 | 7641 | 948 | 1484 |
| R-squared | 0.204 | 0.895 | 0.544 | 0.495 | 0.007 | 0.006 | 0.027 | 0.016 |
| Number of firms | 3452 | 3578 | 4073 | 4398 | 1495 | 1668 | 286 | 323 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A6:** Manufacturing versus services sectors (using PSM one-to-one matching)

| | Manufacturing | | | | Services | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial leverage | | External equity | | Financial leverage | | External equity | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.0139*** | 0.0123*** | -0.00313 | -0.00753*** | 0.0157*** | 0.0130** | -0.0134** | -0.0128** |
| | (0.00338) | (0.00407) | (0.00194) | (0.00251) | (0.00418) | (0.00590) | (0.00623) | (0.00625) |
| Intercept | 0.140*** | 0.152*** | 0.146*** | 0.154*** | 0.146*** | 0.156*** | 0.161*** | 0.176*** |
| | (0.0102) | (0.00672) | (0.00745) | (0.00475) | (0.0134) | (0.00951) | (0.0169) | (0.0106) |
| Obs. | 15839 | 23981 | 15839 | 23981 | 14180 | 21277 | 14180 | 21277 |
| R-squared | 0.056 | 0.042 | 0.339 | 0.351 | 0.976 | 0.943 | 0.344 | 0.788 |
| Number of firms | 4045 | 4045 | 4045 | 4045 | 3611 | 3611 | 3611 | 3611 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A7:** Manufacturing low tech versus manufacturing high tech (using PSM one-to-one matching)

| | Low-technological sectors | | | | High-technological sectors | | | |
|---|---|---|---|---|---|---|---|---|
| | Financial leverage | | External equity | | Financial leverage | | External equity | |
| | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years | After 1 year | After 3 years |
| $SUB_{it}$ | 0.0181*** | 0.0194*** | -0.00627** | -0.00875*** | 0.00922** | 0.00501 | -2.26e-05 | -0.00671* |
| | (0.00499) | (0.00604) | (0.00246) | (0.00328) | (0.00449) | (0.00533) | (0.00302) | (0.00372) |
| Constant | 0.155*** | 0.163*** | 0.151*** | 0.157*** | 0.123*** | 0.141*** | 0.139*** | 0.149*** |
| | (0.0134) | (0.00909) | (0.00961) | (0.00576) | (0.0155) | (0.00987) | (0.0116) | (0.00783) |
| Obs. | 8262 | 12337 | 8262 | 12337 | 7577 | 11644 | 7577 | 11644 |
| R-squared | 0.047 | 0.060 | 0.411 | 0.532 | 0.075 | 0.027 | 0.225 | 0.142 |
| Number of firms | 2116 | 2116 | 2116 | 2116 | 1929 | 1929 | 1929 | 1929 |
| Firm FE | YES | YES | YES | YES | YES | YES | YES | YES |
| Time FE | YES | YES | YES | YES | YES | YES | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

**Table A8:** Structural break (in 2008) in the effect of innovation subsidies

| | Financial leverage<br>2008<br>3 years | External equity<br>2008<br>3 years |
|---|---|---|
| $SUB_{it}$ | 0.0115*** | -0.00340 |
| | (0.00394) | (0.00370) |
| $Break$ | 0.00474 | 0.0298*** |
| | (0.00792) | (0.00700) |
| $SUB_{it} * break$ | 0.00221 | -0.0154** |
| | (0.00612) | (0.00675) |
| Intercept | 0.150*** | 0.138*** |
| | (0.00400) | (0.00403) |
| Obs. | 45715 | 45715 |
| R-squared | 0.909 | 0.762 |
| Number of siren | 7739 | 7739 |
| Firm FE | YES | YES |
| Time FE | YES | YES |

Note: Standard errors (in parentheses) are clustered at the firm level to take into account potential autocorrelation.
The structural break is tested in 2005.
*, ** and ***: Significance at the 10%, 5% and 1% level, respectively.

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