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The impact of public support for innovation on SME performance and efficiency

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Abstract

This article examines the impact of two types of financial support for innovation granted by French public institutions to French SMEs on a set of firm performance measures. Using an original database that provides information on repayable advances and subsidies obtained by 5,448 French SMEs over the period 2010-2016, we evaluate the effectiveness of such financial support using a quasi-experimental design. Our findings indicate that both repayable advances and subsidies significantly improve targeted SMEs' turnover, level of intangible assets and total employment at one year and three years after support is granted. The impact on firm-level TFP is only positive and significant after three years, while being negative in the very short run. Our results also provide evidence that the combination of both instruments for a given innovation project within a year does not entail significantly higher effects. A heterogeneous analysis reveals that the impact of financial support instruments for innovation is significantly higher for young, micro and small firms. Furthermore, our analysis shows that innovation support benefits more to firms located in the Paris region than in other regions and this tends to exacerbate regional inequalities. Finally, our findings indicate that the transformation of Oséo into Bpifrance in December 2012 has led to an increase in the effectiveness of the innovation policy.

Keywords: Innovation policy; firm performance; policy evaluation; Mahalanobis distance matching; difference-in-difference.

JEL: O33; O38; C14; C21.

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Raphaël Chiappini[1] Sophie Pommet[2]

Abstract

This article examines the impact of two types of financial support for innovation granted by French public institutions to French SMEs on a set of firm performance measures. Using an original database that provides information on repayable advances and subsidies obtained by 5,448 French SMEs over the period 2010-2016, we evaluate the effectiveness of such financial support using a quasi-experimental design. Our findings indicate that both repayable advances and subsidies significantly improve targeted SMEs' turnover, level of intangible assets and total employment at one year and three years after support is granted. The impact on firm-level TFP is only positive and significant after three years, while being negative in the very short run. Our results also provide evidence that the combination of both instruments for a given innovation project within a year does not entail significantly higher effects. A heterogeneous analysis reveals that the impact of financial support instruments for innovation is significantly higher for young, micro and small firms. Furthermore, our analysis shows that innovation support benefits more to firms located in the Paris region than in other regions and this tends to exacerbate regional inequalities. Finally, our findings indicate that the transformation of Oséo into Bpifrance in December 2012 has led to an increase in the effectiveness of the innovation policy.

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1. Introduction

Fostering innovation has become one of the main objectives of developed economies since the 90's. In this perspective, governments have proposed different types of public funding programs to support innovative firms, especially the youngest ones.

The economic literature suggests two set of rationales for governments to offer such financial support to innovative companies. First, innovative firms produce positive R&D externalities and drive technological change by bringing new innovations to the market (Czarnitzki and Delanote, 2015). Therefore, innovative firms and especially the youngest ones play a central role in economic growth (Criscuolo et al., 2014; Haltwinger et al., 2013; Accetturo, 2022) and represent an important determinant of productivity growth in developed countries (Alon et al., 2018). Second, the action of public authorities is legitimized by the existence of market failures (Montmartin and Massard, 2015) among which the most known are related to external funding access (Hall, 2002; Colombo and Grilli, 2007). The problem of financial constraints is one of the most important barriers faced by small and young innovative firms (Blanchard et al., 2013) and reduces their ability to start a new innovative project (Mancusi and Vezzuli, 2014). This issue can result in lower start-up performance, slower productivity growth and, ultimately, hampers countries' growth potential (Hottenrott and Richstein, 2020).

Consequently, most governments in OECD countries have developed public funding programs targeting innovative companies, especially through subsidies (OECD, 2014). The variety of instruments developed can be divided into two categories: direct versus indirect financial support (Bloom et al., 2019). Direct financial support takes the form of grants, loans or guarantee schemes, while indirect support takes the form of tax incentives (Bloom et al., 2019). These different public funding programs are costly for governments. Thus, the

evaluation of public policies is widely recognized as an important issue in all OECD economies (Fantino and Cannone, 2013).

The main objective of governments is to stimulate innovation and firm growth and productivity. Thus, the effectiveness of such policies can be measured through different indicators. In this perspective, the main outcomes evaluated in the literature are Research and Development (R&D) investments and patent applications (see among others: De Blasio et al., 2015; Howell, 2017; Huergo and Moreno, 2017; Mar and Massard, 2021). However, policy effectiveness can also be studied through a broad range of outcomes like firms' economic and financial performance (Howell, 2017; Hottenrott and Richstein, 2020). Previous studies have generally concluded that public funding programs contribute to firm performance, but very few investigate the effectiveness of support to innovative firms by taking into account their heterogeneity and by considering both the impact on their economic performance and their productivity. Besides, as explained by Hottenrott and Richstein (2020), studies have mostly analyzed grant-based programs. Insights from these studies may thus be specific to this type of public funding instrument. In France, in addition to grants, repayable advances similar to subsidized loans are also used and represent a large part of the total direct public funding. However, we still know little about their effectiveness in improving the performance of innovative companies (Fantino and Cannone, 2013; Bertoni et al., 2019; Hottenrot and Richstein, 2020).

The aim of this paper is to provide an evaluation of the French financial support program for innovative firms. In particular, we aim at identifying a causal effect of this program on SME economic performance and efficiency. We considered three variables to measure firm economic performance: the turnover, the number of employees, and the investment in intangible assets, and one variable to measure firm efficiency, the firm-level total factor productivity (TFP). We developed a unique database that combines information on

firm balance sheets, income statements, number of employees, and financial support (type, date and amount) provided by the French public institution (Oséo or Bpifrance) between 2010 and 2016. We used Mahalanobis distance matching (MDM) to address the selection bias due to self-selection into the policy. Then, to control for unobserved firm characteristics that could have influenced the firms' decision to apply for financial support, we applied a difference-in-differences (DID) analysis on the matched sample. Using this methodology, we compared the effectiveness of the two main financing instruments (free subsidies and repayable advances) provided by French public institutions, and their combination.

We find that the different types of public support have induced a significant increase in the turnover, level of intangible assets and employment of targeted firms, both in the short and medium run. Our results also demonstrate that the effect is highly heterogeneous, while being significantly higher for young, micro, and small firms. Results regarding firm efficiency are more mixed. It seems that in the short run, financial support provided by French public institutions lowered the TFP of targeted firms. This could be explained by the fact that it takes time for the investment in intangible assets to be profitable and to be reflected by an increase in firm-level TFP. Our results support this assumption, as we found a significant positive effect of the different financing instruments on firm-level TFP, three years after the aid is obtained by targeted firms. Moreover, our findings also underscore the strong regional heterogeneity in the effect of the policy. The effect is significantly higher for firms located in the Paris region, which can deepen current regional inequalities. Finally, we show that the transformation of Oséo into Bpifrance at the end of December 2012 increased the effectiveness of the policy.

This paper makes five important contributions to the existing literature. First, if the literature is full of analyses of indirect financial support (tax credit) to French SMEs, very few evaluate the impact of French direct support programs for innovation on SME performance.

Only Chiappini et al. (2022) examine the impact of direct subsidies on SMEs' financial constraints in the French case. Thus, this paper is the first that focuses on the economic performance of French SMEs. Second, this analysis not only focuses on standard indicators of firm performance such as turnover, employment and assets, but it also investigates the impact of financial support on firm efficiency. Few studies in the literature have assessed the impact of financial support for innovation on firm TFP (see Grima et al., 2007; Grilli and Murtinu, 2012; Howell, 2017; Santos, 2019). Furthermore, results concerning TFP are mixed and call for a better understanding of the effect. Our results contribute to this scarce literature by revealing that the impact can be negative in the short run, while becoming positive after three years. Third, we document the strong heterogeneity associated with the policy, especially regarding age and size of targeted firms. We also investigate the heterogeneity linked to the financial instrument used to finance innovation, which complements the few studies focusing on the complementarity of different types of financial support (see Fantino and Cannone, 2013; Huergo and Moreno, 2017; Hottenrott and Richstein, 2020). Fourth, we demonstrate that the policy can increase existing regional inequalities in France, which is important from a policymaker point of view. Finally, our results also highlight how institutional changes can influence the effectiveness of such a policy and how the positive effect of the policy can be maximized by increasing the scope of financial support while maintaining an important selection and evaluation of applicants.

The remainder of the article is organized as follows. Section 2 presents the related literature review. Section 3 presents the institutional framework. Section 4 outlines the empirical strategy used to assess the causal impact of financial support on firm competitiveness. Section 5 describes the database and the sample selection. Section 6 presents the results of the policy evaluation. Section 7 presents a few robustness checks. Section 8 concludes.

2. The impact of public financial support for innovation: key findings and issues in the economic literature

A wide range of studies have analyzed the impact of public financial support for innovation on the performance of innovative SMEs. According to Dvouletý et al. (2021), different types of indicators have been considered going from basic indicators measuring firm performance (survival) to the most challenging one, firm-level productivity.[3] Apart from studies based on U.S samples of firms (Lerner, 1999; Howell, 2017), most studies in Europe have been conducted on samples of innovative firms from Germany (Cantner and Kösters, 2015; Hottenrott and Richstein, 2020), Italy (Colombo et al., 2011; Grilli and Murtinu, 2012; De Blasio et al., 2015, Manaresi et al., 2021), Spain (Huergo and Moreno, 2017; Bertoni et al., 2019) and Sweden (Söderblom et al., 2015). The studies conducted in different European countries have analyzed different types of public instruments such as: subsidies, subsidized loans (or low-interest loans) and participative loans.[4] Instruments vary because European countries each follow their own public innovation policies. However, there are still very few studies that analyze both the effects of different types of instruments on the performance of innovative SMEs and/or their complementarity (see Fantino and Cannone, 2013; Huergo and Moreno, 2017; Hottenrott and Richstein, 2020).

The rationale behind these studies is that, in general, governments provide financial support to innovative firms with an objective of increasing R&D expenses (and investments) to foster innovativeness. As explained by Hottenrott and Richstein (2020), the public financial instruments dedicated to innovative SMEs are expected to positively affect firm investments, which are expected to affect, in return, firm performance through their impact on innovativeness and, hence, on revenues and employment. Therefore, we might expect a

[3] For a systematic review of the literature on public financial support, see Dvouletý et al. (2021).

[4] Most studies focus on the analysis of pure subsidies.

positive impact of public support both on firm economic performance and on firm-level productivity.

Because we are interested in gaining a deeper understanding of the effects of the different direct public financial instruments designed to finance innovation, we will mainly concentrate on the key findings that relate to the impact of these instruments on the performance and efficiency of innovative firms.

When analyzing the impact of public financial support for innovation[5] on firm employment, sales, turnover, and investment in tangible and intangible assets, the results of the different studies seem to converge. Some studies find a positive effect of public financial support on the employment and/or turnover and sales of innovative firms (see among others, Lerner, 1999; Howell, 2017; Bertoni et al., 2019; Hottenrott and Richstein, 2020; Manaresi et al., 2021).[6] The studies of Lerner (1999) and Howell (2017) analyze the impact of the subsidies granted by the U.S. SBIR program on, respectively, firm employment and sales and on firm revenue. Bertoni et al. (2019) analyze a hybrid form of financing, namely participative loans, on a sample of innovative Spanish firms. They also find a positive impact of this instrument on the growth of employment and sales of beneficiaries. However, the magnitude of the impact varies depending on the size, age, and sectoral classification of companies. Bertoni et al. (2019) find that the effect is larger for high-tech, young, and small companies. In the same vein, Hottenrott and Richstein (2020) analyze the impact of both grants and subsidized loans and their complementarity effects on the growth of employment and revenue of German start-ups. Once again, the results indicate a significant positive effect.

[5] It should be mentioned here that a wide variety of public programs for financing innovation are under-scrutinized in the different European studies.

[6] More generally, some empirical works find a positive impact of public support on firm employment, sales and revenue in European countries (see among others: Bernini and Pellegrini, 2011; Bia and Mattei, 2012; Cerqua and Pellegrini, 2014; Criscuolo et al., 2019).

Analyzing the case of innovative Swedish firms, Söderblom et al. (2015) also find a positive impact of R&D grants on firm sales, while Cantner and Kösters (2015) show a positive effect on the employment growth of German firms.

The positive impact of public support for innovation can also be seen in increased investments in tangible[7] assets. Hottenrott and Richstein (2020, p.2) explain that these investments "[…] are necessary to bring new products to the market and to implement process innovations". They find that recipients of innovation support invest more in tangible assets than their non-subsidized counterparts, and this is particularly true in the case of subsidized loans. The same result is found by Fantino and Cannone (2013) on a sample of innovative Italian firms that received a concessional loan. However, here again, the effectiveness of the instrument depends on the size of the firm and has a greater effect on the smallest ones. De Blasio et al. (2015) also found a similar positive effect of R&D subsidies on the assets of a sample of Italian firms.

It should be mentioned that even if most studies find that public support for innovation has positive effects on the economic performance of firms, contradictory results can also be found, even within the same study. For instance, De Blasio et al. (2015) find no effect of the subsidy program on firm sales but a positive and significant effect on the overall size of the balance sheet (assets).

Apart from tangible assets, the impact of public innovation policy can also be measured by another firm indicator, taken from balance sheets: investments in intangible assets. As explained by De Blasio et al. (2015), if the innovation policy is effective, an increase in intangible assets, reflecting a signal of (latent) innovation, should be observed.

[7] More generally, some studies find a positive impact of public support on the growth of a firm's tangible or fixed assets (see among others: Bernini and Pellegrini, 2011; Cerqua and Pellegrini, 2014; Criscuolo et al., 2019).

The analysis of Fantino and Cannone (2013) confirms this prediction, as their results reveal a positive effect of subsidies, but only after the first year of the project. On the contrary, De Blasio et al. (2015) find no effect on this outcome.

Finally, the more puzzling results are found when analyzing the impact of public financial support for innovation on firm-level productivity. In this case, the results do not converge on a positive effect. Here, contrary to what we described for previous firm performance measures, most studies report negative or non-significant effects either in the general case of public financial support[8] or in the case of public financial support for innovation (see among others: Girma et al., 2007; Colombo et al., 2011; Grilli and Murtinu, 2012; Fantino and Cannone, 2013; Karhunen and Huovari, 2015). Two variables are generally used to measure firm efficiency: labor productivity that is measured as the ratio of value added over the number of employees and the TFP estimated with a production function approach (Cobb Douglas). On a sample of Finnish SMEs, Karhunen and Huovari (2015) found no significant effect on labor productivity of subsidized firms after five years. One to two years after the subsidy was granted, the results even showed a negative impact on the productivity growth of recipients. In the same vein, Fantino and Cannone (2013) found no effect on labor productivity of subsidized firms. When using a more refined measure of productivity, namely TFP, the results remain puzzling. Some studies point out the need to dissociate the type of subsidy allocated to firms in order to have a better understanding of the observed effects. Their authors claim that it is essential to distinguish subsidies allocated on an automatic basis from those granted on a competitive basis (Colombo et al., 2011). For instance, Grilli and Murtinu (2012) show on a sample of Italian innovative firms that, overall,

[8] For instance, Bernini and Pellegrini (2011) and Bernini et al. (2017) find that public subsidies negatively affect TFP growth of firms. Cerqua and Pellegrini (2014) also report a negligible impact of subsidies on firm productivity, while Bergström (2000) and Criscuolo et al. (2019) find no effect on TFP.

subsidies do not have a significant positive effect on the firms' TFP growth. However, the impact became significant and positive for firms that had received a subsidy provided on a competitive basis (Colombo et al., 2011; Grilli and Murtinu, 2012). A similar result is obtained by Girma et al. (2007) on a sample of Irish firms. The period of observation is also a criterion that should be taken into account when analyzing TFP growth of firms. On a sample of Italian firms, Bernini et al. (2017) observed that the impact of subsidies on TFP in the medium run was slightly negative (during the first three years), while it became positive after four or five years.

Taken together, these different results call for the need for a deeper understanding of the effects of different types of instruments designed to finance innovative firms. First, as shown by the different studies, each type of instrument should be considered individually. This is important because the effects of financing tools on the economic performance and efficiency of firms can be mitigated depending on their nature, e.g., whether they are pure free grants or low-interest loans. To evaluate the effectiveness of direct public support for innovation, we need to dissociate the different instruments. Second, studies show that the effectiveness of such support can be heterogeneous depending essentially on the size and age of the firms. Thus, the effectiveness of public support should be evaluated by taking this type of heterogeneity into account in order to maximize its effect by targeting firms more specifically. Finally, if the impact on the firms' economic performance is generally positive, the impact on firm-level productivity is more contrasted. The different studies that have analyzed the impact of public support for innovation on the firms' TFP have usually considered only one type of public instrument: the R&D subsidy. However, as explained by Hottenrott and Richstein (2020), the different instruments can have a different impact on the performance of firms and although debt-based support instruments play an important role in

practice, we still know little about their effectiveness in improving firms' economic performance and productivity.

3. Direct public funding for innovative French SMEs

3.1 The French institutional framework

The French public organization designed to support innovation was created in 1967 under the name ANVAR. In 2005, this institution was renamed Oséo and was tasked with providing financial support to innovative French SMEs. As explained by Masquin and Huber (2012), this institution was created to remedy market imperfections by providing funding to innovative companies. Thus, its mission was to directly promote innovation in French companies by: 1/granting different types of financial support and; 2/facilitating the transfer of knowledge between laboratories and companies (Reinhart, 2014). The creation of Oséo led to a large increase in the budget dedicated to the funding of innovation. More specifically, the budget of Oséo was around €800M in 2005 while the budget of ANVAR was around €200M in 2004 (Masquin and Huber, 2012). However, Oséo had extended missions compared with those of ANVAR. For instance, a series of innovation, funding and export assistance mechanisms had been merged into this single body.

In 2012, existing structures were reorganized and simplified leading to the creation of Bpifrance at the end of December 2012. This French public investment bank was the result of a merge between Oséo, CDC Entreprises and the Fonds Stratégique d'Investissement (FSI). [9] BPI took over Oséo's assignments and expanded them. Similarly to Oséo, BPI grants funding to innovative companies after an in-depth selection process by which each project is

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

scrutinized individually. In addition, the expenses incurred by the companies after obtaining financial support are monitored.

In this paper, we evaluated the effects of financial support distributed between 2010 and 2016, which means that we evaluated the effects of support distributed by both Oséo (2010-2012) and Bpifrance (2013-2016). Because we investigated the financial innovation support allocated by two successive structures, we tested whether the institutional change from Oséo to Bpifrance could be associated with a different level of effectiveness in the allocation of innovation funding.

3.2 The instruments of direct financial assistance

BPI and Oséo before it, offer a wide range of financing options to innovative SMEs throughout their development. In short, the different instruments offered by both public institutions to support French SMEs can be grouped into three lines of business: lending, loan guarantees and support for innovation (Masquin and Huber, 2012). In this paper, we focus on innovation funding, and we thus present the two tools specifically created for this purpose: free subsidies and repayable advances. According to Bpifrance, this individual innovation support has represented on average 400 million euros per year since 2010, with an average of 30% of this volume in the form of subsidies.

Subsidies generally finance part of a project. They are intended for the earliest and riskiest development stages (Masquin and Huber, 2012), namely, for 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 an SME. These instruments are mainly awarded to promote the development of projects with a commercial purpose and offer companies the dual service of interest-free

financing and coverage against risk. Repayment of the principal is only due if the project is technically or commercially successful, but a flat-rate repayment is due even in the event of failure (Masquin and Huber, 2012). Like subsidies, repayable advances finance only a part of a project. As explained by Maskin and Huber (2012), the risk of opportunistic behavior from the entrepreneur is limited by the capacity of the public institution to select projects (through *ex-ante* evaluation) and check that the entrepreneur respects its obligations.

The different targets of the instruments justify the methodology we use in this paper. We have chosen to compare: 1/ the non-granted firms with the subsidized firms ; 2/ the non-granted firms with the firms that received a repayable advance; and 3/ the non-granted firms with the ones that received the two types of instruments simultaneously. We did not directly compare firms that received a subsidy with the ones that received a repayable advance because these two types of support are mainly designed to finance different types of expenses.

4. Empirical methodology: a quasi-experimental approach

In this paper, we aim to assess the causal impact of innovation financing instruments provided by Oséo/Bpifrance on the performance of targeted firms, namely the average treatment effect on the treated (ATT):

$$\Delta^{TT} = \frac{1}{N_T} \sum_{k=1}^{N_T} \left(y_{i,T} - \widehat{y_{i,c}} \right) \quad (1)$$

Where N_T represents the number of treated firms, $y_{i,T}$, the outcome variable of treated firms and $\widehat{y_{i,c}}$, the counterfactual states, i.e., the outcome that would have been attained by these firms in the absence of treatment. This is the main challenge in assessing the causal impact of innovation policies on firm performance, as the counterfactual situation cannot be observed and must be estimated.

Using a before/after analysis on treated firms is not a valid solution because the estimation could suffer from an "Overall Trend Bias". Failing to control for time trends leads to biased results when exogeneous time shocks such as an increase/decrease in interest rates or economic recession drive changes in the performance of targeted firms. Using only the average values of the outcome variables of other untreated firms also introduces a bias because of the well-known selection bias. This is the case because, as in most observational studies, the selection of firms is not random, as the public institution chooses to provide financing to innovative firms based on specific criteria.

To deal with this important endogeneity bias, most empirical analyses on public support for innovation use non-parametric (matching) techniques based on propensity scores (see, among others, Czarnitzki and Lopes-Bento, 2013; Afcha and Garcia-Quevedo, 2016; Howell, 2017; Freel et al., 2019; Ben Abdesslem and Chiappini, 2019; Santos, 2019; Hottenrott and Richstein, 2020; Manaresi et al., 2021; Mar and Massard, 2021; Chiappini et al., 2022). The use of instrumental variables (IV), which is a suitable alternative, can be very challenging as it imposes the exclusion restriction assumption, meaning that the selected instrument should have a significant impact on the probability that a firm obtains financing for innovation but should not directly influence the firm's performance. In a similar vein, regression discontinuity (RDD) can also be a valid estimation strategy, used for instance in Santoleri et al. (2022) or Accetturo (2022), but cannot be implemented in our case as it requires information about the process by which the public institution selects or rejects firms; information that has not been made available by Bpifrance.

Consequently, following previous studies on the topic, we adopted, in a first step, a matching approach. The main idea behind this technique is to construct a comparison group when assignment to the treatment group can be modeled on the basis of observable characteristics. The comparison group needs to be as similar as possible to the treatment

group, in terms of observables before the start of the treatment. It avoids possible "confounders" from imbalance in observables and removes the selection bias (Rosenbaum and Rubin, 1983; Lechner, 2002). As emphasized in Hottenrott and Richstein (2020), matching approaches also make no assumptions about the functional form or error distribution, which is an important advantage.

Matching methods are based on two key assumptions. First, the matching estimator is built on the unconfoundedness assumption which states that assignment to the treatment group is unconfounded given pre-treatment variables denoted *X*. This means that within each cell defined by covariates *X*, the treatment is random, and selection into treatment only depends on the observables *X*. Therefore, it implies that all variables that influence treatment assignment and potential outcomes simultaneously must be observed. In our case, we should be able to observe all the characteristics that drive the selection process by which Oséo/Bpifrance allocates subsidies, repayable advances or both instruments to innovative firms. The choice of the observables *X* is therefore crucial for ensuring that the matching procedure is unbiased. To select these variables properly, we referred to previous literature on the topic. Huergo and Trenado (2010), for example, show on a sample of Spanish firms that age, export status of firms and sector in which firms operate are important drivers of application for low-interest credit for R&D purposes. As in Hottenrott and Richstein (2020) who consider two types of public instruments (free grants and low-interest rate loans), we incorporated other firm-specific observations to control for firm size and firm financing structure. The second key assumption underlying matching approaches is the common support assumption. It ensures that individuals with the same value for observables *X* have a positive probability of being both treated and non-treated (Heckman et al., 1997). If the score distribution of both groups does not overlap, it creates an important bias (Caliendo and

Kopeinig, 2008). Consequently, it is better to impose the overlap condition when using a matching approach.

The most famous approach used in the empirical literature is the propensity score matching (PSM) method developed by Rosenbaum and Rubin (1983). It consists in matching treated and untreated individuals based on only one variable, called the propensity score, rather than on the set of observables X. Thus, it reduces the multidimensionality problem (Rosenbaum and Rubin, 1983). Common practice is to use one-to-one PSM. Several steps are involved. First, the probability of being treated, in our case receiving financing support for innovation from Oséo/Bpifrance, conditional on observables X, is estimated using a logistic regression and used to generate propensity scores. Second, a matching algorithm such as the nearest-neighbor (NN), is used to match each individual to a counterfactual individual. Third, matched pairs with the largest score distance are pruned from the dataset to ensure balanced propensity score distribution. Fourth, balancing tests are used to assess whether the PSM adequately balances the covariates X between treated and control groups after the matching. Finally, the causal effect is estimated using the difference in outcome variables between the two groups.

While PSM is the most widely used matching technique in the literature, some important limitations of the approach have been emphasized recently. In particular, King and Nielsen (2019) put forth evidence of the "PSM paradox" that strongly deteriorates causal inference. They argue that in the fourth step, PSM eliminates some matched sets based on the absolute distance in propensity scores, which tends to increase imbalance, model dependence and bias. This is a paradox because the aim of the PSM method is to decrease imbalance between the treated and the control group. King et al. (2011) and King and Nielsen (2019) point out that the problem increases with the number of observables X used in the first step. King and Nielsen (2019) also argue that the PSM paradox is present in many empirical

applications. Moreover, this problem is not shared by other matching methods. That is why King and Nielsen (2019) suggest that Mahalanobis distance matching (MDM) or coarsened exact matching (CEM) should be used instead. However, the use of exact matching can be challenging as it does not work very well with a high number of covariates *X*, and therefore often leads to individuals not being matched, increasing the bias linked to the matching approach (Stuart, 2010). In contrast, MDM has some important advantages according to King et al. (2011). First, MDM does not reduce the multivariate dataset (covariates) to one scalar (score) but computes the measure of match quality directly from the multivariate dataset, which prevents loss of information as in the first step of PSM. Second, MDM only requires the computation of the sample covariance matrix, while PSM implies a logistic estimation that, in some cases, can perform poorly. That is why, in this paper we used MDM to assess the causal impact of financing for innovation provided by Oséo/Bpifrance on the performance of French SMEs.

Note that MDM assumes that there are no remaining unobservable differences between the treated and the control group. However, it is very likely that unobserved firm characteristics have influenced their decision to apply for financing from the French public institution. Therefore, an endogeneity bias linked to selection into the treatment based on unobserved characteristics could be present in our analysis. To control for unobserved heterogeneity and time trends, we combined MDM with a difference-in-difference (DID) estimation, as follows:

$$y_{it} = \gamma INST_{it} + \delta_t + \theta_i + \varepsilon_{it} \quad (2)$$

Where y_{it} denotes the outcome variable (TFP, turnover, intangible assets or total employment) in the logarithmic form of firm i, $INST_{it}$ is a dummy variable that equals 1 for treated firms, three years (or one year) after the date they received financing from

Oséo/Bpifrance, δ_t are time-fixed effects, θ_i are firm-fixed effects that control for unobserved heterogeneity, and ε_{it} indicates the error term. The coefficient γ captures the ATT.

Note that combining MDM with DID allows control for time-invariant unobserved factors affecting selection into treatment, but not for time-varying factors. It is also important to note that Daw and Hatfield (2018) warn about combining matching on pre-treatment observables *X* with a DID regression if the pre-treatment outcome level is correlated with the treatment assignment. This can introduce regression-to-the-mean bias, especially if pre-treatment level differences are high (Chabé-Ferret, 2017). Consequently, we chose not to match individuals based on pre-treatment outcome variables and to use the MDM approach on two pre-treatment periods, meaning that we used covariates on *t-1* and *t-2*. This choice was made because Chabé-Ferret (2017) claims that using more pre-treatment observations lowers the regression-to-the-mean bias.

Our empirical strategy, thus, involves three important steps. First, we used MDM to form the counterfactual group. MDM was performed for each year of our sample (2010-2016) using cross-sectional data.[10] Second, we checked the quality of the matching procedure using both univariate t-tests of equality of means between treated and matched firms for each covariate used and Hotelling T^2 multivariate test. Third, we used treated and matched firms to estimate the DID model described in Eq. (2) for each outcome variable.

Finally, it is important to note that one key assumption must be fulfilled for the DID to be unbiased. This assumption is called the Common Trend Assumption (CTA), according to which the outcome variable follows the same trend in both groups in the absence of treatment. It is very difficult to test this assumption because we cannot observe the trend of the treated

[10] MDM was run 6 times for each type of financing provided by Oséo/Bpifrance using the Stata command psmatch2. Note that for the year 2010, we only used one pre-treatment period, as we did not have data for 2008.

group without the treatment. If the assumption is not testable, compelling graphs on pre-treatment observations are commonly used to assess whether the CTA has failed.

5. Data and variables

5.1 Data sources and sample selection

We combined two different databases and built an original firm-level panel dataset for French SMEs covering the period 2010-2019. First, we used the unique database on French innovative SMEs provided by Bpifrance. It contains detailed information on French SMEs that received a subsidy, a repayable advance or both by Oséo or Bpifrance from 2010 to 2019. The database includes information regarding the SIREN of the firm, the year the firm received financial support from Oséo/Bpifrance, the amount of financial support, the total amount of the innovation project and the type of financial support (subsidy or repayable advance). This database was then merged with the FARE database provided by the French National Institute of Statistics (INSEE). The FARE database includes almost all French firms and provides accounting and performance variables at the firm-level such as value added, number of employees, turnover, debt, equity, exports, etc. The merge of these two databases allowed us to obtain detailed characteristics about firms two years before they obtained financing from Oséo/Bpifrance for innovation and three years after. It also served to identify a donor pool for potential counterfactual firms, which were identified using MDM.

We chose to limit the analysis to SMEs and exclude large firms from our sample for two main reasons. First, the main target of Oséo/Bpifrance is specifically SMEs (Riedinger et al., 2011). Second, as emphasized in Mar and Massard (2021), it is almost impossible to identify a causal effect for large firms as they often accumulate a large amount of different aid. SMEs are defined in our analysis according to the INSEE classification as firms with less

than 250 employees and a turnover lower than 50 million euros. We also excluded all public institutions such as the National Center for Scientific Research (CNRS in French) or universities from the sample. Finally, we also limited our analysis to firms for which we have data on outcome variables, two years before they received financial support from the French public institution and three years after, in order to identify the causal effect properly.

Thus, we ended up with a sample of 1,870 firms that received a repayable advance over the period 2010-2016, 2,995 firms that received an innovation subsidy and 583 firms that received both an innovation subsidy and a repayable advance for the same project within a year over the period 2010-2016. As described in Section 3, the three instruments do not have the same purpose. Innovation projects financed by both a subsidy and a repayable advance are larger in terms of cost (€1.2 million on average over the period 2010-2016, compared to €670,000 for projects that received only a repayable advance and €357,000 for projects that received only a subsidy). Consequently, financial support provided by the French public institution is higher for these projects (€395,000 on average over the period 2010-2016, compared to €212,000 for repayable advances and €82,000 for subsidies). However, the average share of an innovation project financed by both a subsidy and a repayable advance (36% over the period 2010-2016) is not significantly higher than the average share financed by only a subsidy (35%) or even only a repayable advance (32%).

5.2 Outcome variables

In this paper, we investigated the impact of innovation support provided by Oséo/Bpifrance on four outcome variables at the firm-level: TFP, turnover, total intangible assets, and total employment.

Firm-level TFP is our key measure of firm efficiency. While this variable is widely used in the literature, its estimation at the firm-level raises some important methodological

issues, and several methods have been proposed in the literature (see Van Beveren, 2012 for an extensive literature review on the topic). In this paper, we used the Wooldridge-Levinsohn-Petrin methodology (WLP) derived from Wooldridge (2009) and used in Petrin and Levinsohn (2012). The approach is based on the semi-parametric method introduced by Levinsohn and Petrin (2003) and involves the estimation of a Cobb-Douglas production function. However, this estimation may suffer from both a simultaneity issue and a selection bias. The reason is that unobserved productivity shocks are correlated with both input and firms' exit choice. Consequently, Levinsohn and Petrin (2003) propose to use intermediate inputs to proxy for unobserved firm-specific productivity. It solves the simultaneity bias as the intermediate input decision is made after the productivity shock is realized (Li and Su, 2022). Wooldridge (2009) also shows that the moment conditions used by Levinshon and Petrin (2003) are easily implemented in a generalized method of moments (GMM), which strengthens robust standard errors. All variables needed to compute firm-level TFP using the WLP approach were taken from the FARE database. They include value added, sum of tangible and intangible assets (capital input), number of employees (labor input), and material cost (material input) or capital stock (investment).

The other three measures of firm performance were also taken from the FARE database. First, we used the firm-level turnover which is measured as the sum of sales in France and abroad of goods and services produced. Second, we used the firm-level total intangible assets, which can be a proxy of innovation because they include assets that are not physical in nature such as intellectual property, trademarks or patents, and exclude financial assets. Third, we used the firm-level total number of employees to measure total firm employment.

5.3 Selected covariates for matching

As mentioned in Section 4, selection of covariates that predict selection into the policy is crucial for the estimation of the ATT. We relied on previous studies that identify several firm characteristics that significantly influence the decision to apply for financing for innovation. First, it is important to note that we chose to exclude pre-treatment outcome variables from covariates. As described in Section 4, regression-to-the mean bias is increased when one combines matching with DID regression. We selected eight covariates that determine selection into the policy.

First, as depicted in several studies (Huergo and Trenado, 2010; Santos, 2019; Chiappini et al., 2022), firm age is an important factor driving the process for being selected to receive financial support for innovation. Younger firms face higher credit constraints than older firms (Howell, 2017) and are therefore more likely to apply for the financial support needed to finance their R&D. Moreover, Oséo/Bpifrance also seeks to target younger firms. Conversely, older firms could have more experience which could reduce their application costs (Hottenrott et al., 2017). Consequently, we included both the logarithm of age and the logarithm of age squared as covariates to allow for non-linear relationship in the first step of the matching procedure. Second, firm size has also been found to be an important determinant of a firm's capacity to benefit from innovation policies (Howell, 2019; Hottenrott and Richstein, 2020; Mar and Massard, 2022). Thus, we used the logarithm of firms' total value of assets as a measure of firm size. Third, export status has also been found to influence greatly the probability of being financed by an R&D low-interest credit (Huergo and Trenado, 2010). The reason is that exporters seem to face lower application costs (Huergo and Moreno, 2017) and to have more incentive to innovate due to stronger competition pressure, which increases their need for financial support to finance their R&D (Czarnitzki and Lopes-Bento, 2013). We included a dummy variable that captures whether the firm exports in our set of covariates.

Fourth, financial characteristics of firms are also crucial when public institutions evaluate applications. Two mechanisms could be at stake. First, if the aim of the public institution is to reduce firms' financial constraints, firms with more important financial constraints have a higher probability of being financed by the public institution. However, as some financing instruments are reimbursable such as repayable advances, the public institution can also select firms with better financial health in order to decrease the risk of loss. Consequently, we had two different measures of financial constraints in the set of covariates: the ratio between firms' total debt and firms' total assets and the ratio between firms' total value of equity and firms' total assets. Finally, we also included sector and region fixed effects, because firms that operate in highly technological sectors are more likely to apply for innovation support. Geographical location is also an important determinant because firms located in regions in which Oséo/Bpifrance is more active and does more advertising are more likely to apply for an innovation support scheme. Note that for all covariates, the data used in the MDM had been collected two years before obtaining financial support. Table A.1. describes all the variables used in this analysis and their sources.

6. Results

6.1. Validity of the MDM and the DID

Table A.2. reports the results of both the univariate t-tests of equality of means between treated and matched firms for each covariate used in the first step of the analysis and of the Hotelling multivariate test, for each year for which MDM was performed. Panel A shows the results for firms that received a repayable advance and their corresponding control group. Panel B presents the results for firms that received an innovation subsidy and Panel C for firms that received both a repayable advance and an innovation subsidy for the same project within the same year. Most of the tests strongly support the null hypothesis of means

equality between treated and matched firms. This provides evidence of the validity of our matching method for each year and each type of financial support for innovation under scrutiny.

In Figure A.1., we checked whether the common trend assumption fails in our setup. To obtain unbiased results when using a DID estimation, it is effectively crucial to ensure that the CTA holds. We performed a graphical representation of each outcome variable for treated and control firms for each of the financial support instrument under scrutiny two years before targeted firms obtained the aid from the public institution. It appears that treated and control firms followed the same trend before obtaining financial support in most cases and years. This is especially true for firm-level TFP that seems to exhibit the exact same trend in treated and control groups each year and for each financial instrument. This indicates that the CTA holds when using MDM matching on two pre-treatment periods.

6.2. ATT of financial support for innovation on firm performance

Table 1 presents the average treatment effects of the three different financial support schemes provided by Oséo (2005-2012) and Bpifrance (2013-2016) on the four different measures of firm performance retained in this analysis at one year and three years after the treatment. Panel A displays estimation results for the sample of firms that received only a repayable advance, while Panel B reports results for the sample of firms that received only a subsidy and Panel C for the sample of firms that received both instruments. Note that in every specification, standard errors are clustered at the firm level to take into account the fact that the OLS standard errors understate the standard deviation of the DID estimator because of serial correlation (Bertrand et al., 2005).

Table 1. Impact of financial support for innovation on firm performance

	Panel A: Repayable advances							
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
$INST_{it}$	-0.0212***	0.0179*	0.0332***	0.126***	0.0873***	0.312***	0.0385***	0.0666***
	(0.0072)	(0.0098)	(0.0093)	(0.0169)	(0.0124)	(0.0232)	(0.0062)	(0.0108)
Intercept	0.257***	0.251***	7.664***	7.633***	4.920***	4.845***	2.786***	2.772***
	(0.0006)	(0.0026)	(0.0008)	(0.0045)	(0.0011)	(0.0062)	(0.0006)	(0.0029)
Obs.	20,819	20,819	20,819	20,819	20,819	20,819	20,819	20,819
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
	Panel B: Subsidies							
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
$INST_{it}$	-0.00639	0.0131*	0.0404***	0.102***	0.0651***	0.227***	0.0429***	0.0688***
	(0.00465)	(0.00671)	(0.00651)	(0.0109)	(0.00948)	(0.0175)	(0.00455)	(0.00810)
Intercept	0.322***	0.318***	7.501***	7.477***	4.513***	4.459***	2.599***	2.585***
	(0.000435)	(0.00178)	(0.000609)	(0.00290)	(0.000887)	(0.00464)	(0.000426)	(0.00215)
Obs.	32,034	32,034	32,034	32,034	32,034	32,034	32,034	32,034
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
	Panel C: Both							
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
$INST_{it}$	-0.0340**	-0.00171	0.0126	0.124***	0.117***	0.361***	0.0519***	0.0721***
	(0.0134)	(0.0177)	(0.0172)	(0.0290)	(0.0248)	(0.0439)	(0.00979)	(0.0180)
Intercept	0.267***	0.264***	7.807***	7.774***	5.209***	5.120***	2.998***	2.983***
	(0.00126)	(0.00488)	(0.00161)	(0.00801)	(0.00233)	(0.0121)	(0.000920)	(0.00496)
Obs.	6,234	6,234	6,234	6,234	6,234	6,234	6,234	6,234
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. *, **, *** denote significance at 10%, 5%, and 1%, respectively.*

Columns 1 and 2 of Table 1 report results for TFP, while columns 3 and 4 present results for turnover, columns 5 and 6 for total intangible assets and columns 7 and 8 for total employment. Table 1 reveals that three years after obtaining a repayable advance or an innovation subsidy, the performance of targeted firms significantly increased. We estimate that firms receiving a repayable advance (a subsidy) from Oséo/Bpifrance increased their turnover by 13% (10%), their intangible assets by 31% (23%) and their total employment by 7% (7%) after three years. In the short run (at one year), the estimated ATT is way lower, which illustrates the fact that positive effects take time to materialize. Results regarding firm-

level TFP are relatively low at three years: a repayable advance or an innovation subsidy only increases firm-level TFP by 1.8% and 1.3%, respectively. In the short run, the effect is even significantly negative for repayable advances and not significant for subsidies. This result is not surprising. As depicted in our results, in the short run, firms targeted by the different financial schemes provided by the French public institution increase their level of employment, of sales and of investment in intangible assets, which can explain the negative impact in a very short period. Firms seem to increase their employment level more than their production, reflected here by turnover, which deteriorates firm-level TFP, as described in Bernini and Pellegrini (2011). The positive effect on TFP takes more time to materialize as new production factors must be assimilated efficiently by the firm. Results concerning firms that received both a repayable advance and a subsidy are not very different. The magnitude of the positive effect at three years is only slightly higher for intangible assets and employment. Nevertheless, we can see that the impact of this instrument on firm-level TFP is not significant at three years. This could be explained by the fact that innovation projects concerned by this instrument are way bigger in terms of cost and, therefore, take more time to be profitable. Overall, we do not find evidence of a complementary effect of the two instruments, contrary to what is found for grants and subsidized loans in Hottenrott and Richstein (2020). However, in our case, innovation projects financed and the amount granted to firms that received both a repayable advance and a subsidy are significantly higher than those for firms that obtained only a repayable advance or only a subsidy (see Section 5.1). For these innovation projects, a subsidy or a repayable advance alone would not have been sufficient to help start the project. This is reflected by the fact that the share of the project financed by this instrument is not, on average, different than the one financed by a repayable advance or a subsidy.

6.3. Investigating heterogeneities

In what follows, we only present the estimation results at three years after the treatment.

6.3.1. Age and size heterogeneity

In Table 2, we report estimation results of the ATT for different age categories. We split our sample into three sub-samples based on age of firms: firms that are up to six years old (the minimum in our sample), firms between 7 and 14 years old and firms older than 14 years. The analysis of the heterogeneity of the impact of firm age is important as younger firms face higher financial constraints and, thus can be highly dependent on public funding. Table 2 reports estimation results three years after the firm received the financial support.

Our results highlight that the causal impact of all financing instruments decreases with the age of firms because the impact of firm performance on all measures is significantly higher for younger firms than for older ones. For instance, firms aged less than 7 years old and targeted by a repayable advance increase their TFP by 9%, their turnover by 31%, their intangible assets by 50% and their employment level by 13%, three years after receiving the financial support. On the contrary, older firms (over 14 years old) only increase their level of intangible assets by 14% after three years. Estimates for the subsidy instrument are slightly lower but go in the same direction. Results when firms combine both a repayable advance and a subsidy for a given innovation project are very similar (except for TFP) and not significantly higher for each firm's age category, thus, confirming our previous results.

Regarding firm size, we decomposed our sample into three sub-samples following the classification of the INSEE. First, we considered micro firms characterized by less than 10 employees and a turnover below 2 million euros. Then, we considered small firms characterized by a number of employees over 10 and less than 50 and a turnover below 10

million euros. Finally, we also considered medium-sized firms characterized by more than 50 employees but less than 250 and a turnover below 50 million euros. Estimation results of the causal impact of the different types of financial support provided by Oséo/Bpifrance on the targeted firms' performance after three years are summarized in Table 3. They are also interesting because they highlight an important heterogeneity of the effect. It seems that the positive effect of the financial support for innovation only concerns micro and small firms. We found no significant impact on the performance of medium-sized firms.

Moreover, it seems that the effect is significantly higher for micro firms than for small firms. Three years after they obtained a subsidy, treated firms had increased their turnover by 14%, their level of intangible assets by 35% and their level of employment by 10%. Magnitudes of the effects are slightly higher for firms than benefitted from a repayable advance or from both a repayable advance and a subsidy.

To summarize, younger and smaller firms, which are more financially constrained, have strongly benefited from the different types of financial support provided by Oséo and Bpifrance. If repayable advances seem to be slightly more effective in terms of firm performance, our results do not provide evidence of the complementarity of the two instruments.

Table 2. Impact of financial support for innovation on firm performance by age of firms (at three years)

Panel A: Repayable advances												
	TFP			Turnover			Intangible assets			Employment		
	<7years	7-14y	>14y	<7years	7-14y	>14y	<7years	7-14y	>14y	<7years	7-14y	>14y
$INST_{it}$	0.0885**	0.0162	-0.00951	0.308***	0.0821***	0.00434	0.501***	0.230***	0.154***	0.127***	0.0433**	0.00865
	(0.0347)	(0.0158)	(0.00693)	(0.0600)	(0.0227)	(0.0108)	(0.0594)	(0.0419)	(0.0249)	(0.0319)	(0.0178)	(0.00979)
Intercept	0.0847***	0.340***	0.258***	6.423***	7.423***	8.350***	4.452***	4.856***	5.054***	2.072***	2.564***	3.249***
	(0.0065)	(0.0046)	(0.0019)	(0.0113)	(0.0066)	(0.0030)	(0.0112)	(0.0122)	(0.0070)	(0.0060)	(0.0052)	(0.0027)
Obs.	4,065	6,648	9,544	4,065	6,648	9,544	4,065	6,648	9,544	4,065	6,648	9,544
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel B: Subsidies												
	TFP			Turnover			Intangible assets			Employment		
	<7years	7-14y	>14y	<7years	7-14y	>14y	<7years	7-14y	>14y	<7years	7-14y	>14y
$INST_{it}$	0.0434*	-0.0146	-0.00737	0.197***	0.0298*	0.0286***	0.345***	0.157***	0.139***	0.0823***	0.0397***	0.0304***
	(0.0252)	(0.0116)	(0.00523)	(0.0391)	(0.0179)	(0.00848)	(0.0503)	(0.0303)	(0.0195)	(0.0240)	(0.0149)	(0.00870)
Intercept	0.240***	0.412***	0.290***	6.281***	7.175***	8.131***	3.900***	4.444***	4.695***	1.844***	2.330***	3.035***
	(0.0048)	(0.0033)	(0.0014)	(0.0074)	(0.0052)	(0.0023)	(0.0096)	(0.0087)	(0.0054)	(0.0046)	(0.0043)	(0.0024)
Obs.	5,516	9,891	15,787	5,516	9,891	15,787	5,516	9,891	15,787	5,516	9,891	15,787
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel C: Both												
	TFP			Turnover			Intangible assets			Employment		
	<7years	7-14y	>14y	<7years	7-14y	>14y	<7years	7-14y	>14y	<7years	7-14y	>14y
$INST_{it}$	-0.00476	-0.0187	-0.0132	0.271***	0.0467	0.0393*	0.543***	0.270***	0.202***	0.182***	0.0413	0.0328*
	(0.0558)	(0.0337)	(0.0135)	(0.0973)	(0.0434)	(0.0231)	(0.114)	(0.0796)	(0.0556)	(0.0487)	(0.0304)	(0.0189)
Intercept	0.0483***	0.397***	0.260***	6.455***	7.591***	8.535***	4.737***	5.165***	5.303***	2.241***	2.831***	3.443***
	(0.0119)	(0.0101)	(0.0039)	(0.0207)	(0.0130)	(0.0066)	(0.0244)	(0.0239)	(0.0159)	(0.0104)	(0.0091)	(0.0054)
Obs.	1,188	2,093	2,746	1,188	2,093	2,746	1,188	2,093	2,746	1,188	2,093	2,746
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note: Standard errors (in parentheses) are clustered at the firm level. *, **, *** denote significance at 10%, 5%, and 1%, respectively.*

Table 3. Impact of financial support for innovation on firm performance by firm size (at three years)

	TFP			Turnover			Intangible assets			Employment		
Panel A: Repayable advances												
	<10	10-50	>50	<10	10-50	>50	<10	10-50	>50	<10	10-50	>50
$INST_{it}$	0.0162	0.0103	0.00231	0.157***	0.0956***	0.0199	0.519***	0.260***	0.0373	0.0480**	0.0466***	0.0176*
	(0.0245)	(0.0112)	(0.00843)	(0.0370)	(0.0188)	(0.0135)	(0.0503)	(0.0299)	(0.0339)	(0.0210)	(0.00969)	(0.0105)
Constant	0.272***	0.250***	0.232***	6.277***	7.900***	9.473***	3.845***	5.032***	6.211***	1.440***	3.058***	4.482***
	(0.0049)	(0.0033)	(0.0026)	(0.0074)	(0.0055)	(0.0042)	(0.0101)	(0.0087)	(0.0105)	(0.0042)	(0.0029)	(0.0032)
Obs.	6,759	9,971	3,665	6,759	9,971	3,665	6,759	9,971	3,665	6,759	9,971	3,665
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel B: Subsidies												
	TFP			Turnover			Intangible assets			Employment		
	<10	10-50	>50	<10	10-50	>50	<10	10-50	>50	<10	10-50	>50
$INST_{it}$	0.0146	0.0118*	-0.0120*	0.141***	0.0740***	-0.0199	0.348***	0.153***	0.0168	0.0998***	0.0393***	0.00364
	(0.0159)	(0.0070)	(0.0068)	(0.0233)	(0.0118)	(0.0133)	(0.0340)	(0.0220)	(0.0283)	(0.0156)	(0.0066)	(0.0092)
Constant	0.366***	0.300***	0.258***	6.274***	7.920***	9.388***	3.557***	4.756***	6.012***	1.385***	3.027***	4.452***
	(0.0036)	(0.0020)	(0.0021)	(0.0053)	(0.0034)	(0.0041)	(0.0077)	(0.0063)	(0.0088)	(0.0035)	(0.0019)	(0.0029)
Obs.	12,155	14,976	4,294	12,155	14,976	4,294	12,155	14,976	4,294	12,155	14,976	4,294
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel C: Both												
	TFP			Turnover			Intangible assets			Employment		
	<10	10-50	>50	<10	10-50	>50	<10	10-50	>50	<10	10-50	>50
$INST_{it}$	-0.00746	0.0163	-0.00168	0.139	0.108***	0.0282	0.732***	0.278***	0.0176	-0.0398	0.0677***	0.0328*
	(0.0554)	(0.0225)	(0.0146)	(0.0888)	(0.0350)	(0.0259)	(0.109)	(0.0624)	(0.0650)	(0.0442)	(0.0174)	(0.0187)
Constant	0.295***	0.246***	0.272***	6.297***	7.822***	9.426***	4.154***	5.148***	6.233***	1.550***	3.076***	4.464***
	(0.0112)	(0.0066)	(0.0047)	(0.0179)	(0.0103)	(0.0084)	(0.0219)	(0.0184)	(0.0210)	(0.0089)	(0.0051)	(0.0060)
Obs.	1,596	3,094	1,411	1,596	3,094	1,411	1,596	3,094	1,411	1,596	3,094	1,411
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

*Note: Standard errors (in parentheses) are clustered at the firm level. *, **, *** denote significance at 10%, 5%, and 1%, respectively.*

6.3.2. Regional heterogeneity

Lastly, the impact could also be heterogeneous due to the location of targeted firms. While regional fixed effects have been introduced into our matching strategy to control for selection into policy linked to regional characteristics, some strong discrepancies could exist in the average effect due to the presence of partners, knowledge flows, and agglomeration economies within regions that could drive the profitability of innovation projects. We therefore sought to distinguish the impact of the policy on firms located in the Paris region[11] (the "core" of France) from its impact on firms located in the other regions ("the periphery" of France). To achieve this, we created a dummy variable (*Paris*) that equals one if the firm is located in the Paris region and zero otherwise. We then interacted this variable with the variable $INST_{it}$ described in Eq. (2). Note that we used the NUTS1 classification of regions that includes 13 French metropolitan regions. Table 4 summarizes estimation results. Our results provide evidence of strong regional discrepancies in the causal impact. If financial support instruments provided by Oséo/Bpifrance strongly increase the performance of French firms in both the Paris region and other French regions, the impact is significantly higher on firms located in the core of France. For instance, firms located in the Paris region that received a repayable advance experienced an increase of 33% (0.0737+0.252) of their turnover, of 49% of their intangible assets and of 15% of their total employment. The corresponding effects recorded by firms located in other French regions for the same financial instrument, are only 7%, 27%, and 4%, respectively. For TFP, results are even more striking as the causal impact is only significant for firms located in the Paris region.

[11] The region is called "Île de France".

Table 4. Regional heterogeneity of the impact (at three years)

	Panel A: Repayable advances			
	TFP	Turnover	Intangible assets	Employment
$INST_{it}$	-0.00175	0.0737***	0.267***	0.0445***
	(0.0103)	(0.0174)	(0.0249)	(0.0114)
Paris	0.254***	0.361***	0.389***	0.352***
	(0.0231)	(0.0432)	(0.0511)	(0.0251)
$INST_{it}$ *Paris	0.0955***	0.252***	0.221***	0.107***
	(0.0273)	(0.0507)	(0.0603)	(0.0292)
Intercept	0.198***	7.559***	4.765***	2.699***
	(0.00480)	(0.00883)	(0.0113)	(0.00542)
Obs.	20,819	20,819	20,819	20,819
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
	Panel B: Subsidies			
	TFP	Turnover	Intangible assets	Employment
$INST_{it}$	-0.00396	0.0732***	0.192***	0.0582***
	(0.00711)	(0.0118)	(0.0201)	(0.00863)
Paris	-0.0268	0.0626	-0.425	0.0694
	(0.105)	(0.216)	(0.400)	(0.157)
$INST_{it}$*Paris	0.0628***	0.105***	0.130***	0.0384**
	(0.0166)	(0.0279)	(0.0410)	(0.0192)
Intercept	0.325***	7.460***	4.578***	2.565***
	(0.0295)	(0.0608)	(0.112)	(0.0441)
Obs.	32,034	32,034	32,034	32,034
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
	Panel C: Both			
	TFP	Turnover	Intangible assets	Employment
$INST_{it}$	-0.0283	0.0945***	0.359***	0.0534***
	(0.0187)	(0.0318)	(0.0517)	(0.0185)
Paris	0.107***	0.119*	0.0111	0.0753*
	(0.0404)	(0.0706)	(0.0856)	(0.0443)
$INST_{it}$*Paris	0.107***	0.119*	0.0111	0.0753*
	(0.0404)	(0.0706)	(0.0856)	(0.0443)
Intercept	0.264***	7.774***	5.120***	2.983***
	(0.00490)	(0.00800)	(0.0121)	(0.00494)
Obs.	6,234	6,234	6,234	6,234
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

*Note: Standard errors (in parentheses) are clustered at the firm level. *, **, *** denote significance at 10%, 5%, and 1%, respectively.*

This result is true for the three financial support schemes. This has very important policy implications. By only fostering TFP in firms located in the Paris region (the core), financial support programs provided by Oséo/Bpifrance tend to exacerbate inequalities between regions, as confirmed by the fact that the Paris region displays the highest per capita GDP in France (€57,600 in 2020 according to INSEE).

6.4. Institutional change and ATT

As described in Section 3, at the end of December 2012, Oséo was transformed into Bpifrance. This resulted in a huge increase in the budget allocated to innovation support by the public institution. According to Brun (2022), the amount of aid granted to firms for financing innovation increased from €452 million to €665 million between 2012 and 2013 (+47%). This could have had a strong impact on the effect of this support on firm performance. To test the impact of this institutional change on the effectiveness of the policy, we created a dummy variable (*Post2012*) that equals one for the years 2013 to 2016 and zero for the years 2010 to 2012. We then interacted this dummy variable with the variable $INST_{it}$ described in Eq. (2). Note that in all estimations, the dummy variable (*Post2012*) is absorbed by time fixed effects. Table 5 reports estimation results.

Our results highlight that the institutional change has led to an increase in the effectiveness of the financial support schemes. We find a positive and significant structural break in the impact of repayable advances and innovation subsidies on firm performance after 2012. More precisely, it seems that the positive effect of Oséo repayable advances on targeted firm turnover (+8%), intangible assets (+24%) and employment (+4%) was reinforced during the second period with the creation of Bpifrance. The net corresponding effects of Bpifrance financial support for the second period are estimated at 14% (0.0847+0.0515) on firm turnover, 33% on intangible assets, and 7% on employment.

Table 5. Institutional reform and change in the impact (at three years)

	Panel A: Repayable advances			
	TFP	Turnover	Intangible assets	Employment
$INST_{it}$	0.0127	0.0847***	0.239***	0.0401***
	(0.0114)	(0.0173)	(0.0285)	(0.0113)
$INST_{it}$ *Post2012	0.00659	0.0515***	0.0932***	0.0334***
	(0.0120)	(0.0197)	(0.0293)	(0.0127)
Intercept	0.250***	7.633***	4.844***	2.771***
	(0.00264)	(0.00457)	(0.00622)	(0.00292)
Obs.	20,819	20,819	20,819	20,819
R-squared	0.792	0.931	0.932	0.943
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
	Panel B: Subsidies			
	TFP	Turnover	Intangible assets	Employment
$INST_{it}$	-0.00112	0.0713***	0.149***	0.0641***
	(0.00914)	(0.0138)	(0.0215)	(0.00870)
$INST_{it}$ *Post2012	0.0180*	0.0387***	0.0992***	0.00588
	(0.00957)	(0.0147)	(0.0221)	(0.0101)
Intercept	0.317***	7.477***	4.457***	2.585***
	(0.00181)	(0.00294)	(0.00471)	(0.00220)
Obs.	32,034	32,034	32,034	32,034
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
	Panel C: Both			
	TFP	Turnover	Intangible assets	Employment
$INST_{it}$	-0.0146	0.0918***	0.279***	0.0705***
	(0.0189)	(0.0282)	(0.0457)	(0.0168)
$INST_{it}$ *Post2012	0.0208	0.0523*	0.134***	0.00255
	(0.0184)	(0.0287)	(0.0444)	(0.0201)
Intercept	0.264***	7.773***	5.119***	2.983***
	(0.00493)	(0.00812)	(0.0122)	(0.00505)
Obs.	6,234	6,234	6,234	6,234
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES

*Note: Standard errors (in parentheses) are clustered at the firm level. *, **, *** denote significance at 10%, 5%, and 1%, respectively.*

This result is also particularly interesting from a policymaker point of view. It reveals that institutional changes have strong consequences on the effectiveness of public policies. The increase in financial support was not counterproductive and did not translate into a less restrictive selection process but rather it extended the scope of targeted firms, probably in the

peripheral regions. In this respect, Brun (2022) has observed that Bpifrance has developed its network of regional branch offices over the last few years.[12]

7. Robustness checks

In this section, we report the results of robustness checks carried out to test the sensitivity of our results to alternative specifications. First, we estimated results of the ATT using PSM in the first step rather than MDM. Second, we performed falsification tests.

7.1. PSM as an alternative matching approach

Even if the literature has emphasized some shortcomings when using PSM, such as the PSM paradox, it has the advantage of reducing the multidimensionality problem. Consequently, to test the robustness of our results with an alternative matching method, we implemented the one-to-one nearest neighbor PSM on the first step of our analysis rather than MDM. Balancing tests were also performed and illustrate the accuracy of the matching as most t-tests of mean equality of covariates after PSM show no significant difference between treated and matched firms for each year of the sample.[13] Table A.3 displays estimation results of the ATT. We notice that results are highly similar in terms of signs, significance of coefficients, and magnitude of the effects.

7.2. Placebo test

To test the sensitivity of our results, we constructed a placebo test based on a "fake" treatment using an alternative group. We excluded treated firms from the sample and focused our analysis on our groups of matched firms exclusively (using MDM). We created a fake treatment each year and constructed a "new" group of treated firms, and then estimated the DID described in Eq. (2). Table A.4. provides estimation results of the ATT. We observe that,

[12] Around 50 regional branch offices in 2019 (Brun, 2022).

[13] Results of balancing tests for PSM are available upon request.

in most cases, the fake treatment had no significant impact on firm performance, which supports our results.

8. Conclusion

This paper provides an evaluation of the French financing support program for innovative SMEs. We evaluated the impact of two types of public instruments provided by the public bank of investment in France: pure free grants and repayable advances.

The analysis shows that the two public instruments have a positive effect on firm economic performance measured by turnover, level of intangible assets and employment, both in the short and medium run. Our results also show that the effect is heterogeneous depending on the size and age of firms, with a higher effect on young, micro, and small firms. However, the results are more mixed when analyzing firm efficiency. Receiving financial innovation support negatively impacts the TFP of recipients in the short run while it positively impacts their TFP in the medium term, i.e., three years after being supported. Our findings also underscore that there is a strong regional heterogeneity in the effect of the policy. The effect is significantly higher for firms located in the "Paris region" than for firms located in the rest of France. We also show that the transformation of Oséo into Bpifrance at the end of December 2012, increased the effectiveness of the policy. Finally, the analysis of both free subsidies and repayable advances does not provide evidence of a complementarity of these two instruments. However, repayable advances seem to be slightly more effective in terms of firm performance compared to subsidies.

Our study has several implications from a public policy point of view. First, the French public organizations should continue to allocate financial support for innovation through a selective process. As shown by Colombo et al. (2011), financial support provided on a competitive

basis is the most effective when the objective is to promote the growth of recipients. In this context, our positive results lead us to conclude that the French public organizations should continue to allocate financial support on a competitive basis. Second, the French government should allocate financial support in priority to young companies because the most important effects are observed for these firms, especially when the financial instrument takes the form of a repayable advance. Finally, the results show that the policy can increase regional inequalities, with the firms located in Paris experiencing higher benefit effects from the financial support. This result pleads in favor of more decentralization. Bpifrance should thus pursue its efforts to extend its network of regional branch offices in peripheral French regions. Recent developments of Bprifrance appear to be moving in that direction.

One interesting aspect not addressed in the present paper that could constitute future research, would be to test the impact of these public instruments on the performance of French firms in the long run. While it is important to support small and young innovative firms, the question of the survival of these firms is also important. If the objective of public authorities is to encourage national champions, then we must also be interested in the fate and effectiveness of these firms in the long term.

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Appendix

Table A.1. Description of the variables

Variable	Description	Source
Outcome variables		
Total Factor Productivity (TFP)	Computed following Wooldridge-Levinshon-Petrin approach	FARE
Turnover	The turnover of the firm in *k* euros	FARE
Intangible	The total intangible assets of the firm	FARE
Employment	The total number of employees	FARE
Covariates for matching		
Age	Difference between the year the firm received the financial support and the year of firm creation	FARE and BPI
Age^2	The Squared term of Age	FARE and BPI
Total debt/Total assets	The ratio between total debts and total assets	FARE
Equity financing	The ratio between the value of a firm's equity and total assets	FARE
Size	The total value of a firm's assets	FARE
Export	A dummy variable that equals 1 if the firm exports and 0 otherwise	FARE

Table A.2. Results of balancing tests after matching (MDM approach)

Panel A: Firms that received a repayable advance												
	2010			2011			2012			2013		
	Control N= 379	Treated N=383	t-stat	Control N= 215	Treated N=215	t-stat	Control N= 166	Treated N=167	t-stat	Control N= 148	Treated N=149	t-stat
$Ln(Age)_{t-1}$	2,471	2,416	0,769	2,385	2,275	1,105	2,222	2,133	0,894	2,319	2,147	1,297
$Ln(Age)_{t-2}$				2,522	2,428	1,093	2,036	1,926	0,934	2,472	2,334	1,235
$Ln(Age)^2_{t-1}$	7,013	6,904	0 ,333	6,714	6,294	0,954	5,248	4,907	0,720	6,556	6,007	0,978
$Ln(Age)^2_{t-2}$				7,116	6,717	0,941	5,716	5,389	0,715	6,973	6,446	0,971
$Ln(Assets)_{t-1}$	7,634	7,764	-1,398	7,445	7,687	-2,058**	7,212	7,332	-0,825	7,248	7,444	-1,279
$Ln(Assets)_{t-2}$				7,548	7,821	-2,390***	7,303	7,467	-1,149	7,357	7,578	-1,494
$(Debt/Assets)_{t-1}$	0,508	0,536	-1,880*	0,497	0,507	-0,544	0,541	0,554	-0,347	0,516	0,529	-0,469
$(Debt/Assets)_{t-2}$				0,491	0,505	-0,793	0,525	0,540	-0,604	0,498	0,493	0,211
$(Equity/Assets)_{t-1}$	0,425	0,414	0,642	0,418	0,417	0,051	0,421	0,452	-0,921	0,413	0,433	-0,697
$(Equity/Assets)_{t-2}$				0,427	0,432	-0,255	0,399	0,419	-0,662	0,442	0,475	-1,139
$Export_{t-1}$	0,865	0,869	-0,1633	0,898	0,884	0,463	0,741	0,743	-0,032	0,777	0,752	0,513
$Export_{t-2}$				0,851	0,856	-0,136	0,855	0,808	1,146	0,777	0,785	-0,170
Hotelling T-stat	11,490 (p-value= 0,078)			14,023 (p-value: 0,3267)			12,446 (p-value=0,446)			11.897663 (p-value=0,493)		
	2014			2015			2016					
	Control N= 155	Treated N=157	t-stat	Control N= 313	Treated N= 315	t-stat	Control N= 483	Treated N= 484	t-stat			
$Ln(Age)_{t-1}$	2,316	2,207	0,974	2,334	2,228	1,383	2,410	2,374	0,659			
$Ln(Age)_{t-2}$	2,127	1,996	0,978	2,465	2,378	1,434	2,265	2,221	0,687			
$Ln(Age)^2_{t-1}$	5,885	5,418	0,868	6,226	5,868	1,157	6,053	5,906	0,541			
$Ln(Age)^2_{t-2}$	6,321	5,875	0,859	6,654	6,313	1,146	6,496	6,356	0,536			
$Ln(Assets)_{t-1}$	7,131	7,251	-0,808	7,366	7,610	-2,446**	7,385	7,566	-2,319**			
$Ln(Assets)_{t-2}$	7,288	7,427	-1,001	7,506	7,782	-2,921***	7,385	7,567	-2,325**			
$(Debt/Assets)_{t-1}$	0,511	0,518	-0,269	0,503	0,529	-1,650	0,510	0,517	-0,441			
$(Debt/Assets)_{t-2}$	0,527	0,528	-0,039	0,503	0,528	-1,580	0,510	0,516	-0,433			

$(Equity/Assets)_{t-1}$	0,435	0,465	-1,026	0,422	0,408	0,849	0,424	0,431	-0,401
$(Equity/Assets)_{t-2}$	0,427	0,453	-0,775	0,417	0,401	1,018	0,424	0,431	-0,397
$Export_{t-1}$	0,813	0,815	-0,054	0,840	0,832	0,288	0,853	0,839	0,609
$Export_{t-2}$	0,665	0,662	0,039	0,866	0,876	-0,387	0,855	0,841	0,613
Hotelling T-stat	7,104 (p-value= 0,865)			21,000 (p-value=0,0589)			15,337 (p-value=0,235)		

Panel B: Firms that received a subsidy

	2010			2011			2012			2013		
	Control N= 491	Treated N=493	t-stat	Control N= 455	Treated N=461	t-stat	Control N= 532	Treated N=536	t-stat	Control N=435	Treated N=440	t-stat
$Ln(Age)_{t-1}$	2.341	2.291	0.755	2.583	2.519	1.068	2.522	2.445	1.509	2.467	2.374	1.667*
$Ln(Age)_{t-2}$				2.452	2.375	1.110	2.392	2.299	1.573	2.328	2.218	1.670*
$Ln(Age)^2_{t-1}$	6.529	6.387	0.492	7.463	7.200	0.864	7.004	6.706	1.206	6.749	6.348	1.487
$Ln(Age)^2_{t-2}$				7.062	6.788	0.870	6.591	6.280	1.218	6.328	5.907	1.504
$Ln(Assets)_{t-1}$	7.125	7.198	-0.944	7.203	7.395	-2.331**	7.344	7.552	-2.684***	7.253	7.426	-2.109**
$Ln(Assets)_{t-2}$				7.312	7.526	-2.659***	7.242	7.419	-2.192**	7.154	7.292	-1.621
$(Debt/Assets)_{t-1}$	0.524	0.529	-0.366	0.499	0.498	0.068	0.506	0.502	0.363	0.495	0.497	-0.169
$(Debt/Assets)_{t-2}$				0.506	0.498	0.581	0.506	0.501	0.419	0.501	0.501	0.014
$(Equity/Assets)_{t-1}$	0.386	0.384	0.142	0.404	0.410	-0.429	0.405	0.415	-0.750	0.421	0.435	-0.919
$(Equity/Assets)_{t-2}$				0.404	0.416	-0.893	0.400	0.414	-1.070	0.405	0.421	-1.087
$Export_{t-1}$	0.831	0.826	0.224	0.857	0.850	0.292	0.731	0.741	-0.351	0.733	0.743	-0.331
$Export_{t-2}$				0.853	0.850	0.103	0.831	0.829	0.107	0.722	0.739	-0.560
Hotelling T-stat	3.902 (p-value= 0.692)			16.544 (p-value= 0,1784)			23.548 (p-value=0,026)			18.004 (p-value=0.125)		

	2014			2015			2016		
	Control N= 387	Treated N=394	t-stat	Control N= 263	Treated N=266	t-stat	Control N=401	Treated N=405	t-stat
$Ln(Age)_{t-1}$	2.456	2.356	1.535	2.566	2.485	1.100	2.455	2.420	0.555
$Ln(Age)_{t-2}$	2.309	2.189	1.583	2.441	2.346	1.116	2.311	2.268	0.582
$Ln(Age)^2_{t-1}$	6.816	6.421	1.221	7.268	6.920	0.946	6.821	6.681	0.431
$Ln(Age)^2_{t-2}$	6.390	5.975	1.224	6.860	6.494	0.959	6.386	6.239	0.436

$Ln(Assets)_{t-1}$	7.284	7.447	-1.830*	7.296	7.417	-1 .235	7.294	7.401	-1.206
$Ln(Assets)_{t-2}$	7.173	7.295	-1 .299	7.177	7.275	-0.966	7.294	7.401	-1.207
$(Debt/Assets)_{t-1}$	0.451	0.471	-0.463	0.492	0.485	0.364	0.502	0.502	-0.028
$(Debt/Assets)_{t-2}$	0.472	0.496	-0.512	0.510	0.506	0.251	0.502	0.502	-0.026
$(Equity/Assets)_{t-1}$	0.468	0.514	-0.788	0.413	0.420	-0.359	0.405	0.412	-0.463
$(Equity/Assets)_{t-2}$	0.428	0.472	-0.794	0.396	0.409	-0.674	0.405	0.412	-0.462
$Export_{t-1}$	0.80	0.844	-0.546	0.829	0.816	0.394	0.840	0.827	0.504
$Export_{t-2}$	0.711	0.756	-0.472	0.856	0.816	1.231	0.840	0.827	0.504
Hotelling T-stat	11.103 (p-value= 0.640)			8.287 (p-value=0,775)			5.862 (p-value=0.759)		

Panel C: Firms that received both

	2010			2011			2012			2013		
	Control	Treated	t-stat	Control	Treated	t-stat	Control	Treated	t-stat	Control	Treated	t-stat
	N= 244	N=249		N= 96	N=98		N= 93	N=93		N=29	N=30	
$Ln(Age)_{t-1}$	2.345	2.268	0.938	2.523	2.450	0.583	2.380	2.341	0.310	2.609	2.404	0.889
$Ln(Age)_{t-2}$				2.390	2.297	0.628	2.222	2.175	0.315	2.481	2.249	0.865
$Ln(Age)^2_{t-1}$	6.380	6.115	0.701	7.070	6.829	0.389	6.364	6.210	0.272	7.554	6.540	0.902
$Ln(Age)^2_{t-2}$				6.656	6.400	0.398	5.929	5.769	0.272	7.159	6.105	0.904
$Ln(Assets)_{t-1}$	7.782	7.947	-1.522	7.540	7.861	-1.745*	7.782	8.049	-1.518	7.953	7.974	0.265
$Ln(Assets)_{t-2}$				7.366	7.647	-1.430	7.673	7.908	-1.283	7.857	7.682	0.546
$(Debt/Assets)_{t-1}$	0.472	0.483	-0.581	0.506	0.503	0.089	0.482	0.465	0.607	0.453	0.434	0.359
$(Debt/Assets)_{t-2}$				0.521	0.527	-0.199	0.502	0.484	0.605	0.502	0.463	0.678
$(Equity/Assets)_{t-1}$	0.469	0.481	-0.530	0.405	0.412	-0.232	0.441	0.466	-0.763	0.452	0.491	-0.761
$(Equity/Assets)_{t-2}$				0.396	0.394	0.074	0.412	0.423	-0.332	0.392	0.429	-0.650
$Export_{t-1}$	0.865	0.863	0.042	0.865	0.878	-0.268	0.785	0.763	0.349	0.828	0.800	0.268
$Export_{t-2}$				0.854	0.847	0.140	0.871	0.860	0.214	0.828	0.800	0.268
Hotelling T-stat	1.542 (p-value= 0.163)			9.283 (p-value= 0.722)			6.973 (p-value=0.882)			4.261 (p-value=0.989)		

	2014			2015			2016		
	Control	Treated	t-stat	Control	Treated	t-stat	Control	Treated	t-stat
	N= 45	N=45		N=19	N=19		N=49	N=49	

$Ln(Age)_{t-1}$	2.441	2.345	0.541	2.036	1.854	0.663	2.261	2.253	0.043
$Ln(Age)_{t-2}$	2.306	2.189	0.574	1.822	1.601	0.513	2.090	2.081	0.044
$Ln(Age)^2_{t-1}$	6.578	6.261	0.369	4.863	4.079	0.634	5.934	5.915	0.019
$Ln(Age)^2_{t-2}$	6.142	5.800	0.382	4.356	3.548	0.632	5.453	5.431	0.022
$Ln(Assets)_{t-1}$	7.471	7.849	-1.640	7.646	7.683	-0.097	7.783	7.892	-0.451
$Ln(Assets)_{t-2}$	7.347	7.693	-1.417	7.539	7.519	0.050	7.783	7.892	-0.451
$(Debt/Assets)_{t-1}$	0.452	0.471	-0.463	0.428	0.395	0.526	0.439	0.441	-0.053
$(Debt/Assets)_{t-2}$	0.472	0.496	-0.512	0.433	0.425	0.107	0.439	0.441	-0.053
$(Equity/Assets)_{t-1}$	0.468	0.514	-0.788	0.466	0.531	-0.967	0.453	0.454	-0.029
$(Equity/Assets)_{t-2}$	0.428	0.472	-0.794	0.464	0.494	-0.388	0.453	0.454	-0.029
$Export_{t-1}$	0.800	0.844	-0.546	0.947	0.895	0.588	0.837	0.796	0.517
$Export_{t-2}$	0.711	0.756	-0.546	0.842	0.789	0.408	0.837	0.796	0.517
Hotelling T-stat	11.103 (p-value= 0.640)			4.659 (p-value=0.989)			0.624 (p-value=0.999)		

Table A.3. Impact of financial support for innovation on firm performance using PSM (1,1)

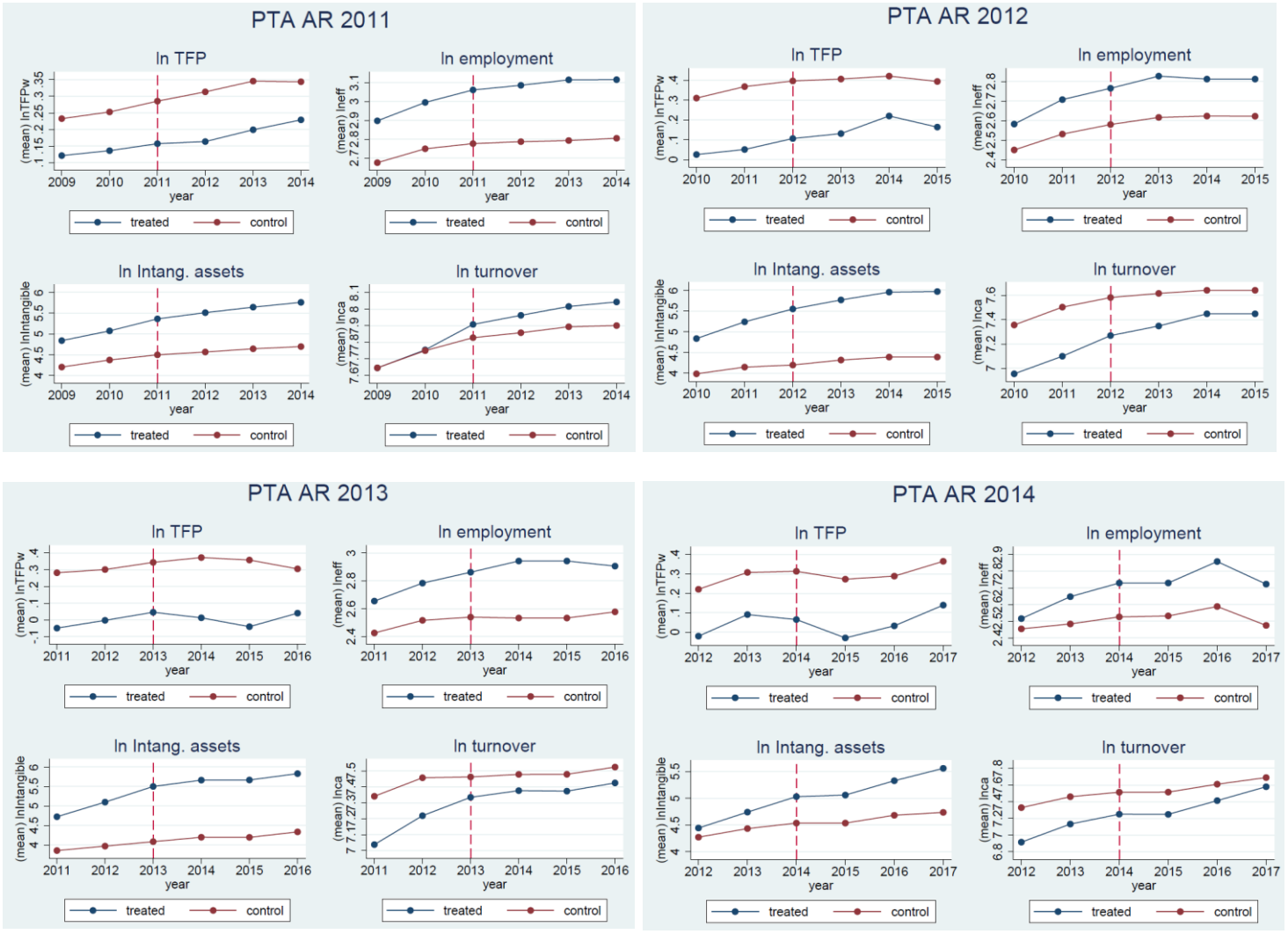
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
Panel A: Repayable Advances								
INST	-0.0188***	0.0287***	0.0360***	0.146***	0.0879***	0.307***	0.0368***	0.0671***
	(0.00719)	(0.0101)	(0.00934)	(0.0170)	(0.0126)	(0.0250)	(0.00639)	(0.0117)
Intercept	0.270***	0.260***	7.722***	7.687***	5.029***	4.956***	2.802***	2.787***
	(0.000643)	(0.00266)	(0.000835)	(0.00449)	(0.00112)	(0.00658)	(0.000571)	(0.00307)
Obs.	20,932	20,932	20,932	20,932	20,932	20,932	20,932	20,932
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Panel B: Subsidies								
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
INST	-0.00617	0.00658	0.0380***	0.0905***	0.0639***	0.232***	0.0395***	0.0645***
	(0.00463)	(0.00664)	(0.00660)	(0.0114)	(0.00953)	(0.0177)	(0.00460)	(0.00805)
Intercept	0.324***	0.322***	7.518***	7.497***	4.615***	4.560***	2.609***	2.595***
	(0.000426)	(0.00173)	(0.000607)	(0.00298)	(0.000877)	(0.00463)	(0.000423)	(0.00210)
Obs.	32,513	32,513	32,513	32,513	32,513	32,513	32,513	32,513
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Panel C: Both								
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
INST	-0.0320**	0.00288	0.0126	0.127***	0.115***	0.331***	0.0485***	0.0690***
	(0.0135)	(0.0168)	(0.0170)	(0.0277)	(0.0248)	(0.0437)	(0.0102)	(0.0184)
Intercept	0.276***	0.272***	7.848***	7.814***	5.232***	5.153***	3.012***	2.997***
	(0.00125)	(0.00458)	(0.00158)	(0.00755)	(0.00230)	(0.0119)	(0.000941)	(0.00501)
Obs.	6,286	6,286	6,286	6,286	6,286	6,286	6,286	6,286
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES

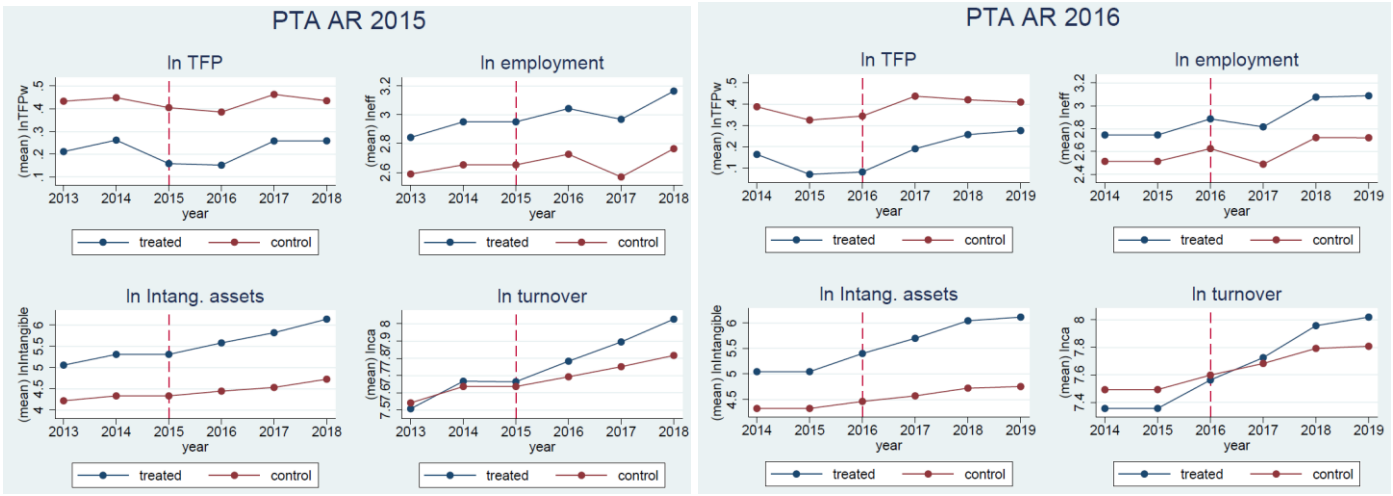
Table A.4. Fake treatment test

Panel A: Repayable Advances								
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
INST	-0.00270	-0.0125	-0.00330	-0.0169	-0.00360	-0.00579	-0.00351	-0.00624
	(0.00538)	(0.00827)	(0.00745)	(0.0113)	(0.0108)	(0.0157)	(0.00639)	(0.00986)
Intercept	0.360***	0.369***	7.667***	7.680***	4.373***	4.376***	2.633***	2.637***
	(0.00268)	(0.00722)	(0.00372)	(0.00990)	(0.00541)	(0.0137)	(0.00319)	(0.00860)
Obs.	10,145	10,145	10,145	10,145	10,145	10,145	10,145	10,145
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Panel B: Subsidies								
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
INST	0.00857**	0.00449	0.00348	0.00267	-0.00864	0.0223*	0.00113	0.00587
	(0.00344)	(0.00501)	(0.00482)	(0.00711)	(0.00842)	(0.0115)	(0.00478)	(0.00695)
Intercept	0.406***	0.406***	7.525***	7.524***	4.112***	4.088***	2.475***	2.471***
	(0.00172)	(0.00438)	(0.00241)	(0.00621)	(0.00421)	(0.0101)	(0.00239)	(0.00607)
Obs.	15,975	15,975	15,975	15,975	15,975	15,975	15,975	15,975
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Panel C: Both								
	TFP		Turnover		Intangible assets		Employment	
	t+1	t+3	t+1	t+3	t+1	t+3	t+1	t+3
INST	0.00395	0.0168	0.0206	0.0108	0.00901	0.00689	0.00904	-0.00952
	(0.0102)	(0.0133)	(0.0163)	(0.0189)	(0.0193)	(0.0271)	(0.0101)	(0.0145)
Intercept	0.396***	0.383***	7.873***	7.874***	4.672***	4.671***	2.849***	2.861***
	(0.00504)	(0.0116)	(0.00804)	(0.0164)	(0.00957)	(0.0236)	(0.00500)	(0.0126)
Obs.	3,100	3,100	3,100	3,100	3,100	3,100	3,100	3,100
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES

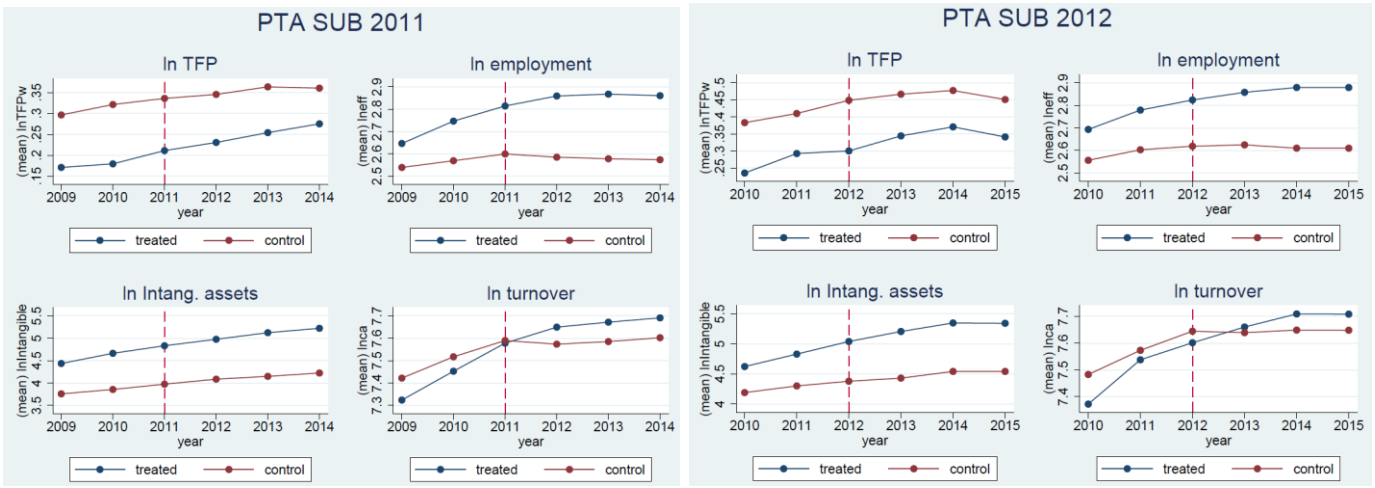
Figure A.1. Investigating the common trend assumption

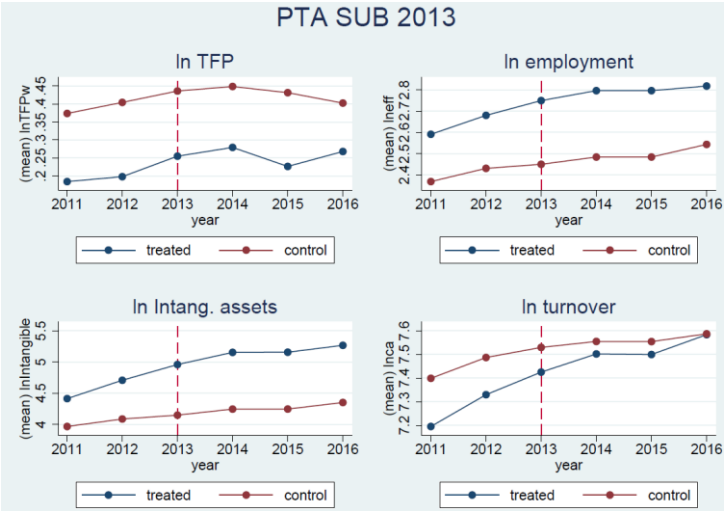
Panel A: Firms that received repayable advances

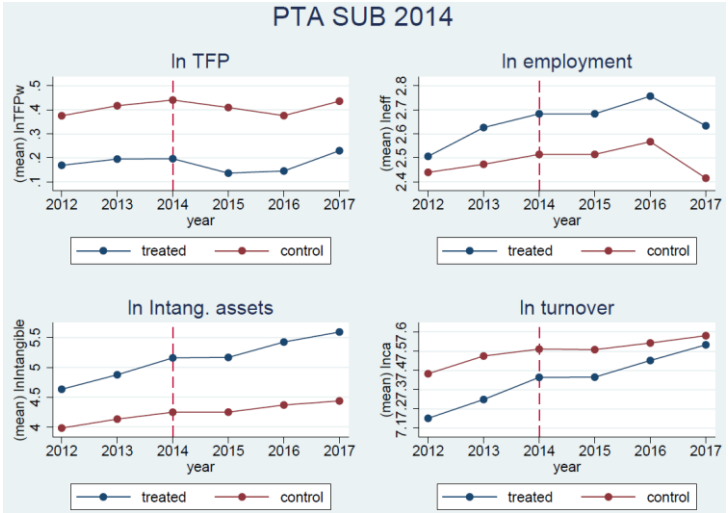


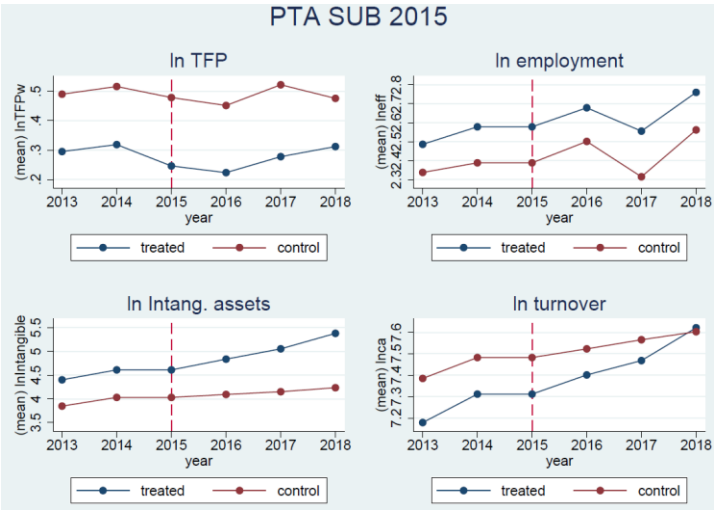


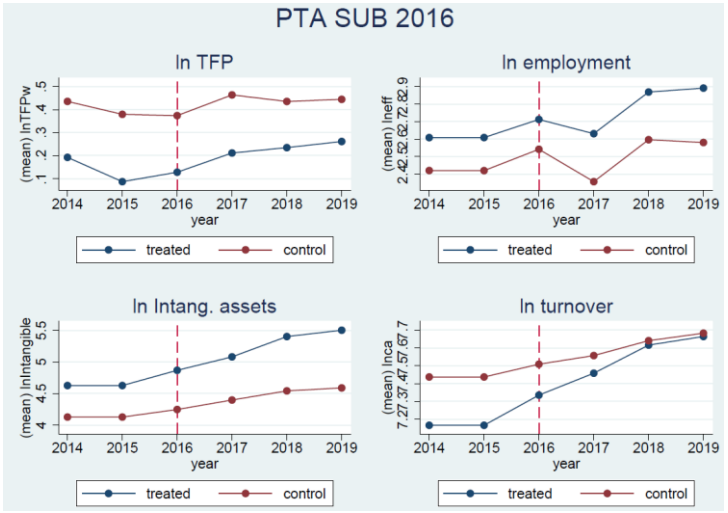
Panel B: Firms that received a subsidy



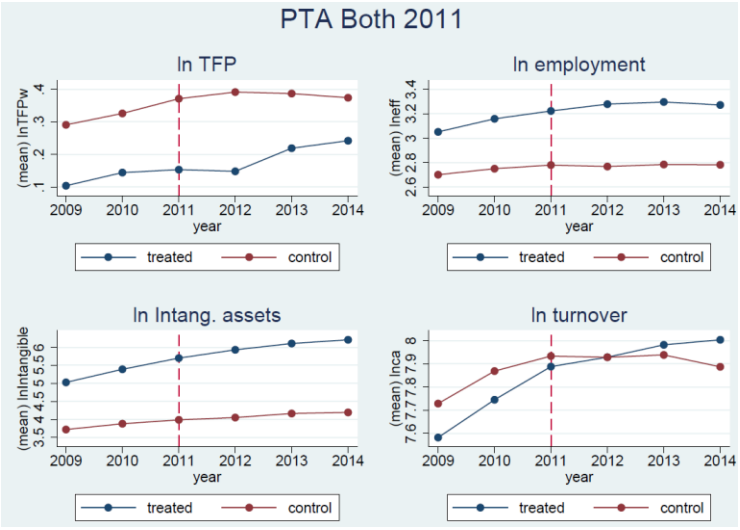

PTA SUB 2013
ln TFP
(mean) lnTFPw
year
treated
control
ln employment
(mean) lneff
year
treated
control
ln Intang. assets
(mean) lnIntangible
year
treated
control
ln turnover
(mean) lnca
year
treated
control

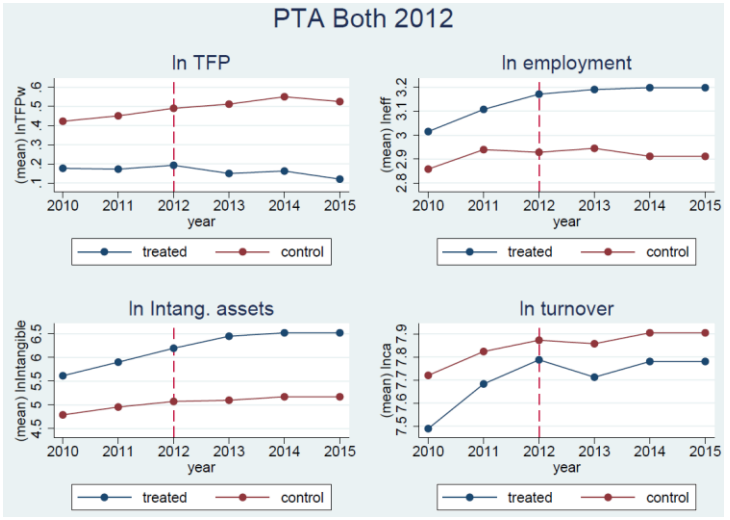

PTA SUB 2014
ln TFP
(mean) lnTFPw
year
treated
control
ln employment
(mean) lneff
year
treated
control
ln Intang. assets
(mean) lnIntangible
year
treated
control
ln turnover
(mean) lnca
year
treated
control

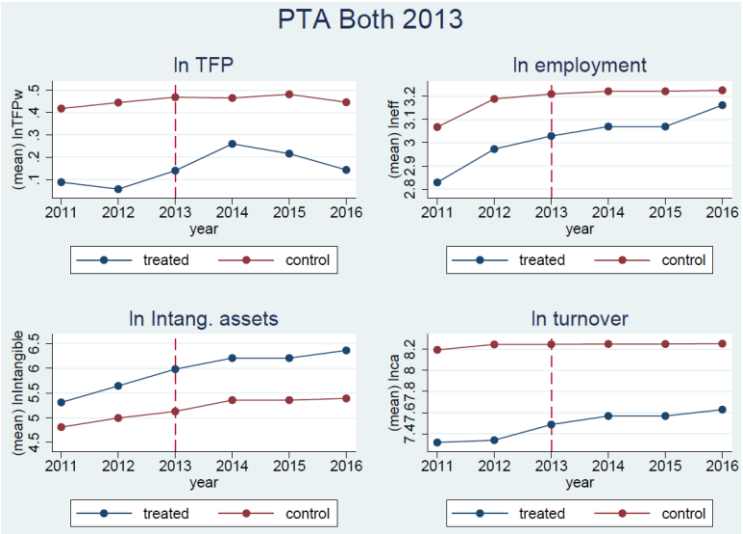

PTA SUB 2015
ln TFP
(mean) lnTFPw
year
treated
control
ln employment
(mean) lneff
year
treated
control
ln Intang. assets
(mean) lnIntangible
year
treated
control
ln turnover
(mean) lnca
year
treated
control

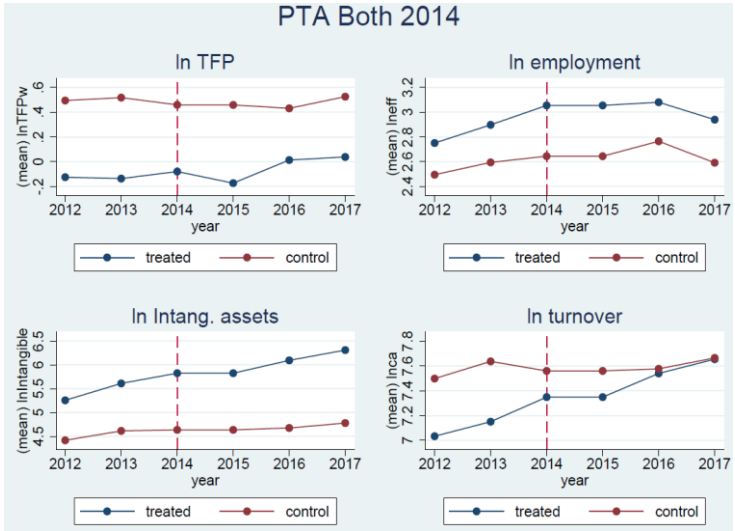

PTA SUB 2016
ln TFP
(mean) lnTFPw
year
treated
control
ln employment
(mean) lneff
year
treated
control
ln Intang. assets
(mean) lnIntangible
year
treated
control
ln turnover
(mean) lnca
year
treated
control

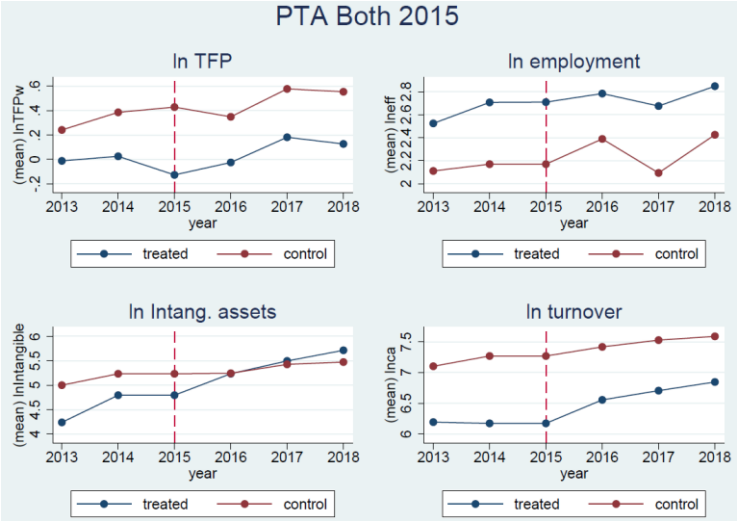
Panel C: Firms that received both

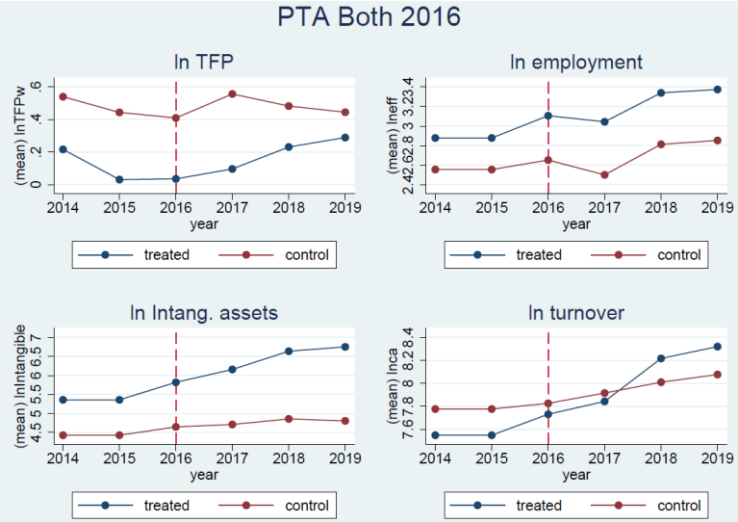









PTA Both 2015
ln TFP
(mean) lnTFPw
year
treated
control
ln employment
(mean) lneff
year
treated
control
ln Intang. assets
(mean) lnIntangible
year
treated
control
ln turnover
(mean) lnca
year
treated
control


PTA Both 2016
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(mean) lnTFPw
year
treated
control
ln employment
(mean) lneff
year
treated
control
ln Intang. assets
(mean) lnIntangible
year
treated
control
ln turnover
(mean) lnca
year
treated
control

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