Does Public Financial Support Stimulate Innovation and Productivity?

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Abstract[*]

The aim of this paper is to contribute to the scarce empirical literature that evaluates the effects of public financial support to innovation on innovation expenditures, innovation, and productivity in developing countries. Propensity score matching techniques and innovation survey data are used to analyze the impacts of public financial support to innovation on Uruguayan firms. The results indicate that there is no crowding-out effect of private innovation investment by public funds, and that public financial support in Uruguay seems to increase private innovation expenditures. Financial support also appears to induce increased R&D expenditures and innovative sales, and these effects are more important for service firms. Public funds do not, however, significantly stimulate private expenditures by firms that would carry out innovation activities even in the absence of financial support. Probably due to the short time frame in which the evaluation was conducted, little evidence of an effect on applications for patents or productivity was found.

JEL Classifications: O31, O32, O38, C21
Keywords: Public financial support to innovation, Innovation, Productivity, Policy evaluation

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1. Introduction

The need for public support of innovation and, particularly, public financial support, rests on the assumption that innovation is a non-rival good (i.e., that it can be used by multiple firms) and cannot be fully protected because its output is basically knowledge (i.e., how to produce new or improved goods or services) and most of it is tacit knowledge (i.e., it is not codified). Therefore firms cannot fully internalize the return to the innovation investment. In other words, we have a problem of positive externalities for innovation. This generates a gap between the social and the private return on innovation, and consequently firms tend to underinvest with respect to the social optimum.

As noted by Hall and Lerner (2010), there is some evidence that imitations are not free, and that they can cost between 50 and 75 percent of the original R&D investment. This can mitigate the above-mentioned externality problem, but the problem persists since the returns are not fully internalized by the original investor. Moreover, this available evidence is for manufacturing. We believe the problem affects service innovations even more than those in manufacturing because service innovations rely less on codified knowledge (which can be more easily protected) and presumably the costs of imitation are lower for this type of innovations.

The argument for public financial support goes beyond the externality problem mentioned above. Even when this problem can be solved with intellectual property protection, there are other characteristics of the innovation investment that justify public financial support. In particular, innovation investment is highly uncertain and the asymmetric information that exists between the innovator and the investor could be greater than in other types of investment, leading to more important problems of moral hazard and adverse selection.[1] Therefore, credit constraints and high cost of credit are likely to affect the level of innovation investment and, consequently, the amount of innovation. The intangible characteristics of services and the non-technological and more ad-hoc characteristics of many innovations in the service sector make these problems even more challenging than for manufacturing innovations.

These theoretical considerations have stimulated public intervention in different countries with the objective of increasing innovation investment, innovation, and productivity. These interventions created the need to evaluate their effects.

[1] Given that the innovator has more information about the project than the investor, the innovator can use this advantage to increase his profit to the detriment of the investor.

So far, most of the available empirical literature has focused on public financial support policies for research and development (R&D) activities and their impact on R&D expenditures. As pointed out by Hall and Lerner (2010), the focus on R&D instead of the broader concept of innovation investment is largely related to measurement and the availability of data. In addition, most of the available evidence does not distinguish between manufacturing and services, and in fact most papers are related to the manufacturing sector only. The potential positive effects of public support could be even more important for services than for manufacturing, not only because of the above-mentioned arguments, but also because the service sector represents more than 70 percent of the GDP of advanced economies and more than 60 percent for less developed economies. Therefore, the service sector is key to the aggregate productivity of countries and this sector needs to be better understood. Finally, most of the studies available are for Organisation for Economic Co-operation and Development (OECD) or European countries, and thus evidence is lacking for less developed economies.

This paper aims to help fill some of these gaps by evaluating the impact of public financial support on innovation in a developing country. Quasi-experimental methods and innovation survey data from Uruguay are used.

This paper contributes to the literature in three ways. First, it evaluates the effects of public financial support for innovation on innovation expenditures, innovation and productivity, thus extending research beyond the R&D context. Second, it analyzes the possible heterogeneity of effects on services and manufacturing. Finally, the evaluation is based on data of a developing Latin American country, where the empirical evidence is scarce.

Findings showed no crowding-out effect, either full or partial, between public and private innovation expenditures. Moreover, there is evidence of a crowding-in effect. There are also positive effects on innovation (measured as the percentage of innovative sales). Firms that received financial support increased ratio of R&D expenditures to total innovation expenditure relative to those that did not. There were no effects on productivity and applied for patents, probably due to the short time frame in which the evaluation was conducted. We found similar, but not identical, effects when we analyzed the service and manufacturing sectors separately. While there was no crowding-out effect in either sector, we found that public financial support stimulated private innovation expenditures only in manufacturing. Productivity was increased in service firms. Public funds do not, however, significantly stimulate private expenditures by firms that would carry out innovation activities even in the absence of financial support.

This paper is organized as follows. The second section discusses available evidence on public financial support and innovation in developing countries. Section 3 describes the empirical strategy and data. Section 4 presents the main results. Section 5 reports the conclusions.

2. Public Financial Support and Innovation: Available Evidence

Most of the available evidence focuses on developed countries and manufacturing firms, and uses R&D expenditures as the outcome variable. David, Hall, and Toole (2000) extensively surveyed this literature, finding substitution effects between public and private R&D in one-third of the studies analyzed. More recent studies have focused (mostly) on matching methodologies to evaluate the crowding-out effect. Along these lines, different studies have found that public financial support stimulates privately financed R&D, so the crowding-out hypothesis is rejected. Examples are Almus and Czarnitzki (2003), who use data from a survey of German manufacturing firms; Duguet (2004), who uses a pool of French R&D-performing firms; and Gonzalez and Pazó (2008), who use a sample of Spanish firms to evaluate the effect of subsidies. As for the service sector, Czarnitzki and Fier (2002) found that financial support stimulated private expenditures on innovative activities by studying a panel of German service firms. However, there are no studies that we know of that allow direct comparison of the impact that a certain policy imposes on the service and manufacturing sectors.

As for evidence regarding the policy impact on innovation (rather than on R&D and innovation efforts which are inputs for innovation), Aerts and Czarnitzki (2004) found no significant effects of public support for innovation on patent applications from a survey of Flemish firms. Czarnitzki and Hussinger (2004) found that the impact on this variable was positive for a set of German manufacturing firms, and Czarnitzki, Hanel, and Rosa (2011) found a positive impact on the number of new products introduced by Canadian manufacturing firms.

Evidence regarding the impact on firm performance, particularly productivity, is scarcer. Czarnitzki, Hanel, and Rosa (2011) found that the impact on the profitability of firms was not significant, while Wallsten (2000) found no significant impact on employment for small American high-tech small firms. These results may be because such policy effects often do not arise until several years after policy implementation, and thus the results may not have been observed over the short periods of analysis. On a different note, Lokshin and Mohnen (2013) found that fiscal incentives had a positive impact on the wages of R&D workers for Dutch firms.

The available evidence of the effects of public financial support on innovation is scarce in emerging and developing countries. A few examples can be found in Crespi, Maffioli, and Melendez (2011), Hall and Maffioli (2008), and López-Acevedo and Tan (2010).

Crespi, Maffioli, and Melendez (2011) evaluated the effects of financial incentives for R&D (matching grants and contingent loans) given by Colciencias in Colombia on a firm's beneficiaries economic performance. With a dataset that allowed analysis of long-term effects, the authors found significant impact of public funding from Colciencias on firm performance. More precisely, the authors found that introduction of new products and labor productivity increased around 12 and 15 percent, respectively, with these effects becoming more significant between three and five years after the firms started being treated.

Hall and Maffioli (2008) synthesized the results of a series of evaluations of Technology Development Funds (TDFs) in Argentina, Brazil, Chile, and Panama. The authors evaluated TDF recipients with data from innovation and industrial surveys. They found that TDFs did not crowd out R&D from private sources and that they had a positive impact on the intensity of R&D. Also, although low-cost credit had a more positive effect than matching grants on R&D projects—suggesting that different types of financing affected firms differently—matching grants were more effective for new innovators. The authors also found that participating in a TDF result in a more proactive attitude toward innovation strategy. Although Argentina and Brazil were not included in this part of the study, using a firm's willingness to engage with external financing and knowledge sources as proxies for innovation strategy shifts, the authors found that TDFs had a positive effect on innovation. Conversely, participation in a TDF did not positively affect patent grants or new product sales, which were used as measures of innovative output, although the authors noted that the time frame may have been too short to observe the full effects of TDF participation in this regard. Evidence concerning the potential effects on firm performance was not uniform, such that TDF participation was found to positively impact firm growth but not firm productivity. The authors argued that this could be due to the short time frame in which the evaluations were conducted, and that additional impact evaluations based on longer panel data are needed to shed some light on long-run effects.

López-Acevedo and Tan (2010) evaluated small and medium enterprise (SME) credit programs in Mexico, Chile, Colombia, and Peru. The authors found positive gains in labor productivity, sales, and employment in Chile, and higher value added, sales, export, and employment in Mexico. In Colombia, the results suggested positive effects on exports, investment in R&D, and total factor productivity. Finally, in Peru the findings showed significant positive effects in sales and profits. Confirming the findings of Hall and Maffioli (2008), López-Acevedo and Tan (2010) noted that some of the estimated effects on firm performance did not materialize until after several years. Table A.1 in the Appendix summarizes the results of 26 impact evaluations.

3. Empirical Strategy and Data

3.1 Empirical Strategy

The objective of this paper is to estimate the impact of public financial support on innovation investment, innovation, and productivity. Since we cannot observe what would happen if the "treated" firms did not get such financial support (the counterfactual), a suitable proxy is required. Firms that did not get public financial support could be considered candidates for a comparison (or control) group; however, it is possible that these firms did not get support because of some characteristic that could also affect the outcome variables. For example, it could be more difficult for small firms to get public financial support, and we know that the size of firms affects innovation. Therefore, if the innovation performance of firms that got support is compared with that of firms that did not get support, firms that received financial support are likely to show more innovation, but this could simply be because they are bigger and not because of the public financial support.

Luckily, this problem can be circumvented using certain assumptions. In this study we used propensity score matching methods.[2] The following briefly explains the rationale behind this strategy and makes explicit some methodological decisions.

One of the parameters of interest in this paper is:

$$\tau_{\mathrm{ATT}} = E[Y(1)|\mathrm{D} = 1] - E[Y(0)|\mathrm{D} = 1]$$

where τ_{ATT} is the average treatment effect on the treated; $E[Y(1)|\mathrm{D} = 1]$ is the mean value of the outcome variable $Y(1)$ (e.g., innovation investment) given that the firms received public financial support; and $E[Y(0)|\mathrm{D} = 1]$ is the counterfactual (i.e., the expected value of outcome variable, $Y(0)$) for the firms in the treatment group in case they did not receive public financial support. D=1 means that the firm belongs to the treatment group.

[2] See Caliendo and Kopeining (2008) and Crespi, Maffioli, Mohnen, and Vázquez (2011) for very intuitive presentations of these methods.

Unfortunately, we do not observe the counterfactual. What we do observe is $E[Y(0)|\mathrm{D} = 0]$, which in our case is the mean of the innovation investment for firms that do not belong to the treatment group ($\mathrm{D} = 0$) and do not receive treatment. Of course, $E[Y(0)|\mathrm{D} = 0]$ must not need to be equal to $E[Y(0)|\mathrm{D} = 1]$ and therefore can introduce a bias to the estimation in case it is used as a proxy for $E[Y(0)|\mathrm{D} = 1]$. Note that,

$$\tau_{\mathrm{ATT}} = E[Y(1)|\mathrm{D} = 1] - E[Y(0)|\mathrm{D} = 1] - E[Y(0)|\mathrm{D} = 0] + E[Y(0)|\mathrm{D} = 0],$$

and therefore

$$E[Y(1)|\mathrm{D} = 1] - E[Y(0)|\mathrm{D} = 0] = \tau_{\mathrm{ATT}} + bias,$$

where $bias \equiv E[Y(0)|\mathrm{D} = 1] - E[Y(0)|\mathrm{D} = 0]$. As previously noted, if firms with particular characteristics tend to be selected in the treatment group and these characteristics affect outcomes, then there will be bias. On the contrary, if the assignment to both groups is completely random, such bias should not be a concern. Because this condition does not normally hold for innovation survey data, we had to do something else.

Assuming the differences between the treated and control groups comes from observable characteristics (e.g., firm size, or capital and knowledge intensity) that are not affected by the treatment, we can proceed to find firms that are similar on these characteristics in both groups and compare them. The identification assumption is that, given a set of observable covariates X that are not affected by treatment, potential outcomes are independent of treatment assignment (unconfoundness or conditional independence assumption [CIA]). This implies that selection into the treatment group is only based on observable variables X, that can be controlled for.

Usually, X is of high dimension. Hence, to deal with this dimensionality problem, propensity scores can be balanced. We can use the Xs to estimate the probability of being selected for treatment P(D=1| X)=P(X) —using a probit or logit model in the case of binary treatment— and use this probability to find similar firms in both groups (treated and control).

The propensity score matching (PSM) estimator for average treatment effect on the treated is

$$\tau_{\mathrm{ATT}}^{\mathrm{PSM}} = E[Y(1)|\mathrm{D} = 1, \mathrm{P(X)}] - E[Y(0)|\mathrm{D} = 0, \mathrm{P(X)}]$$

Assuming conditional (on the propensity score, P(X)) independence of outcome variables with respect to treatment, this estimator is unbiased.

An additional important condition to use PSM, besides CIA, is to have enough treated and control firms on the common support. More formally, we need $0 < P(\mathrm{D} = 1|\mathrm{X}) < 1$. This condition ensures that firms with the same values of X have a positive probability of being both participants and non-participants, and we avoid predicting perfectly if a firm belongs to the control or the treatment group.

The matching algorithm used in this work is Nearest Neighbor Matching (NNM) with replacement, using a caliper of 20 percent of the standard deviation as suggested in the literature. We use oversampling, taking advantage of the big number of potential controls in our sample. In particular, for each treated firm, we found the 5 nearest neighbors (matching partners) and compared them with the treated firm.

We combined the propensity score matching with Mahalanobis metric matching over size and sectoral dummies. Hence, a treated firm is matched with the closest control firm of the same sector and similar size using the distance defined by the Mahalanobis distance.

3.2 Data

We applied the above methodology to evaluate the effect of financial support granted to Uruguayan service and manufacturing firms during the period 2004–09. For this purpose, we used two waves of Innovation Surveys (IS): 2004–06 and 2007–09.

The IS data was collected in parallel with the Economic Activity Survey (EAS), using the same sample and statistical framework. In these surveys, all the firms with more than 49 workers were included (mandatory). Firms with 20 to 49 employees and with fewer than 19 workers were selected using simple random sampling within each economic sector at the ISIC 2-digit level up to 2005. From that point forward, random strata were defined for units with fewer than 50 workers within each economic sector at the ISIC 4-digit level.

We matched the IS with the 2004 and 2007 EAS because we needed information on the size of the firm at the beginning of the period, capital (fixed assets), and productivity. To avoid endogeneity problems associated with the size, capital, and productivity, we used these variables at the beginning of the period. All of the other variables used in the empirical exercise came from the IS. When matching with the EAS, some firms were lost because of sampling problems, hence when using data collected from the EAS, the size of the sample was reduced.

To reduce the loss of observations and recover the information for the missing variables at the beginning of the period in each survey, we used an imputation procedure based on a regression between Log Size (t–1) against age and sectoral dummies. We used this regression to predict size in (t–1) for the missing observations. The same was done for capital stock and productivity. Note that this technique uses the information available at the beginning of the period of the survey, not the end, to avoid interaction between causal effects. In any case, for robustness, we presented the results with the reduced sample (i.e., without the imputation procedure).

For the service sector, the final number of included firms in the IS was 1,868; 885from the first survey and 983 from the second. For the manufacturing sector, the final number of included firms was 1,727; 816 from 2004–06 survey and 911 from the 2007–09 survey.

The treatment variable was financial support. We considered a firm to be financially supported if it received some financial support from the public sector[3] in the period of reference. In the first instance, we evaluated the effect of financial support on innovation expenditure (IE) effort (expenditures on innovation over sales). Total innovation expenditures comprised investment in design, installation of machinery, industrial engineering, embodied and disembodied technology, marketing, and training—we were able to distinguish between total and private innovation expenditures. Then, we analyzed the effect of financial support on R&D expenditures (both internal and external) over innovation expenditure, share of innovative sales, applied for patents, and productivity. Productivity was defined as the logarithm of sales over total employment.

Table 1 reports the number of firms in each sector, divided into KIBS (knowledge intensive business services) and traditional services, or high-tech and low-tech manufacturing sectors. Manufacturing sector firms tend to invest more in innovation activities than service firms. The high-tech sector innovates the most, followed by the KIBS sectors. The third column of the table shows the manufacturing bias of innovation policies. While more than 4 percent of the manufacturing firms received public financial support during 2004–09, only 2 percent of the service firms obtained financial support.

[3] The survey includes information regarding financial support received from the public sector, excluding public firms from the definition of public sector.

Table 1. Firms with Innovation Activities and Financial Support (2004–09)

	Observations	Percent with innovation activities	Percent with financial support
Services	1,868	38.5	2.1
KIBS	628	42.0	1.9
Traditional	1,240	36.7	2.3
Manufacturing	1,727	42.3	4.2
High-tech	399	52.4	5.8
Low-tech	1,328	39.3	3.7

***Note**:* Authors' calculations based on the 2004–06 and 2007–09 IS.

Table 2 reports the innovation effort (innovation expenditures/sales) for firms with and without financial support. On average, firms from the manufacturing sector invested more in innovation activities than firms from the service sector. One fact to highlight is that the private effort of firms with financial support (column 2) is notably higher than the effort of firms without financial support and with innovation activities (column 4) in the manufacturing sector. On average for manufacturing firms, the difference is 0.9 percentage points, with the high-tech sector being the highest at 1.77 percentage points. On the contrary, in the service sector, the private effort of those that received financial support was lower than those that undertook innovation activities without financial support—on average 0.7 percentage points lower. This difference is driven by traditional service firms. KIBS show higher private effort with financial support than without it (increase of 2.65 percentage points).

This raw data leads us to conclude that a crowding-out effect could exist in the service sector, but not in the manufacturing sector. Our empirical strategy tries to disentangle whether this is an effect derived from the fact that public financial support tends to be directed to firms that invest more in the manufacturing sector than to firms that show poor performance in innovation in the service sector. This will be done by comparing firms with similar probability of obtaining financial support.

Table 2. Innovation Effort in Firms with and without Financial Support, Averages for 2004–09 *(in percent)*

	Innovation effort			
	With		**Without**	
	Total	**Private**	**All**	**IE>0**
Services	6.37	3.62	1.61	4.33
KIBS	9.77	6.93	1.75	4.28
Traditional	4.91	2.21	1.54	4.35
Manufacturing	7.50	5.05	1.66	4.16
High-tech	6.27	5.07	1.64	3.30
Low-tech	8.08	5.04	1.67	4.50

Note*:* Authors' calculations based on the 2004–06 and 2007–09 IS.

Finally, Table 3 presents the mean of the selected matching variables of the control and treatment groups by sector. Firms in the treatment group tend to be larger than those in the control group. Also, firms in the treatment group tend to have obtained more patents than those in the control group. Firms in the treatment group tend to be located in Montevideo (the capital of the country), belong to networks, and have more stores. With respect to age and ownership status, there are no clear differences.

Table 3. Mean Comparison of Financially Supported Firms and Non-supported Firms on Selected Controls

	Services		KIBS		Traditional	
	With	Without	With	Without	With	Without
Size (log employees)(t−1)	4.48	3.85	4.11	3.87	4.64	3.84
Foreign owned	7.5%	10.4%	16.7%	13.8%	3.6%	8.7%
Age (years)	23.9	18.3	11.6	13.7	29.4	20.7
Obtained patent	5.0%	1.2%	8.3%	1.3%	3.6%	1.2%
Network	30.0%	19.9%	50.0%	18.3%	21.4%	20.6%
Group	15.0%	15.6%	16.7%	16.2%	14.3%	15.3%
Stores	4.7	3.9	1.6	1.4	6.0	5.1
In Montevideo	85.0%	74.3%	100.0%	87.2%	78.6%	67.8%
	Manufacturing		**High-tech**		**Low-tech**	
	With	Without	With	Without	With	Without
Size (log employees)(t−1)	4.24	3.80	4.09	3.56	4.30	3.87
Foreign owned	9.7%	11.5%	8.7%	17.3%	10.2%	9.9%
Age (years)	32.29	25.56	35.96	28.01	30.57	24.84
Obtained patent	2.8%	2.7%	0.0%	3.2%	4.1%	2.5%
Network	16.7%	7.9%	17.4%	10.1%	16.3%	7.2%
Group	18.1%	13.2%	8.7%	16.0%	22.4%	12.4%
Stores	1.85	1.74	1.57	1.60	1.98	1.79
In Montevideo	83.3%	78.0%	91.3%	87.0%	79.6%	75.4%

Note*:* Authors' calculations based on the 2004–06 and 2007–09 IS.

4. Results

Initially, the results for the complete sample of firms, including both manufacturing and service sector firms, are presented together. To reduce endogeneity issues, the strategy is to match observations according to their pre-treatment behavior. With this objective we are working with the variables size, capital per worker, and productivity at t-1.

We also present results dividing the sample into manufacturing and service sector firms. We used two different groups of observations to select the controls for the average treatment effects on the treated estimator. First, we used the full sample, including both firms-observations *with and without* innovation expenditures. Second, we restricted the sample to observations *with* innovation activities. In the first case, we took into account the potential effect of financial support on the inducement to undertake innovation activities. In the second, we evaluated the stimulus of financial support on the effort considering that all supported firms would have performed innovation activities in the absence of support.

4.1 Complete Sample Results

In the first stage, we investigated factors that influence the probability of receiving public financial support. The dependent variable took the value one if the firm received public funding and zero if it did not. Table 4 (on the following page) displays marginal effects after probit estimation. The first column takes all firms as the possible control group, while the second column is restricted to firms that reported positive innovation expenditures.

The vector of explanatory variables includes firm characteristics that may influence the probability of getting public funds. We included the size of the firm in a quadratic form, measured as the logarithm of the number of employees in t–1, age (proxy for experience), a dummy variable for foreign owned (when more than 10 percent was foreign owned), capital intensity (measured as fixed assets per worker), and productivity at t–1. We also included dummies indicating if the firm had obtained patents in the period of reference (as a proxy for past innovation effort), if it belonged to a network or to a group of firms, if it was located in Montevideo, the number of stores, the age of firms, and its quadratic form. The dummy for obtained patents tries to control for the persistence in innovation, since obtaining a patent is a long process and the obtained patent is probably a consequence of past innovations. Finally, we included 33 sectoral dummies (at the 2-digit level).

Results show that the most important determinant of the probability of receiving public funds is size —the larger the firm, the higher the probability of receiving public funds. On the contrary, being foreign owned decreases the probability of receiving public funds for innovation. These were the only two significant variables (with the exception of some sectoral dummies).

According to our empirical strategy, the matching was done using the calculated propensity score. Hence, some important assumptions needed to be validated. The first was to check the common support or overlap condition. For this purpose, we performed a visual analysis of the density distribution of the propensity scores in both groups.

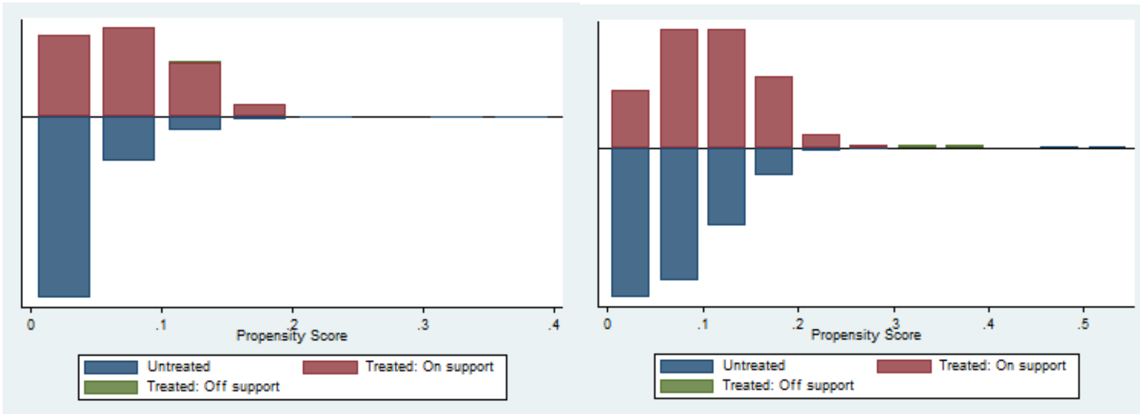
Table 4. Estimation of the Propensity Score

	(1)	(2)
	All firms	**Only innovative firms**
Size(t−1)	0.0408***	0.0663*
	(0.0147)	(0.0374)
Size(t−1)^2	−0.00292*	−0.00499
	(0.00160)	(0.00396)
Foreign owned	−0.0163***	−0.0405***
	(0.00588)	(0.0156)
Age	−0.000182	−0.000475
	(0.000287)	(0.000693)
Age^2	2.54e−06	6.49e−06
	(2.66e−06)	(6.22e−06)
Obtained Patent	0.0129	−0.00653
	(0.0222)	(0.0327)
K_L(t−1)	−0.000361	−6.85e−05
	(0.00252)	(0.00532)
Productivity(t−1)	0.00315	−0.00434
	(0.00362)	(0.00898)
Network	0.0123	0.00562
	(0.00891)	(0.0173)
Group	0.000225	−0.00245
	(0.00818)	(0.0193)
Stores	−6.75e−05	−0.000243
	(0.000152)	(0.000452)
Montevideo	0.00814	0.0181
	(0.00638)	(0.0163)
Industry dummies	yes	yes
Observations	2,914	1,382
Log likelihood	−423.1	−356.4

***Notes**:* Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1 shows the calculated propensity score by treated and control group. Observations in the control group are more left skewed than the treatment group, but a comparison of the minimum and maximum propensity scores leads to the conclusion that significant overlap is achieved. When taking into account firms with positive innovation expenditures, there are some firms that are off common support. We restricted the estimation to the region of common support of the propensity scores.

Figure 1. Propensity Score of Treated and Potential Controls Considering all Firms (left panel) and Only Firms with Positive Innovation Expenditures *(right panel)*



Finally, since we did not condition on all covariates but on the propensity score, it has to be checked if the matching procedure is balancing the distribution of the relevant variables in both the control and the treatment group.

In Table 5 (on the following page), the treated group appears to be different from the potential control groups in some relevant variables before the matching, but similarity between treated and controls is achieved after the matching. Table 5 also shows that the differences were significantly reduced and were not statistically significant.

Table 6 (on the following page) reports the results for the average treatment effect considering the following performance variables: investment expenditures, private innovation effort, the share of R&D in innovation expenditures, the share of innovative sales, applications for patent, and (log) productivity.

Results show that financial support has a stimulating effect on both private and total innovation expenditures. Financially supported firms invested 4.5 percent more of their sales in innovation than non-supported firms. This result indicates that not only is there no crowding-out effect, but also that firms invested more from their private budget.

Financially supported firms spent 8 percent more of their innovation expenditures on R&D than control firms. This result was expected since usually financial support is directed to R&D. Remember that this sample includes all potential firms in the control group (i.e., firms could also have zero innovation expenditures). Hence, this result can be interpreted as public financial support having inducement effects on innovation activities.

Table 5. Mean Comparison of Financially Supported and Non-supported Firms on Selected Variables before and after Matching

		All firms in the potencial control						Potential control with positive IE					
		Mean			%reduct	t-test		Mean			%reduct	t-test	
Variable		Treated	Control	%bias	bias	t	p>t	Treated	Control	%bias	bias	t	p>t
Size	Unmatched	4.34	3.84	46.2		4.69	0.00	4.34	4.08	23.4		2.27	0.02
	Matched	4.35	4.28	6.5	85.9	0.52	0.61	4.37	4.28	7.7	66.8	0.61	0.54
Foreign	Unmatched	0.090	0.107	-5.8		-0.58	0.56	0.09	0.16	-20.7		-1.90	0.06
owned	Matched	0.091	0.146	-18.6	-221	-1.26	0.21	0.09	0.18	-25.3	-22	-1.77	0.08
Age	Unmatched	29.342	21.816	33.7		3.90	0.00	29.15	24.80	18.6		1.98	0.05
	Matched	29.491	27.513	8.8	73.7	0.64	0.52	29.51	28.05	6.3	66.4	0.45	0.65
Patent	Unmatched	0.04	0.02	11.5		1.43	0.15	0.04	0.04	0.3		0.03	0.98
obtained	Matched	0.04	0.03	6	47.5	0.41	0.69	0.04	0.04	-0.5	-50.5	-0.03	0.98
K/L	Unmatched	0.634	0.620	1		0.08	0.94	0.64	0.73	-5.1		-0.40	0.69
	Matched	0.639	0.686	-3.3	-236.6	-0.34	0.73	0.65	0.80	-8.3	-62.7	-0.93	0.35
Productivity t-1	Unmatched	13.738	13.361	36.1		3.59	0.00	13.74	13.67	6.5		0.63	0.53
	Matched	13.746	13.739	0.7	98	0.05	0.96	13.75	13.91	-15.5	-138	-1.18	0.24
Network	Unmatched	0.21	0.16	12		1.31	0.19	0.20	0.22	-5.6		-0.55	0.58
	Matched	0.209	0.141	17.6	-46.6	1.32	0.19	0.206	0.195	2.5	54.3	0.19	0.85
Group	Unmatched	0.171	0.147	6.6		0.70	0.48	0.165	0.200	-8.9		-0.87	0.39
	Matched	0.173	0.169	1	85.4	0.07	0.95	0.168	0.221	-13.7	-54.4	-0.96	0.34
Stores	Unmatched	2.883	2.781	0.5		0.04	0.97	2.917	3.982	-3.9		-0.29	0.77
	Matched	2.90	2.27	3.3	-518.4	0.80	0.42	2.94	2.24	2.6	34.2	0.89	0.38
In Montevideo	Unmatched	0.847	0.757	22.6		2.18	0.03	0.853	0.796	15.1		1.44	0.15
	Matched	0.845	0.783	15.7	30.8	1.17	0.24	0.850	0.783	17.8	-18	1.26	0.21

Table 6. Effects from Financial Support

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	**IE effort**	**Private IE effort**	**R&D[1]**	**Innovative sales[2]**	**Applied for patents**	**Productivity**
ATT	4.492***	1.922**	8.242***	14.63***	0.0268	0.123
	(1.230)	(0.850)	(2.643)	(4.306)	(0.0263)	(0.0990)
Treated group	110	110	110	110	110	110
Off support	1	1	1	1	1	1
Potential control group	2,803	2,803	2,803	2,803	2,803	2,803

Notes: [1]Share of innovation expenditures that is R&D. [2]Share of sales due to innovation.
Bootstrapped standard errors in parentheses. 100 replications *** p<0.01, ** p<0.05, * p<0.1.

Receiving financial support significantly increased the share of innovative sales relative to firms in the control group. Finally, receiving financial support had no statistically significant effect on productivity. This result is not surprising since we were looking at a very short time horizon, and effects on productivity can become apparent only much later. Probably for the same reason, results show that there was no statistical effect on the application for patents in the current period.

Table 7 presents the results taking into account only firms with positive investment. These results show that financial support had no stimulating effect on private investment, indicating that there was no crowding-out effect. Firms added the amount of subsidies to their private investment, not substituting private investment with public funds, but also not increasing their private innovation investment. Results show that financially supported firms made larger R&D investments. On the other hand, there were no significant effects on the share of innovative sales, applications for patents, or productivity.

Table 7. Effects from Financial Support: Firms with Positive IE

	(1)	(2)	(3)	(4)	(5)	(6)
	IE effort	**Private effort**	**R&D[1]**	**Innovative sales[2]**	**Applied for patents**	**Productivity**
ATT	2.531**	−0.107	5.427*	6.436	0.00561	−0.0151
	(1.055)	(0.937)	(3.005)	(3.928)	(0.0250)	(0.100)
Treated group	107	107	107	107	107	107
Off support	2	2	2	2	2	2
Potential control group	1,273	1,273	1,273	1,273	1,273	1,273

Notes: [1]Share of innovation expenditure that is R&D. [2]Share of sales due to innovation.
Bootstrapped standard errors in parentheses. 100 replications *** p<0.01, ** p<0.05, * p<0.1.

To check the robustness of our results, we used the same methodology but without doing the imputation procedure. In this case, the treatment group comprised 80 firms, compared with 109 firms using the imputation procedure. Results in Tables A.2 and A.3 in the Appendix indicate that results were robust to the imputation procedure. Quantitative results were very similar, with the exception of the results for R&D, where the impact was smaller when the imputation procedure was not considered.

To summarize, the results lead to the conclusion that there was no crowding-out effect of private funds by public funds. Also, public financing in Uruguay seems to induce some increase in private innovation effort, R&D, and innovation expenditures, and has positive effects on sales derived from innovation. However, public funds do not seem to significantly stimulate private expenditures by firms that would carry out innovation activities in the absence of subsidies. Finally, probably due to the short time period in which the evaluation was conducted, there were no effects on applied patents and productivity. In what follows, we distinguish between the service and manufacturing sectors.

4.2 Results for the Service and Manufacturing Sectors

Because of the existing heterogeneities between service and manufacturing firms, and therefore the different impact that financial support could have on each sector, in this section, we present results for the manufacturing and service sectors separately. Table 8 reports the marginal effects of the probability of receiving public financial support. Size is still a very important determinant in the service sector, while less so in the manufacturing sector. When restricting the sample to firms that show positive innovation expenditures, size becomes statistically insignificant. In the manufacturing sector, being foreign owned negatively affects the probability of being financially supported, while no other variable seems to have statistically significant effects on probability, except some of the sectoral dummies.

Table 8. Estimation of the Propensity Score

	Services		**Manufacturing**	
	(1)	(2)	(3)	(4)
Control group	**All**	**IE>0**	**All**	**IE>0**
Size(t−1)	0.00801***	0.0175***	0.0194***	0.0116
	(0.00212)	(0.00629)	(0.00682)	(0.0124)
Foreign owned	−0.00714	−0.0249	−0.0357**	−0.0545**
	(0.00674)	(0.0190)	(0.0144)	(0.0270)
Age	−0.000133	−0.000621	−4.91e−05	0.000109
	(0.000282)	(0.000816)	(0.000701)	(0.00119)
Age^2	9.31e−07	4.29e−06	4.08e−06	5.32e−06
	(2.37e−06)	(6.38e−06)	(7.02e−06)	(1.16e−05)
Obtained patent	0.0243	0.0204	−0.00501	−0.0408
	(0.0338)	(0.0515)	(0.0365)	(0.0408)
K_L(t−1)	3.34e−05	2.85e−05	−0.00756	−0.00822
	(0.000974)	(0.00262)	(0.00873)	(0.0138)
Productivity(t−1)	0.00326	0.00427	0.00385	−0.0158
	(0.00313)	(0.00862)	(0.00897)	(0.0172)
Network	0.00576	−0.00558	0.0298	0.0209
	(0.00732)	(0.0168)	(0.0253)	(0.0335)
Group	−0.00492	−0.0150	0.0110	0.0209
	(0.00631)	(0.0185)	(0.0222)	(0.0372)
Stores	−7.17e−05	−0.000261	−0.00238	−0.00335
	(0.000121)	(0.000425)	(0.00339)	(0.00563)
Montevideo	0.00954*	0.0267	0.00308	0.00826
	(0.00557)	(0.0167)	(0.0176)	(0.0291)
Industry dummies	yes	yes	yes	yes

Observations	1,758	684	1,156	698
Log likelihood	−167.1	−135.1	−255.6	−218.9

Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Tables A.4 and A.5 and Figures A.1 and A.2 in the Appendix report the balance test for the covariates for treatment and control groups, and the estimated propensity score (to check for common support). The results are satisfactory, showing that, after the matching, the mean of the covariates in the control and treatment groups cannot be rejected to be equal in the sample. Also, analysis of the estimated propensity scores led to the conclusion that significant overlap is achieved.

Table 9 shows the effects of financial support on the financially supported firms in the service and manufacturing sectors. Results show that financial support stimulated both private and total investment in the manufacturing sector. Financially supported firms invested 2 percent more of their sales in innovation than non-supported firms. This result indicates that not only does no crowding-out effect exist, but also that financial support increases private innovation investment. On the contrary, in the service sector, the mean of private IE effort is positive but not significantly different from zero, while total investment is higher for the treated firms. This also signals that there is no crowding-out effect and that instead firms add the amount of the support to their private investment. This led us to conclude that in neither sector was there crowding-out effect and that for the manufacturing sector there was evidence of a positive effect on private investment.

Table 9. Financial Support Effects on Supported Firms

Dependent variable	(1) IE effort	(2) Private IE effort	(3) R&D[1]	(4) Innovative sales[2]	(5) Applied for patents	(6) Productivity
Service sector	4.370**	1.490	8.753*	20.73***	0.0632	0.366**
	(1.815)	(1.223)	(4.969)	(7.287)	(0.0487)	(0.178)
Treated group	38	38	38	38	38	38
Off support	1	1	1	1	1	1
Potential control group	1,758	1,758	1,776	1,775	1,777	1,778
Manufacturing sector	4.402**	1.951*	6.704**	9.924*	-0.0139	-0.0102
	(1.999)	(1.159)	(3.303)	(5.240)	(0.0224)	(0.110)
Treated group	72	72	72	72	72	72
Off support	0	0	0	0	0	0
Potential control group	1,156	1,156	1,157	1,156	1,158	1,159

Notes: *[1]Share of innovation expenditure that is R&D. [2]Share of sales due to innovation.*
*Bootstrapped standard errors in parentheses. 100 replications. *** p<0.01, ** p<0.05, * p<0.1.*

R&D investment as a proportion of innovation expenditures was higher in treated firms, both in the service and manufacturing sectors. Innovative sales were higher in financially supported firms than in control firms in both sectors. This effect in the service sector was 20 percent higher innovative sales than for control firms, compared with 9 percent in the manufacturing sector. Productivity was higher in financially supported firms in the service sector, while in the manufacturing sector this effect was negative, though not statistically significant. The first result was unexpected given the short time frame of the evaluation. Finally, there were no significant effects on applied patents.

When restricting the sample to firms with positive innovation expenditures (Table 10), the mean difference in private effort between the treated and control groups was not statistically significant in either sector. This means that there was no crowding-out effect of public financial support. Also, there was no stimulating effect in total innovation expenditures, R&D expenditures as a proportion of innovation expenditures, applied patents, or private effort. Further, the effects on innovative sales and productivity were not significant.

Table 10. Financial Support Effects on Supported Firms if IE>0

	(1) IE effort	(2) Private effort	(3) R&D[1]	(4) Innovative sales[2]	(5) Applied for patents	(6) Productivity
Service sector	2.866	−0.0910	4.364	6.341	0.0288	0.230
	(1.908)	(1.227)	(5.793)	(8.986)	(0.0615)	(0.174)
Treated group	38	38	38	38	38	38
Off support	0	0	0	0	0	0
Potential control group	684	684	684	684	684	684
Manufacturing sector	3.005	0.501	3.912	4.585	−0.0435	0.00676
	(1.899)	(1.287)	(3.662)	(4.955)	(0.0333)	(0.125)
Treated group	69	69	69	69	69	69
Off support	2	2	2	2	2	2
Potential control group	698	698	698	698	698	698

***Notes**:* [1]Share of innovation expenditure that is R&D. [2]Share of sales due to innovation.
Bootstrapped standard errors in parentheses. 100 replications. *** p<0.01, ** p<0.05, * p<0.1.

To summarize, when analyzing the differential impact of financial support in the service and manufacturing sectors, the results led us to conclude that there was no crowding-out effect of private funds by public funds in either sector, but that there were no effects on firms that would have carried out innovation activities in any case.

5. Conclusion

This paper evaluates the impact of public financial support on innovation using quasi-experimental methods and innovation survey data from Uruguay for the manufacturing and service sectors. This paper contributes to the literature in three ways. First, it presents an impact evaluation of public financial support for innovation on innovation expenditures. Therefore the analysis is extended beyond the R&D context. Second, it analyzes the possible heterogeneity of effects on services and manufacturing. Finally, the evaluation is for a developing Latin American country, where the empirical evidence is scarce.

Based on the results, we conclude that there is no crowding-out effect of private funds by public funds, and that public financing in Uruguay seems to induce some increase in private innovation effort. Moreover, financial support induces some increase in R&D expenditures as a proportion of innovation expenditures and in innovative sales. However, public funds do not significantly stimulate private expenditures by firms that would carry out innovation activities in the absence of financial support.

Based on the results of analyzing the differential impact of financial support in the service and manufacturing sectors, we conclude that there is no crowding-out effect of private funds by public funds in either sector but that there is a crowding-in effect on manufacturing firms. The positive impact of public funding on R&D and innovative sales is larger in the service sector than in manufacturing. An unexpected (given the short time frame of the evaluation) positive effect of public funding on productivity was found for service firms.

When the control group was restricted to firms that innovate, the above-mentioned positive effects vanished. This implies that the positive impact is probably an inducement effect (i.e., firms are induced to innovate thanks to the public funding).

These results call for a re-thinking of public innovation policy. On one hand, there is evidence of the bias toward manufacturing firms in terms of public financial support. But results show that the positive effects could be even bigger for service firms. This result raises the question of how public funds are and should be targeted to the service sector.

Finally, more research is needed in the area of relative effectiveness of different instruments of support for innovation. Such research could help focus instruments where they would have the biggest impact.

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Appendix

Table A.1. Summary of Available Evidence

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
Aerts and Czarnitzki (2004)	Belgium (Flanders)	Financial support	R&D expenditure (net of subsidy): + Patent applications: n.s.	Innovation survey (CIS3: 1998–2000) linked to other data resources on patents and financial statements *Unit of analysis:* manufacturing, computer services, R&D services and business-related services firms	Non-parametric matching
Almus and Czarnitzki (2003)	Germany (Eastern)	All public R&D schemes	R&D expenditure (net of subsidy): +	Innovation panel (1995, 97, 99) *Unit of analysis:* manufacturing firms	Non-parametric matching
Avellar (2011)	Brazil	Fiscal incentives	R&D expenditure (net of subsidy): + Expenditure on innovative activities (net of subsidy): +	Innovation survey (2006–08) *Unit of analysis:* all firms	Non-parametric matching
		Financial support	R&D expenditure (net of subsidy): + Expenditure on innovative activities (net of subsidy): +		
Bloom, Griffith, and Van Reenen (2002)	Australia, Canada, France, Germany, Italy, Spain, United Kingdom, and U.S.	Fiscal incentives	R&D expenditure: +	Panel with tax information from national sources and R&D expenditure at the country level from OECD database (1979–97) *Unit of analysis:* national manufacturing sectors	Instrumental variables with fixed effects
Busom (2000)	Spain	Financial support	R&D expenditure (net of subsidy): + R&D personnel: +	Innovation survey (1988) *Unit of analysis:* all firms	Heckman's selection model
Crespi, Maffioli, and Melendez (2011)	Colombia	Financial support and promotion of research alliances	Product innovation: + Labor productivity: +	Industrial, innovation and administrative panel (1995–2007) *Unit of analysis:* manufacturing firms	Fixed effects

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
Czarnitzki (2002)	Germany	Financial support	R&D expenditure: +	Innovation panel (1994, 96, 98), database with credit information from a credit rating agency and patenting activity from the national patent office *Unit of analysis:* manufacturing SMEs	Tobit model
Czarnitzki and Fier (2002)	Germany	Financial support	Expenditure on innovative activities (net of subsidy): +	Innovation panel (1997, 99) *Unit of analysis:* service firms	Non-parametric matching
Czarnitzki, Hanel, and Rosa (2011)	Canada	Fiscal incentives	Number of new products: + Sales of new products: + Profitability: n.s. Domestic market share: n.s. International market share: n.s. Allowed keeping up with competitors: n.s.	Innovation survey (1999) *Unit of analysis:* manufacturing firms	Non-parametric matching
Czarnitzki and Hussinger (2004)	Germany	Financial support	R&D expenditure (net of subsidy): + Patent applications: +	Innovation panel, public information on R&D funding, database with credit information from a credit rating agency and patenting activity from the national patent office *Unit of analysis:* manufacturing firms	Non-parametric matching to estimate the policy effect on R&D expenditure and probit model to estimate the effect of R&D on patent application.
Duguet (2004)	France	Financial support	R&D expenditure (net of subsidy): +	R&D surveys and fiscal information on firms (1985–97) *Unit of analysis:* all firms	Non-parametric matching
González, Jaumandreu, and Pazó (2005)	Spain	Financial support	Decision to invest on R&D: + R&D expenditure (net of subsidy): +	Entrepreneurial panel (1990–99) *Unit of analysis:* manufacturing firms	Tobit model

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
González and Pazó (2008)	Spain	Financial support	R&D expenditure (net of subsidy): +	Entrepreneurial panel (1990–99). *Unit of analysis:* manufacturing firms	Non-parametric matching
Görg and Strobl (2007)	Ireland	Financial support	R&D expenditure (net of subsidy): n.s.	Entrepreneurial panel and public database on R&D grants (1999–2002). *Unit of analysis:* manufacturing firms	Difference in differences with non-parametric matching.
Hall (1993)	USA	Fiscal incentives	R&D expenditure (net of subsidy): +	Entrepreneurial panel (1980–91) *Unit of analysis:* manufacturing firms	Instrumental variables
Hall and Maffioli (2008)	Argentina (1994–2001)	Financial support	R&D expenditure (net of subsidy): +	Innovation panel (1995–2001) *Unit of analysis:* all firms	Instrumental variables with fixed effects
	Argentina (2001–04)		R&D expenditure: + Sales of new products: n.s. Sales growth: n.s. Employment growth: n.s. Exports growth: n.s. Productivity growth: n.s.	Innovation panel (2002–04) *Unit of analysis:* all firms	Difference in differences with non-parametric matching
	Brazil (1996–2003)		R&D expenditure (net of subsidy): +	Innovation panel (1997–2003) *Unit of analysis:* all firms	Differences with non-parametric matching
			Patents: n.s. Employment growth: + Sales growth: + Productivity growth: n.s.		Difference in differences with non-parametric matching
	Brazil (1999–2003)		R&D expenditure (net of subsidy): +	Innovation panel (1999–2003) *Unit of analysis:* all firms	Differences with non-parametric matching

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
			Patents: + Employment growth: n.s. Sales growth: n.s. Productivity growth: n.s.		Difference in differences with non-parametric matching
	Chile (1998–2002)		R&D expenditure: n.s. Patents: n.s. New products: n.s. Sales growth: n.s. Employment growth: n.s. Exports growth: n.s. Productivity growth: n.s.	Innovation panel (1999–2001) *Unit of analysis:* all firms	Difference in differences with non-parametric matching
			Product innovation: n.s. Process innovation: n.s. Financial access: n.s. Training and organization activities: n.s. Use of external knowledge: +		Differences with non-parametric matching
	Panama (2000–03)		R&D expenditure: + Sales growth: n.s. Productivity growth: + Exports growth: n.s. Sales of new products: +	Innovation panel (2001–03) *Unit of analysis:* all firms	Fixed effects with non-parametric matching

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
			Product innovation: + Process innovation: + Financial access: + Training and organization activities: n.s. Use of external knowledge: +		Differences with non-parametric matching
Hujer and Radić (2005)	Germany	All public R&D schemes	New products: + New or improved products: n.s.	Entrepreneurial panel (1999–2000) *Unit of analysis:* all firms	Probit model
			New products: + New or improved products: +		Non-parametric matching
			New products: n.s. New or improved products: -		Simultaneous two-equation probit model
			New products: n.s. New or improved products: n.s.		Difference in differences
Hussinger (2003)	Germany	Financial support	R&D expenditure (net of subsidy): +	Innovation panel, public information on R&D funding and patent application, and database with credit information from a credit rating agency *Unit of analysis:* manufacturing firms	Heckman's selection model and semi-parametric two-step selection models
Klette and Moen (2012)	Norway	Financial support	R&D expenditure: +	Innovation panel (1982–95) *Unit of analysis:* high-tech firms	Fixed effects regression
Lach (2002)	Israel	Financial support	R&D expenditure (net of subsidy) : n.s.	Innovation panel (1990–95) *Unit of analysis:* manufacturing firms	Difference in differences

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
Lokshin and Mohnen (2013)	Netherlands	Fiscal incentives	Wages of R&D workers: +	Innovation panel and census data on production (1997–2004) *Unit of analysis:* all firms	Instrumental variables
Lööfand Heshmati (2005)	Sweden	Financial support	R&D expenditure (net of subsidy): +	Innovation survey (CIS3: 1998–2000) *Unit of analysis:* all firms	Non-parametric matching
López-Acevedo and Tan (2010)	Mexico	Different programs supporting innovation in SME's	Sales: + Employment: + Wages: n.s.	Industrial panel linked to program participation information (1994–2005) *Unit of analysis:* SMEs	Fixed effects with non-parametric matching
	Chile		Product or process innovation: + Probability of investing in R&D: + Implementation of quality control systems: + Provision of training for employees: + Sales: - Labor: + Productivity: -	Innovation and entrepreneurial panel (1992–2006) *Unit of analysis:* SMEs	Difference in differences with non-parametric matching.
	Colombia		Sales: + Employment: + Wages: + Exports: n.s.	Innovation and entrepreneurial panel linked to administrative tax information (1992–2006) *Unit of analysis:* SMEs	Fixed effects with non-parametric matching
	Peru		Profits: + Sales: +	Industrial panel linked to program participation information (1994–2005) *Unit of analysis:* SMEs	Fixed effects with non-parametric matching

Author(s)	Country	Policy measure	Outcome variable(s) and impact	Data source	Method
Özçelikand Taymaz (2008)	Turkey	Financial support	R&D expenditure (net of subsidy): +	Innovation panel, entrepreneurial panel and database with information on R&D support (1993–2001) *Unit of analysis:* all firms.	Random effects Tobit, fixed effects regression and dynamic models
Suetens (2002)	Belgium (Flanders)	Financial support	R&D personnel: n.s.	Innovation panel and annual national accounts database (1992–99) *Unit of analysis:* all firms	Instrumental variables with fixed effects
Wallsten (2000)	USA	Financial support	R&D expenditure (net of subsidy): n.s. Employment: n.s.	Financial reports (1990–92) *Unit of analysis:* small high-tech firms	Instrumental variables

Note: n.s.=not significant effect at the 5 % level, +(-) = positive (negative) effect found.

Table A.2. Effects from Financial Support: Sample without Imputed Observations

Dependent variable	(1) IE effort	(2) Private effort	(3) Innovative sales 2/	(4) R&D 1/	(5) Applied for Patents	(6) Productivity
ATT	4.534***	2.134**	15.23***	5.032*	0.0154	−0.0263
	(1.489)	(1.027)	(4.672)	(3.015)	(0.0312)	(0.130)
Treated group	78	78	78	78	78	78
Off support	2	2	2	2	2	2
Potential control group	1,861	1,861	1,861	1,861	1,861	1,861

Notes*:* [1]Share of innovation expenditure that is R&D. [2]Share of sales due to innovation.
Bootstrapped standard errors in parentheses. 100 replications *** p<0.01, ** p<0.05, * p<0.1.

Table A.3. Effects from Financial Support using Sample with IE>0: Sample without Imputed Observations

	(1) IE effort	(2) Private effort	(3) Innovative sales 2/	(4) R&D 1/	(5) Applied for Patents	(6) Productivity
ATT	3.335**	0.903	6.690	2.511	0.00281	−0.0981
	(1.508)	(1.111)	(5.721)	(3.516)	(0.0357)	(0.119)
Treated group	77	77	77	77	77	77
Off support	2	2	2	2	2	2
Potential control group	918	918	918	918	918	918

Notes*:* [1]Share of innovation expenditure that is R&D. [2]Share of sales due to innovation.
Bootstrapped standard errors in parentheses. 100 replications *** p<0.01, ** p<0.05, * p<0.1.

Table A.4. Mean Comparison of Supported Firms, Non-supported Firms on Selected Controls in the Service Sector

Variable	Unmatched Matched	Mean Treated	Control	%bias	%reduct bias	t-test t	p>t	Mean Treated	Control	%bias	%reduct bias	t-test t	p>t
Size	Unmatched	4.69	3.70	63.7		4.4	0	4.74	4.18	35.3		2.30	0.02
	Matched	4.57	4.44	8.5	86.6	0.38	0.704	4.62	4.48	8.7	75.2	0.39	0.70
Foreign	Unmatched	0.08	0.09	-6.2		-0.37	0.714	0.08	0.15	-21.1		-1.14	0.33
owned	Matched	0.08	0.10	-9	-46.9	-0.38	0.708	0.08	0.16	-23.8	-12.7	-0.98	0.35
Age	Unmatched	23.90	18.25	24.9		1.89	0.058	23.95	20.64	13.8		0.94	0.51
	Matched	24.34	18.75	24.7	1.1	1.02	0.31	24.41	20.64	15.7	-13.7	0.66	0.38
Patent	Unmatched	0.05	0.01	22.6		2.2	0.028	0.05	0.03	12.5		0.88	0.97
obtained	Matched	0.05	0.03	11.2	50.4	0.41	0.681	0.05	0.05	1	91.8	0.04	0.97
K/L	Unmatched	0.84	0.65	11.7		0.58	0.565	0.86	0.74	5.2		0.24	0.81
	Matched	0.86	0.79	4.1	64.5	0.18	0.861	0.88	0.63	10.9	-110.7	0.98	0.33
Productivity t-1	Unmatched	13.39	13.10	25.5		1.73	0.084	13.40	13.31	8.2		0.53	0.60
	Matched	13.41	13.29	10.4	59.3	0.44	0.665	13.42	13.42	-0.4	94.7	-0.02	0.99
Network	Unmatched	0.28	0.20	19.4		1.28	0.2	0.26	0.30	-8.9		-0.52	0.60
	Matched	0.29	0.21	18.8	2.9	0.8	0.429	0.27	0.25	4.8	46	0.21	0.84
Group	Unmatched	0.15	0.14	3.3		0.21	0.833	0.16	0.20	-12		-0.69	0.49
	Matched	0.16	0.13	8.8	-164.8	0.38	0.702	0.16	0.20	-8.9	26	-0.37	0.70
Stores	Unmatched	4.79	3.39	5.7		0.27	0.791	4.89	6.07	-3		-0.14	0.89
	Matched	4.89	2.95	7.9	-39.2	0.95	0.344	5.00	3.22	4.6	-51.1	0.83	0.41
In Montevideo	Unmatched	0.8718	0.7353	34.7		1.92	0.055	0.8947	0.7988	26.7		1.45	0.15
	Matched	0.8684	0.8022	16.8	51.5	0.76	0.447	0.8919	0.8382	15	44	0.66	0.51

Table A.5 Mean Comparison of Supported Firms, Non-supported Firms on Selected Controls in the Manufacturing Sector

Variable	Unmatched Matched	Mean Treated	Control	%bias	%reduct bias	t-test t	p>t	Mean Treated	Control	%bias	%reduct bias	t-test p>t
Size	Unmatched	4.22	3.81	36.6		2.83	0.006	4.22	4.12	8.9		0.69
	Matched	4.22	4.21	1.3	96.5	0.08	0.773	4.26	4.29	-2.9	67.6	-0.18
Foreign	Unmatched	0.10	0.13	-9.8		-0.77	0.651	0.10	0.18	-22.4		-1.64
owned	Matched	0.10	0.17	-21.5	-119.3	-1.2	0.841	0.10	0.19	-25.9	-15.6	-1.45
Age	Unmatched	32.29	27.48	21.8		1.9	0.973	31.93	29.09	12.5		1.03
	Matched	32.29	28.01	19.4	11.1	1.19	0.635	32.57	28.84	16.4	-31.2	0.97
Patent	Unmatched	0.03	0.03	0.6		0.05	0.008	0.03	0.04	-8.8		-0.65
obtained	Matched	0.03	0.04	-7.8	-1149	-0.42	0.721	0.03	0.05	-12.1	-37.2	-0.66
K/L	Unmatched	0.52	0.59	-6.7		-0.43	0.401	0.53	0.72	-17.7		-1.13
	Matched	0.52	0.66	-12.9	-94.3	-0.81	0.422	0.54	0.73	-17.6	0.5	-0.95
Productivity t-1	Unmatched	13.93	13.78	16.2		1.2	0.444	13.92	14.05	-15.3		-1.15
	Matched	13.93	13.90	2.5	84.6	0.15	0.787	13.94	14.05	-12.4	19.1	-0.70
Network	Unmatched	0.17	0.10	19.7		1.81	0.001	0.17	0.14	7		0.58
	Matched	0.17	0.12	14.1	28.7	0.81	0.964	0.17	0.16	4.3	37.8	0.24
Group	Unmatched	0.18	0.15	6.8		0.58	0.058	0.17	0.19	-6.6		-0.52
	Matched	0.18	0.17	1.8	74	0.1	0.684	0.17	0.20	-5.9	10.6	-0.33
Stores	Unmatched	1.85	1.81	1.9		0.12	0.958	1.86	1.83	1.7		0.11
	Matched	1.85	1.76	4.3	-130	0.25	0.654	1.87	1.61	13.7	-717.3	1.14
In Montevideo		0.8333	0.7915	10.7		0.85		0.831	0.7927	9.8		0.76
		0.8333	0.7913	10.7	-0.5	0.64		0.8261	0.8	6.7	31.9	0.38

Figure A.1. Propensity Score of Treated and Potential Controls Considering all Firms (left panel) and only Observations with Positive Innovation Expenditure (right panel), Service Sector

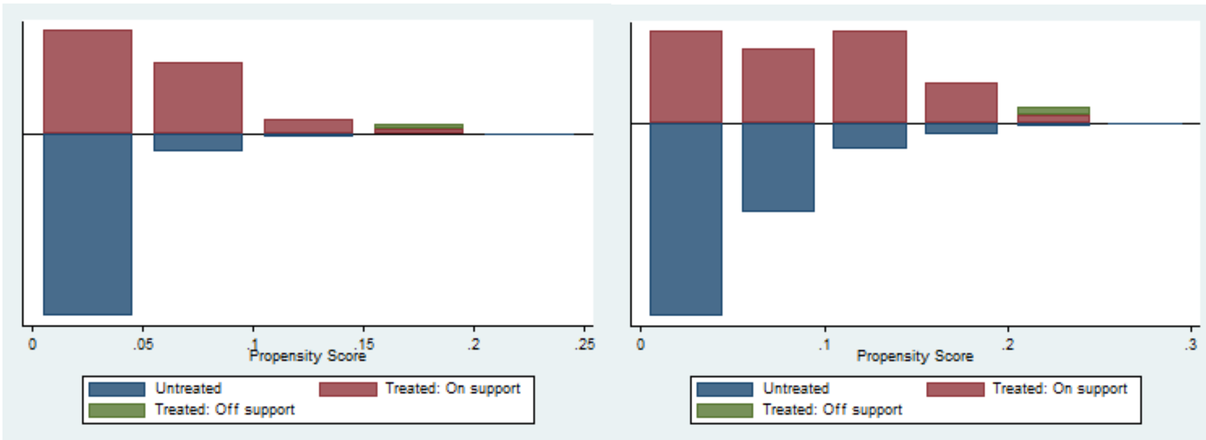

Figure A.2. Propensity Score of Treated and Potential Controls Considering all Firms (left panel) and only Observations with Positive Innovation Expenditure (right panel), Manufacturing Sector