Does BNDES Innovation Credit Boost Firms' R&D Expenditures? Evidence from Brazilian Panel Data*

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Abstract

We evaluate the effects of BNDES direct credit support for R&D on firms' innovation efforts. We use data from *Pesquisa de Inovação* (Pintec, IBGE) for the period of 2003-2014, a Brazilian firm-level data set that surveys innovation activities, and BNDES data on credit for innovation over the period 2004-2014, to estimate the effects of credit on firms' R&D Expenditures. We adopt a Fixed Effects (FE) approach to deal with the endogeneity problem associated to the selection of firms that received BNDES innovation credit and estimate the impact of BNDES support. We also use a complementary approach based on the Difference-in-Differences estimator. Our findings show evidence of positive and significant effects of BNDES credit on firms' R&D expenditures for both estimators. Based on FE estimates, we obtain BNDES-supported firms tend to invest at least 30% more on R&D than non-supported companies in the analyzed period.

JEL classification: D04; O31
Keywords: BNDES; Credit; Brazil; Evaluation; Innovation; Firms; Panel Data

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1 Introduction

The purpose of this paper is to evaluate the impact of BNDES innovation credit on firms' R&D Expenditures. There is a theoretical consensus that public support is needed to promote firms' innovation activities, especially research and development (R&D), which can result in the development of new products and processes for society. This process can ultimately lead to new market sales and create new employment opportunities within individual firms.

Direct support for innovation based on credit or grants are generally offered in many countries to companies based on the idea that, without these incentives, firms' investment in R&D would be suboptimal from the social point of view. For the one side, the higher level of uncertainty commonly related to innovation projects lead to a lower degree of interest among private funds to finance such investments.

For the other side, the semi-public characteristic of goods such as knowledge causes a lower degree of appropriability. Thus, as appropriability of knowledge is incomplete, externalities arise, which could lead to underinvestment in innovation activities (Nelson,1959 and Arrow, 1962). In addition, it is important to consider interaction between agents and innovative networks, which might generate spillover effects (Teece, 1986). Hence, some kind of public incentive and coordination is justified to incentive private agents to interact and devote resources to innovation (Mazzucato, 2011).

In order to support innovation, the Brazilian government provides a variety of instruments to support R&D activities and promote innovation networks. Governmental resources for innovative activities increased from BR$ 15,8 billion, in 2000, to BR$ 85, 6 billion, in 2013, accordingly to the Brazilian Science and Technological Ministry. BNDES is one the most important instruments, offering direct innovation credit with attractive financial conditions to companies.

This paper uses a microeconometric approach to evaluate BNDES effects on firms' innovation efforts. The related empirical literature in general finds a positive effect of public credit on firms' R&D Expenditures (e.g., Hall 1993; Berger, 1993; Irwin and Klenow, 1996; David, Hall and Toole, 2000; Bloom, Griffith und Van Reenen, 2002; McKenzie and Sershun, 2010).

Most of the empirical literature on direct support for innovation focuses on input additionality. These studies are typically based on firm-level panel data and usually estimate R&D demand equations using a dummy variable for the innovation support (see Hall and van Reenen 2000). Although the focus on input additionality is fully justified as a main criterion for evaluating direct support effectiveness, a smaller number of evaluations have also addressed

the effects of R&D incentives on innovation outputs. Cappelen et al (2008), for instance, investigated output additionality in terms of introducing new products and processes and found significant effects for innovations with rather low degree of novelty.

Brazilian empirical literature on innovation policy impact estimates the effects of different government programs, most of them focused on tax incentives. For example, Avellar (2009) measures governmental programs impacts on R&D expenditures, using Pintec and propensity score matching techniques. Her main results point out to significant impacts on R&D expenditures. Araujo et al (2012) measure the impact of grants on R&D employment, showing that R&D employment of the treated group grew at a higher rate than those of the control group.

We noted that, despite there is an expressive number of papers that evaluate different Brazilian innovation instruments, none of them focus specifically on evaluating BNDES innovation credit on input additionality. This paper contributes originally to the empirical literature as it is the first one to evaluate the role of BNDES in the Brazilian Innovation System.

This paper is organized in six section, including this Introduction. Next section present a brief description of the main BNDES credit lines and programs to support firms' innovation activities. Section three discuss the Empirical Strategy used to estimated the effects of BNDES on firms' R&D Expenditures. Section four describe the dataset, focusing on variables used in the models. Section five presents the estimation results of our empirical strategy and, finally, section six discuss the main findings of the empirical analysis and its implications.

2 BNDES Innovation Credit

Within-companies innovation support is a strategic priority for BNDES credit policy, due mainly to its potential in increasing companies' productivity and competitiveness. BNDES innovation support has begun in the 1960s with the establishment of the Technological Fund (Funtec), created to finance the technological development in Brazil. After a long period without creating additional financing instruments dedicated to innovation, the issue came back to the fore in the late 1990s through the creation of sectorial credit programs and equity funds to support technology-based companies.

For example, in 1997 BNDES created Prosoft to support and promote innovation in the information technology services sector (IT). In 2004, Profarma was created to support pharmaceutical industry, a well-known intensive R&D sector. After that, BNDES launched Proengenharia to support

local engineering in sectors such as automotive, capital goods, defense, oil & gas, chemical, petrochemical and shipbuilding.

On the 2000s, BNDES launched horizontal credit lines to support R&D and project innovation in all companies, regardless of its size or sector of its activity: *Linhas de Inovação*. The lines were created in addition to the existing sectorial support structure (Prosoft, Proengenharia and Profarma).

Those programs offered better financial conditions to encourage companies to invest in innovation projects. Their interest rates are lower than the ones charged in other BNDES lines and sometimes fixed. BNDES innovation credit finances equipment acquisition; training of employees; acquisition and licensing of intellectual property rights; registration of patents, trademarks, designs and plant varieties; research and development activities; among others.

To look closer to BNDES innovation credit, Table 1 presents BNDES data at the financing-level (or loan-level) on its support to firms' innovation activities during the period 2004-2014. BNDES had 598 financing operations with companies in the whole period and this number increased over time, going from 10 operations in 2004 to 106 operations ten years later.

BNDES sectorial programs, Profarma, Proengenharia and Prosoft, concentrated almost 57% of the operations in the period. Table 1 also shows that the horizontal lines for supporting firms' innovation, like the innovation lines, are the second group in number of operations.

The analysis of the evolution of contracting for the horizontal lines over time shows that innovation line are gradually substituted for Innovation/PSI from 2012 on, because of the more attractive financial conditions of PSI Innovation Program. The "Others" category includes several BNDES lines that were irrelevant in terms of operations or those that were extincted.

On the other hand, Table 2 shows the total value of the loans given by BNDES for firms to support innovation activities in the 2004-2014 period. It can be seen that BNDES gave more than BR$ 16 billion in credit for firms during the whole period. The total amount of loans grew over time, mainly after 2009, coinciding with the period of BNDES expansion in the Brazilian credit market.

Table 1: Number of financing operations by BNDES Innovation Lines/Programs over time

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Profarma	1	15	16	17	18	17	12	14	13	15	13	151
Inovação/PSI	0	0	0	0	0	0	0	0	24	65	39	128
Prosoft	7	4	8	7	14	14	12	13	11	7	23	120
Linhas Inovação	0	0	1	15	10	9	14	23	7	0	0	79
Proengenharia	0	0	0	0	2	6	6	5	13	20	13	65
Others	2	2	4	1	0	3	7	10	2	6	18	55
Total	10	21	29	40	44	49	51	65	70	113	106	598

Source: BNDES.

Table 2: Total loans by BNDES innovation Lines/Programs over time

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
Proengenharia	0	0	0	0	118,723	286,194	700,309	584,952	824,054	1,860,348	579,422	4,954,002
Inovação/PSI	0	0	0	0	0	0	0	0	676,757	2,220,786	715,372	3,612,915
Profarma	16,873	102,004	230,802	526,629	114,775	234,476	45,236	343,809	217,060	742,973	475,863	3,050,501
Prosoft	14,885	56,562	24,629	22,877	235,044	70,499	56,721	90,936	148,918	625,478	209,441	1,555,991
Linhas Inovação	0	0	6,788	180,175	44,473	204,416	217,787	366,332	366,188	0	0	1,386,159
Others	38,000	13,557	10,265	5,025	0	21,779	1,088,252	354,324	29,494	27,185	327,969	1,915,851
Total	69,758	172,123	272,484	734,706	513,015	817,364	2,108,305	1,740,353	2,262,471	5,476,770	2,308,067	16,475,419

Notes: Total loans in BR$ thousands current values. Source: BNDES.

In terms of the amount of credit relative magnitude, Proengenharia was the more relevant BNDES Program, with almost BR$ 5 billion in operations in the whole period. The total amount of loans for BNDES horizontal lines were roughly BR$ 3.6 billion in the period, being the second most relevant category of financing. The amount of credit for Profarma (approximately BR$ 3 billion) is more than twice the value of Prosoft, what might be associated with the lower size of Prosoft firm's compared to the average size of Profarma firms.

By looking at firm-level data on the access of BNDES Innovation lines and Programs, we note that the number of firms supported grows over time, from just 8 companies in 2004, to 71 in 2014, as it is shown in Table 3. This table also presents loan value distribution statistics for firms during the 2004-2014 period. The mean value of the distribution of loans for firms increased over the period, going from roughly BR$ 8.7 million to BR$ 32.5 at the interval end.

However, given the loans value distribution is right-skewed, we observe the median is far below the mean for each year. For instance, the loans median were BR$ 2,464 in 2008, while the mean were BR$ 15,089. The median loan for supporting firms' innovation varied between BR$ 4.5 million (in 2004) and BR$ 14.8 million (in 2013). After 2009, the last quartile of the loans distribution started to remain above BR$ 20 million per firm.

Table 3: Distribution of BNDES innovation Loans per Firm over time

Year	N	Mean	S.D.	P25	P50	P75
2004	8	8,720	9,953	2,370	4,473	12,437
2005	15	11,475	13,958	3,000	5,811	13,050
2006	22	12,386	18,808	2,550	4,750	9,900
2007	30	24,490	58,809	2,350	5,717	15,828
2008	34	15,089	37,497	1,400	2,464	7,799
2009	42	19,461	35,604	2,433	4,700	23,960
2010	37	56,981	190,755	2,794	6,156	20,982
2011	36	48,343	139,893	3,668	6,205	23,750
2012	48	47,135	90,508	3,485	12,326	36,174
2013	69	79,373	193,309	5,300	14,787	71,000
2014	71	32,508	56,448	3,000	11,471	33,188

Notes: BNDES loans in BR$ thousands current values. Source: BNDES.

Additionally, BNDES data allows us to calculate the share of large firms in the total number of companies supported by BNDES Innovation Programs

over the 2004-2014 period, accordingly to BNDES threshold [1]. For instance, in 2004, just 25% of supported firms were classified as large, while, in 2013, almost three quarters of them were large.

3 Empirical Strategy

The objective of this paper is to estimate the effects of BNDES credit for firms' innovation on R&D expenditures. We are specifically interested in answering two questions: whether BNDES has current effects and also look at the effects on the trends of this variable.

We employed a microeconometric approach to try to separate how much of the difference in R&D Expenditures between supported firms and not supported can be, in fact, attributed to BNDES funding. The main problem associated to this goal is to deal with the selection bias that can occur because firms that are more likely to carry out innovative activities are more inclined to meet BNDES' credit requirements.

We adopt a Fixed Effect (FE) approach to try to reduce the endogeneity problem derived from the sample selection bias. In a fixed-effects model, firms variation over time serve as their own controls. The idea is that whatever effects the omitted variables have on the firms at one time, they will also have the same effect at a later time, hence we can eliminate this fixed components with those models.

In order to estimate BNDES effects on the current level of the outcome variable of interest, we estimated the following equation:

$$Y_{it} = \beta BNDES_{it} + X'_{it}\gamma + \alpha_i + \rho_t + \epsilon_{it} \tag{1}$$

Where Y_{it} is the dependent variable of firm i in year t; $BNDES_{it}$ is a dummy variable that assumes 1 if firm i in year t had access to BNDES innovation credit and 0 otherwise, X'_{it} is a vector of control variables, α_i is the individual-specific fixed effects, ρ_t is the year-specific effects and ϵ_{it} is the error term. We are interested in estimating the effects associated to the parameter β, which captures the current effect of BNDES innovation credit on R&D Expenditures.

We estimated equation 1 using the Fixed Effects estimator. The FE estimator allows us to eliminate firms' time-invariant unobserved heterogene-

[1] The threshold changed during the period of analysis. In 2010, for example, firms were classified as large if they had annual or annualized Gross Operating Revenues higher than or equal to BR$ 90 million. For detailed information, see BNDES website http://www.bndes.gov.br.

ity that might be associated with firms' self-selection to BNDES innovation credit.

We are also interested in the effects of BNDES innovation credit on firms' R&D Expenditures trends. We estimated those effects based on a regression formulation of the Difference-in-Differences estimator (DID), as follows:

$$Y_{it} = \alpha + \beta_1 BNDES_{it} + \beta_2 Post_t + \beta_3 BNDES_{it} * Post_t + X'_{it}\gamma + \epsilon_{it} \quad (2)$$

Where Y_{it} is the dependent variable of firm i in year t, $BNDES_{it}$ is a dummy variable that assumes 1 if firm i in year t had access to BNDES innovation credit and 0 otherwise, $Post_t$ assumes 1 in the post-treatment year and 0 otherwise, $BNDES_{it} * Post_t$ is an interaction dummy that assumes 1 for the treated firm in the post-treatment year, X'_{it} is a vector of control variables, and ϵ_{it} is the error term.

The parameter of interest is the OLS estimates of β_3, which captures BNDES effects on firms' trends. The DID estimator uses the trends of non-treated firms as the counterfactual for the observed trends of the treated (conditional on time-varying firms' covariates). The DID approach is based on the assumption that, in the absence of treatment, both groups would have displayed parallel trends.

4 Data

This section describe data used for the current analysis. We used firm-level data to carry out our empirical strategy based on two sources: Pintec-IBGE and BNDES. The Brazilian Innovation Survey (Pintec) from IBGE (Brazilian Geographic and Statistics Institute) is a firm-level data that aims to explore and measure the innovative activities developed by Industrial and selected Services sectorial companies, as well as to monitor their evolution over time. Pintec follows conceptual and methodological guidelines of Oslo Manual of Organization for Economic Cooperation and Development (OECD, 1997), which makes Pintec data comparable to other international innovation surveys.

Pintec surveys only Brazilian formal companies with 10 or more employees. Survey sample design is restricted to manufacturing, extractive, electricity and gas, music editing and recording, data processing and internet hosting, telecommunications, information technology, architecture, engineering, testing and technical analysis and R&D services sectors. For companies with 500 or more employees (for manufacturing) and 100 or more employees

for services, Pintec is a census survey and for companies below those threshold, it is a sample survey. Pintec's sample design is defined to represent the target population of Brazilian firms under those selection criteria. [2]

Pintec is published by IBGE on a triennial basis and, by now, there are six available editions of Pintec: 2000, 2003, 2005, 2008, 2011 and 2014. For each version of the survey, its questionnaire refers to a period of three years for the qualitative variables: the survey year and previous two. While, for the quantitative variables, like R&D Expenditures, Pintec's reference year is precisely the year of the survey. In this paper, we used Pintec's survey years of 2003, 2005, 2008, 2011 and 2014 to build a firm-level panel data for the period 2003-2014.

For its turn, BNDES Data is a financing-level data comprising information about firms' innovation loans contracted over the period 2004-2014.[3] We found that BNDES had 598 financing-level operations with companies in this whole period. BNDES Data considers only credit lines, filtering out BNDES' grants and equity lines for innovation. We aggregated BNDES financing-level data by company and year of the loan, so we built a firm-level BNDES data for the 2004-2014 to be merged with Pintec's panel.

In order to maximize the number of BNDES' supported firms found in each year of Pintec, we adapted the year information of BNDES data to match with the closest superior Pintec's year. For instance, we matched 2012, 2013 and 2014 BNDES' firm-level data years to 2014 Pintec's year. We then merged both firm-level panels to obtain the final dataset for the 2003-2014 period, where we estimated the models presented in the last section.

The dependent variable in the models is R&D expenditures. Our control variables includes a series of firm size indicators such as Employment, Sales, Production Costs, Raw Material Consumption, Wages and Labor Productivity (calculated as the ratio of gross production value to firms' employment). We also interact a dummy variable for firms in the manufacturing sector with year dummies to control for sectorial year-specific effects. Additionally, Pintec's available indicators variables allows us to control for firms' access to other alternatives of public support for innovative activities.

[2]Pintec sample design explore information available from other Brazilian sources in the National System of Innovation in its attempt to represent adequately the innovation phenomenom at a more aggregate level. Examples of those sources of information are: companies that have received any governmental support for innovative efforts, and companies that have declared to carry out formal R&D efforts and that have applied for patents. For more details, see http://www.pintec.ibge.gov.br

[3]BNDES Profarma credit program is included as a whole in BNDES innovation dataset. Thus, we considered both its innovation and fixed capital lines, because we consider the pharmaceutical sector as being a very relevant R&D intensive sector and then would like to analyse the innovation behaviour of the whole supported companies.

Table 4 shows descriptive statistics at the firm-level for some of the variables of Pintec. The final dataset comprises 67,517 observations of firms, with a mean of 13,500 per year. The firms supported by BNDES account for 241 observations of firms over the whole period. The number of firms supported grows from 13 in 2005 to 98 in 2014. Table 4 also compares the means of some innovation indicators and control variables used in the models by treatment status. We see there are large differences between firms supported by BNDES and the non-supported ones. In general, treated companies tend to invest more in R&D activities and are larger than the others in terms of sales, employment, operational costs, raw material consumption, wage and labor productivity.

Those substantial differences stems from the pattern of selection to access BNDES innovation credit. As investment in innovation activities is very risky, larger companies tend to be more willing to carry out such activities. Also, despite several special financial conditions for BNDES innovation lines, like reduced threshold for applying for direct support and lower interest rates, BNDES credit risk policy still tends to favor the selection of larger companies. For example, BNDES in general requires the companies to offer collateral for the loans, additionally to the existence of transaction costs like the requirement of audited balance sheet for contracting.

Table 4 also allows us to compare the evolution of the difference of sample means over time. There is a general crescent trend for the continuous variables over the period, especially from 2011 on. This trend is more evident for firms supported by BNDES and results in a crescent discrepancy between the groups of supported and non-supported firms over the period.

Table 4: Descriptive Statistics of firms characteristics by treatment status

Treatment Status	Non-supported 2005	BNDES 2005	Non-supported 2008	BNDES 2008	Non-supported 2011	BNDES 2011	Non-supported 2014	BNDES 2014
Employment	294.3	956.4	305.7	2,140	342.8	3,060	361.3	2,862
Sales	86,501	507,344	101,153	1,018,000	130,746	2,276,000	168,204	2,137,000
Production costs	45,378	274,009	54,127	398,230	60,467	1,268,000	86,358	1,244,000
Raw material costs	37,039	134,190	42,728	250,929	45,342	1,180,000	64,161	1,154,000
Wages	6,436	40,083	8,042	70,125	11,118	192,037	17,253	201,238
Industrial firm (dummy)	0.942	0.846	0.877	0.689	0.904	0.696	0.845	0.745
Other public support (dummy)	0.139	0.692	0.127	0.590	0.186	0.841	0.215	0.847
Labor productivity	162.0	331.8	202.2	240.3	206.0	791.9	269.7	558.1
Any innovation (dummy)	0.502	0.923	0.470	0.902	0.459	0.870	0.490	0.898
Product innovation (dummy)	0.316	0.923	0.318	0.738	0.275	0.812	0.314	0.847
Process innovation (dummy)	0.401	0.769	0.386	0.705	0.399	0.768	0.431	0.796
Product and process innovation (dummy)	0.215	0.769	0.234	0.541	0.215	0.710	0.255	0.745
R&D Expenditures	762.8	30,375	1,019	11,196	1,196	48,725	1,773	60,707
R&D Employment	3.356	89.62	2.647	38.13	2.936	138.2	3.113	146.8
New-Product Sales	13,792	101,476	13,731	104,264	18,984	754,284	33,287	836,956
Number of firms	12,983	13	15865	61	13994	69	13810	98

Notes: Monetary variables in BR$ thousands. Source: Pintec and BNDES.

5 Results

This section presents results based on the estimation of the models describe above. We show BNDES impact estimates on R&D Expenditures based on the FE and DID estimators. In the first table, we present results for the R&D expenditures variable in levels and in logs and compare estimates for Pooled OLS and Fixed Effects estimators. We also compare FE estimates for unbalanced and balanced panel samples.

We found a positive and significant BNDES effect on firms' current R&D expenditures for all of the specifications shown in Table 5. As expected, the size of the estimates tend to decrease when we compare the POLS estimates with the FE ones. When we compare only FE estimates, we see that the magnitude of the estimated coefficients increases for the balanced panel estimates. The effects are positive and significant for the specifications of the dependent variable in BR$ thousands and in logs. The FE models controls for several firm-level economic dimensions that vary over time and also for sector-specific period effects.

In terms of the size of the effects, Table 5 shows that BNDES-supported firms tend to invest roughly BR$ 10 million more on average (column 3) than non-supported companies that had positive levels on R&D investment during 2005-2014. We can also approximate the size of the effects using FE estimates for the dependent variable in logs. In this case, the coefficients show a 32% increase in current R&D expenditures for supported firms (for the unbalanced panel) compared to a 40% increase for the balanced panel.[4].

[4] The size of the BNDES effects on R&D Expenditures is similar to the size of the estimates obtained in Machado et al (2014) for the BNDES effects on firms' Fixed Capital Investment

Table 5: BNDES estimated effects on R&D expenditures

	POLS (BR$ thousand) (1)	FE (BR$ thousand) (2)	FE Balanced (BR$ thousand) (3)	POLS (Logs) (4)	FE (Logs) (5)	FE Balanced (Logs) (6)
BNDES	13,722***	8,980***	10,035***	1.219***	0.318***	0.403***
	(774.1)	(2,486)	(2,912)	(0.125)	(0.111)	(0.123)
Log Sales	623.2	371.2	547.3	0.147**	0.266	0.411*
	(422.8)	(1,366)	(2,305)	(0.0682)	(0.187)	(0.242)
Log Employment	-238.3	1,366	1,459	-0.156**	-0.0320	-0.141
	(472.4)	(1,488)	(2,596)	(0.0762)	(0.196)	(0.265)
Log Wages	2,017***	-140.0	-136.9	0.694***	0.157*	0.219*
	(211.4)	(538.7)	(955.9)	(0.0341)	(0.0816)	(0.122)
Log Production costs	-628.8**	981.9**	1,350	-0.118***	0.0729	0.0633
	(248.9)	(461.3)	(973.3)	(0.0402)	(0.0716)	(0.106)
Log Raw material costs	152.3	-318.3*	-409.3	0.00596	-0.0273	-0.0596*
	(129.3)	(167.1)	(322.0)	(0.0209)	(0.0338)	(0.0305)
Log Labor productivity	570.3	-670.1	-361.4	0.160**	-0.0881	-0.0707
	(449.4)	(1,431)	(2,508)	(0.0725)	(0.180)	(0.229)
Government support	1,803***	1,065***	1,180**	0.566***	0.290***	0.291***
	(196.2)	(337.3)	(509.8)	(0.0317)	(0.0507)	(0.0654)
Constant	-17,158***	-6,255	-8,917	0.00321	4.086***	5.021***
	(897.1)	(5,277)	(8,292)	(0.145)	(1.002)	(1.068)
Sector*Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,322	8,322	3,179	8,322	8,322	3,179
R-squared	0.229	0.081	0.093	0.474	0.153	0.174
Number of firms		5,493	1,416		5,493	1,416

Notes: Robust Standard errors in parentheses. *** p0.01, ** p0.05, * p0.1. Source: Pintec and BNDES.

The analysis of DID estimates tend to show a positive and (in some specifications) significant effect over the period 2005-2014. Table 6 shows the significant effects are concentrated in BNDES' 2014-2011 and 2011-2008 DID estimates. Consequently, the DID estimates indicate BNDES credit tend to affect also the trends of firms' R&D Expenditures, additionally to the positive current effect.

Table 6: DID estimates of BNDES effects on firms' R&D Expenditures

	R&D expenditures (BR$ thousand) (1)	R&D expenditures (logs) (2)
BNDES (2008-2005)	6,931***	0.341
	(1,862)	(0.405)
Controls	Yes	Yes
Observations	2,958	2,958
R-squared	0.229	0.424
BNDES (2011-2008)	5,100**	0.0306
	(2,590)	(0.357)
Controls	Yes	Yes
Observations	2,790	2,790
R-squared	0.261	0.456
BNDES (2014-2011)	7,198***	-0.0456
	(2,499)	(0.292)
Controls	Yes	Yes
Observations	2,799	2,799
R-squared	0.280	0.435

Notes: Standard errors in parentheses. *** p0.01, ** p0.05, * p0.1. Balanced sample.
Source: Pintec and BNDES.

6 Conclusion

This paper evaluated the impact of BNDES innovation credit on firms' R&D Expenditures. Using firm-level data on innovation activities (from Pintec-IBGE) and on access to innovation credit (from BNDES), we constructed a panel dataset over the period 2005-2014 and estimated the BNDES effects. We adopted a Fixed Effects approach to deal with the endogeneity problem associated to the selection of firms who receive the credit and estimate current BNDES effects on R&D Expenditures. We also used a complementary approach based on the Difference-in-Differences estimator to address the effects on the trends of our dependent variable.

Our findings showed evidence of positive and significant BNDES effects on firms' R&D expenditures for both estimators. Based on the FE estimates, we obtained an increase in current firms' R&D expenditures varying between

30% and 40% percent. Those results implies rejection of the hypothesis that BNDES Credit would simply crowd out private sources of R&D investment. On the contrary, the estimates obtained here indicate a complementary relation between private and public sources of financing R&D Expenditures at the firm-level.

Future agenda will focus on decompose the analysis by company size and economic sectors. We want to explore BNDES effects on other firms' innovative dimensions, related to firm performance. We also intend to employ alternative approaches for estimating BNDES effects, such as dynamic panel models and quasi-experimental empirical strategies in order to evaluate the robustness of our results.

7 References

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