

Institute for Applied Economic Research (IPEA)

Impacts of the Brazilian science and technology sectoral funds on the industrial firms' R&D inputs and outputs

Bruno César Araújo

Donald Pianto

Fernanda De Negri

Luiz Ricardo Cavalcante

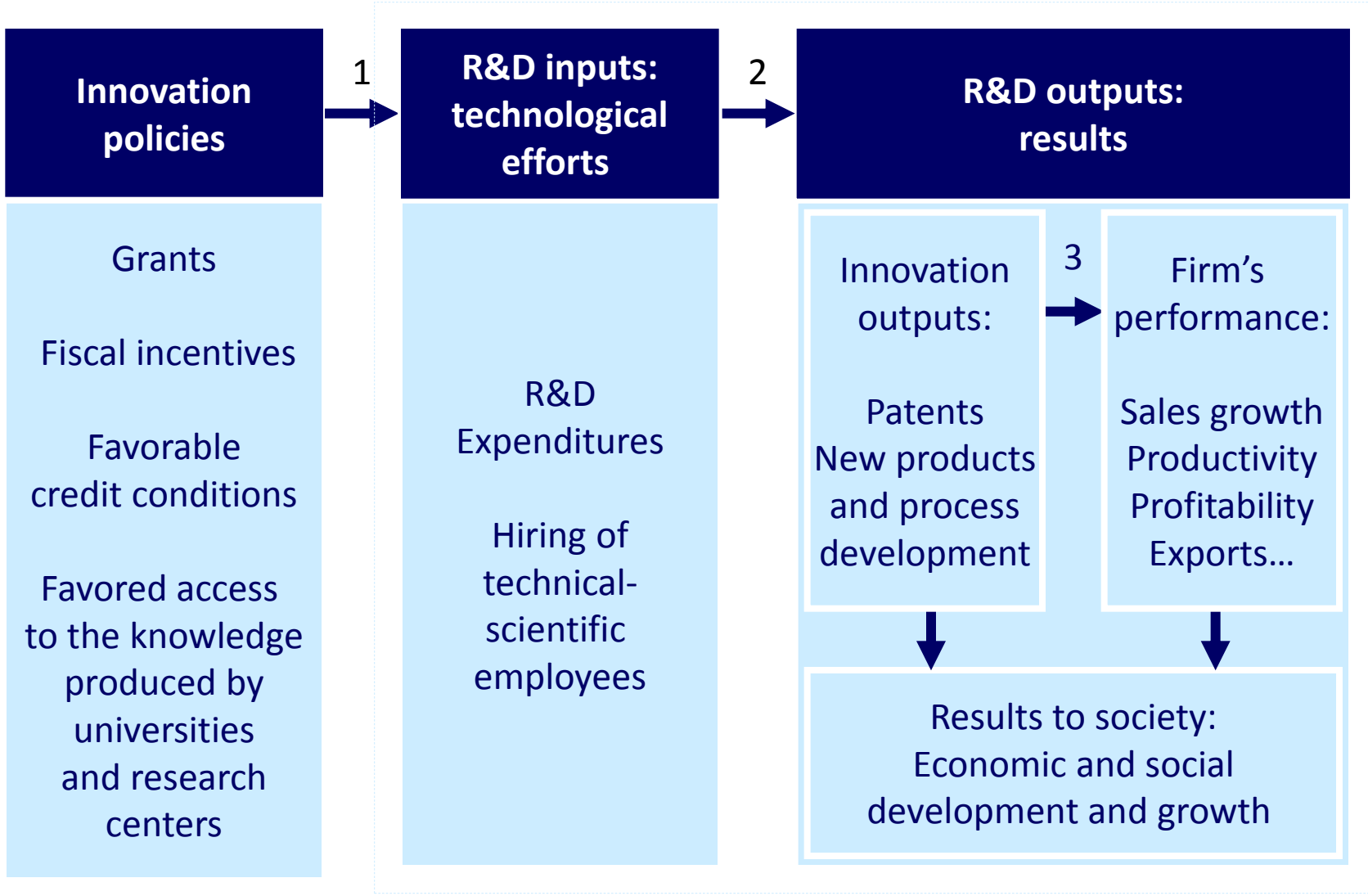
Patrick Alves

Tartu, May 2010

Introduction

- The Brazilian science and technology sectoral funds were established at the end of the 1990s, aiming at providing more stable financial resources to science, technology, and innovation (ST&I) activities in Brazil.
- Their funding comes from taxes on specific activities (e.g. telecommunications, electricity, oil & gas etc).
- Similarly to other instruments used to foster innovation at the firm level, the sectoral funds are expected to increase firms' technological efforts as well as their result indicators.
- The aim of this paper is to evaluate the impacts of the sectoral funds on the industrial firms' R&D inputs and outputs in Brazil.

Theoretical background



Methodological procedures

- Definition of the variables used in the model;
- Construction of the database and of the treatment and control groups aiming at tackling with the selection bias typically observed in this kind of analysis; and
- Econometric procedures used to compare the samples

Treatment definition

- A dummy variable for the access to the funds for the first time was used in order to define the treatment group.
- The access to the funds may involve:
 - Cooperative projects with universities and research centers (both as project leader or participant);
 - Credit at favorable conditions (even if the credit resources do not originate directly from the sectoral funds, the firms which benefited from these resources were included in the treatment group because interest rates are subsidized by the funds); and
 - Grants (although no firm would access grants before 2007).

Treatment definition

- No grant size effect has been considered.
- The focus was set in the access to the funds in general, although some preliminary econometric analysis was performed in order to distinguish the impacts of each instrument.
- 344 different firms accessed the sectoral funds, most of them involved in cooperative projects only (around 70% of the total).

Methodological procedures

Treatment group

Year	Cooperative projects only	Credit only	Both	Total
2001	0	17	0	17
2002	47	13	3	63
2003	13	5	0	18
2004	79	0	0	79
2005	56	25	2	83
2006	48	32	4	84

Methodological procedures

Variables

- R&D inputs (technological efforts): “technical-scientific employees” (PoTec), which corresponds to the number of researchers, engineers, R&D directors and managers and “scientific professionals”.
 - This proxy has been used in face of the absence of an updated version of the Brazilian innovation survey (PINTEC).
 - It follows the pioneer study by Blank and Stigler (1957).
- R&D outputs (results):
 - Innovation outputs: patents were dropped as an indicator, as the data were not available.
 - Firm’s performance: growth rates of the company (evolution of total number of employees) and high-tech exports.

Database construction

- Panel data of firms between 2000 and 2007.
- Industrial firms (sectors from 5 to 33 in the Brazilian Standard Industrial Classification).
- Firms with five or more employees at the Brazilian Annual List of Social Information (RAIS) in 2006 and 2007.

Methodological procedures

Sampling procedures: control group

- The control group was defined using a Propensity Score Matching (PSM) procedure aiming at reducing the selection bias that makes firms which accessed the funds follow a different path when compared to the ones that did not.

Matching procedure

- Probit based upon the following explanatory variables:
 - PoTec (lagged and interacted with year dummies);
 - Number of employees (lagged and interacted with year dummies);
 - Dummies for multinational and corporation companies;
 - Sector; and
 - Region.
- Since the access to the sectoral funds is a rare event, a bootstrap procedure has been applied (as typically used in credit scoring analyses).
- Kernel matching algorithm with common support restriction.

Results

- Probit results;
- Propensity score matching;
- Comparison between treatment and control groups; and
- Preliminary analysis of the impacts of each instrument on the number of technical-scientific employees.

Results

Probit results

- 450 probit repetitions; sample sizes: 330 (treatment group) and 2000 (control group).
- Probit results: fairly good adjustment for most variables.
- Pseudo $R^2 \approx 50\%$ suggests a reliable model for matching firms.

Results

Distribution of probit coefficients after 450 repetitions

(control sector and year dummies and interactions not shown)

	Estimate (Median)	[90% Conf. Interval]	
Log of the number of technical-scientific employees (t_{-1})	0.528	0.342	0.755
Log of the number of employees (t_{-1})	0.208	0.326	0.441
Multinational dummy	-0.933	-1.53	-0.431
Corporation dummy	0.549	0.032	1.24
Pseudo R ²	0.495	0.449	0.539
Log Likelihood	-738.7	-797.4	-673.4

Propensity score matching

- PSM allowed treatment and control groups to have similar characteristics at the moment before the treatment (cf. unmatched and matched columns in the next table).
- Balancing conditions show that, for the variables of interest, treatment and control groups had the same averages at the moment before the treatment (averages are not significantly different).

Results

R&D inputs and outputs in t_{-1}

	Unmatched		Matched	
	Treatment	Control	Treatment	Control
Number of technical-scientific employees	46.09	0.42	21.97	26.84
Number of employees	998	48	737	1.023
High tech exports	3.367	64	3.229	3.836

Results

- Positive impacts of the sectoral funds on the technological efforts (R&D inputs) of the firms.
- Growth rates of the PoTec of those firms that accessed the funds are significantly greater than the ones of the firms that did not access the resources.
- After four years, the treatment group accumulated more than 25 percentage points of advantage over the control group.

Results

Level and growth rate diff-in-diff between treatment and control groups

		Number of technical-scientific employees	Number of employees	High tech exports
One year after accessing the funds (t0 - t1)	Level	1.3*	28.8 ^{ns}	-190.1 ^{ns}
	%	6.82***	6.82***	6.18 ^{ns}
Two years after accessing the funds (t0 - t2)	Level	1.7 ^{ns}	30.4 ^{ns}	10.2 ^{ns}
	%	11.52***	9.64***	15.03 ^{ns}
Three years after accessing the funds (t0 - t3)	Level	2.2 ^{ns}	-21.9 ^{ns}	1,122.2 ^{ns}
	%	15.72***	11.52*	14.22 ^{ns}
Four years after accessing the funds (t0 - t4)	Level	6.2*	-30.9 ^{ns}	-210.3 ^{ns}
	%	26.74**	16.07 ^{ns}	35.80*

Obs.: ns: not significant; * significant at 10%; ** significant at 5%; *** significant at 1%.

Results

- Positive impacts of the sectoral funds on the firms' performance (R&D outputs) as measured by its number of employees.
- Significant impacts on the growth rates in the first and second years after accessing the funds.
- Only one marginally significant impact was found for the high-tech exports.

Impacts of each instrument on the number of technical-scientific employees

- A preliminary analysis of each instrument on the number of technical-scientific employees suggests that most impacts observed in the technological efforts can be associated to the credit instrument.
- Cooperative projects, as expected, showed less significant (if any) impacts.

Results

Impacts of each instrument on the number of technical-scientific employees

	t_1	t_2	t_3	t_4
Cooperative projects	0.0366 (1.31)	0.0887 (2.21)	0.0933 (1.52)	0.0571 (0.48)
Credit	0.1587 (2.83)	0.2152 (1.98)	0.3890 (2.41)	0.5787 (3.78)
Interaction	-0.2544 (-0.97)	-0.6257 (-2.22)	-0.7790 (-1.56)	-0.9764 (-2.36)

Obs.: t-stat indicated below the coefficients.

Conclusions

- The results obtained clearly show a detachment between the technological efforts of the treatment and control groups.
- These results permit the hypothesis of crowding out to be rejected.
- The sectoral funds showed a positive impact on the number of employees as well (proxy for firm's growth).
- Only one marginally significant impact was found for the high-tech exports:
 - International competition may be tougher; and
 - The impact on exports derives from two sources: the rise in exports of those already exporters and the inclusion of new firms. The former is relatively easier than the latter.
- Preliminary analysis of each instrument on the technological efforts suggests that most impacts observed in the technological efforts can be associated to the credit instrument.

Conclusions

- Further research should deepen the analysis of the impacts of each instrument separately.
- Such an analysis could help policy makers to match the instruments to each specific purpose (e.g., support for small emerging firms or large firms R&D activities may require different instruments).
- Grant size could be considered, as it is expected that the higher the grant size, the higher the impact of the funds on R&D inputs and outputs.