Technological Appropriability and Export Performance of Brazilian Firms

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Objective: to evaluate the relationship between technological appropriability and export performance of Brazilian industrial firms

Literature Review:

- Innovative firms tend to be more intensive in exports (Cassiman *et al* 2010; Aw *et al* 2011; Greenaway & Kneller 2007)

- Both exporting (Bernard & Jensen 1999; Clerides *et al* 1998) and innovative (Klette & Kortum 2004) firms are, in general, larger, more productive and more intensive in skilled labor;

Hypothesis: If a firm innovates + appropriates the results of these innovations -> monopolistic advantages -> boost its export performance

Databases

1) PINTEC Survey (Oslo Manual)

- Editions: 2003; 2005; 2008

- Brazilian *Manufacturing Industrial* Firms

- Firm: Innovates (or try to) or not?

- Innovative firms:
  - Use of formal appropriability methods: invention patent, utility model, industrial design and trademark
  - Expenditures on technological innovation: R&D, acquisition of machinery and equipment, acquisition of technology, others.

- Number of employees (firm size)

- Origin of capital

- The Survey:
  - = >500 employees: probability sampled with certainty (census)
  - < 500 employees: sample (non-certainty sampled)

- Database Limitations
  - Use in Brazil and/or abroad?
  - Time of protection?
  - Number of patents and other methods per firm?
  - Patent: licensed or own application?
  - Two short

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Database

2) Export data

- Department of foreign trade-SECEX
- Period: 2005 and 2008

3) Firm age (proxy – maturity of the firm)

- RAIS / Ministry of Labor and Employment

Relationship between innovation and exports in the Brazilian industry (2008)

Export perfomance of innovative (I) and non-innovative (NI) firms

	Number of Firms		Average values		
	Non-Exporting	Exporting	Exporting firms/Total (%)	Exports (US$)	Exports: Firm/Sector (%)
Non-Innovative	56,422	5,020	8.2%	351,047	0.12%
Innovative	32,744	5,617	14.6%	3,310,078	0.43%

Source: IBGE/Pintec 2008 e MDIC/Secex 2008. Elaborated by the authors.

- Innovative firms present a higher "probability to export"
- On average, the exported value of innovative firms represents almost ten times the observed among non-innovative ones.
- Innovative firms also have a higher participation on sectorial exports

Correlation between innovation and exports in the Brazilian industry (2008):

Dependent variables (2008)

- Probability to export (d_exp): dummy = 1, if firm exported; otherwise, d = 0
- log (exp): log of the value of exports
- firm share: share of firms' exports per sector (ISIC 3 digits)

Explanatory variables:

- **innovative firm**: dummy = 1, if firm has innovated among 2006 and 2008;
- log of number of employees, a proxy for firm size;
- foreign: dummy = 1 if the firm is foreign; otherwise, dummy = 0
- mixed: dummy = 1 if the firm has similar foreign and national capital; otherwise, dummy = 0
- - dummies for sectorial controls

Dependent variable:	dummy export Logit (1)	log(exp) OLS (2)	export share OLS (3)
innovative firm	0.0224***	0.293***	0.00109***
	(0.00664)	(0.0846)	(0.000230)
log(number of employees)	0.0715***	1.532***	0.00582***
	(0.00180)	(0.0475)	(0.000309)
foreign	0.164***	7.153***	0.0368***
	(0.0154)	(0.446)	(0.00337)
mixed	0.201***	6.668***	0.0155***
	(0.0380)	(1.212)	(0.00399)
Observations	13,945	13,945	13,841
R-squared		0.310	0.101

Appropriability and exports of Brazilian industrial *innovative* firms

- **The data suggest a positive relationship between innovation and exports**

- **So, is the export performance of *innovative* firms related to their technological appropriability?**

- **Focus: innovative firms**

Panel database - Industrial *innovative* **large** firms (>=500 employees)

- To include all PINTEC surveys
- To use temporal lags in variables of control:
  - Innovation expenditures take some time to impact on exports
  - To reduce simultaneity
- Appropriability variables: without lag

  - Appropriability methods and export data: 2005 and 2008
  - Variables of control (temporal lag): 2003 and 2005

Large industrial firms:
  - 68% of sales
  - 66% of innovative expenditures
  - 88% of R&D expenditures

Database

	Variables	Source	2008	2005
			Year	Year
Dependent Variables	Export Dummy; log(export); export share	SECEX	2008	2005
Variables of Interest	Dummies of Invention Patent, Utility Model, Industrial Design and Trademark	PINTEC	2008 (reported to be used between 2006 and 2008)	2005 (reported to be used between 2003 and 2005)
Control Variables	Firm Size; Firm Age; R&D and other Firm Investiment Expenditures	PINTEC; RAIS	2005	2003

Descriptive Statistics - <u>Industrial innovative **large** firms (>=500 employees)</u>

Number of Firms

	patents	utility	design	trademark
Firms 2005	227	170	87	398
Firms 2008	277	144	146	405
Diferença	50	-26	59	7

Firms both periods	608
Firms only one period	423
Firms only 2005	204
Firms only 2008	219

Summary Statistics - 2008

Variable	mean	sd	p5	p95	median	N
dummy export	0.869	0.337	0.000	1.000	1.000	827
log(exports)	14.637	6.193	0.000	20.681	16.755	827
firm share on sectorial exports	0.239	0.000	0.000	1.000	0.078	827
log(R&D expenditures)	4.905	3.651	0.000	9.938	5.858	827
log(technology transfer expenditures)	5.653	3.641	0.000	10.352	6.771	827
log(machinery and equipment expenditures)	2.767	3.201	0.000	8.455	0.000	827
log(other innovative expenditures)	5.098	3.409	0.000	10.065	5.730	827

Descriptive Statistics (2)

Averages between the groups that <u>use and do not use</u> each type of appropriability

(<u>Industrial innovative **large** firms, 2008</u>)

Panel A: Invention Patent

Variable Name		IP=0	IP=1	p-value
log(exports)	mean	13.689	16.519	0.000
	std error	0.286	0.270	
dummy export	mean	0.827	0.953	0.000
	std error	0.016	0.013	
firm share on sectorial exports	mean	0.211	0.293	0.000
	std error	0.014	0.020	

Panel B: Utility Model

Variable Name		UM=0	UM=1	p-value
log(exports)	mean	14.211	16.659	0.000
	std error	0.248	0.331	
dummy export	mean	0.849	0.965	0.000
	std error	0.014	0.015	
firm share on sectorial exports	mean	0.231	0.272	0.083
	std error	0.012	0.026	

Panel C: Industrial Design

Variable Name		ID=0	ID=1	p-value
log(exports)	mean	14.339	16.027	0.001
	std error	0.245	0.405	
dummy export	mean	0.855	0.938	0.003
	std error	0.014	0.020	
firm share on sectorial exports	mean	0.226	0.296	0.009
	std error	0.012	0.028	

Panel D: Trademark

Variable Name		TM=0	TM=1	p-value
log(exports)	mean	14.112	15.184	0.006
	std error	0.316	0.289	
dummy export	mean	0.846	0.894	0.021
	std error	0.018	0.015	
firm share on sectorial exports	mean	0.232	0.246	0.272
	std error	0.016	0.016	

- Groups of firms that use any appropriability methods present a better export performance (most statistically significant)

Econometric analysis: formal appropriability methods and export performance

Dependent variables - export performance (Y) are:

- Export dummy : propensity to export (dummy = 1, if firm exported; otherwise, dummy = 0);

- log (exports): log of value of exports

- firm share on sectorial exports: share of firms' exports per sector (ISIC 3-digit)

Explanatory variables

Variables of interest (appropriability methods):

- Invention Patent, Utility Model, Industrial Design, Trademark (+)

Variables of control:

- Origin of capital: dummy – foreign and mixed (+ / -)

- Firm size: logarithm of number of employees (+)

- Logarithm of innovative expenditures: R&D, technological transfer, machinery and equipment and others) (+)

- Firm age (+)

- Sectorial controls (ISIC 2-digits)

- Dummy of period

Appropriability and export performance (dummy_exp) of large firms – Pooled Panel / Logit Model

Dependent Variable:	Dummy Export		
	(1)	(2)	(3)
invention patent	0.133***	0.0941***	0.0815***
	(0.0263)	(0.0263)	(0.0257)
utility model	0.0617*	0.0373	0.0321
	(0.0320)	(0.0337)	(0.0344)
industrial design	0.0588*	0.0536	0.0399
	(0.0342)	(0.0359)	(0.0357)
trademark	0.0264	0.0250	0.0119
	(0.0174)	(0.0175)	(0.0177)
foreign		0.131***	0.117***
		(0.0257)	(0.0261)
mixed		0.219**	0.231***
		(0.0893)	(0.0832)
log(number of employees)		0.0335**	0.0234*
		(0.0140)	(0.0126)
log(R&D expenditures)			0.00631**
			(0.00306)
log(technology transfer expenditures)			0.00489
			(0.00353)
log(machinery and equipment expenditures)			-0.000846
			(0.00283)
log(other innovative expenditures)			0.00620*
			(0.00339)
firm age		0.000326	0.000177
		(0.000647)	(0.000611)
Observations	1,639	1,556	1,556
R-squared			
Firm Fixed Effect	No	No	No
Dummy Period	Yes	Yes	Yes
Dummy ISIC	Yes	Yes	Yes

Appropriability and export performance (log_export value) of large firms Pooled (1-3) and Fixed Effect (4-6)

Dependent Variable:	log (exports)					
	(1)	(2)	(3)	(4)	(5)	(6)
invention patent	2.517***	1.278***	1.103***	0.569*	0.543*	0.516*
	(0.305)	(0.297)	(0.296)	(0.305)	(0.300)	(0.300)
utility model	0.413	0.148	−0.0116	0.404*	0.429*	0.420*
	(0.343)	(0.319)	(0.323)	(0.243)	(0.243)	(0.246)
industrial design	0.502	0.398	0.281	−0.131	−0.138	−0.157
	(0.364)	(0.340)	(0.339)	(0.231)	(0.236)	(0.235)
trademark	0.447	0.369	0.0925	−0.543**	−0.534**	−0.505**
	(0.319)	(0.298)	(0.299)	(0.235)	(0.229)	(0.223)
foreign		2.758***	2.468***		−1.071	−1.006
		(0.299)	(0.304)		(0.872)	(0.872)
mixed		2.826***	2.670***		−0.0789	0.00741
		(0.423)	(0.433)		(0.877)	(0.884)
log(number of employees)		1.560***	1.223***		−0.213	−0.265
		(0.219)	(0.218)		(0.560)	(0.550)
log(R&D expenditures)			0.154***			0.0227
			(0.0575)			(0.0538)
log(technology transfer expenditures)			0.0407			−0.0210
			(0.0467)			(0.0426)
log(machinery and equipment expenditures)			0.0357			−0.0465
			(0.0502)			(0.0291)
log(other innovative expenditures)			0.130**			0.0451
			(0.0619)			(0.0517)
firm age		0.00326	1.54e−05			
		(0.0116)	(0.0113)			
Observations	1,639	1,638	1,638	1,639	1,639	1,639
R-squared	0.050	0.223	0.240	0.022	0.027	0.031
Firm Fixed Effect	No	No	No	Yes	Yes	Yes
Dummy Period	Yes	Yes	Yes	Yes	Yes	Yes
Dummy ISIC	Yes	Yes	Yes	No	No	No

Appropriability and export performance (share) of large firms
Pooled (1-3) and Fixed Effect (4-6)

Dependent Variable:	firm share on sectorial exports (3 digits)					
	(1)	(2)	(3)	(4)	(5)	(6)
invention patent	0.0982***	0.0684***	0.0604***	0.0406**	0.0394**	0.0386**
	(0.0193)	(0.0193)	(0.0198)	(0.0172)	(0.0173)	(0.0173)
utility model	−0.0314	−0.0335	−0.0384*	−0.00854	−0.00797	−0.00785
	(0.0228)	(0.0221)	(0.0222)	(0.0148)	(0.0148)	(0.0147)
industrial design	0.0325	0.0293	0.0235	−0.00340	−0.00317	−0.00371
	(0.0260)	(0.0254)	(0.0256)	(0.0178)	(0.0173)	(0.0173)
trademark	0.0126	0.00625	−0.00418	−0.0249*	−0.0245*	−0.0242*
	(0.0163)	(0.0161)	(0.0162)	(0.0138)	(0.0138)	(0.0137)
foreign		0.0820***	0.0707***		−0.0968	−0.0974
		(0.0184)	(0.0186)		(0.0677)	(0.0671)
mixed		0.150***	0.140***		−0.0644	−0.0650
		(0.0467)	(0.0480)		(0.0557)	(0.0558)
log(number of employees)		0.0477***	0.0366***		0.0133	0.0140
		(0.00981)	(0.0101)		(0.0344)	(0.0342)
log(R&D expenditures)			0.00520*			−0.000705
			(0.00295)			(0.00371)
log(technology transfer expenditures)			0.00377			−0.000728
			(0.00289)			(0.00226)
log(machinery and equipment expend			−0.00145			−0.000977
			(0.00261)			(0.00200)
log(other innovative expenditures)			0.00575*			0.000447
			(0.00296)			(0.00322)
firm age		0.00133**	0.00119**			
		(0.000519)	(0.000515)			
Observations	1,639	1,638	1,638	1,639	1,639	1,639
R-squared	0.022	0.062	0.072	0.013	0.019	0.020
Firm Fixed Effect	No	No	No	Yes	Yes	Yes
Dummy Period	Yes	Yes	Yes	Yes	Yes	Yes
Dummy ISIC	Yes	Yes	Yes	No	No	No

Main Conclusions

- According to international literature, we document for the Brazilian case that an innovative firm has a higher chance to export than a non-innovative one.

- We investigate whether the use of any type of formal Appropriability Method is related to a better export performance. The main results show:
  - A positive statistically significant correlation between Invention Patents and all export performance variables tested (probability to export, export revenues and export market share)
  - A negative statistically significant correlation between trademark and export value / export share. There is no statistically significant relationship between trademark and probability to export

Some Caveats

1) Results may suggest different strategies regarding local and external market.

- Firms that use Invention Patent: exports are more relevant
- Firms that use Trademark: may prefer local market

- Total Applications (Brazilian): abroad / Brazil (2007/2008)
  - Trademarks: 3.3%
  - Invention Patent: 21.5%

(Source: WIPO Statistics Database)

- PCT and Madrid Treaty

Thank You

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Additional analysis

1) Appropriability and export performance (log(exp))- <u>Including interactions</u>
Pooled (1-3) and Fixed Effect (4-6)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
IP	2.705***	1.578***	1.581***	1.166*	1.142*	1.174*
	(0.577)	(0.561)	(0.564)	(0.623)	(0.628)	(0.630)
UM	2.983***	0.787	0.792	0.438	0.332	0.398
	(0.986)	(0.903)	(0.906)	(0.546)	(0.563)	(0.571)
ID	1.609*	1.440	1.449	0.213	0.210	0.224
	(0.937)	(0.918)	(0.914)	(0.340)	(0.362)	(0.362)
TM	0.167	−0.0840	−0.0755	−0.331	−0.267	−0.200
	(0.450)	(0.414)	(0.420)	(0.295)	(0.285)	(0.282)
IPUM	−3.246**	−1.933	−1.937	−0.172	0.0578	−0.0681
	(1.492)	(1.375)	(1.376)	(0.994)	(0.996)	(0.999)
IPID	−1.586	−3.527**	−3.519**	−1.527*	−1.457*	−1.366
	(1.471)	(1.488)	(1.492)	(0.832)	(0.866)	(0.879)
IPTM	0.872	0.215	0.215	−0.786	−0.829	−0.838
	(0.743)	(0.711)	(0.711)	(0.565)	(0.573)	(0.572)
UMID	−3.428*	−1.792	−1.799	0.106	0.414	0.381
	(1.960)	(1.814)	(1.814)	(0.631)	(0.680)	(0.669)
UMTM	−0.698	0.566	0.560	0.811	0.913	0.819
	(1.245)	(1.181)	(1.183)	(0.926)	(0.951)	(0.934)
IDTM	0.680	−0.389	−0.391	−0.161	−0.206	−0.206
	(1.253)	(1.192)	(1.190)	(0.627)	(0.632)	(0.624)
IPUMID	3.064	3.299	3.302	1.340	0.786	0.933
	(2.728)	(2.518)	(2.520)	(1.562)	(1.587)	(1.597)
IPUMTM	0.531	−0.0335	−0.0280	−0.650	−0.874	−0.738
	(1.731)	(1.625)	(1.626)	(1.269)	(1.274)	(1.253)
IPIDTM	−0.919	1.632	1.618	1.638*	1.553	1.413
	(1.980)	(1.862)	(1.875)	(0.937)	(0.953)	(0.962)
UMIDTM	0.296	0.649	0.658	−1.387	−1.664	−1.596
	(2.452)	(2.348)	(2.348)	(1.367)	(1.374)	(1.347)
IPUMIDTM	0.296	−0.954	−0.959	−0.484	0.0703	−0.0543
	(3.317)	(3.091)	(3.093)	(2.087)	(2.056)	(2.043)
SM			−0.0298			−0.287
			(0.300)			(0.211)