What drives the survival and growth of new firms in Brazil? A learning and capability perspective

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ABSTRACT

This paper examines the factors affecting the survival and growth of young, small Brazilian firms from a learning and capability perspective. We have also examined four specific sectors: food processing, automotive, chemicals and electronics, in order to obtain a comprehensive view of the particular nature of different technological regimes and sectoral systems on the growth and survival of young firms. This paper extends earlier empirical research focusing on age, size, and innovation as drivers of survival and growth. It includes R&D and different types of technological capabilities. The paper shows that the factors affecting the survival or young small firms are different from the ones affecting growth. The presence of all types of technological capabilities is necessary for the survival of Brazilian firms, while innovation is not. On the other hand project capabilities and linkages are key factors affecting very high growth. Innovation becomes a distinguishing positive factor when firms strive for high growth. Differences exist among the four sectors.

1. Introduction

The industrial growth of the new emerging countries is driven by the presence of some large domestic firms and by a population of young new enterprises. While a lot of analyses and case studies has been dedicated to the growth of large domestic firms in China, India, Brazil and other countries, much less is known on the growth of young domestic enterprises. This comes at a surprises because new firms are considered as a main driver of the industrial dynamics and a possible source of innovation.

So the issues related to the survival and growth of new domestic companies become therefore central to any analysis of industrial development. In particular, one may ask which are the drivers of the survival and the growth of domestic companies? And given the major emphasis of the recent literature on learning and capabilities in economic development, a key question is the role of capabilities in affecting the survival and growth of young firms.

This paper examines the factors affecting the survival and growth of young and small firms in a key leading country: Brazil. It does by examining the period 2003-2008 growth and focusing on factors such as size, foreign ownership, innovation, R&D and various types of technological capabilities related to investment, projects and linkages. The structure of this paper is as follows. Section 2 delves into the survival and growth of young firms. Section 3 describes the database and the methodology for measuring survival and growth. Section 4 analyses the main drivers of firm’s survival within the four different sectors. Then in section 5 we turn to the second main issue, the main drivers of growth of young small Brazilian firms, for the same four selected sectors. Finally in the Section 6, some concluding remarks are provided.

2. The survival and growth of young firms

The survival and growth of young firms can be placed within the realm of industrial dynamics and of industry evolution (Nelson and Winter, 1982). A lot of analyses have been conducted at the empirical level to identify the links between firm age, size, growth and survival (Phillips and Kirchhoff, 1989; and Audretsch, 1995). In particular young innovative firms have also been an active area of empirical and theoretical research as they impact the economy overall performance ((Veugelers, 2009; Schneider and Veugelers, 2010) affecting technological change and industrial evolution (Malerba and Orsenigo, 1999). Acquiring experience may be a crucial determinant of survival rates, which unfortunately is not a quick and easy task (Geroski, 1995). There are, however, some expected mitigating factors related to the selection process such as being an efficient firm (Jovanovic, 1982) a large firm (Dunne et al., 1988) or a foreign owned firm (corporate parent may help with its previous experience, financing, and external knowledge) (Hall, 1987). Nevertheless, multinationals are more likely to close a plant than a comparable domestic firm (Bernard and Jensen, 2002).

Regarding the influence of size on growth, the results are not conclusive. Confirming the Gibrat's Law, Hart and Prais (1956) found that firm's growth is independent from its size**.** Hall (1987), Dunne and Hughes (1994) found evidence that smaller firms grow faster however the analysis needs to be complemented with firm's age. Evans (1987), studying firm's size and age concludes that growth decreases with age when firm's size is held constant for young firms, and growth decreases with size for different phases of the business cycle. Audrestch (1995) suggests that growth, at least for small and young firms, tend to be negatively related to firm size. Concerning age, younger companies are more dynamic but also more volatile in their growth experience than older companies (Dunne and Hughes, 1994). If new firms born small, with imperfect knowledge about their true efficiency levels and limited resources, the first times in the market can be crucial (Jovanovic, 1982). The risk of disappearing in the first years[1] subsequent to their birth may be very high, hence if they overcome this first critic period, they would tend to grow very fast (Mata, 1994).

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[1] The risk is still higher if these firms belong to what Beesley and Hamilton (1984) called 'seedbed' industries, essentially innovative and with high birth and death rates

All these analyses have concerned advanced countries: North America and Europe. In this paper we move the analysis of the factors affecting survival and growth to a key emerging country: Brazil.

We focus on some key l factors that affect the survival and growth of young firms: size, capital ownership nationality, R&D, innovation and several types of technological capabilities. Let's examine some of these factors more in detail.

One factor is innovation. If entry is used as a vehicle for introducing innovations (Geroski, 1995), it may increase the probability of survival by giving means to cope with the technological environment (Banbury and Mitchell, 1995, Cefis and Marsili, 2006). However, innovation entails additional elements of inherent uncertainty. The first one is the achievement of appropriate production processes and products, and the second one involves marketing the innovative product (Audretsch, 1995). Furthermore, the results of innovation may not be immediately reflected on growth, as it may take a firm a long time to convert 'increases in economically valuable knowledge' (Coad and Rao, 2008) into successful manufacturing procedures. In the meanwhile innovations are considered only 'real options' for the firm (Bloom and Van Reenen, 2002).

R&D is another key factor. Formal and informal learning plays a major role for the survival and growth of young firms. The slower is the process of informal and formal learning and the more turbulent is the market environment, the more likely it is that firms will fail to cope (Geroski, 1995). Learning is partly informal and tacit, and partly formalized through R&D activities. (Hall, 1987, Geroski, 1995). In this paper we are able to identify only formal learning.

A third factor refers to technological capabilities. Here we take from the classification of different types of technological capabilities proposed by Lall (1992). We focus here on three types of technological capabilities: project execution, investments and linkages. They refer to different functions of firms. The first one regards the level of importance of

projects and technical procedures necessary to implement product or process innovation. The second one refers to the training for innovation, quality certification and investments in new equipment, and the third one is about the importance of external sources of information, research and education centers and other sources of information (patents, fairs, conferences, etc.). In a sense project execution capabilities refer to dimensions that are related to the non formalized and routine based aspects of the activities of the firms. The linkage capabilities refer to all the types of search for technology sources that need to feed the innovative and R&D activity of firms. As Lall (1992) clearly states, this categorization is broadly indicative, and does not necessarily defines a sequence of learning by firms. It just highlights different dimensions of technological capabilities that may be relevant for survival and growth of firms. And they complement the more formal search activities of firms that take place through R&D. Of course, not all these capabilities have to be present with the same intensity or breadth. And the sectoral context in terms of technological regimes and sectoral systems matter: in fact the relevance of formal search (i.e. R&D) and technological capabilities differs according to the sector (Malerba and Orsenigo, 1999; Malerba,2002).

Using three consecutive Community Innovation Surveys (CIS) called PINTEC[2] 2003, 2005 and 2008 this paper provides several novel results for survival and growth of young and small Brazilian industrial firms. To our knowledge, very few studies have been focused on the role of R&D, innovation and competences on the survival and growth of young companies, in particular regarding new leading countries. While the traditional literature has focused on age, size, foreign ownership, and innovation, we shed some light on the effect of R&D and other technological capabilities on these firms.

Our results provide empirical evidence that possessing technological capabilities and being national matter for survival and growth. However, being an innovator and investing in R&D is not always relevant, neither for survival nor for growth, at least under a short term view.

[2] Pesquisa de Inovação Tecnológica, IBGE (Instituto Brasileiro de Geografia e Estatística)

We also claim that the determinants of survival and growth of young firms may differ from sector to sector because sectoral systems may differ in the knowledge, learning processes and competences. So we assume that specific sectoral industrial patterns (Breschi et al., 2000) and sectoral systems (Malerba, 2002) , can exert significant impacts on the likelihood of survival and growth of newborn firms (Audretsch, 1991; Agarwal and Audretsch, 2001), we delve into four industrial sectors (food processing, automotive, chemicals, and electronics) and study their main drivers of survival and growth of young firms to see wether the factors differ significantly from one secto to another..

3. Database, variables and methodology

3.1. Database

Our data sources are the Brazilian Innovation Surveys Pintec 2003 (11.337 industrial firms), Pintec 2005 (13.575 industrial firms) and Pintec 2008 (14.355 industrial firms) , conducted by the IBGE (Instituto Brasileiro de Geografia e Estatistica) according to the Oslo Manual 3rd Edition and the Community Innovation Survey (CIS III), considering only industrial firms with more than 10 employees. Then, the smallest manufacturing plants are omitted from the analysis.

These surveys are related to firms' innovative performance for the period 2001-2008. Regarding stratification, Pintec considers innovation a rare phenomenon. Consequently if it follows the traditional design sample model -consisting in random stratification (by firm size, location, and activity) of firms- only a few innovative firms would be included. In spite of this, Pintec includes firms that have more probability of innovating[3]. Every year some firms are drop from the survey and are replaced by others, while new firms have also the opportunity to enter the survey every year, then the final composition of the

[3] Pintec has three levels of stratification, based on the probability of being an innovator. The "certain" stratus includes large firms (with more than 500 employees) with at least one principal indicator of technological activities. On the other extreme, firms without any indicator of technological activities are considered as not eligible. The sample is finally constructed with the 80% of eligible firms and the 20% of non eligible firms. The second level of stratification allows obtaining reasonable regional estimates in both UFe and Large Regions and also regarding economic activities.

sample is an unbalanced panel supposed to be representative of the Brazilian industry (Kannebley et al., 2005). For the purpose of our two analyses the samples are right censored: even if firms continue to exist after 2008 we consider this year as the censoring point.

Our unit of observation is the establishment, defined as an entity which can perform different economic activities operating at different geographic locations.

Table 1 reports descriptive statistics of the number of firms by size in each survey, absolute values of sales and sales growth, as well as percentages of sales growth, according to firm size (measured as the number of permanent employees).

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Table 1. Descriptive statistics – Sales and growth by firm's size

Number of employees	Total	10 to 29	30 to 49	50 to 99	100 to 249	250 to 499	> 500
Number of firms	20599	11916	3051	2413	1656	650	912
Sales 2003	953705414	39174346	28472797	54914195	105090677	107263839	618789561
Number of firms	21966	12037	2664	2837	2300	981	1086
Sales 2005	1217445461	52276662	33537113	62568271	117197802	124559542	827306070
Number of firms	33034	20093	4576	3995	2288	880	1202
Sales 2008	1896136040	75253634	53112359	97101953	171460567	183308553	1315898974
2003-2005 Growth	263740047	13102317	5064316	7654077	12107125	17295703	208516510
2005-2008 Growth	678690579	22976972	19575246	34533682	54262765	58749011	488592904
2003-2008 Growth	942430626	36079289	24639562	42187758	66369890	76044713	697109414
% 2003-2005 Growth	27.65%	33.45%	17.79%	13.94%	11.52%	16.12%	33.70%
% 2005-2008 Growth	55.75%	43.95%	58.37%	55.19%	46.30%	47.17%	59.06%
% 2003-2008 Growth	98.82%	92.10%	86.54%	76.82%	63.15%	70.90%	112.66%

Notes: All variables are expressed in R$ (1000) and deflated with the appropriate Consumption Price Index (Índice Nacional de Preços ao Consumidor Amplo, IPCA - IBGE), base 2003.
Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)

We observe that the smallest and largest firms present the highest sales growth rates, across the three studied intervals: 2003-2005, 2005-2008 and 2003-2008. Considering that sales have been properly deflated, 2003-2008 seems to be a very interesting period to study, since the rate of sales have grown in mean 98.82%.

3.2. Methodology

Our empirical analysis has then, two main scopes: survival and growth. Giving a first glance to our expected drivers of survival (size, age, innovation and domestic capital) and to our studied sectors, we run a simple univariate analysis performing tests of equality survival, which means to divide the sample into strata or groups. The expected number of deaths is obtained under the null hypothesis of no differences between the survival functions of the two groups. Our survival function (Cefis and Marsili, 2005) is defined as:

$$S(t) = 1 - F(t) = \Pr(T>t) \qquad \text{(I)}$$

where F is the cumulative distribution function of the duration time T, with unit variance, and represents the probability that a firm exits[4] before 2008.

Then, we delve into a multivariate analysis of the main drivers of survival. We proceed to estimate a multivariate non-parametric Cox proportional hazards model (Cox 1972) following equation II as our hazard function:

$$h_f(t) = h(t; X_i) = h_o(t) \exp(\beta_1 X_1 + \ldots\ldots + \beta_k X_k) \qquad \text{(II)}$$

where ho(t) is an arbitrary and unspecified baseline hazard function reflecting the probability of failure conditional on the firm's having survived until time t after entry into the market, $X_1 \ldots X_k$ is a vector of measured explanatory variables for the *i*th firm, and $\beta_1 \ldots \beta_k$ is the vector of unknown regression parameters to be estimated (Agarwal and Audrestch, 2001).

Through the Cox model we obtain estimates of β1…….. βk but we do not provide direct estimate of h0(t) that is the baseline hazard, then few assumptions need be made about the relationships among variables (Breslow, 1974). As time is discrete in our studied models, ties are expected. We select the Breslow method (an approximation of the exact marginal likelihood) for handling ties values simple, because we do not the order in which subjects will fail.

The second part of the empirical model regards firm's growth from 2001 to 2008, is calculated only form firms which survive[5] till 2008, and is defined as:

$$\text{Growth} = \ln(S_{t'} / S_t) \qquad \text{(III)}$$

where S are firm's sales, t' is 2008 and t is 2001, then t'- t is the number of years between these two dates. Our first caveat regards growth due to mergers. As no information is

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[4] The fact that a firm is not on the dataset in 2008 may mean several things. It may have failed (i.e. filed for bankruptcy), it may have voluntarily dissolved itself, it may have merged with another firm, or it may have been acquired by another firm (Evans, 1987). With our databases we are not able to distinguish these situations.

[5] Working only with firms which survive over the studied period may create sample selection problems. To solve them Doms et al. (1995) estimate the inverse Mills ratio constructed from the survival model and include it as a regressor in the growth model. However problems of identification are created in the growth equation

available on mergers, there is no way to distinguish between internal growth and growth due to these processes (Evans, 1987).

Standard least squares regression techniques, which provide estimates that calculate the average effect of the independent variables on the 'average firm', may hide important features of the underlying relationship[6] (Coad and Rao, 2008). Then, we include OLS results only as a reference point but, as expecting different growth performance amongst firms, we also run quantile regressions (Koenker and Basset, 1978), which provide an equally convenient method for estimating models for conditional quantile functions. Indeed segmenting the sample into subsets defined according to the conditioning covariates is always a valid option.(Koenker and Hallock, 2001). Then, letting $\{X_t: t = 1,\ldots, T\}$ denote a sequence of (row) K-vectors of our drivers of growth (regressors), $\{Y_t: t = 1, \ldots, T\}$ is a random sample on the regression process $U_t = Y_t - X_t b$ having distribution function F. The θth regression quantile, $0<\theta<1$, is defined as any solution to the minimization problem (Koenker and Basset, 1978):

$$\min_{b \varepsilon R} \left[\sum_{t \varepsilon \{t: Y_t \geq X_t b\}} \theta \, |Y_t - X_t b| + \sum_{t \varepsilon \{t: Y_t < X_t b\}} (1-\theta) \, |Y_t - X_t b| \right]$$

Then, our linear regression model for firm's growth takes the following form:

$$Growth_{i,t} = \alpha + (\beta_1 X_1 + \ldots\ldots + \beta_k X_k) + \varepsilon_{i,t} \qquad \text{(IV)}$$

where $X_1 \ldots X_k$ is a vector of measured explanatory variables for the *i*th firm, and $\beta_1 \ldots \beta_k$ is the vector of unknown regression parameters to be estimated

3.3. Variables

Our key dependent variable for the survival analysis is firm's survival time, calculated as the number of years between 2001 and the year in which the firm exits (if this happens before 2008), or the censored year to the right (that is 2008) for continuing firms. We study survival at two levels of aggregation: in the first part this event is defined for young and small firms. In the second part, since we intend to take into account sectoral effects,

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[6] Firms at the rth quantile can perform better than the proportion the reference group of firms and worse than the proportion $(1-\tau)$ (Koenker and Hallock, 2001).

we redefine it for each of our four selected sectors: automotive, food, chemicals and electronics.

For the growth analysis the dependent variable is calculated by taking differences of logs of size, measured by total sales between 2003 and 2008. Then, following the same fashion as in survival, the growth analysis is applied to young and small firms and to firms of the selected sectors.

The description of the independent variables, common to both analyses, is presented in Table 2. Regarding the years of reference used for constructing the variables, we use two types of variables: one group (. R&D expenditures, firm's characteristics and control variables) refers to firm's previous year information, while the other group (. TCs and innovation) covers innovation activities during the past three years. Each firm is evaluated over the three types of investment, production, linkages and capabilities, according to Lall's taxonomy (Lall, 1992). The basic idea is "the attempt of a qualification, however tentative or cautious[7], of firm level technological behaviour" (Lall and Latsch, 1999, p.52).

Regarding internal and external R&D expenditures, even if they are a crucial TCs (Gonsen, 1998; Lall and Latsch, 1999; Wignaraja, 2002 and 2008), due to its increasing importance, we keep them separately from the other technological capabilities. Innovation is a binary variables which take value one, if firms introduce at least one new product to the Brazilian market over a three year period – including the year of the survey, or if firms introduce or improve of at least one new process, to their sector within Brazil or either of them, and zero otherwise.

The domestic nature of firm's capital is among our variables of interest. Then, we include it as a binary variable that takes value one if the firm's capital is completely national or zero otherwise.

Finally two sets of control dummy variables (region and year), allow us accounting for the pertinent fixed effect. A third set of control dummy, the sector (CNAE2), is included

[7] Even if inter-firm comparisons across firms can be biased with respect to indicating differences in "capabilities cum capacities" (the extent of sophistication levels can differ intra and inter firm respectively), since most of the analysis is concerned with relative values, it is possible that this potential bias has minimal consequences (Westphal et al., 1990; Wignaraja, 2002).

when studying all the industrial sectors together, to minimize the effects of autocorrelation.

Table 2. Independent Variables Description

Variables	Notation	Definitions	Value
Project Technological Capabilities	Investment TCs1	Simple mean, after adding the level of importance of projects and technical procedures necessary to implement product or process innovation. Changes in production or quality procedures and methodologies to improve products and process are included (excludes R&D)	Metric
Production Technological Capabilities	Production TCs2	Simple mean, after adding the level of importance of training for innov., quality certification and investments in new equipment	Metric
Linkages Technological Capabilities	Linkages TCs3	Simple mean, after adding the level of importance of external sources of information, research and education centers and other sources of information (patents, fairs, conferences, etc.)	Metric
R&D Expenditures	R&D	The sum of internal and external expenditures in R&D in local currency (1000) R$	Metric
Innovation	Inno	The firm introduced new products or new process or significantly improved either of them for the domestic market or sector	Nominal
Domestic	DOME	The national origin of the control capital (yes/no)	Metric
Sector	Sector	A set of variable dummy for 3 digit CNAE sector	Nominal
Region	Region	A set of variable dummy for the 6 regions	Nominal
Year	Year	A set of variable dummy for the three years (2003, 2005 and 2008)	Nominal

Sources: authors' elaboration based on Pintec 2003, 2005 and 2008

4. Main drivers of firm survival

We present in table 3 a correlation matrix of the traditional drivers of survival for the whole sample: size, age and innovation. Due to our special interest in firm's growth, we also include it among the covariates:

Table 3. Correlation matrix of survival times and covariates

	Survival Time	Age	Size	Sales Growth	Innovation
Survival Time	1				
Age	0.2841	1			
	0.0000				
Size	0.5366	0.2759	1		
	0.0000	0.0000			
Sales Growth	0.1324	-0.0815	0.0592	1	
	0.0000	0.0000	0.0000		
Innovation	0.1808	0.0811	0.3095	0.019	1
	0.0000	0.0000	0.0000	0.064	

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005

and 2008 (IBGE)

The results show that all the variables are positively and significantly related to survival, having size the highest coefficient for the whole sample.

Our next step, already anticipated in the methodology section, is the univariate analysis of the main drivers of survival drivers of all young and small firms and of young and small firms from our four selected sectors. We present the results in table 4:

Table 4. Non parametric tests of equality of survival functions across samples

Tests	Events	Chi-Square (1)	Pr > chi2
Small vs. non small			
Log-rank test	7583	9224.32	0.000
Wilcoxon (Breslow) test	7583	7498.93	0.000
Tarone-Ware test	7583	8210.46	0.000
Young vs. non young			
Log-rank test	2126	0.11	0.7452
Wilcoxon (Breslow) test	2126	6.07	0.0137
Tarone-Ware test	2126	2.81	0.0935
Innovator vs. non innovator			
Log-rank test	669	855.24	0.000
Wilcoxon (Breslow) test	669	833.28	0.000
Tarone-Ware test	669	876.46	0.000
Domestic vs. Foreign Owned			
Log-rank test	15579	473.71	0.000
Wilcoxon (Breslow) test	15579	468.38	0.000
Tarone-Ware test	15579	493.56	0.000
Food vs. non food			
Log-rank test	1970	15.23	0.000
Wilcoxon (Breslow) test	1970	9.17	0.002
Tarone-Ware test	1970	11.41	0.000
Automotive vs. non automotive			
Log-rank test	385	0.1	0.7483
Wilcoxon (Breslow) test	385	0.000	0.9524
Tarone-Ware test	385	0.01	0.9398
Chemical vs. non chemical			
Log-rank test	796	2.49	0.1145
Wilcoxon (Breslow) test	796	2.44	0.1181
Tarone-Ware test	796	2.53	0.1115
Electrical vs.non electrical			
Log-rank test	274	62.86	0.000
Wilcoxon (Breslow) test	274	70.7	0.000
Tarone-Ware test	274	69.73	0.000

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)

As expected, size, innovation and domestic capital variables matter for survival. Regarding these drivers, the results from the different tests convey similar points. Instead, regarding age variables, the Log-rank Test fail to reject the null hypothesis of no difference between the survivor functions in the two groups (young or not young), suggesting that being young is not a determinant for survival; while conversely, the Wilcoxon (Breslow) Test and the Tarone Test, provide different conclusions due to the different weights function used. Indeed, the Log-rank test uses 1 as the weight at all failure times and it is the most appropriate when the hazard functions are thought to be proportional across the groups if they are not equal while. The Wilcoxon (Breslow) and Tarone Test tests use the number of subjects and the squared root of the number of subjects at risk of failure respectively, at each distinct failure time, giving heavier weights to earlier failure times. Our intuition is then, that the first years are crucial for young firms', and that having overcome them, the probability of survival increases.

Regarding sectors, only for the Automotive the three tests convey to the same conclusion: we cannot reject the hypothesis that the survivor functions are the same for both groups, suggesting that belonging to one of the three remaining studied sectors Food, Electronic[8] or Chemical (which observes the highest significance levels), has a positive effect on firm survival.

The following step regarding survival is the multivariate analysis of the main drivers of survival. We run a Cox regression model following equation (V):

$$h_f(t) = h(t; X_f) = h_o(t) \exp(\beta_1 R\&D + \beta_2 TCs + \beta_3 Inno + \beta_4 DO + C_i) \qquad (V)$$

where R&D are firm's investments in research and development, TCs are firm's technological capabilities, Inno is the dummy variable which indicates if the firm introduce any type of innovation, and C*i* are control dummies for individual effects or individual heterogeneity (sector, region). We present the results in table 5:

[8] The Electronic Sector includes CNAe 30 and 32 which includes electronic material, communication equipment, computers, office machines, etc.

Table 5. Cox regressions – Breslow method for ties

	Young and Small	Food Processing	Automotive	Chemicals	Electronics
R&D	0.999	7.55E+10	7.31e+10***	0.997	1.00E+00
	0.0006	5.24E+09	8.27E+08	0.00607	8.57E-04
Project TCs	1.3**	1.559812	3.64E-01	1.589	2.208
	0.157	0.678	3.57E-01	0.746	2.754
Investment TCs	0.522***	0.685	2.126	0.268*	1.243
	0.073	0.274	1.965	0.211	1.52
Linkages TCs	0.119***	0.057***	0.9	0.166***	1.12e-12***
	0.016	0.022	0.362	0.0863	9.39E-02
Innovation	0.898	1.81	3.37e-10***	0.508	3.29e-01**
	0.109	0.603	2.28E-11	0.331	1.88E-01
Domestic	1.476**	0.994***	1.003	1.10E+15	1.861
	0.286	0.002	0.003		1.089
Sector	X	------	-----	------	-----
Region	X	X	X	X	
Age	X	X	X	X	
N observations	2432	222	32	72	84

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)

*Notes: * Significant at 10%, ** significant at 5%, *** significant at 1%. Standard Errors between parntheses*

Technological capabilities seen as indigenous efforts (e.g. investments in skills, training, new equipment, linkages, etc.) for adapting to technological change should provide additional tools for survival within young and small Brazilian industrial firms as seen in Table 5. All the TCs (except R&D) variables are positively and significantly related to survival for all young and small firms. This is also true, at different strengths and for different TCs, for all our selected sectors. This is a very interesting finding, because the four sectors represent very diverse technological regimes (Malerba and Orsenigo, 1999) and sectoral systems (Malerba,2002) which are, in different ways, highly exposed to technological changes. For instance project capabilities do not have a significant impact on firm's survival within our four selected sectors. In this sense, projects and preliminary activities are frequently only the starting point to pave the way for building the other TCs, and may not be easily and immediately reflected in increasing the probability of survival of firms.

Only within the automotive sector, firms explore technological opportunities by actively investing in R&D and innovating (at lower coefficient), enhancing their chances of

survival. Instead, for the other sectors and for all the young and small firms together, R&D investments are not positively and significantly related to survival of firms. These findings can be explained at least in two ways. One is that firm's efforts in investing in R&D are possibly not enough for increasing the likelihood of survival. The other is that R&D investments may have yet not produced results, within the period compressed in our analysis

For the food processing, what matters for survival is to build linkages TCs. Being domestic is also a premium for survival, which is shared with the young and small firms all together. The intuition in this sense is that multinational firms are more prone to close their local establishment or leave the country if the results are not what they expected than domestic firms[9].

The only factor that exert positive influence on chemicals firm's survival are linkages TCs, while for electronic firms linkages TCs and being innovative are important (even if they are at low coefficient level) for survival. Regarding the latter aspect, introducing innovation not always, and not for every sector, can exert positive effects on survival. Indeed, firms may become too exposed to the risk of exit and introducing innovation may compromise their survival probabilities. For all our small and young sampled firms and for the other three sectors, innovation is not significantly related to survival.

5. Main drivers of firm growth

We complement our study analyzing whether growth is also fostered by the same drivers than survival for young small firms and for our four sectors in Brazil. This is particularly important because growth is "the over-riding factor correlated with survival" (Phillips and Kirchhoff, 1988). The quantile regression coefficients can be interpreted as the partial derivative of the conditional quantile of y with respect to particular regressors (Coad and Rao, 2008) and our model is then:

$$\text{Growth}_{i,t} = \alpha + (\beta 1\text{R\&D} + \beta 2\text{TCs} + \beta 3\text{Inno} + \beta 4\text{DO} + \text{C}i) + \varepsilon_{i,t} \qquad \text{(VI)}$$

[9] In this sense frequently multinational parents firms do not give the subsidiaries the adequate time for recover costs associated with internationalization and adaptation or generation of new routines for market entry (Sapienza et al, 2008).

where again R&D are firm's investments in research and development, TCs are firm's technological capabilities, Inno is the dummy variable which indicates if the firm introduce any type of innovation, and C*i* are controls for individual effects or individual heterogeneity (sector, region). We also control for common macroeconomic shocks by including year dummies (Coad and Rao, 2008). Table 6, column 1 shows the OLS results and from column 2 to 4, the quantile regression for the 25%, 50%, and 75% quantiles.

Table 6. Quantile regression- Young small firms- 25%, 50%, and 75% quantiles

	OLS	.25 Quantile	.50 Quantile	.75 Quantile
R&D	-0.00002	-0.00002***	-5.39E-06	-0.00002***
	0.00003	5.39E-06	7.20E-06	5.41E-07
Projects TCs	0.446**	0.042	0.042	0.044***
	0.22	0.186	0.144	0.01
Investment TCs	-0.394**	0.178	-0.105	-0.443***
	0.171	0.157	0.129	0.008
Linkages TCs	-0.352**	0.044	0.067	0.019*
	0.185	0.181	0.144	0.012
Innovation	-0.02	-0.027	0.053	0.046***
	0.133	0.0887	0.071	0.005
Domestic	0.151	-0.017	0.134*	0.23***
	0.133	0.079	0.078	0.005
Sector	X	X	X	X
Region	X	X	X	X
Year	X	X	X	X
No. of Observations	2577	2577	2577	2577

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)

*Notes: * Significant at 10%, ** significant at 5%, *** significant at 1%. Standard Errors between parntheses*

Following the same fashion of survival, the R&D coefficient is not positive and significant for small and young firms' growth, neither for OLS nor for quantile regressions. Regarding technological capabilities (TCs), we found evidence that some of them are crucial for survival, but however do not exert immediate positive and significant effect over sales growth. We observe results which contrast survival and growth: investment TCs help survival but seems not enough for growing. Innovation goes in the opposite sense, if considering the 0.75 quantile (fast-growth firms), in the sense that it is positive and significant for growing but not for every young and small firm's survival. These results about the upper quantile probably reflect that innovation may lead to a fast

increase in sales, but may compromise survival due to the inherent uncertainty of innovative activity.

The quantile regression growth analysis is replicated for our four selected sectors in tables 7 to 10.

Table 7. Quantile regression- Food Sector- 25%, 50%, and 75%quantiles

	OLS	.25 Quantile	Median	.75 Quantile
R&D	-0.0002	-0.00007	0.0001	0.002***
	0.0009	0.0001	0.0002	0.0005
Project TCs	1.073	1.091***	-0.235	-2.701**
	0.875	0.37	0.714	1.124
Investments TCs	-1.857***	-1.602***	-0.791	0.418
	0.696	0.35	0.592	0.73
Linkages TCs	0.548	0.858***	0.389	-1.182
	0.662	0.203	0.499	0.856
Innovation	-0.612	-0.329***	-0.185	-0.851
	0.575	0.132	0.282	0.546
Domestic	0.459	0.291	0.479	0.703
	1.17	0.21	0.448	0.52
Region	X	X	X	X
Year	X	X	X	X
No. of observations	244	244	244	244

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)

*Notes: * Significant at 10%, ** significant at 5%, *** significant at 1%. Standard Errors between parntheses*

Interestingly, within the food processing sector the relationship between TCs and growth is different if we consider the lower quantile and the upper quantile regressions. Among the former, project and linkages capabilities are positive and significant for growth but innovation exert the opposite effect. While among the latter R&D play the crucial role for growth, regardless the other TCs. Unexpectedly project capabilities are negative and significant for growth within fast growing firms. One the one hand these results confirm the importance of keeping R&D separate from the other TCs as it allows identifying it as a determinant for growth within fast growing firms. On the other hand they underscore that, probably due to the increasing requirements of sophistication and differentiation in food, firms grow fast only if they invest in R&D and not only in preliminary projects within this sector. All the other variables remain either non significant or negative for growth.

Table 8. Quantile regression- Automotive Sector- 25%, 50%, and 75%, quantiles

	OLS	.25 Quantile	Median	.75 Quantile
R&D	-0.0007	-0.005***	-0.0003	-0.0004**
	0.0007	0.0002	0.0006051	0.0002
Project TCs	-0.737	0.715	0.083	0.818
	2.206	0.688	2.572122	0.802
Investment TCs	4.149	0.786	2.046	1.624*
	3.222	0.739	2.843137	0.976
Linkages TCs	-3.819*	-1.984**	-2.935	-2.876***
	2.262	0.945	2.737152	0.811
Innovation	0.86	0.889***	1.204	0.343
	1.387	0.342	0.7489999	0.23
Domestic	-1.391**	-0.235	-1.058	-0.372
	0.646	0.169	0.7258086	0.249
Region	X	X	X	X
Year	X	X	X	X
No. of observations	41	41	41	41

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)

*Notes: * Significant at 10%, ** significant at 5%, *** significant at 1%. Standard Errors between parntheses*

The picture is very different regarding the automotive sector Innovation is a fundamental factor for growth for the 0.25 quantile, which seems to prove that small and young firms are especially pressed to innovate within this sector. Then, even if sometimes delaying growth, innovation is crucially needed. The fast growth firms instead, focus on investment capabilities which includes the acquisition of new equipment, training and quality certification. Unexpectedly linkages capabilities are negatively and significantly related to growth for the higher and lower quantiles. We suspect that for both low and high growth firms, too close or dependent relationships with external sources of knowledge and information can be negative for sales growth. All the other variables are not significant for growth.

Table 9. Quantile regression- Chemical Sector- 25%, 50%, and 75%, quantiles

	OLS	.25 Quantile	Median	.75 Quantile
R&D	-0.00007	0.0001	0.00005	-0.0001
	0.0002	0.0002	0.00005	0.0002
Project TCs	0.335	0.185	0.03	0.198
	0.558	1.372	0.242	0.602
Investment TCs	-0.206	-0.565	0.283	-0.00819
	0.504	1.075	0.207	0.457
Linkages TCs	-0.65	-0.49	-0.193	0.606
	0.555	1.217	0.244	0.639
Innovation	0.334	0.441	-0.402	0.174
	0.329	0.712	0.139	0.449
Domestic	0.253	0.077	0.085	0.454
	0.236	0.608	0.112	0.331
Region	X	X	X	X
Year	X	X	X	X
No. of observations	115	115	115	115

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)
*Notes: * Significant at 10%, ** significant at 5%, *** significant at 1%. Standard Errors between parntheses*

The numerical results for OLS and quantile regression estimations agree that neither of the studied variables is significant and positive for small young firm's growth within the chemical sector.

Table 10. Quantile regression- Electronic Sector- 25%, 50%, and 75% quantiles

	OLS	.25 Quantile	Median	.75 Quantile
R&D	-0.00002	-0.00004	-0.00004	-0.00007***
	0.0000375	0.00003	0.00003	0.00003
Project TCs	1.782*	1.351	1.394	3.203*
	1.043926	1.391	1.391	1.698
Production TCs	-2.029**	-0.612	-2.265	-2.682
	0.942003	1.211	1.211	1.923
Linkages TCs	-1.113	-0.62	-0.887	-2.061**
	0.7323079	1.558	1.558	1.272
Innovation	0.392	0.462	0.295	0.738*
	0.4245691	0.548	0.548	0.455
Domestic	0.218	-0.361	-0.428	0.059
	0.4628714	0.574	0.574	0.608
Region	X	X	X	X
Year	X	X	X	X
No. of observations	111	111	111	111

Source: authors elaboration based on Pintec (Pesquisa de Inovação Tecnólogica) 2003, 2005 and 2008 (IBGE)
*Notes: * Significant at 10%, ** significant at 5%, *** significant at 1%. Standard Errors between parntheses*

Regarding the electronic sector, project TCs and innovation matter for growth for the upper quantile. Even if the project TCs are positively and significantly related to growth, both for the upper quantile and for the OLS, the coefficient on project TCs is much larger at the higher quantiles (at the .75 quantile, the coefficient of project TCs on growth is over 2 times larger than at the OLS). Finally, confirming what has been found for all the young and small firms in Table 6, innovation matters for growth at the upper quantile within the electronic sector and it remains clear that innovative activity makes an important contribution to electronic firms superior growth performance

6. Conclusions

In this paper we focused on factors affecting the survival and growth of young, small firms. Our attention has been devoted to Brazilian industrial firms, as an interesting example of a leading emerging industrial country . We have also examined four specific sectors: food processing, automotive, chemicals and electronics, in order to obtain a comprehensive view of the particular nature of different technological regimes and sectoral systems on the growth and survival of firms.

. This paper extends earlier empirical research focusing on age, size, and innovation as drivers of survival and growth and includes R&D and different types of r technological capabilities. The paper shows that the factors affecting the survival or young small firms are different from the ones affecting growth. The presence of all types of technological capabilities are necessary for the survival of Brazilian firms, while innovation is not. On the other hand innovation, project capabilities and linkages are key factors affecting very high growth. These results indicate that what matters for survival are basic technological capabilities related to project execution, investments and linkages. Innovation becomes a distinguishing positive factor when firms strive for high growth. However in this respect, major efforts for investments are not associated with high growth, because investments may take away resources for current growth.

Some other interesting findings emerge from this study.

First, young and small domestic firms have more chances to survive than foreign owned firms, and -but only if they belong to the upper quantile (.75)- they are more prone to grow.Second, the link between R&D, and survival and growth remains limited or even negative. One explanation can be found in the fact that the desired positive effects of R&D are frequently not immediate, and may be missing in our results which consider only a short period of time. With longer time series we would be able to learn more about the impact of R&D on survival and growth. The other explanation is that small and young firms do not consider R&D a priority or do not have the resources to invest in it.

Third, sectors differ in the factors affecting the survival and growth of young small Brazilian firms. Technological capabilities are not always a factor that increases the chance of survival and growth in every sector. In food, only linkage capabilities affect positively the survival of firms. On the contrary, in auto, linkage capabilities help young firms to grow highly. In chemicals linkage and investment capabilities affect survival while in electronics survival is affected by linkage capabilities and high growth by project capabilities and innovation. R&D is a key determinant for the high growth of small young firms only in food processing, while for the other three sectors R&D remains insignificant and even negative for some of them. On the contrary, innovation has a positive impact on growth in the automotive and electronic sectors.

This paper is just the first step in an examination of the drivers of survival and growth of young small Brazilian firms. In nutshell, our evidence demonstrates that beyond the factors which have been traditionally studied, formal learning such as R&D and various types of technological capabilities may play a major explanatory role. However these factors act differently for survival and for growth, and for different sectors. Further research may complement the present analysis by focusing more in depth on the reasons why these factors differ for survival and for growth, why we find differences across sectors and whether the contextual systemic conditions influence survival and growth.

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