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Differentiating some trees of the forest of innovative Brazilian SMEs

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Abstract

This work aims to present a typology model that seeks to identify patterns of innovation in Brazilian small and medium enterprises (SMEs). To this end, we used as methodology a measurement with the formulation of indicators designed to assess the dimensions of innovative efforts and results and the organizational performance of enterprises. These indicators were created based on the Survey of Technological Innovation (PINTEC), conducted by the Brazilian Institute of Geography and Statistics (IBGE). The results showed the existence of different patterns among the enterprises analyzed, and macro-innovative enterprises tend to have superior organizational performance

Keywords: *innovation, typology, small and medium enterprises, performance.*

Diferenciando algumas árvores da floresta de PMEs brasileiras inovadoras

RESUMO

Este trabalho tem como objetivo apresentar um modelo de tipologia que busca identificar padrões de inovação em pequenas e médias empresas brasileiras (PMEs). Para tanto, utilizamos como metodologia uma medida com a formulação de indicadores destinados a avaliar as dimensões de esforços e resultados inovadores e o desempenho organizacional das empresas. Esses indicadores foram criados com base na Pesquisa de Inovação Tecnológica (PINTEC), realizada pelo Instituto Brasileiro de Geografia e Estatística (IBGE). Os resultados mostraram a existência de padrões diferentes entre as empresas analisadas, e as empresas macro-inovadoras tendem a ter desempenho organizacional superior.

Palavras-chave: inovação, tipologia, pequena e média empresas, desempenho.

INTRODUCTION

The concept of technological product and process innovation (TPPI) – introduction in the market of a new or significantly improved product/process (OECD, 1997) – has been present in Brazil since 1990, receiving the attention of various authors – of the public, private and academy sectors – and recognition as an important element for the competitiveness of nations, since Schumpeter (1982 [1912]) and, therefore, of enterprises (de Negri & Salerno , 2005). According to Hollenstein (2003), the business environment is becoming increasingly competitive and heterogeneous and, taking into consideration the current degree of globalization and competition that has reached organizational ecosystems, it is imperative the search for an innovation strategy to differentiate one enterprise from its competitors (ANDERSÉN, 2012). Its main feature is the successful exploration and management of ideas and its differential is in change itself (Neely & Hii, 1998, 1999).

Academic research on the subject of technological innovation focuses, in general, on the study of large organizations (INÁCIO, 2012). According to Wolfe (1994), studies related to innovation should focus on three lines of research: diffusion of innovation, innovation processes and drivers of innovation. This article falls in the last line of research, as, by means of a quantitative approach, it creates a series of indicators that identify patterns of innovation and generally address their impact on the organizational and innovative performance of Brazilian small and medium industrial enterprises (SMEs). According to Peng, Schroeder and Shah (2008, pp. 735) "the ability to innovate is the strength or proficiency of a set of organizational practices for the development of new products/processes."

This study aims to fill a gap on research related to the subject of innovation in Brazilian SMEs – business employing from 10 to 249 individuals. Using as a database the innovation research (PINTEC) conducted by the Brazilian Institute of Geography and Statistics (IBGE), for the triennium 2003-2005 (IBGE, 2007), this research brings new results concerning the association between two dimensions of innovation – called Innovative Efforts (IEs) and Innovative Performance (IP) – and the dimension of Organizational Performance (OP) for Brazilian innovative industrial SMEs.

The operationalization of the research occurred from the creation of a typology, which from two axes – of efforts and results from innovation – has four quadrants (or four distinct and exclusive groups) of innovative SMEs. From the use of the methodological resource called polar extremes, we analyzed only two of these groups, which are the most different among themselves, the innovative SMEs named Macro-innovative (NI), comprising SMEs with high degree of Novelty and high degree of Impact of their innovations and SMEs named Micro-innovative (ni), comprising SMEs with low degree of novelty and low degree of impact of their innovations.

Finally, the article is structured in four sections in addition to this introduction. The second section brings a brief summary of the literature on innovation in SMEs. The third section brings

details on the procedures to establish a typology in addition to the indicators used. Then, the fourth section presents the results, listing what are the main characteristics of innovative SMEs. Finally, the fifth section brings reflections, limitations and possible developments for future research.

IMPORTANCE OF SMES AND THEIR RELATION WITH INNOVATION

As highlighted by Lundström and Stevenson (2002), the stimulus to create SMEs is seen as one of the responses to high rates of unemployment and economic stagnation. One of the precursor research studies to emphasize this point was by David Birch, in 1981 (apud OECD, 2002b), who showed that more than 80% of the new jobs generated came from small rather than large enterprises, in the United States.

Statistical data from 2011 show the potential of micro and SMEs in the Brazilian economy. They represent 27% of the GDP. When it comes to absolute values, the production generated by these SMEs quadrupled in ten years, jumping from R$ 144 billion in 2001 to R$ 599 billion in 2011. Moreover, these businesses have 52% of the employees with formal contract and represent 40% of the wages paid, and in total numbers they amount to 8.9 million small enterprises (SEBRAE, 2014).

Comparing these Brazilian numbers with some countries of the European Union for the year of 2005, we can realize that, numerically, the proportion of micro and SMEs is practically the same, being 99.4% against 99.3%, respectively. However, the same does not happen with the other two indicators (employment and participation in the GDP). Micro and SMEs account for approximately 72% of the formal jobs and 61% of the GDP in the European Union (OECD, 2006). For these two indicators, it is clear how far we still need to go.

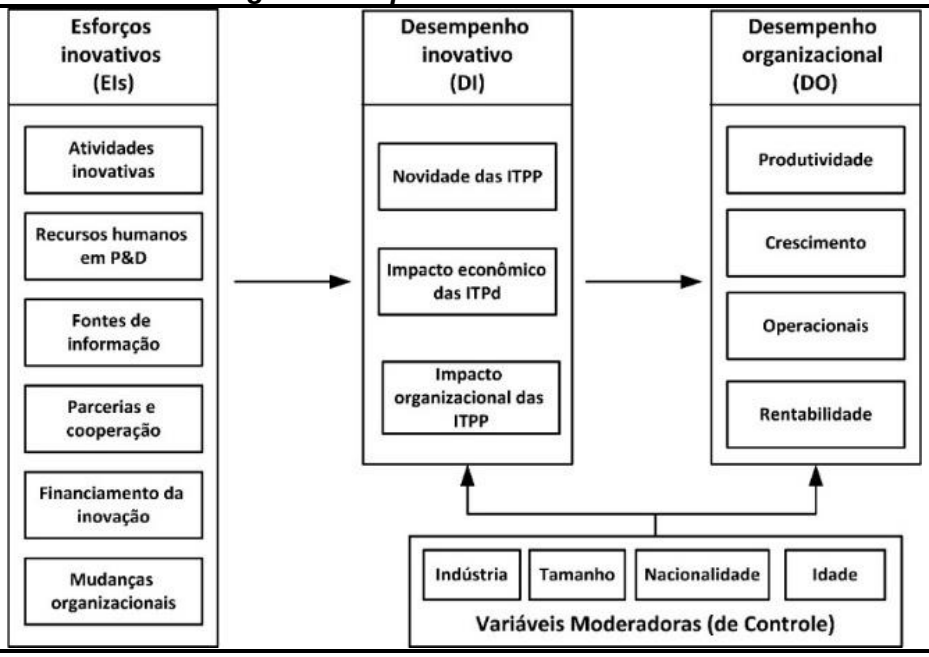
Another point the literature highlights is related to the role of SMEs in the process of generation and dissemination of TPPI (Ács & Audretsch, 1990; Rothwell & Zegveld, 1982). The pattern that manifests itself in the technological sphere is the same as in the economic sphere, i.e., a low propensity to innovate results in low levels of innovative performance and technological efforts (de Negri & Salerno, 2005; Kannabley Jr., Porto, & Pazzelo, 2005; Quadros, Furtado, Bernardes, & Franco, 2001; Souitaris, 1999, 2002; Terziovski, 2010; Tidd, Bessant, & Pavitt, 2001). However, we have to consider that a smaller number of SMEs, called technology-based companies, stand out in relation to their innovative results and efforts (Fernandes & Côrtes, 1999; Fernandes, Côrtes, & Oishi, 2000).

Thus, the measuring of the level of innovative impacts that these SMEs are developing and, therefore, the understanding of whether such innovations affect the organizational performance of these enterprises become the essential task for the advancement and management of the innovative process as a whole. Such a task is exactly what this study sought to develop, in addition to going a step further by implementing a typology that identified the innovative patterns present in the sample of enterprises studied.

METHODOLOGY

Being the innovation process inherently multi-disciplinary, interactive and uncertain (Freeman, 1995; Kline & Rosenberg, 1986; Lundvall, 1992; Nelson, 1993), the research model used four dimensions of research. Figure 1 provides a detailed view of the proposed model and its four dimensions of research.

Figure 1.*Proposed Research Model*



Caption: TPI = technological product innovations.
Source: Prepared by the authors.

Subtitle:
EIs: Innovative Efforts (IEs); innovative activities; human resources in R&D; Information sources; Partnerships and cooperation; Financing of innovation; Organizational changes;
DI: Innovative performance (IP); News from the TPPI; Economic impact of TPI; Organizational impact of the TPPI;
DO: Organizational performance (OP); Productivity; Growth; Operating; Profitability;
Variáveis moderadoras: Moderating variables; Industry; Size; Nationality; Age; Moderating variables (of control).

Two of them show important aspects of the innovation process: the dimension of the efforts made in order to innovate (named Innovative Efforts - IEs) and the innovative results effectively achieved and their impacts (named Innovative Performance - IP). The third comprises the economic and financial dimension of the enterprise, named Organizational Performance (OP). Being innovation an important way to ensure competitive advantage, the analysis of the relationship between the dimensions of innovative and organizational performance assumes an important role in this research.

The fourth dimension includes a set of variables named moderating variables (or of control), from the mediation and influence on the main interface to be studied, between the variables of IEs and IP.

The research model is based on the premise shared by several researchers, especially those aligned with the evolutionary theory of the firm (Dosi, 1982, 2006 [1984]; Nelson & Winter, 2005

[1982]; Pavitt, 1984), in which enterprises differ in relation to their technological and market opportunities. This means that different enterprises have different ways of organizing themselves (of doing things) with a view to innovation which, in turn, use distinct IEs that lead to different results (Davila, Epstein, & Shelton, 2006).

Data sources

The Survey of Technological Innovation – PINTEC (2005) – and the Annual Survey of Industry – PIA-Enterprise (2003 and 2005)–, both conducted by IBGE, were used as the data source for the development of indicators.

From PINTEC, we could create all the indicators of the dimensions of Innovative Efforts (IEs) and Innovative Performance (IP), and the indicators of organizational performance came from the Annual Survey of Industry – Enterprise (PIA-Enterprise).

The PINTEC has as main objective the construction of sectoral, national and regional indicators and indicators for technological innovation activities in Brazilian industrial enterprises. Its design is aligned with the conceptual and methodological recommendations described in the Oslo Manual (OECD, 2005), allowing analyses and international comparisons. Moreover, PINTEC is the only research on technological innovation with national scope that extends to enterprises that employ ten or more persons (IBGE, 2005).

The PIA-Enterprise, also carried out by IBGE, has been annual since 1996 and forms the central core of statistics for the Brazilian extractive and transformation industries, generating annual information on industrial enterprises employing five or more persons, classified according to CNAE, related to data on production, intermediate consumption, spending on payroll, among others.

A last database comprising invention patents and utility models, made available by INPI (Brazilian Institute of Industrial Property), was also incorporated into the analysis. It is needed because PINTEC brings no quantitative information on patents. Both the filed patent application (same period covered by PINTEC, 2003 to 2005, these included) and the already granted patent application were considered (ten years, 1996 to 2005, inclusive). The PIA-Enterprise and PINTEC questionnaires can be accessed from the IBGE website (in Portuguese).[1]

Construction of the typology

For the construction of the typology, we used the variables presented in Table 1. All these variables are obtained from the PINTEC questionnaire (2005) and the "Source" column indicates what questions provide such data.

[1] http://www.pintec.ibge.gov.br/;
http://www.ibge.gov.br/home/estatistica/economia/industria/pia/empresas/defaultempresa2005.shtm.

Table 1. Indicators created from Innovative Performance (IP)

Indicators	Code	Scale	Interval	Source
Degree of novelty of the TPPI[1] (Degree of novelty of the main technological product or process innovation)	GNIO	Ordinal	High; Low	Q13 and Q19
Degree of impact of the TPPI (Aggregate indicator composed of the variables IEIT, IOIT, PNIT and NPCD)	GIIO	Ordinal	High; Low	N.A.
Economic impact of the TPPI (Participation of the TPI in net sales revenues, internal and external market)	IEIT	Metric	[0, 100]	Q88 and Q92
Organizational impact of the TPPI1[1] (Importance of the impacts of the TPPI in product, market, process, and others)	IOIT	Metric	[0, 45]	Q93 to Q105
Number of patents granted and filed (Number of patents granted and still under review)	NPCD	Metric	[0, ∞[	INPI Base

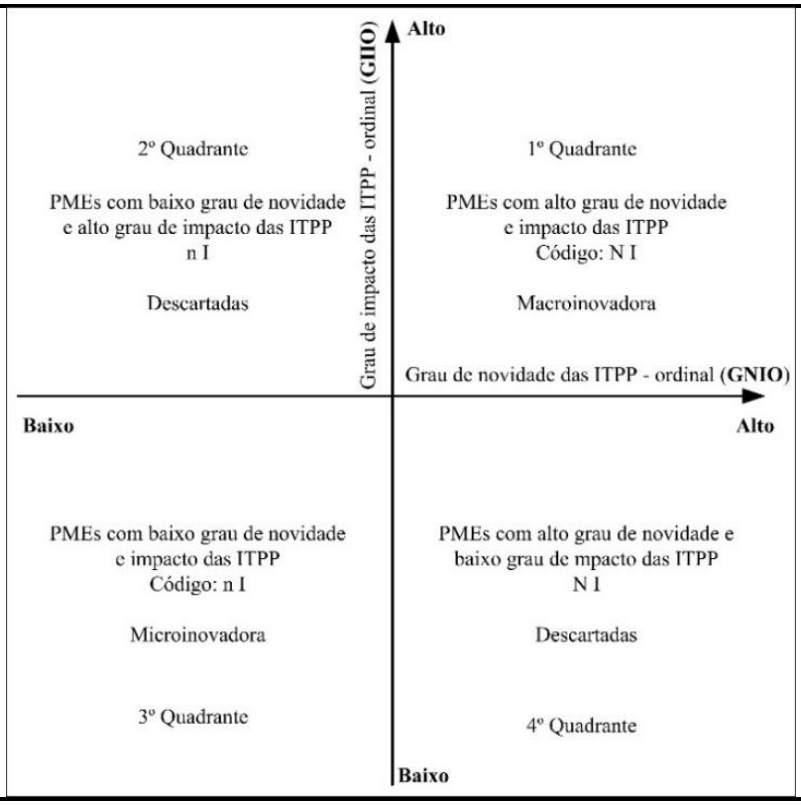
Source: IBGE, Director of Research Studies, Coordination of Industry, PINTEC 2005, PIA-Enterprise 2003 and 2005.
Notes: [1] Mean value of the 15 original questions in Likert scale, being High=4, Medium=3, Low=2, Not relevant=1.
Prepared by the authors.

In relation to typology, the X-axis, represented by the GNIO acronym (the "O" refers to the ordinal scale of the measurement), classifies the SMEs in two distinct and mutually exclusive groups of high and low degree of novelty of the TPPI.

Similarly, the Y-axis, represented by the GIIO acronym (the "O" refers to the ordinal scale of the measurement), classifies the SMEs into two distinct and mutually exclusive groups of high and low degree of impact of the TPPI.

As we use the approach of the polar extremes, we discarded the SMEs belonging to the 2nd and 4th quadrants and kept the SMEs belonging to the 1st and 3rd quadrants, as they are the ones that differ along the three dimensions assessed (IEs, IP and OP), from a theoretical point of view.

Figure 2:Criterion for the classification of SMEs as Macro- and Micro-innovative



Source: Prepared by the authors.
Subtitle: High; Low 2nd quadrant; SMEs with a low degree of novelty and high degree of impact of the TPPI; Discarded; Degree of impact of the TPPI – ordinal (GIIO); 1st quadrant; SMEs with a high degree of novelty and impact of the TPPI; Code; Macro-innovative; Degree of novelty of the TPPI – ordinal (GNIO); SMEs with a low degree of novelty and impact of the TPPI; Micro-innovative; 3rd quadrant; SMEs with a high degree of novelty and low degree of impact of the TPPI; 4th quadrant.

Thus, the two indicators that formed the two axes of classification of the SMEs follow these criteria:

a) Regarding the selection using the indicator GNIO, the degree of novelty is selected according to the answers to the respective questions taken from PINTEC, thus we have following measurement indicator:

Degree of novelty of the TPPI (*GNIO*)

$$GNIO = \begin{cases} High\,, \;\; if\; \{(Q_{11} or\; Q_{17} = 1)\; or\; (Q_{13}\; or\; Q_{19} = 3\; or\; 4)\} \\ \\ Low, Otherwise \end{cases}$$

Source: PINTEC, 2005.

Note: It will be high if new TPPI were introduced in the national or international market.

b) Regarding the classification of enterprises in the Y-axis, we used three different indicators that complement each other. Then, we standardized this auxiliary indicator to later use it to classify the SMEs into high or low degree of impact of the innovations. Such formulation can be seen below:

Degree of impact of the TPPI (*GIIM*)

$$GIIM = IEIT + IOIT + NPCD$$

Note: All indicators should be standardized ($\mu = 0\ and\ \sigma = 1$) before being combined.

Degree of impact of the TPPI (*GIIO*)

$$GIIO = \begin{cases} Low,\ if\ \{GIIM_{enterprise} \leq 0\} \\ High\ ,\ Otherwise \end{cases}$$

The application of this methodology culminated in a typology which covered approximately 52.4% of the 27,960 Brazilian industrial SMEs, as shown in Table 2. In the category "Macro-innovative" *NI* (high degree of novelty and impact of the TPPI) we obtained 1,666 SMEs, and in the category "Micro-innovative" *ni* (low degree of novelty and impact of the TPPI) we obtained 12,972 SMEs. The remaining 47.6% of SMEs were discarded.

Table 2.Typology created for the SMEs

SMEs		Total	Analyzed		Discarded	
			NI	ni	Ni	nI
of the typology	n	27,960	1,666	12,972	1,120	12,202
		100	6.0	46.4	4.0	43.6

Source: IBGE, Director of Research Studies, Coordination of Industry, PINTEC 2005, PIA-Enterprise 2003 and 2005.
Prepared by the authors.

All of the analyses of the indicators, being them for Innovative Performance (IP), Innovative Efforts (IEs) and Organizational Performance (OP), were backed by the application of statistical significance test, for which two tests were used. For the metric variables, we used the *F-value* from the analysis of variance (ANOVA). For the categorical variables, we created contingency tables and used the chi-square test (χ^2).

RESULTS

In this section, we compare the results of the two groups of SMEs according to their innovative performance, the effects of the innovative efforts and the organizational performance. There will always be a column named "National mean" related to the measurement of the indicator for the total of innovative enterprises, i.e. the 27,960 SMEs.

Innovative performance (IP)

We used four indicators that measured the degree of novelty, organizational and economic impact of the TPPI and the number of enterprises with patents (filed or granted), as shown in Table 3. All four indicators showed values in line with the typology created as the Macro-innovative SMEs obtained higher values, while the Micro-innovative ones obtained lower values, all statistically significant. These results were expected as the typology was developed with the purpose of separating the SMEs into two mutually exclusive groups, called macro- and micro-innovative.

Table 3.Innovative Performance (IP)

Indicators Used	Scale	Typology		National Mean	F-Value Significance
		NI	ni		
Degree of novelty of the TPPI GN	(Mean, Likert scale 1-3)	2.2	1.0	1.1	93718.40***
Economic impact of the TPPI EI	(%/NSR)	36.9	4.1	27.1	5482.37***
Organizational impact of TPPI OI	(Mean, Likert scale 1-4)	2.6	1.9	2.0	910.69***
Enterprises with patents EP	(%/enterprises of the typology.)	38.0	11.0	15.0	46.18***

Source: IBGE, Director of Research Studies, Coordination of Industry, PINTEC 2005, PIA-Enterprise 2003 and 2005.
Note:Significance: $p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***, not significant = $^{+}$.

The GN indicator measured the degree of novelty of the TPPI on a Likert scale from 1 to 3 (1=New for the enterprise, 2=New for the national market, 3=New for the international market). The data arranged in Table 3 show that all micro-innovative SMEs are in fact broadcasting SMES, as they implement TPPI that have already been developed by other enterprises. On the other hand, macro-innovative SMEs, for the most part, are enterprises that have implemented TPPI for the national market. Very few SMES have implemented TPPI for the international market. Although not reported, our additional tabulations showed that they were 14% for product innovations and 6% for process innovations.

The second indicator (EI) measured the economic impact of innovations, i.e. what percentage of the net sales revenues (NSR) is due to the sale of innovative products (introduced and sold between 2003 and 2005, being these years inclusive), being the sale both in the national and international markets. The macro-innovative enterprises use 37% of their NSR, while for the micro-innovative ones this percentage drops to only 4% against the national mean that reached a percentage of approximately 27%.

The third indicator (OI) measured the organizational impact caused by the TPPI using 12 questions in a Likert scale of 4 points (high, medium, low importance and not relevant), which address, for example, issues such as product (Q93: improved quality of goods and services), market (Q96: expanded participation in markets) and process (Q100: reduced production costs). The mean of the group of the macro-innovative enterprises was 2.6 (mean between medium and high impact), while for the micro-innovative ones it was 1.9 (mean between not relevant and low impact).

The last indicator (EP) measured in terms of percentages the number of SMEs in each category of the typology, the number of enterprises that reported having patents (filed and granted, the latter between 2003 and 2005, being these years inclusive). For the macro-innovative SMEs, 38% of them pointed out having patents, while this value falls to 11% for the micro-innovative ones, which is below the national mean.

Innovative efforts (IEs)

In this section, the aim is to find empirical evidence on the association between outputs (IP) and a set of indicators (seventeen of them) of different sizes (six of them) from the inputs (IEs) of the innovative process, as shown in Table 4. The rationality of using multiple indicators is related to

complementarity. Despite the literature review showing that much of the work on inputs for innovation is focused on activities of R&D (OECD, 2002a), we decided to increase the range of indicators investigated because this indicator does not have the same importance in all sectors or for all SMEs (Evangelista, Iammarino, Mastrostefano, & Silvani, 2001).

Within the dimension of innovative activities, we selected two indicators. Both show, as a percentage of total enterprises from each category of the typology, the proportion of SMEs that reported the realization of an innovative activity as of high importance. In the case of the first indicator, this activity is the internal R&D, that is, those carried out by the enterprise itself and not contracted externally. The results indicate a statistically significant difference and in line with the expected hypothesis that macro-innovative enterprises (53%) would present a value higher than the micro-innovative ones (7.4%). We decided to present this indicator as the number of enterprises that indicated it as of high importance (on a scale containing high, medium, low and not relevant) instead of the traditional indicator of R&D intensity (ratio between the value of expenditure on R&D and the value of the NSR, expressed as a percentage) because, as Santamaría, Nieto and Barge-gil (2009) point out, innovation often involves informal R&D activities, such as experimentation, learning, assessment and adaptation of technologies to then start more concrete and formal activities.

Table 4.Innovative Efforts (IEs)

Indicators	Typology		National	F-Value Significance / χ^2
	NI	ni	Mean	
Innovative activities (Enterprises that reported 'high importance',%/total enterprises)				
Internal R&D activities	53.0	7.4	14.6	3027.74***
Acquisition of machinery and equipment	64.4	62.8	65.0	842.52***
Human resources in R&D (%/EP)				
Number of persons employed in internal R&D	7.3	0.7	1.9	326.92***
Number of masters+doctors employed in internal R&D	0.8	0.04	0.2	187.74***
Sources of information (Enterprises that reported 'high importance',%/total enterprises)				
Sources within the enterprise	50.4	36.7	40.6	190.28***
Suppliers	41.8	38.7	39.9	75.42***
Customer/Consumers	64.5	33.7	42.3	921.36***
Educational and research centers	26.5	8.6	13.4	640.41***
Partnerships and Cooperation (Enterprises that reported 'high importance',%/total enterprises)				
Suppliers	8.6	0.8	2.6	615.16***
Customer/Consumers	11.0	0.8	3.0	665.25***
University, research institute/training center	7.1	0.2	1.6	513.07***
Enterprises with cooperative relations (%/total enterprises)	20.8	2.6	5.6	1125.88***
Financing for innovation (%/total enterprises)				
Enterprises with government support	22.4	20.0	17.8	143.57***
Public funding rate (%/NSR)	3.7	0.4	1.6	49.22***
Enterprises with organizational changes (%/total enterprises)				
Strategic and/or in structure	54.1	38.4	42.5	216.10***
Of advanced management techniques	65.7	34.9	41.7	743.71***

Source: IBGE, Director of Research Studies, Coordination of Industry, PINTEC 2005, PIA-Enterprise 2003 and 2005.
Note:Significance: $p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***, not significant = $^{+}$.

The second indicator captured other aspects of innovative activities, linked to the technology incorporated (Franco & Quadros, 2003), such as the acquisition of machinery and equipment. Although statistically significant, the difference between macro-innovative (64.4%) and micro-innovative enterprises (62.8%) is not relevant in practical terms. However, it is important to note that the values themselves are relevant, that is in the case of Brazil, the most used way to innovate by the SMEs is from the acquisition of embedded technology and not its development, even in the case of macro-innovative enterprises.

The second dimension of inputs is related to the human resources employed in innovative activities. According to the Frascati Manual (OECD, 2002a), these are the set of individuals that will generate new knowledge and research and develop new products and processes. The use of high qualified human resources is an essential factor for the development of innovations (FAPESP, 2001). Again, the results converge with the typology created, i.e., macro-innovative SMEs present 7.3% of the staff employed on R&D activities, while the micro-innovative ones present only 0.7%. In the second indicator of the category, we measured a subset of the staff, the masters and doctors, and it corresponds to a small participation – less than 1% – in these enterprises.

The third dimension addresses the sources of information used to innovate and the indicators report, as a percentage of total enterprises from each category of the typology, the proportion of SMEs that reported the different types of sources of information as of high importance. In general, for macro-innovative enterprises, three of the four sources – Sources within the enterprise (50.4%), Customers (64.5%) and Research centers (26.5%) – have an important role. These sources differ regarding the moderating variable 'sector' as we can see in Table 5, as the macro-innovative enterprises are in sectors of greater technological intensity and dynamism than the micro-innovative ones. Similar results are reported in the research of Chamanski and Waagø (2001), in which a strong association was found between universities and sectors such as biotechnology, medical technology and chemical engineering, among others.

Table 5.Demographic information of the SMEs

Moderating variables	MACRO (NI)	MICRO (ni)
Size of enterprises (persons employed)	(100 – 249)	(10 to 29)
Life cycle of the enterprise	Mature	In development
Ranges of technological intensity (OECD, 2011)	Medium-high; Medium-low	Low
Sectors of concentration	Chemistry, Machinery & Equip.; Electronics	Textile, Mineral
Origin of the Controlling Capital	National*	National

Notes: * There is a presence of 9% of foreign controlling capital in the segment of macro-innovative enterprises.
Prepared by the authors.

The fourth dimension of inputs refers to the types of organizations with whom the SMEs perform their partnerships in order to innovate. They are also measured as a percentage of total enterprises from each category of the typology that reported the different types of organizations as of high importance. The results show that, while 20.8% of macro-innovative SMEs perform

partnerships, only 2.6% of the micro-innovative ones do so. Although they are not reported in Table 4, our additional data reveal that, in general, for macro-innovative enterprises, the nature of the cooperation is for the realization of R&D activity. For macro-innovative enterprises, the main partnerships are carried out with customers/consumers (11%), suppliers (8.6%) and research centers (7.1%).

The fifth dimension addressed is funding up to innovation. The first indicator shows, in percentage, that the number of enterprises that reported having some type of government support in both groups is similar (22.4% for macro-innovative and 20.0% for micro-innovative enterprises) and, although statistically significant, in practical terms it does not represent this difference. As commented before, as the main way of SMEs to innovate is from the acquisition of machinery and equipment, most of them receive government funding – BNDES Finame — to do so. However, as shown by the second indicator, the rate of public funding is low (national mean of 1.6% on the NSR).

Finally, the sixth dimension of inputs addressed organizational innovations. Both indicators measured, as a percentage of total enterprises from each category of the typology, the proportion of SMEs that reported the realization of an organizational change. The first indicator reports whether the enterprise made a change in its strategy and/or structure, while the second indicator addresses the implementation of progress management techniques, such as, for example, management information system such as ERPs.

The group of macro-innovative SMEs, in both indicators, presented higher values (54.1% and 65.7%) in relation to its counterpart (38.4% and 34.9%), which in turn is below the national average of 42.5% and 41.7%, for changes in strategy and/or structure and advanced management techniques, respectively.

According to Lam (2005) and Miles and Snow (2003 [1978]) the process of creating a new product or process usually involves more innovations than the product itself, and as a rule, the choices of enterprises in relation to technological and market options is a balance between capabilities, resources and organizational structure. These results are in line with what we expected, as the macro-innovative enterprises that have a higher degree of novelty and impact of their TPPI perform important changes in the organizational structure of the enterprise, since they seek the improvement of the performance, cost reduction and organizational efficiency. In addition, changes in management techniques, the use of information technology, control methods and product and process management are an important flow of learning for the enterprise, in which the capabilities accumulated by it over time will be translated into the improvement of the quality and work efficiency.

Organizational performance (OP)

The purpose of this section is to present evidence on the relationship between IP and OP. This will be achieved by comparing the simple arithmetic mean of nine OP indicators distributed

across four dimensions along the two categories of innovative SMEs (macro and micro). As in the analysis of IP and IEs, here we also used the statistical method of analysis of variance (ANOVA) to access the statistical significance. Table 6 presents the results.

Table 6.Organizational Performance (OP)

Indicators	Code	Scale	Typology		National Mean	F-Value Significance / χ^2
			NI	ni		
Productivity						
Productivity of the work	PDT	(R$/EP)	64,219	41,049	44,833	81.21***
Asset turnover	GAT	(xTimes)	2.3	2.6	2.6	9.55+
Profitability						
Operating margin	MOP	(%)	8.7	6.5	6.8	22.37***
Return on assets	ROA	(%)	10.1	8.4	9.0	4.64+
Growth						
Growth rate of the NSR	TCV	(%)	32.1	38.8	36.8	15.23+
Growth rate of the EP	TCP	(%)	9.5	8.9	10.1	6.72+
Operational						
Enterprises with exports	EMPEX	(%/enterprises)	31.2	14.6	14.4	688.20***
Wage per capita	SALEMP	(R$/EP)	10,951	8,937	8,870	113.20***
Investment per capita	INVPO	(R$/EP)	7,612	5,807	6,320	8.54***

Source: IBGE, Director of Research Studies, Coordination of Industry, PINTEC 2005, PIA-Enterprise 2003 and 2005.
Note:Significance: $p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***, not significant = +.

The indicators used were those able to be calculated with the database employed. They are based on the research of Carton and Hofer (2006) and are represented by the dimensions of profitability, growth and productivity. Additionally, we added a fourth dimension named operational indicators.

Starting by the two indicators of the dimension of Productivity (PDT and GAT), they are usually used to assess how well enterprises use their resources. The indicator of productivity of the work (PDT) expresses the ratio between the value of industrial transformation (VTI) and the total number of persons employed in the enterprise. The VTI is considered a measure of added value of the enterprise and, *roughly speaking*, is the result of the difference between net sales revenues and the direct costs of production.

As expected, the category of macro-innovative SMEs (NI), which is the group with the highest innovative performance, is also the group with the greatest productivity of the work (R$ 64,000), being approximately 56% above the productivity of the group of micro-innovative SMEs (R$ 41,000). The second indicator is the asset turnover (GAT), which measures the contribution of the capital in the generation of results and is expressed by the ratio between net sales revenues (NSR) and total assets of the enterprise. The more sales are generated, the more efficiently the assets are used. There was no statistically significant difference between the indicator and the groups of macro- and micro-innovative SMEs.

We used two indicators of profitability (MOP and ROA). The first of the indicators, called operating margin (MOP), measures the proportion of sales of the enterprise that turns into operating profit (that generated solely and exclusively by the main activity of the enterprise, minus

the administrative, operational and commercial costs). The second one, called return on asset (ROA), assesses the ability of the enterprise to generate profits for each Real (R$) invested in its asset. As shown by the data, for the group of macro-innovative SMEs, 8.7% of the sales were transformed into operating profit, while for the group of micro-innovative SMEs this value was 6.5%, which is below the national average (6.8%). This result ratifies the assumption that most innovative enterprises obtain a premium price for their innovations and thus receive a relatively higher margin than their less innovative counterparts.

The results for the indicator of return on assets, although being in the same direction of the indicator MOP, did not reach statistical significance and thus are not taken into consideration. One possible cause for the non-significance rests on the amount of SMEs that this indicator could calculate. The ROA is calculated with the aid of data from PIA-Enterprises 2005, primarily representing enterprises with thirty or more persons employed. According to our additional tabulations, both groups (macro and micro-innovative SMEs) have, respectively, 57% and 56% of their enterprises belonging to the range from 10 to 29 persons employed. However, as the macro-innovative enterprises amount to only 1,666 SMEs, the indicator was calculated only for 589 of them. For the micro-innovative enterprises, as its total is 12,972, we could calculate the ROA for 4,105 of them. Unfortunately, this unbalance between the numbers of observations per group affects the statistical significance calculation (Hair Jr., Anderson, Tatham, & William, 2005; Steverson, 1986).

In relation to the growth rates of persons employed (TCP) and the net sales revenues (TCV) for the triennium 2003-2005, the differences were not statistically significant, to a large extent, because of the argument shown above. However, both groups follow a very similar behavior in relation to the growth of sales and persons employed, as we can see in Table 6. When one grows, the other also grows, and vice versa, maintaining the proper proportions of growth, which are more pronounced in sales than in the number of persons employed.

Finally, the last dimension called operational indicators was used to denote some indicators unrelated to the financial performance of the enterprise. Three of them were proposed and represent different aspects of the organizational performance of the enterprise. The first assesses the existence, or not, of sales to the foreign market (EMPEX) and is measured in a dichotomous categorical scale (yes/no) and express the result as a percentage over the total number of enterprises in each group. We highlight that the group of macro-innovative SMEs has a clear tendency of being exporting enterprises (31% of them), while in the group of micro-innovative SMES only approximately 15% of them have exported in the triennium, being this number a statistically significant result. However, it is worth mentioning that the additional tabulations, not presented here, show that both groups export very little in terms of intensity of exports (percentage on the NSR), being this value 4.6% and 3.3%, respectively for macro- and micro-innovative enterprises.

The second indicator is a measure to assess the quality of the workforce, more broadly, and not only that intended for the internal activities of R&D. This qualification is indirectly accessed by the per capita value of the expenses of the enterprise with salaries (SALEMP). On average, macro-innovative SMEs (R$ 10,951 per capita) pay 22% more than the micro-innovative ones (R$ 8,937 per capita). Obviously, these salaries are associated with factors such as schooling and the average time of the worker in the enterprise, which could not be tabulated in this research. However, the number of persons employed in internal activities of R&D and their level of qualification can be indicative of these, and according to the indicators of innovative efforts (IEs) shown in Table 4, the group of macro-innovative enterprises has a significantly higher percentage of persons employed in activities of R&D, which employs 20 more times masters + doctors (0.08% of total persons employed against 0.04% in micro-innovative enterprises).

The third and final indicator (INVPO) corresponds to the per capita investment of the company in 2005. It shows the amount of resources invested in 2005 in the acquisition of assets of lasting permanence, intended for the normal functioning of the enterprise, as well as the expenses needed to put these items in place and conditions of use in the operating process. Here, it is interesting to note that, even though both groups have assigned similar importance to the acquisition of machinery and equipment (according to Table 4, 64.4% for macro- and 62.8% for micro-innovative enterprises), the value allocated by macro-innovative enterprises was approximately 31% higher in relation to the micro-innovative ones. This leads us to believe that, in addition to machinery and equipment, the other acquisitions, such as land and buildings, means of transport, furniture and computers, the improvements carried out to increase the useful life of the assets of the enterprises, among others, are relevant for macro-innovative SMEs.

CONCLUSION

There is no doubt that, for a long time, innovation has been seen as the engine of economic development. However, there are few studies that bring empirical evidence on Brazilian SMEs, using samples with national reach. This research aimed to fill this gap by investigating the relationship between two of the most important dimensions of the innovative process (IEs and IP) with organizational performance (OP).

Our results show that within the forest of innovation of SMEs, some trees matter more than others. The results show that the innovative efforts (IEs) performed, whether by macro- or micro-innovative enterprises, have a strong and statistically significant association with innovative results (IP), and these groups are configured as the theory of creation of the typology predicted, in an opposite continuum, showing a great discontinuity between what a group does, and achieves as a result, in relation to the other group.

Through the creation of 29 indicators that captured different aspects of the IEs, IP and OP, and using statistical procedures such as ANOVA, we could create a typology of innovative SMEs that classified 27,960 enterprises into four distinct and mutually exclusive classes, and two of them

were kept for analysis and presented in this research. The results pointed to two distinct patterns, being macro-innovative SMEs superior to the micro-innovative ones for most of the indicators created in the three dimensions (IEs, IP and OP).

Some stylized facts about macro-innovative enterprises is that they are only 11% of the number of enterprises in the typology; however, they represent 19% of the total wages, 20% of the NSR, 26% of the exported values, 34% of the total patents and 57% of the persons employed and 66% of the expenditures in internal activities of R&D. In addition, they are enterprises with new TPPI for the Brazilian market and/or the world, and such innovations generate a high organizational and sales impact; they have a strong relationship with customers and research centers, as sources of information and cooperation for innovation, and they carry out a large proportion of organizational innovations as a way to facilitate their TPPI.

In relation to demographic characteristics, the macro-innovative enterprises are relatively larger (100 to 249 persons employed) and more mature than their counterparts, they are focused on sectors of greater technological dynamism and there is a certain concentration of enterprises that are part of groups with foreign controlling capital (9%).

Of the nine indicators of organizational performance created, seven reflected a strict, meaningful and positive association between IP x OP, in line with what we expected from the literature review. We highlight the indicators of productivity of the work (PDT), operating margin (MOP), export operations (EMPEX), investment in fixed assets (INVPO) and spending on staff (SALEMP).

These results allow us to say that public policies that encourage innovation in SMEs should focus on encouraging the creation of macro-innovative enterprises and not only innovative enterprises, in general. Analogously, managers of SMEs should focus on increasing their training in innovation and guiding their efforts to pursue innovation strategies that lead to results similar to what was presented herein.

Some contributions and differences of this research also need to be highlighted. To a large extent these contributions are related to the difficulty and limitations identified by the literature review on past studies and can be listed as: the analysis is based on a national and not local sample, or even on few cases of the domestic industry; all analyses are based on information from individual enterprises (microdata) rather than aggregated data; a large number of indicators (29 of them), understood in several theoretical dimensions of analysis and of different nature (metric, interval, ordinal and categorical), were integrated into the search model.

We also mention the limitations that were part of this study, among them: the PINTEC does not cover enterprises that employ from 1 to 9 persons; service companies are excluded from this analysis; and, the existing limitations in the calculation of the indicators of performance, as only enterprises with 30 or more persons employed were available.

Finally, future research studies can pursue the systematic application of this typology of innovative SMEs in order to monitor, in a longitudinal study, the importance of SMEs for the proposed groupings.

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