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Does internationalization matter? Comparing the innovative performance of Brazilian multinational and non-multinational companies

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ABSTRACT

Using data from the Brazilian Innovation Survey (PINTEC) and from a reference group composed of 110 Brazilian internationalised companies, the article applies a Propensity Score Matching (PSM) to obtain a control group of non-internationalised companies with similar characteristics to the reference group. PSM tests the following hypotheses: internationalised companies introduce more process and product innovations that display higher degrees of novelty, better technical enhancements and better organisational and marketing innovations. The results show that internationalisation matters to Brazilian companies only in terms of higher-level innovation novelty. The Brazilian case reveals also that the development of domestic technological leadership is a precondition for internationalisation even when it is strongly supported by public policies. Finally, internationalisation matters for developing countries to catch up as long as companies are able to explore technological niches and acquire rare resources of knowledge to get a technological leadership at global scale.

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Introduction

In the last decades of the twentieth century, multinational companies (MNC) deepened their international production networks and developed international innovation networks. MNCs' international innovation networks aimed to capture the capabilities and competences dispersed globally. Their growth strategy turned from a model of building capabilities and competences internally—in the firm and in their country of origin—to a model of capturing capabilities and competences abroad, allowing MNCs to access technology and to learn more advanced management practices. In this sense, technological internationalisation emerged as a strategy to achieve competitiveness and growth.

The building of technological capabilities is firm specific and restricted by the institutional characteristics of the country where the MNC carries out its activities. An MNC's technological capability-building usually starts in its home country. Afterwards, the MNC extends its boundaries by interacting locally and by capturing technological resources of knowledge scattered throughout the world. This process of knowledge accumulation is specific, asymmetric and path dependent. Internationalization is, in this way, a process of international capture of competences and transfer of knowledge which impacts on the firm's efficiency and on its innovative capability.

The internationalisation process is not homogeneous among countries and firms. The internationalisation of firms from developing countries is more restricted than that from developed countries (UNCTAD, 2013). While in Asian countries, led by China, internationalisation was an important strategy to accelerate catching up at the microeconomic level, in other industrialised emerging economies, such as Brazil, it played a very limited part (UNCTAD, 2014). From the catching-up point of view, the relevant question about internationalisation is whether it makes a difference in terms of improving the innovative capacity of the emerging market multinational companies (EMNCs). This article discusses whether, in the case of an emerging country (Brazil), late and limited internationalisation has had any impact on firms' innovative capabilities. To do that, the paper compares the innovative performance of internationalised Brazilian MNCs with that of non-internationalised Brazilian companies. We consider that access to new information sources and the absorption of competencies in the internationalisation process positively affect the innovative performance of Brazilian MNCs. This hypothesis is tested using

PINTEC/IBGE microdata analysis and a specific Brazilian MNCs database built for this purpose, since there are no data available describing this area.

Empirical analysis must overcome two methodological challenges. First, some firm characteristics have a positive impact on the internationalisation process and determine the firm's innovative capacity. That may generate a selection bias problem. Second, as the timing of Brazilian firms' internationalisation was different, it was not possible to establish a homogeneous comparison of the innovative performance before and after their internationalisation. In this sense, empirical analysis uses the propensity score matching (PSM) method, as it replicates a randomised experiment by obtaining treated and control groups with similar covariate distributions, thereby reducing any possible covariate bias.

This article represents pioneering empirical evidence for Brazil about the real importance of internationalisation as a strategy to acquire external technological resources to improve the innovation process through technology transfer and external spill-overs. If internationalisation matters, EMNCs should be able to build new leaderships at the national level and in global competition.

This article is organised as follows. The following section introduces the characteristics of the internationalisation of companies from EMNCs and presents the theoretical hypotheses in relation to the MNCs innovative performance for the Brazilian case. After that, the Brazilian multinational companies are described. The subsequent section presents the database and the empirical analysis, and describes the variables selection, the PSM estimation and its application. The penultimate section discusses the results. Finally, our conclusions and a critical analysis are presented.

The internationalization of companies from developing countries

The internationalisation of companies from developing countries, or EMNCs, in comparison to those from advanced economies (AMNCs), is quite recent, since the mid-1990s, and acquired importance in the second half of the 2000s. This phenomenon represents the 'third wave of internationalization' after the internationalisation of American companies in the 1950s (first wave) and the internationalisation of Japanese companies in the 1980s (second wave) (Kogut, 2001). Developing countries participated in the global internationalisation process later, and they did it in a hierarchical and asymmetrical way—that is, in specific regions and in low value-added activities.

There are two major differences between EMNCs and AMNCs. The first is that AMNCs are more mature. Maturity demonstrates the stage of the technological capabilities (management of R&D projects or organisation of production) and the evolution of the internationalisation process—that is, when the company presents autonomy to lead innovation, overcoming barriers to the technology transfer among units of the company placed in different countries (Bell & Pavitt, 1995; Lall, 1982). This is because the ability to absorb and transfer knowledge from the host country requires maturity of technological and organisational capabilities. Maturity is also related to the stage of the internationalisation process. At the beginning, companies build simpler organisational structures that usually evolve into more complex networks over time (Narula, 2012; Ramamurti, 2009).

The second difference between EMNCs and AMNCs refers to the characteristics of their home countries' environment that indirectly affects the specificity, quality and composition of the companies' resources and assets. In the initial stages of the internationalisation process, firm-specific assets are at first conditioned to their home country assets (location-specific assets) (Dunning, 1988; Luo & Wang, 2012; Narula, 2012, p. 189; Tan & Meyer, 2010; Teece, 2014). This is because the main motivations for internationalisation are their workforce skills qualifications, the need for learning with foreign partners and customers, and to diversify the knowledge base and its applications (Cyrino, Parente, Dunlap, & Góes, 2017). For example, institutional restrictions facilitated the internationalisation of Chinese companies, and growth of the internal market allowed the companies to remain operative in their home country. Latin American companies looked for technological knowledge in technical fields in which their home countries had no advantage at all (Esteban-Jardim & Urraca-Ruiz, 2017). Home countries also influence the ability to manage complex and unstable environments with institutional failures (Cuervo-Cazurra, 2012; Cuervo-Cazurra & Genc, 2008; Meyer, Mudambi, & Narula, 2011), giving a less risk averse character to the firm (Luo & Tung, 2007). For example, an important motivation to internationalise for Latin American companies is to diversify the country risk due to institutional instabilities companies encounter in their home countries (Carneiro & Brenes, 2014; Casanova & Kassum, 2013).

There are three different approaches in EMNC internationalisation theory: OLI, LLL and the springboard perspective. The LLL paradigm (linkage, leverage and learning) extended the OLI paradigm (ownership, location, and internalisation advantages), in which EMNCs are usually followers or latecomers (Mathews, 2002, 2006). The EMNCs remain far from the technological frontier; their main motivation is, therefore, to obtain or develop ownership advantages (internal resources) that they still do not have. Throughout this process, EMNCs make strategic alliances (linkage) with global leaders to minimise risks and uncertainties. They also look for strategic assets and other sources of competitive advantage to enforce (leverage) their ownership advantages. By linking and leveraging, they learn, which allows them to progress in a cyclical process of technological capabilities accumulation.

An alternative approach is the springboard perspective (Luo & Tung, 2007). According to this view, EMNCs' internationalisation is a way to acquire strategic resources to compete in global markets to overcome the constraints imposed by their home countries and by being latecomers. EMNCs' internationalisation is a kind of institutional escapism due to institutional voids in their home countries such as limited legal protection of intellectual property rights, weak legal enforcement and transparency, corruption and so on, or even the absence of specific legal requirements demanded by the companies (Boisot & Meyer, 2008; Witt & Lewin, 2007). In this sense, four features act as centrifugal forces (from the inside to the outside) in developing countries (Narula, 2012): (1) limited infrastructure and political instability; (2) imperfections in capital markets; (3) not taking part in international agreements with industrialised countries; and (4) institutional inefficiencies that specifically affect the growth of the firm in local markets.

The theory of EMNCs from developing countries is the synthesis of two elements: the motivation to develop competitive advantages by capturing external resources, and the need to overcome inefficiencies and constraints in their home countries. Therefore, we assume that MNCs should present better innovative behaviour and performance than their non-internationalised compatriots. According to the corporate coherence theory, internationalisation is a process through which competence building allows the firm to improve its economic performance in terms of: (i) productivity growth on a global level, including its home country; (ii) the absorption of knowledge spill-overs from competing firms, suppliers and customers; and (iii) the development of technological and innovative capacities. This article focus on the latter.

The internationalisation process allows extending technological, productive and organisational capabilities to foster the firm's competitive position (Cantwell & Piscitello, 2013; Kogut, 1989). Thus, Brazilian MNCs' innovative performance should be better than that of non-internationalised firms (that is, their local counterparts). The main hypotheses are as follows.

Hypothesis 1A: Brazilian MNCs perform more process and product innovation than their local counterparts.

Hypothesis 1B: Brazilian MNCs have higher degrees of novelty in their innovations than their local counterparts.

Hypothesis 1C: Brazilian MNCs have better technical enhancement in their innovations than their local counterparts.

Hypothesis 1D: Brazilian MNCs perform better organizational and marketing innovations than their local counterparts.

To test the above hypotheses, this article compares the innovative performance of Brazilian internationalised and non-internationalised companies. On the one hand, firm characteristics such as innovation efforts, expressed through the expenditure on innovative activities, workforce qualification, size and continuous carrying out of R&D activities, among others, impact the firm's innovative capacities. On the other hand, the concentration of Brazilian foreign direct investment (FDI), the heterogeneity of national productivity and the characteristics of Brazilian MNCs suggest a higher propensity to perform innovative behaviour.

Brazilian multinational companies

From the second half of the 1990s, following international trends, Brazil registered changes in its productive structure: a reduction of the weight of manufacturers and an increase of the weight of services and products based on natural resources. This structural change had different dimensions in terms of exports, added value or employment. For some authors, the structural change is associated with a precocious deindustrialisation, which means that it is not a natural result of the country's economic development, given the level of Brazilian per capita income (Carvalho & Kupfer, 2011; Urraca-Ruiz, Britto, & Gonçalves de Souza, 2012). For others, it is mainly a

process of regressive specialisation (Oreiro & Feijó, 2010). The Brazilian deindustrialisation has particular characteristics: it is premature, partial and relative. That is, deindustrialisation does not affect the entire national industry in a generalised and uniform way. In fact, Brazilian industry maintains its characteristic of diversity and weight within the country's economic structure.

Some factors contributed to this structural change in the last decades. Those were: the discovery of oil fields (pre-salt oil); companies' strategic defensive restructuring in terms of specialisation and by outsourcing production process activities; the productive fragmentation and deepening of globalisation with the global value chain and strong international competition; the exchange rate appreciation, which favoured the agroindustrial commodities trade; the macroeconomic regime; and inefficient industrial policies (Esteban-Jardim & Perin, 2016). This context influences the motivation and the internationalisation trajectory of Brazilian firms, such as the defensive behaviour of large Brazilian companies in their internationalisation.

Brazilian companies started to internationalise at the end of the 1970s, but only in the 1990s, with economic liberalisation, did the outward FDI become relevant with some big government-owned corporations' internationalisation (e.g. Vale, CSM or Embraer). Since the end of the 2000s, the internationalisation of Brazilian companies has accelerated. The state played a key role as a shareholder in most of the companies that internationalised during that period (Finchelstein, 2017; Hennart, Sheng, & Carrera, 2017; Musacchio & Lazzarini, 2014). At the same time, the National Bank of Development (BNDES) implemented two programmes to promote foreign investment in national corporations. The first, in 1998, consisted in offering long-term loans to African and Latin American countries to hire Brazilian firms to provide engineering services in big infrastructure projects for at least 35 per cent of the loan value. This credit line expanded with the Productive Development Policy between 2007 and 2010, which had specific goals aiming to transform big Brazilian local companies into international leaders. The second programme, in 2005, consisted in directing loans for Brazilian companies to invest outwards (Alem & Cavalcanti, 2005; Caseiro & Masiero, 2014). In 2011, through the Plano Brasil Maior (in English, Larger Brazil Programme), governmental policies focussed on facilitating the acquisition of new technologies or accessing new markets to create 'national champions' (Caseiro & Masiero, 2014).

Support for the internationalisation process concentrated on industries that were already competitive and was mostly based on the exploitation of natural resources like the construction, meat, orange juice, steel, cement, cellulose and petrochemicals industries (Caseiro & Masiero, 2014). Big companies grew, diversified their product scope and became national conglomerates before internationalising (Cuervo-Cazurra, 2008). In this sense, internationalisation was not a motivation to diversify, but diversification was a prior condition for internationalising. Alternatively, small companies used internationalisation as a way to acquire productive and technological competencies from abroad (Borini, Floriani, & Fleury, 2012).

Most Brazilian companies' foreign investment went to Latin America (47%), Europe and the United States (Cyrino, Barcellos, & Tanure, 2010). Destinations are largely correlated with the sectoral nature of investments. For example, Gerdau (steel) and Odebrecht (civil construction) went to countries with a similar culture and level of development; Vale (iron) and Embraer (aircraft) went to more distant countries, both geographically and culturally; Sadia (food) and Votorantim (cement) went to countries that were similar culturally but quite distant in terms of level of development level. After the 2000s, the direction of foreign Brazilian investments changed in search of new technology applications and market products, destinations including the United States, Europe and Asia (Arbix & Caseiro, 2012; Caseiro, 2014). In this sense, geographical distance does not seem to be the key factor influencing the direction of Brazilian foreign investments.

In relation to technological internationalisation, Brazilian companies presented four types of innovative activity to improve their competitive performance in foreign markets (Fleury, Fleury & Borini, 2013). The first was to develop new ways to produce and commercialize—that is, a type of innovation linked to new business models. This is the case for some Brazilian leaders like Embraer, Gerdau, Ambev and Odebrecht. The second type was the search for niche markets through the customisation of specific requirements. The most representative example of this type is Marcopolo and some telecommunication companies. The third type was the development of new products in response to the demand for global companies in global value chains. Those were the cases of Web, Sabo and Embraco. The fourth type was innovation commodities that aimed to achieve cost reduction of standardised products. Representative instances included Vale, Petrobras and Votorantim Cements.

As in other developing countries' experiences, Brazilian leaders' internationalisation accelerated the national process of catching up with technologies like surfaces, space technologies, materials processing, oil and basic

material chemistry, metallurgy, engines and pumps, biotechnology and environmental technologies (Urraca-Ruiz, 2019). As predicted by the theory, Brazilian MNCs' leaders built their competitive advantages from their home-base assets that are mainly focussed on the exploitation of natural resources (Carneiro & Brenes, 2014). The Observatorio de Multinacionais Brasileiras (in English, Brazilian MNC Observer) verified for 38 Brazilian MNCs and their 78 subsidiaries that in 30 per cent of cases there were instances of technology transfer from the subsidiary to the matrix, which is evidence of the international capture of technological competences (Chueke, 2014).

The database and empirical analysis

The descriptive empirical analysis of firms' innovative behaviour is based on microdata made available by PINTEC. PINTEC is a triennial innovation survey that follows the Oslo Manual (OCDE, 2005) and the Community Innovation Survey (Eurostat). PINTEC considers that most firm characteristics that influence innovation performance (PINTEC, 2011, 2014). PINTEC's scope includes information about the structural characteristics of the firm, innovative effort, firm performance (like sales, exports, etc), the sources of knowledge and the firm's cooperative activities (IBGE, 2017). From the PINTEC sample, we only kept domestically owned firms. After the withdrawal of foreign-owned firms and outliers, the selected sample for empirical analysis contained 12,374 firms in 2014 and 12,337 in 2011.

Additionally, we built a database with a sample of 179 Brazilian MNCs that expanded their productive, technological or commercial operations overseas (Appendix I). Companies that only export or only franchise overseas but have no foreign investment were excluded from the sample. The database reports company identification, the year of internationalisation, some historical data (e.g. mergers and acquisitions) and the main productive activities. The sources used for collecting those pieces of information were the Bloomberg database, the BNDES list of financial collaboration granted to companies, and other public data sources about MNCs. We identified 110 Brazilian MNCs in the 2014 PINTEC data and 108 in the 2011 PINTEC data: that sample of Brazilian MNCs is the treated group that will be compared with non-internationalised Brazilian firms.

Variables selection

The variables selected for the empirical analysis are clustered in five groups: innovation performance; firm characteristics; location of innovative activity; motivations for internationalisation; and firm's innovative efforts (Figure 1). Innovation performance has four measures: (i) product/process innovation (RIN); the degree of novelty in relation to the market (RNOV); the degree of novelty of the innovation in technical terms (RTEC); and organisational or marketing innovation (RORG). Firm characteristics include: (1) the firm's size according to the number of employees (SIZE); the industrial activity (CNAE_TRAJ); the firm's location in Brazil (LOCAL_EMP and LOCAL_PD); the continuity of R&D activities (CONDP); and belonging to a controlled group (EMGR). The industrial activities were grouped under six labels according to their patterns of innovation (Campos & Urraca-Ruiz, 2009; Melo & Urraca-Ruiz, 2015; Pavitt, 1984). The industrial activities classification is detailed in Appendix II.

There are two variables about the location of the firm's innovation activity in Brazil: the first indicates Brazil's macro region where the companies' headquarters operate (LOCAL_EMP); the second reports Brazil's macro region where the firm carries out R&D activities (LOCAL_PD).

The location overseas is measure by four variables. LOC_X identifies if the innovative activities were conducted overseas. LOCSUB points out if the innovative activities conducted overseas are connected to other firms in the group (1) or not (0); LOCOOP identifies if they are conducted in cooperation with other firms/institutes (1) or not (0); and LOCOUT shows if they were developed by other firms/institutes (1) or not (0).

There are three motivations for internationalisation: (1) access to information (INF); (2) access to foreign investment (FIN); and (3) access to the main consumer markets which are located abroad (LOCMERC).

Finally, there are two groups of variables for the resources to innovate. The first is the intensity of expenditure in relation to the firm's net revenue. Innovation expenditure includes: R&D expenditure (internal and other conducted by R&D organizations) and external technology acquisition expenditure (RPeDTEC); machinery, equipment and hardware acquisition expenditure (RMEQ); and other expenditure related to the cost of bringing the innovation to market (RMER). The second group is employee qualifications, which measures the number of employees that have Master's degrees and doctorates in relation to the total number of firm employees (PHDMS).

Empirical Variable	Variable Description	Treatment
RIN	Innovative Firm	0 = Not Innovative 1 = Innovative
RNOV	Degree of firm's innovation novelty	0 = Not Innovative 1 = Innovation only for firm 2 = Innovation only for domestic market 3 = Innovation for global market
RTEC	Degree of firm's technical innovation novelty	0 = Not Innovative 1 = innovation with technical enhancement 2 = innovation with new technique
RORG	Organizational and Marketing Innovation	0 = Not Innovative 1 = Innovative
SIZE	Firm's size according to the number of employees	1 = 10 to 29 employees 2 = 30 to 49 employees 3 = 50 to 99 employees 4 = 100 to 249 employees 5 = 250 to 499 employees 6 = 500 or more employees
LOCAL_EMP	Localization of the company's headquarter at Brazil's macro region	1 = Central-West 2 = North 3 = Southeast 4 = South 5 = Northeast
LOCAL_PD	Localization of the company's R&D at Brazil's macro region	1 = Central-West 2 = North 3 = Southeast 4 = South 5 = Northeast
CONPD	Continuity of R&D activities	0 = not continuous 1 = continuous
EMGR	Belonging to a group	0 = independent 1 = controlled by a group
CNAE_TRAJ	Technological trajectory	1 = Traditional or related to natural resources 2 = Controlled by suppliers 3 = R&D intensive 4 = Scale economy intensive 5 = Electronic complex 6 = Service
LOCSUB	Overseas Innovative activities connected to other firms in the group	0 = no overseas innovative activity 1 = overseas innovative activity
LOCOUT	Overseas Innovative activities developed by other firms/institutes	0 = no overseas innovative activity 1 = overseas innovative activity
LOCOOP	Overseas innovative activities in cooperation	0 = no overseas innovative activity 1 = overseas innovative activity
INF_X	Access to information source abroad	0 = no source 1 = 1 source 2 = 2 sources 3 = 3 or more sources
FIN_X	Financing abroad	0 = no financing 1 = financing abroad

Figure 1. Empirical variables description and treatment.

The propensity score matching (PSM) estimation

The distribution of the internationalised firms is not random, because they have similar characteristics such as size, innovation pattern, location of main consumer market and location of their headquarters in Brazil's macro region. Hence, the predictor of treatment (the Brazilian firm is internationalised) is an endogenous variable. Such a condition increases the correlation between the predictor and the regression residuals, which in turn results in biased estimators that constitute sample selection bias (Heckman, 1979, p. 153). A PSM methodological strategy (Rosenbaum & Rubin, 1983; Rubin, 1974) is the solution to the described selection bias problem, through a quasi-experimental approach. The same questionnaire must be applied to both groups, the treated and the control, to reduce selection bias, which was done using PINTEC (Heckman, Ichimura, & Todd, 1997).

The propensity score (*pscore*) is the probability that the individual will be treated, considering all other observable and relevant characteristics—that is, given the value of a vector of observed covariates¹ (Rubin, 2001). Hence, any asymmetry identified between the outcomes presented in the treated and control groups is not due to the observable covariates. The *pscore* is the probability that the individual i will be treated, given the value of a vector of observed X_i covariates, being the i indexes of the study's units ($i = 1, \dots, N$) (Rubin, 2001, p. 171). Therefore, e_i being the *pscore*, then

$$e_i \equiv e(X_i) \equiv \Pr(W_i = 1 | X_i)$$

The indication that the unit has not received treatment is given by W_i ($W_i = 1$ or $W_i = 0$) (Heckman et al., 1997). Therefore, if the group of treated units has the same *pscore* e_i value, then the two groups will have the same covariate distribution of X_i covariates regardless of the dimension of X_i .

The PSM application

The methodological design for the PSM application is divided into three stages. The first stage consists in the elaboration and estimation of the selection equation for the *pscore* prediction—that is, the probability that the individual will take part (or not) in the treatment. The second stage considers the selection of covariates which are to be included in the PSM. Considering the conditional independence assumption (CIA),² the variables to be included should simultaneously influence the participation (or non-participation) of the individual in the treatment and in the outcome, namely cofounders. However, Rubin and Thomas (1996) point out that the covariates to be included in the PSM model must preferably be related to the outcome (innovation performance), regardless of whether or not they are related to the treatment (the firm's internationalisation). Nonetheless, if the sample is small, it may not be possible to include a large number of variables.³ If this is the case, the variables related to the outcome must be prioritised, considering that a significant increase in variance may occur if in the PSM includes variables more related to the treatment rather than to the outcome (Brookhart et al., 2006; Stuart, 2010).

The ultimate objective of this selection is to obtain a balanced distribution of covariates in the treatment group, thereby reducing asymmetries in the distribution of observable variables among the two comparison groups (Rubin, 2001). Due to the impossibility of obtaining covariates for the firms' pretreatment period, we selected covariates that present relatively stable behaviour over time (Caliendo & Kopeinig, 2005). The differences in the descriptive statistics and in the distribution of Brazilian MNCs and other Brazilian firms, as well as the distinctive characteristics the Brazilian MNCs present, make the balancing of covariates for obtaining the *pscore* more challenging. The covariates used for calculating the *pscore* are those variables described in the firm's characteristics, in the location of innovative activity and motivations for internalisation, and in the innovative effort sections. Some transformations were made for statistical estimations.

The *pscore* controls covariates efficiently—that is, it reduces bias among the treated and control groups—while the objective of *pscore* modelling is not to estimate the treatment (Brookhart et al., 2006). Therefore, collinearity issues are not relevant in the PSM application (Stuart, 2010, p. 9).

The third stage consists of the analysis of covariate balance in the PSM model, given the matching algorithm. Asymptotically, all of the PSM estimators must generate the same results, for by expanding the sample, they must compare only exact matches (Caliendo & Kopeinig, 2005). Nonetheless, in small samples, the estimator selection is relevant due to the trade-off that may occur between bias and variance.

Figure 2 presents three different algorithms (NNM, Kernel and Radius) applied for the matching⁴ estimation and the criteria selected for each algorithm. The analysis of the results of different estimators is essentially an

Algorithm Matching	Secification	Advantages	Disadvantages
Nearest Neighbour Matching (NNM)	1-to-1	The treated unit is matched with the control unit that has a similar <i>pscore</i> .	It may choose a counter factual unit not adequated, if the nearest neighbour is not similar to the treated unit. Depende da ordenação dos individuos
	With replacements		
	Caliper 0,05		
Kernel with Stratification	Kernel Epanechnikov (Epan) Function	Non-parametric estimator	Potential greater bias in the estimation.
	Bandwidth parameter of 0,06	All units of the control group are used to compute the counterfactual's weighted avarage. This methodology assigns higher weights to matching of the closest units, and lower wights to the matching of furthermost units.	
	Common Support	It uses more informations than the others algorithm.	
	Stratification using the firm's size (six ranges)	Smaller variance The common support is divided in ranges and the matching is withing units in these ranges.	
Radius	Radius of 0,02	The radius is a limit to the matching with the nearest neighbour	No rule for the radius' size.
	Common Support	This methodology uses all the unit within the radius. The chance of an inadequate matching is smaller than the NNM.	

Figure 2. Matching algorithm: Methodological Comparison.

analysis that evaluates the sensitivity and robustness of the covariate selection. All of the estimations were carried out using Stata 14 software, with the *psmatch2* command, customised for the distinct algorithms used in the estimation.

Five parameters evaluate the matching quality and the balance in the covariate distribution among the control and treatment groups. The first is the standardised bias (Rosenbaum & Rubin, 1983). In this parameter, the situation of covariates before and after the matching are compared, and verification of whether there are asymmetries among variables takes place even after the *pscore* conditioning. The second parameter analysed is the t-test for verification of the existence of relevant differences among the two sample groups (treated and control). Therefore, it is hoped that there are differences before the matching which are no longer significant after the matching. The third parameter is comparing the pseudo R^2 before and after the matching. As the pseudo R^2 indicates to what extent regressors explain probability, it is hoped that after the matching there are no substantial differences in the covariate distribution among the two groups; hence, pseudo R^2 must be expressively smaller after the matching.

Rubin (2001) suggests two other parameters complementary to the balance of the covariates' evaluation. Parameter B is based on the condition that the difference between *pscores* means must be separated by less than half of the standard deviation. The guideline for the analysis is less than 25 per cent; however, such a percentage is a reference rather than a rigid validating standard. Such a guideline standard cannot be met when the covariate distribution of both groups is nearly symmetrical or when these distributions have similar variance, or even when the sample sizes of the two groups are alike (Rubin, 2001). The *R* parameter is given by the two groups' *pscore* variance ratio, which must range from 0.5 to 2—that is, the ratio between the *pscore* variances of the two groups must be around 1, so that covariates are distributed evenly.

In general, the criteria for the selection of the matching design must include the method that produces the smaller differences between the means for the highest number of covariates, or for the covariates that are considered more relevant to the model's predictive success. (Rubin, 2007; Stuart, 2010). All of the parameters are informed in the *pstest* in the Stata 14 statistical software.

The NNM, the Kernel Epan and the Radius algorithms were the ones that succeeded in the balancing of the observable characteristics for the group of Brazilian MNCs and for the group of non-internationalised Brazilian firms (Table 1).

For the data pairing with the use of Radius, the parameters for the balance evaluation corroborate the matching adjustments. Figures 3 and 4 illustrate the Radius algorithm's standard bias analysis, pointing out the significant reduction of bias in the variables after the matching. Even though the pairing with the use of the Kernel Epan method presents parameters adjusted to the balance after the matching, the *SIZE* variable continues to present high bias percentage (17.5%) even after the pairing. Considering that the firm's size is an important covariate for the outcome, the Kernel Epan matching method was carried out using the stratification of firm size. Therefore, each firm of the treated group classified in a given size range can only be paired with another firm in the control group that has been classified in that same range. The application of this method has significantly improved the balance of the matching.

Table 1. Matching algorithms Pstest for 2014 and 2011 years.

Variable	2011													
	RADIUS					KERNEL EPAN								
	Mean		Control	%bias	t test		V(T)/V(C)	Mean		Control	%bias	t test		
	Treated				t	p > t		Treated				t	p > t	
SIZE	5.72	3.34		200.9	16.27	.000	0.22*	5.72	3.34		200.9	16.27	.000	0.22*
Unmatched	5.72	5.60		10.3	1.19	.234	0.85	5.72	5.45		22.6	2.46	.015	0.64*
Matched														
CONPD	0.76	0.14		159.3	18.55	.000	.	0.76	0.14		159.3	18.55	.000	.
Unmatched	0.75	0.74		3.9	0.25	.802	.	0.76	0.70		14.1	0.91	.364	.
Matched														
LOCAL_EMP	3.53	3.36		19.4	1.88	.060	0.75	3.53	3.36		19.4	1.88	.060	0.75
Unmatched	3.52	3.53		-1.2	-0.09	.925	0.95	3.53	3.51		2.0	0.16	.874	1.00
Matched														
RPedTEC	0.13	0.02		20.0	4.09	.000	7.22*	0.13	0.02		20.0	4.09	.000	7.22*
Unmatched	0.13	0.12		0.8	0.04	.969	0.72	0.13	0.15		-4.5	-0.22	.828	0.60*
Matched														
RMER	0.01	0.01		5.9	0.49	.624	0.30*	0.01	0.01		5.9	0.49	.624	0.30*
Unmatched	0.01	0.01		3.2	0.30	.766	0.62*	0.01	0.01		0.1	0.00	.996	0.27*
Matched														
RMEQ_TM1N ^a	0.04	0.12		-2.9	-0.22	.828	0.00*	0.04	0.12		-2.9	-0.22	.828	0.00*
Unmatched	0.05	0.04		0.1	0.15	.882	1.80*	0.04	0.04		0.0	0.01	.992	1.58*
Matched														
LOCMERC	0.45	0.17		21.6	2.89	.004	2.40*	0.45	0.17		21.6	2.89	.004	2.40*
Unmatched	0.46	0.43		2.6	0.16	.872	1.05	0.45	0.38		5.7	0.37	.714	1.17
Matched														
LOCOOP	0.10	0.01		41.5	9.99	.000	.	0.10	0.01		41.5	9.99	.000	.
Unmatched	0.08	0.09		-1.6	-0.09	.926	.	0.10	0.09		4.6	0.26	.799	.
Matched														
LOCOUT	0.17	0.07		28.6	3.63	.000	.	0.17	0.07		28.6	3.63	.000	.
Unmatched	0.17	0.17		-0.2	-0.02	.988	.	0.17	0.16		2.3	0.15	.881	.
Matched														
PHDMS_100	0.68	0.13		22.2	3.46	.001	3.65*	0.68	0.13		22.2	3.46	.001	3.65*
Unmatched	0.69	0.57		4.8	0.19	.847	0.33*	0.68	0.59		3.7	0.15	.878	0.33*
Matched														
CNAE_TRAJ	3.02	2.67		19.7	2.14	.032	1.22	3.02	2.67		19.7	2.14	.032	1.22
Unmatched	2.96	2.98		-0.9	-0.07	.947	0.98	3.02	3.00		1.2	0.08	.932	1.02
Matched														
D_procb	0.81	0.39		93.2	8.81	.000	.	0.81	0.39		93.2	8.81	.000	.
Unmatched	0.80	0.80		1.0	0.08	.935	.	0.81	0.77		9.0	0.71	.477	.
Matched														
D_prodb	0.75	0.26		112.5	11.61	.000	.	0.75	0.26		112.5	11.61	.000	.
Unmatched	0.75	0.73		3.0	0.21	.831	.	0.75	0.70		11.7	0.84	.403	.
Matched														
Sample	Ps R ²	LR chi ²	p>chi ²	MeanBias	B	R	%Var	Ps R ²	LR chi ²	p>chi ²	MeanBias	B	R	%Var
Unmatched	0.367	454.56	.000	57.5	91.0*	0.04*	75	0.367	454.56	0	57.5	91.0*	0.04*	75
Matched	0.006	1.80	1.000	2.6	18.4	0.83	38	0.022	6.52	.925	6.3	34.8*	0.63	63

Table 1. Continued

2011														
KERNEL EPAN SIZE STRATIFICATION														
2011														
NNM (1 TO 1)														
	Mean			t test			Mean			t test				
	Treated	Control	%bias	t	p > t	V(T)/V(C)	Treated	Control	%bias	t	p > t	V(T)/V(C)		
SIZE														
Unmatched	5.72	3.34	200.9	16.27	.000	0.22*	5.72	3.34	200.9	16.27	.000	0.22*		
Matched	5.72	5.72	0.0	-0.00	1.000	1.00	5.72	5.69	2.3	0.29	.773	1.01		
CONPD														
Unmatched	0.76	0.14	159.3	18.55	.000	.	0.76	0.14	159.3	18.55	.000	.		
Matched	0.76	0.68	21.4	1.36	.175	.	0.76	0.80	-9.5	-0.65	.515	.		
LOCAL_EMP														
Unmatched	3.53	3.36	19.4	1.88	.060	0.75	3.53	3.36	19.4	1.88	.060	0.75		
Matched	3.53	3.49	4.1	0.32	.752	0.91	3.53	3.52	1.1	0.09	.928	1.22		
RPedTEC														
Unmatched	0.13	0.02	20.0	4.09	.000	7.22*	0.13	0.02	20.0	4.09	.000	7.22*		
Matched	0.13	0.15	-4.5	-0.21	.834	0.56*	0.13	0.16	-5.5	-0.25	.805	0.50*		
RMER														
Unmatched	0.01	0.01	5.9	0.49	.624	0.30*	0.01	0.01	5.9	0.49	.624	0.30*		
Matched	0.01	0.01	4.4	0.48	.633	1.06	0.01	0.01	4.1	0.51	.611	1.95*		
RMEQ_TMNA														
Unmatched	0.04	0.12	-2.9	-0.22	.828	0.00*	0.04	0.12	-2.9	-0.22	.828	0.00*		
Matched	0.04	0.06	-0.8	-0.12	.904	0.01*	0.04	0.05	-0.4	-0.45	.654	0.68*		
LOCMERC														
Unmatched	0.45	0.17	21.6	2.89	.004	2.40*	0.45	0.17	21.6	2.89	.004	2.40*		
Matched	0.45	0.37	6.5	0.42	.677	1.17	0.45	0.23	17.0	1.23	.222	2.08*		
LOCOOP														
Unmatched	0.10	0.01	41.5	9.99	.000	.	0.10	0.01	41.5	9.99	.000	.		
Matched	0.10	0.08	8.0	0.45	.652	.	0.10	0.11	-4.1	-0.22	.826	.		
LOCOUT														
Unmatched	0.17	0.07	28.6	3.63	.000	.	0.17	0.07	28.6	3.63	.000	.		
Matched	0.17	0.16	0.8	0.05	.958	.	0.17	0.18	-2.9	-0.18	.858	.		
PHDMS_100														
Unmatched	0.68	0.13	22.2	3.46	.001	3.65*	0.68	0.13	22.2	3.46	.001	3.65*		
Matched	0.68	0.35	13.3	0.95	.345	2.78*	0.68	0.42	10.4	0.72	.474	2.24*		
CNAE_TRAJ														
Unmatched	3.02	2.67	19.7	2.14	.032	1.22	3.02	2.67	19.7	2.14	.032	1.22		
Matched	3.02	2.92	5.7	0.41	.686	1.05	3.02	3.12	-5.7	-0.40	.686	1.03		
D_procb														
Unmatched	0.81	0.39	93.2	8.81	.000	.	0.81	0.39	93.2	8.81	.000	.		
Matched	0.81	0.74	14.5	1.13	.260	.	0.81	0.81	-2.1	-0.17	.863	.		
D_prodb														
Unmatched	0.75	0.26	112.5	11.61	.000	.	.75	0.26	112.5	11.61	.000	.		
Matched	0.75	0.68	16.5	1.17	.245	.	.75	0.79	-8.5	-0.64	.521	.		
Sample	Ps R ²	LR chi ²	MeanBias	MedBias	B	R	%Var	Ps R ²	LR chi ²	MeanBias	MedBias	B	R	%Var
Unmatched	0.367	454.56	.000	57.5	91.0*	0.04*	75	0.367	454.56	.000	57.5	91.0*	0.04*	75
Matched	0.015	4.51	.984	7.7	10.4	0.06*	38	0.016	4.87	.978	5.7	29.8*	1.86	63
(continued)														

(continued)

Table 1. Continued

2014															
2014															
RADIUS															
KERNEL EPAN															
Variable	Mean					Mean					t test				
	Treated	Control	%bias	t	p> t	V(T)/V(C)	Treated	Control	%bias	t	p> t	V(T)/V(C)			
SIZE															
Unmatched	5.82	3.34	212.1	16.59	.000	0.11*	5.82	3.34	212.1	16.59	.000	0.11*			
Matched	5.82	5.72	8.0	1.19	.235	0.69	5.82	5.61	17.5	2.33	.021	0.49*			
CONPD															
Unmatched	0.81	0.14	179.2	19.96	.000	.	0.81	0.14	179.2	19.96	.000	.			
Matched	0.81	0.79	4.7	0.33	.744	.	0.81	0.75	14.6	0.98	.329	.			
LOCAL_EMP															
Unmatched	3.49	3.35	16.5	1.57	.115	0.66*	3.49	3.35	16.5	1.57	.115	0.66*			
Matched	3.49	3.54	-5.8	-0.45	.652	0.77	3.49	3.49	0.7	0.05	.958	0.79			
RPedTEC															
Unmatched	0.04	3.78	-1.3	-0.09	.925	0.00*	0.04	0.38	-1.3	-0.09	.925	0.00*			
Matched	0.04	0.03	0.0	0.39	.694	0.18*	0.04	0.03	0.0	0.19	.850	0.18*			
RMER															
Unmatched	0.01	0.01	-0.4	-0.03	.977	0.02*	0.01	0.01	-0.4	-0.03	.977	0.02*			
Matched	0.01	0.01	1.6	0.13	.895	0.03*	0.01	0.01	1.7	0.15	.882	0.03*			
RMEQ_TM1N ^a															
Unmatched	0.08	0.06	3.8	0.36	.717	0.68*	0.08	0.06	3.8	0.36	.717	0.68*			
Matched	0.08	0.07	1.6	0.13	.897	0.85	0.08	0.07	1.8	0.14	.889	0.75			
LOCMERC															
Unmatched	0.90	0.14	46.8	8.79	.000	5.72*	0.90	0.14	46.8	8.79	.000	5.72*			
Matched	0.90	1.06	-9.9	-0.53	.594	0.81	0.90	0.98	-4.7	-0.26	.799	0.84			
LOCOOP															
Unmatched	0.05	0.01	21.9	3.77	.000	.	0.05	0.01	21.9	3.77	.000	.			
Matched	0.05	0.06	-8.7	-0.47	.640	.	0.05	0.05	-4.6	-0.26	.799	.			
LOCOUT															
Unmatched	0.12	0.07	16.4	1.95	.052	.	0.12	0.07	16.4	1.95	.052	.			
Matched	0.12	0.13	-3.5	-0.23	.817	.	0.12	0.12	-0.3	-0.02	.982	.			
PHDMS_100															
Unmatched	0.51	0.11	20.9	3.49	.000	4.26*	0.51	0.11	20.9	3.49	.000	4.26*			
Matched	0.51	0.54	-1.3	-0.07	.944	0.74	0.51	0.58	-3.3	-0.17	.862	0.67*			
CNAE_TRAJ															
Unmatched	3.09	2.74	19.6	2.17	.030	1.25	3.09	2.74	19.6	2.17	.030	1.25			
Matched	3.09	3.06	1.8	0.13	.899	1.09	3.09	2.99	5.5	0.40	.692	1.13			
D_procb															
Unmatched	0.88	0.41	112.0	9.93	.000	.	0.88	0.41	112.0	9.93	.000	.			
Matched	0.88	0.85	8.1	0.73	.465	.	0.88	0.83	13.3	1.16	.247	.			
D_prodb															
Unmatched	0.84	0.29	131.6	12.57	.000	.	0.84	0.29	131.6	12.57	.000	.			
Matched	0.84	0.79	10.6	0.84	.402	.	0.84	0.77	16.9	1.30	.195	.			
Sample	Ps R ²	LR chi ²	MeanBias	MedBias	B	R	%Var	Ps R ²	LR chi ²	p>chi ²	MeanBias	MedBias	B	R	%Var
Unmatched	0.401	504.37	60.2	20.9	10.6	0.00*	88	0.401	504.37	.000	60.2	20.9	10.6	0.00*	88
Matched	0.011	3.27	5.1	4.7	24.4	0.61	25	0.022	6.81	.912	6.5	4.6	35.1*	0.51	50
(continued)															

(continued)

Table 1. Continued

	2014									
	KERNEL EPAN SIZE STRATIFICATION									
	Control					Treated				
	Mean	%bias	t	p> t	V(7)/V(C)	Mean	%bias	t	p> t	V(7)/V(C)
SIZE										
Unmatched	5.82	212.1	16.59	.000	0.11*	5.82	212.1	16.59	.000	0.11*
Matched	5.82	0.0	0.00	1.000	1.00	5.82	2.3	0.39	.697	1.08
CONPD										
Unmatched	0.81	179.2	19.96	.000	.	0.81	179.2	19.96	.000	.
Matched	0.81	21.4	1.40	.162	.	0.81	-7.3	-0.53	.598	.
LOCAL_EMP										
Unmatched	3.49	16.5	1.57	.115	0.66*	3.49	16.5	1.57	.115	0.66*
Matched	3.49	2.2	0.17	.869	0.74	3.49	-3.2	-0.24	.811	0.69
RPEDTEC										
Unmatched	0.04	-1.3	-0.09	.925	0.00*	0.04	-1.3	-0.09	.925	0.00*
Matched	0.04	-2.0	-0.12	.907	0.00*	0.04	0.0	1.19	.235	5.55*
RMER										
Unmatched	0.01	-0.4	-0.03	.977	0.02*	0.01	-0.4	-0.03	.977	0.02*
Matched	0.01	2.3	0.30	.765	0.07*	0.01	3.4	1.55	.122	4.21*
RMEQ_TM ^a										
Unmatched	0.08	3.8	0.36	.717	0.68*	0.08	3.8	0.36	.717	0.68*
Matched	0.08	1.1	0.08	.937	0.59*	0.08	6.7	0.75	.456	9.39*
LOCMERC										
Unmatched	0.90	46.8	8.79	.000	5.72*	0.90	46.8	8.79	.000	5.72*
Matched	0.90	-4.9	-0.27	.790	0.84	0.90	-6.1	-0.34	.732	0.94
LOCOOP										
Unmatched	0.05	21.9	3.77	.000	.	0.05	21.9	3.77	.000	.
Matched	0.05	-4.6	-0.25	.799	.	0.05	0.0	0.00	1.000	.
LOCOUT										
Unmatched	0.12	16.4	1.95	.052	.	0.12	16.4	1.95	.052	.
Matched	0.12	-1.3	-0.09	.929	.	0.12	-15.6	-0.97	.335	.
PHDMS_100										
Unmatched	0.51	20.9	3.49	.000	4.26*	0.51	20.9	3.49	.000	4.26*
Matched	0.51	-2.9	-0.15	.877	0.69	0.51	-1.7	-0.09	.925	0.84
CNAE_TRAJ										
Unmatched	3.09	19.6	2.17	.030	1.25	3.09	19.6	2.17	.030	1.25
Matched	3.09	9.4	0.69	.492	1.16	3.09	2.5	0.18	.857	1.08
D _{proc} ^b										
Unmatched	0.88	112.0	9.93	.000	.	0.88	112.0	9.93	.000	.
Matched	0.88	16.5	1.42	.156	.	0.88	6.5	0.60	.552	.
D _{prod} ^b										
Unmatched	0.84	131.6	12.57	.000	.	0.84	131.6	12.57	.000	.
Matched	0.84	20.9	1.59	.114	.	0.84	-4.4	-0.37	.711	.
Sample	Ps R ²	MeanBias	B	R	%Var	Ps R ²	MeanBias	B	R	%Var
Unmatched	0.401	60.2	10.6	0.00*	88	0.401	60.2	10.6	0.00*	88
Matched	0.014	6.9	27.5*	0.61	38	0.031	4.6	41.0*	1.5	38

*If $B > 25\%$, R outside [0.5; 2].^aIf variance ratio outside [0.68; 1.46] for U and [0.68; 1.47] for M .^bThe variable RMEQ is mediated by the firm size.^cThe D_{prod} is a dummy variable that takes the value 1 for product innovation. The D_{proc} is a dummy variable that takes the value 1 for process innovation.

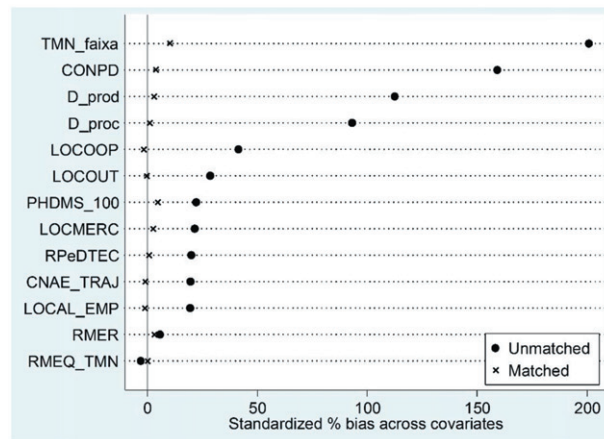


Figure 3. Radius' algorithm standard bias analysis before and after matching- 2011. Note: the variable TMN_faixa is the SIZE variable.

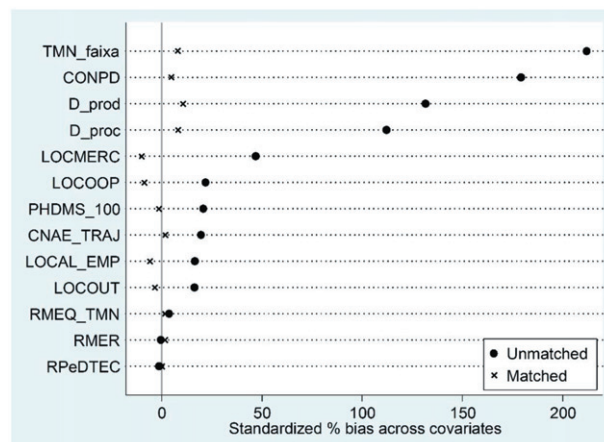


Figure 4. Radius' algorithm standard bias analysis before and after matching - 2014. Note: the variable TMN_faixa is the SIZE variable.

The third pairing algorithm is NNM, with 1 to 1. The balance analysis confirms an effective reduction of the standard bias in the mean and in its median, and a reduction of R^2 . The R parameter remained in the expected range, and where variables had presented differences with the t-test method between the mean of the treated and control groups before pairing, the mean of the two groups did not present significant difference after the matching. Some variables presented significant difference in the ratio between the variances of the control and treated groups. However, in the analysis of the generated p score for both groups, the difference was no longer relevant, since the R parameter adjustment was 1.5, which is compatible with the model's balance. Therefore, the B parameter is elevated after the matching. Rubin (2001) observes that the condition that there must be a small difference between the mean of p scores, evidenced in the B parameter, might not be met if the covariate distributions of the treated and control groups are symmetrical. Therefore, this propensity score estimation is balanced. The propensity score density graphs (Figures 5 and 6) of the treated and control groups demonstrate that they nearly overlap for the NNM.

The empirical tests show that the p score estimation for the various algorithms is not biased. Analysis of the matching balance for the year 2011 demonstrates a similar trajectory for algorithms and covariates identified for the year 2014.

As the matching balances the differences in observable variables, an analysis that verifies to what extent results are sensitive to nonobservable variables is carried out using the Mantel-Haenszel test (Rosenbaum, 2002). The null hypothesis of the Mantel-Haenszel test states that the treatment is not affected at all. Rosenbaum (2002) points out that such a test is limited by two known distributions, where $QMH +$ represents the limit in case the

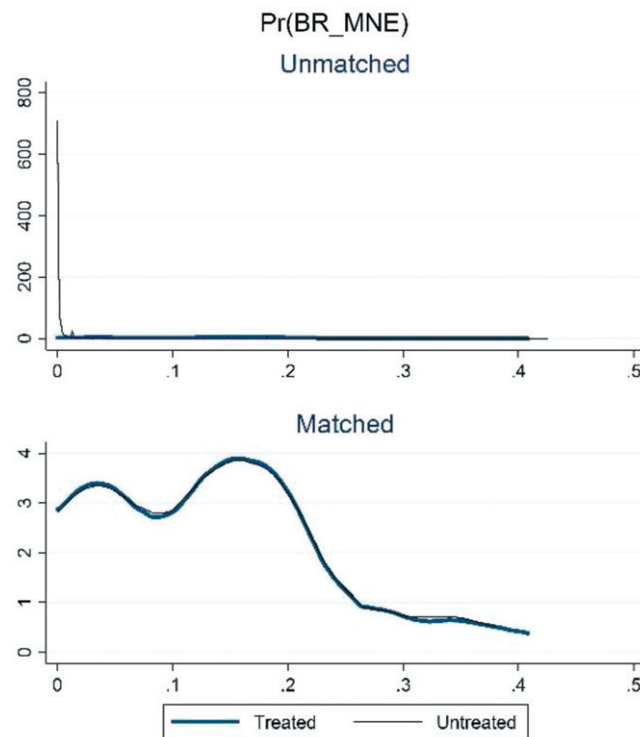


Figure 5. The propensity score density graph of the treated (Brazilian Multinational. Companies – BR_MNE) and control (untreated) groups for NNM algorithm – 2011.

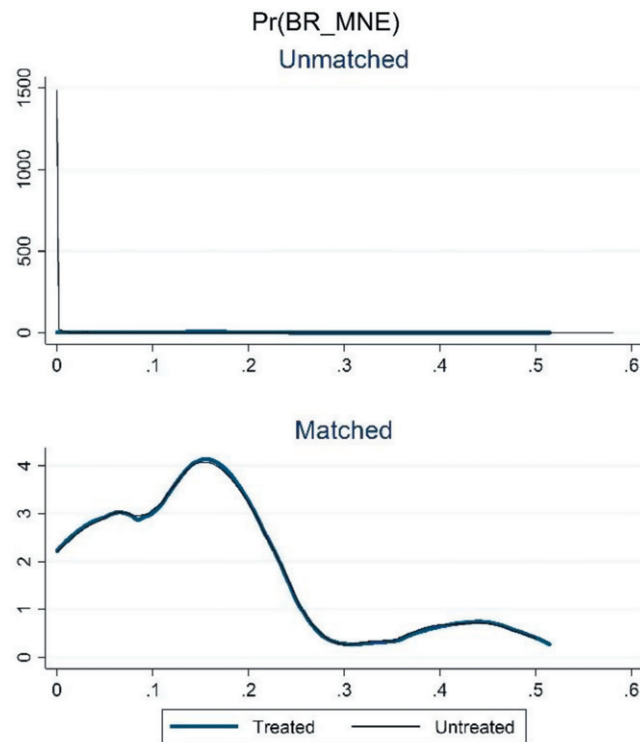


Figure 6. The propensity score density graph of the treated (Brazilian Multinational. Companies – BR_MNE) and control (untreated) groups for NNM algorithm – 2014.

effect of treatment is overestimated, and *QMH* – indicates the limit in case the effect of treatment is underestimated.

Results and discussion

The main characteristics of the Brazilian MNC sample in relation to Brazilian non-internationalised firms are as follows (Tables 2 and 3). First, Brazilian MNCs are large firms; 95 per cent of MNCs have more than 250 employees, while only 24 per cent of non-MNCs are of this size. In the Brazilian case, firm size is a predictor of firm innovation (Kannebley, Porto, & Pazello, 2005). Second, the share of Brazilian MNCs with continuous R&D activities is increasing, reaching 81 per cent during the 2012–2014 triennium. Only 14 per cent of non-internationalised Brazilian firms conducted R&D activities during the same period. Third, Brazilian MNCs are geographically concentrated in the more industrialised regions—the south and southeast, where nearly 90 per cent of the firms reported having R&D units—because of economic agglomeration and availability of local human resources to stimulate a new global market innovation (Romero, 2017). Fourth, the distribution of Brazilian MNCs across industrial activity and innovation patterns is similar to that of non-internationalised MNCs. Nevertheless, there is a higher concentration of Brazilian MNCs in the scale intensive and a slightly higher concentration of non

Table 2. The Brazilian firm's characteristics.

	2011			2014		
	Brazilian MNCs	Non-internationalised Companies	Total	Brazilian MNCs	Non-internationalised Companies	Total
Number of Firms	108	12,229	12,337	110	12,264	12,374
Firm's size (SIZE) %						
1 to 4	8%	79%	78%	5%	77%	76%
5	8%	11%	11%	8%	13%	13%
6	83%	10%	11%	87%	11%	12%
Total	100%	100%	100%	100%	100%	100%
The firm's headquarter location in Brazil (LOCAL_EMP) %						
Central-West and North	3%	9%	9%	3%	10%	10%
Southeast	52%	51%	51%	54%	51%	51%
South	33%	30%	30%	34%	29%	29%
Northeast	12%	10%	10%	10%	11%	11%
Total	100%	100%	100%	100%	100%	100%
The firm's R&D location in Brazil (LOCAL_PD) %						
Central-West, North and Northeast	6%	3%	3%	5%	2.8%	3%
Southeast	42%	9%	10%	47%	10%	9%
South	32%	6%	6%	35%	6%	6%
No R&D	20%	82%	81%	13%	87%	82%
Unit declared						
Total	100%	100%	100%	100%	100%	100%
Continuity of R&D activities %	76%	15%	15%	81%	14%	15%
Belonging to a group %	46%	11%	12%	46%	13%	13%
Industrial Activity %						
Traditional or related to natural resources	18%	20%	20%	16%	20%	20%
Supplier dominated	40%	52%	51%	41%	50%	50%
R&D intensive	7%	5%	5%	6%	4%	4%
Scale intensive	19%	14%	14%	21%	13%	13%
Electronic complex	3%	1%	1%	2%	1%	1%
Service	12%	8%	8%	12%	13%	13%
Others	2%	0%	0%	2%	1%	1%
Total	100%	100%	100%	100%	100%	100%

Table 3. Brazilian firms' innovative behaviour.

	2011			2014		
	Brazilian MNCs	Non-internationalised Companies	Total	Brazilian MNCs	Non-internationalised Companies	Total
Number of Firms	108	12,229	12,337	110	12,264	12,374
Overseas innovative activities %						
Connected to other firms in the group (LOCSUB)	2.8%	0.1%	0.1%	0.0%	0.0%	0.0%
Developed by other firms/institutes (LOCOUT)	16.7%	7.4%	7.5%	11.8%	7.0%	7.1%
Overseas innovative activities in cooperation (LOCOOP) %	10.2%	0.9%	0.9%	4.5%	1.0%	1.0%
Overseas innovative activities (LOC_X) %						
1 Type of innovative activity	27.8%	8.2%	8.3%	17.3%	7.9%	8.0%
2 Types of innovative activity	0.9%	0.1%	0.1%	0.0%	0.2%	0.2%
Access information source abroad (INF_X) %						
No source	60%	93%	92%	51%	90%	90%
1 source	19%	6%	6%	21%	7%	8%
2 sources	14%	1%	1%	17%	2%	2%
3 or more sources	6%	0.3%	0.3%	11%	0%	0%
Financing Abroad (FIN_X)	1.9%	0.2%	0.2%	2%	0.2%	0.2%
Main Consumer Market (LOCMERC) %						
Brazil	91.7%	97.0%	96.9%	83.6%	97.5%	97.4%
Mercosul	2.8%	0.6%	0.6%	6.4%	0.7%	0.7%
The USA	0.9%	0.9%	0.9%	1.8%	0.7%	0.7%
Europe	2.8%	0.9%	0.9%	3.6%	0.5%	0.5%
Asia	1.9%	0.4%	0.4%	2.7%	0.3%	0.3%
Others Countries	0.0%	0.4%	0.4%	1.8%	0.3%	0.3%

internationalised Brazilian companies in the supplier dominated patterns. Fifth, the share of Brazilian MNCs with innovative activities in cooperation with agents overseas decreased in the 2012–2014 period. Nonetheless, it still higher than non-internationalised companies' overseas cooperation. Finally, the Brazilian companies are mostly home-market oriented. However, for Brazilian MNCs, foreign markets are increasingly important. The Brazilian MNCs foreign-market orientation reached a share of 16 per cent in 2014.

These factors show the average different behaviours and characteristics of the Brazilian MNCs and non-internationalised firms. Thus, the application of PSM methodology allows a more adequate comparison between the two groups. The PSM analysis is conducted with the average treatment effect on the treated (ATT) estimation, and with the average treatment effect on the untreated (ATU) estimation. The ATT refers to the average impact internationalisation has on Brazilian MNCs' innovation performance. The ATU refers to the average effect that treatment has if it is applied to firms that have not received the treatment—that is, the average impact of internationalisation on the innovative performance of non-internationalised Brazilian firms.

Analysis of the ATT estimator for the average impact of internationalisation on product or process innovation (RIN) in 2014 shows that the difference between the means of the treated and control groups—regardless of the algorithm applied—is always positive, ranging from 3 per cent to 8 per cent (Table 4). The t-test shows that there is no statistical significance of the internationalisation process on Brazilian MNCs' innovative performance. The exception to the aforementioned scenario is the analysis for the year of 2014. The Kernel algorithm, which stratifies firms by size range, shows a positive and significant impact of internationalisation when compared with firms in the treated group and firms in the control group with the same size.

Analysis of the ATU estimator generates various results that depend on the selected matching algorithm. In 2014, the Kernel and Radius algorithms show that if non-internationalised firms were to receive the treatment, they could reach better innovation performance levels than the firms in the treated group. The NNM algorithm shows that

Table 4. Average difference of the innovative output between treated and control groups.

RIN - Average Difference of the innovative output between treated and control groups														
	2014													
	2014							2011						
	Matched						Unmatched	Matched						Unmatched
	Radius		Kernel Epan Size Stratification		NNM (1-to-1)			Radius		Kernel Epan Size Stratification		NNM (1-to-1)		
			ATT	ATU	ATT	ATU				ATT	ATU	ATT	ATU	
ATT	ATU	ATT	ATU	ATT	ATU	Difference	ATT	ATU	ATT	ATU	ATT	ATU	Difference	
RIN														
Difference	0.042	0.150	0.097**	0.248	0.036	−0.052	0.516***	−0.025	−0.055	0.028	0.253	−0.028	−0.190	0.476***
S.D.	0.048		0.046		0.053		0.053	0.057		0.056		0.077		0.057
Common Support														
Treated	110		110		110		110	106		108		108		108
Control	5,946		5,987		5,947		12,265	6,165		8,758		6,165		12,229

Estadística t: * >1.64 (90%); **>1.96 (95%); ***>2.37 (99%).

Table 5. Average difference of the innovative output between treated and control groups.

RORG - Average difference of the innovative output between treated and control groups														
	2014							2011						
	Matched						Unmatched	Matched						Unmatched
	Radius		Kernel Epan Size Stratification		NNM (1-to-1)			Radius		Kernel Epan Size Stratification		NNM (1-to-1)		
ATT	ATU	ATT	ATU	ATT	ATU	Difference	ATT	ATU	ATT	ATU	ATT	ATU	Difference	
RORG														
Difference	0.034	0.047	0.050*	0.075	0.018	0.058	0.216***	0.029	0.068	0.044	−0.118	0.009	0.084	0.191***
S.D.	0.032		0.030		0.038		0.042	0.028		0.028		0.033		0.042
Common Support														
Treated	110		110		110		110	106		108		108		108
Control	5,946		5,987		5,947		12,265	6,165		8,758		6,165		12,229

Estadística t: * >1.64 (90%); **>1.96 (95%); ***>2.37 (99%).

internationalisation for the non-internationalised firms does not improve their innovative performance. In 2011, analysis of the estimation of various algorithms does not indicate enhancement in the innovation performance, except in the case of the stratified kernel algorithm. Thus, hypothesis 1A about an enhanced product and process innovative performance is not confirmed. Nonetheless, the positive ATT estimator leads to further research on that effect.

Analysis on the degree of novelty of firms' innovations (RNOV) shows different results (Table 5). For 2011, there are three different effects. On the level of innovation only for the firm, the ATT is negative and is statistically significant at the 1% level for all of the algorithms—that is, the impact the treatment has on the generation of innovation only for the firm in Brazilian MNCs is negative. That means that non-internationalised firms innovate more for the firm alone than do MNCs. Following this trend, the ATU is negative. Therefore, the fact that the control group receives treatment generates a less innovative impact on innovation only for the firm than the treated group. This difference is due to the average innovative behaviour of Brazilian non-internationalised firms as follower competitors, which consists in the incorporation of innovations that already have local diffusion. Regarding the degree of novelty in relation to innovation for the domestic market, the ATT is positive and statistically significant in any matching algorithm. Hence, internationalisation intensifies the effect that innovation for the domestic market has on the treated group. In this sense, internationalisation encourages MNCs to incorporate existing innovations from the rest of the world into the domestic market. Complementarily, the ATU is positive for matching with the Kernel and Radius algorithms, and negative for matching with the NNM. Regarding the degree of novelty for the global market, the ATT and ATU show that there is a positive and statistically significant effect of treatment in the treated and untreated group for all of the algorithms. Therefore, it is possible to conclude that internationalised firms achieve higher degrees of novelty in their innovative activity than non-internationalised firms, and that firm internationalisation leads to a greater degree of firm innovation.

Table 6. Average Difference of the innovative output between treated and control groups.

RTEC – Average difference of the innovative output between treated and control groups														
2014								2011						
Matched							Unmatched	Matched						Unmatched
Radius		Kernel Epan Size Stratification		NNM (1-to-1)				Radius		Kernel Epan Size Stratification		NNM (1-to-1)		
ATT	ATU	ATT	ATU	ATT	ATU		Difference	ATT	ATU	ATT	ATU	ATT	ATU	Difference
Level 0														
Difference	−0.032	−0.093	−0.075**	−0.134	0.000	0.118	−0.465***	0.005	0.086	−0.049	−0.236	0.009	0.172	−0.403***
S.D.	0.036		0.034		0.037		0.048	0.040		0.040		0.052		0.048
Level 1														
Difference	−0.022	0.096	−0.014	0.027	0.000	−0.109	0.037	0.009	0.036	0.021	0.264	0.046	0.039	0.087**
S.D.	0.049		0.047		0.068		0.040	0.048		0.047		0.067		0.039
Level 2														
Difference	0.054	−0.003	0.089*	0.108	0.000	−0.009	0.428***	−0.014	−0.122	0.028	−0.029	−0.056	−0.211	0.317***
S.D.	0.052		0.051		0.072		0.041	0.052		0.051		0.074		0.041
Common Support														
Treated	110		110		110		110	106		108		108		108
Control	5,946		5,987		5,947		12,265	6,165		8,758		6,165		12,229

Estadística t: * >1.64 (90%); ** >1.96 (95%); *** >2.37 (99%).

In 2014, considering the degrees of firms' innovation novelty, it is possible to observe two statistically significant results. For innovations only for the firm, we observe the same result as in 2011. For innovation for the global market, the ATT is positive and statistically significant at the 1% level for all of the algorithms applied. Therefore, internationalisation elevates innovations for the global market in the Brazilian MNCs, which generates even greater impact than the impact observed in 2011. The ATU analysis differs among algorithms, while Kernel and Radius evidence a positive impact on innovation for the global market in the control group; the NNM matching does not suggest such an improvement in innovation performance.

In the analysis that measured if the innovation brought about technical enhancement or a new technique (RTEC), the difference between the control and treated groups (ATT) is positive but not statistically significant for the 2014 and 2011 periods (Table 6). For 2011, the ATT of new technique innovation with the use of the NNM matching algorithm shows negative results, but not significant. The negative ATU in all periods regarding technical enhancement and new technique implies that internationalisation of non-internationalised firms would lead to lower levels of technical enhancement of innovation in these firms. These results derive from the industrial activity of Brazilian firms characterised by greater technological maturity.

The behaviour of organisational and marketing innovation (RORG) indicates that the difference between the control and treated groups (ATT) is positive, but not statistically significant (Table 7). The ATU remained positive in both periods.

Thus, in conclusion, Brazilian MNCs have higher degrees of novelty in their innovative activities than their local counterparts. Brazilian MNCs innovate more than non-internationalised Brazilian firms for both domestic and global markets. Nonetheless, there is no statistically significant evidence that the Brazilian MNCs have better technical improvements or perform better organisational and marketing innovation activities than the non-internationalised Brazilian firms.

Final considerations

Internationalisation is a phenomenon historically related to central and mature economies. This is because, in the first place, internationalisation of production as a way to expand the limits of the firm could just take place when a domestic product has matured or when the income elasticity of the product in the domestic market has started to decrease. Secondly, and following a similar pattern, internationalisation of innovative activities is extremely concentrated in the central economies. Even when the technological competences are spread worldwide, it is a fact that frontier knowledge is localised in the triad (USA-Europe-Japan) and other central countries. In this sense, the phenomenon of technological internationalisation from and towards developing countries is peripheral and quite small in relative terms. From the middle nineties, the strong expansion of technological internationalisation

Table 7. Average Difference of the innovative output between treated and control groups.

RNOV - Average difference of the innovative output between treated and control groups															
2014								2011							
Matched							Unmatched	Matched							Unmatched
Radius		Kernel Epan Size Stratification		NNM (1-to-1)		Radius		Kernel Epan Size Stratification		NNM (1-to-1)					
ATT	ATU	ATT	ATU	ATT	ATU	ATT		ATU	ATT	ATU	ATT	ATU	ATT	ATU	
Level 0															
Difference	-0.032	-0.093	-0.075***	-0.134	0.000	0.118	-0.465***	0.005	0.086	-0.049	-0.235	0.014	0.195	-0.403***	
S.D.	0.036		0.034		0.037		0.048	0.040		0.040		0.045		0.048	
Level 1															
Difference	-0.082	-0.047	-0.079	-0.004	-0.173**	-0.259	-0.002	-0.147***	-0.126	-0.129***	-0.126	-0.231***	-0.236	-0.082**	
S.D.	0.053		0.052		0.074		0.046	0.047		0.047		0.060		0.046	
Level 2															
Difference	0.015	0.105	0.056	0.133	0.045	0.143	0.278***	0.081*	0.008	0.100**	0.013	0.144***	-0.042	0.319***	
S.D.	0.050		0.049		0.071		0.028	0.050		0.049		0.060		0.028	
Level 3															
Difference	0.099***	0.099	0.099***	0.006	0.127***	-0.002	0.189***	0.060	0.031	0.079**	0.350	0.074*	0.082	0.166***	
S.D.	0.040		0.040		0.051		0.014	0.038		0.038		0.045		0.014	
Common Support															
Treated	110		110		110		110	106		108		108		108	
Control	5,946		5,987		5,947		12,265	6,165		8,758		6,165		12,229	

Estatística t: * >1.64 (90%); ** >1.96 (95%); *** >2.37 (99%).

included developing countries. Nevertheless, this trend started to revert from the middle of the second decade of the new millennium (Laurens, Le Bas, Schoen, & Larédo, 2015).

Following the global trend as a peripheral economy, Brazilian MNCs accelerated their productive internationalisation and started their technological internationalisation after the 2000s, supported by strong public policies and incentives. Outward Brazilian direct investment (OBDI), and consequently its impact, is extremely concentrated and restricted to a few large firms and industries.

This article aimed to test if internationalisation allows improving substantially the innovative performance of Brazilian firms. Three features characterise Brazilian MNCs: the late internationalisation process, firms' diversification as a precondition for internationalisation and the support of public policies as a defensive strategy. Brazilian MNCs are big companies and mostly national champions, but they are followers in the international arena. Additionally, excepting some few cases, Brazilian MNCs act in supplier dominated and scale intensive industrial activities characterised by low innovation standards and low knowledge-intensive activities with low technological opportunities, such as traditional industries and extracting natural resources. Still, Brazilian MNCs have sought strategic assets abroad. In that sense, the heterogeneity of the results obtained with the matching algorithm in the outcome RIN (product or service innovative firm) exposes the diversity of the Brazilian MNC sample.

The result for innovation novelty is relevant because it is a characteristic of most of the MNCs in the sample. That means that innovative capabilities acquired by internationalisation give the companies a strategic competitive advantage—the degree of novelty of the innovation. This is the result of interaction with wider consumer markets abroad and catching information overseas to create innovations with greater levels of complexity. Those higher novelty level innovations may generate greater value-added products or services and should improve the competitive position of Brazilian MNCs. In 2014, the impact of internationalisation on the highest degree of innovation was significant at 1%—that is, higher than in 2011. Such a result points out that there is a time lag before internationalisation has a positive impact on the innovation so that the firm can be embedded in the host country market and can absorb and develop capabilities.

The Brazilian government encouraged internationalisation of the big Brazilian companies as part of an industrial policy focussed on 'picking winners'. The purpose of this aggressive policy was to create national champions that could compete at a global level. BNDES loans supported most of the internationalisation of Brazilian companies. Therefore, the state protected Brazilian internationalisation as part of a wider policy directed to stimulate the innovation of the Brazilian champions and to accelerate the catching up. In this sense, we can interpret that the benefits of internationalisation not only by the action of the international markets, but also, in a way, by the helping hand of the entrepreneurial state (Mazzucato, 2013). As a result, internationalisation driven by the visible hand allowed the achievement of significant differences in terms of major innovations in relation to non-

internationalised firms—that is, innovations that represented elevated degrees of novelty at a global level. Internationalisation of Brazilian firms had no effect on enhancing technical innovation. Internationalization had no relevant effect on organisational and marketing innovation, either. Results showed that Brazilian MNCs developed distinctive managerial competences and became competitive domestically before internationalising. Most of the MNCs were already national champions and had incorporated the best marketing and organisational practices and innovations before internationalising.

The general conclusion is that internationalisation matters for developing countries as long as MNCs explore technological niches and develop rare resources of knowledge (which are very difficult to imitate), which is a first step to accelerate catching up at the microeconomic level. Firms that internationalise move away from their home country firm compatriots in their competitive position in national and international markets. However, internationalisation is not the solution to all firms' competitiveness issues. In the Brazilian case, a culture of innovation or the modernisation of managerial competences are not necessarily acquired by internationalisation. Both seem to be more a precondition than an expected result. In addition, Brazilian firms' internationalisation is still limited—that is, restricted to few firms and in specific industries, mainly in sectors with medium technological content that are intensive in natural resources. The international role of these companies as innovative players is still marginal.

This article raises some economic policy implications. The incentives to internationalise should extend to a broader group of industrial activities, including some of medium–high technology intensity, to accelerate catching-up in industries that generate more added value. Public policies designed to encourage the internationalisation of small and medium-sized companies specialising in technological niches would help to reduce the strong heterogeneity in the Brazilian productive structure. An example is the 'born globals'. Such public policies would act to integrate and to structure productive and technological internationalisation as part of a wider acceleration of catching up, and not as a phenomenon restricted and limited to national champions or large firms.

Notes

1. In a randomized experiment, it is possible to measure covariates before and after treatment. However, in the case of the present research, it is not possible. Therefore, variables that are measured only after treatment are considered a proxy for the appropriate covariates.
2. The PSM application considers the Conditional Independence Assumption (CIA). That is, given the same observable covariates of individuals, both the treatment probability and the potential outcomes are independent.
3. The introduction of a large number of covariates may increase the variance (Caliendo & Kopeinig, 2005). The variables that may have been affected by the treatment should not be considered, especially in cases where the treatment and the outcome are observed in the same timeline (Stuart, 2010).
4. Bootstrapping was not used in the estimation of Radius and Kernel. Empirical studies demonstrate that bootstrapping in general is not valid for matching estimators, and when it is applied, it does not present a clear beneficial contribution to the estimations (Abadie & Imbens, 2008).

Data set availability statement

The article's methodology uses the Brazilian Innovation Survey (PINTEC – Pesquisa de Inovação Tecnológica) data set, which is available at the Brazilian Institute of Geography and Statistics (IBGE) located in Brazil. The data are accessed at the IBGE site, involving significant red tape.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix I

Brazilian Multinational Companies' sample

Acumuladores Moura S.A.
 AES TIETE ENERGI
 Agrale S.A.
 AGRENCO LTD
 ALPARGATAS S.A.
 ALTUS SA
 ALUPAR INV-UNIT
 Alusa Engenharia S.A.
 AMBEV SA
 ANDRADE GUTIERREZ Engenharia e Construção
 AREZZO INDUSTRIA
 Artecola Indsutrias Químicas Ltda.
 B2W CIA DIGITAL
 Bauducco & CIA Ltda
 BAUMER
 Bematech S.A.
 Bertin
 Bioembryo
 BOMBRIIL
 BRADESPAR SA
 BRASKEM S.A.
 BRF SA
 BRQ SOLUCOES EM Informática
 CAMBUCI AS
 CAMIL ALIMENTOS
 CBMM - Cia Brasileira de Metalurgia e Mineração
 CCX CARVAO COL
 Compoende
 CEMIG
 Ci&T Software S.A.
 CIA HERING
 Cia Providência Indústria e Comércio
 Cinex
 Cipher
 Citrosuco
 Construtora Camargo Corrêa
 COSAN
 COSAN LOGISTICA
 COTEMINAS S.A.
 CPM Braxis S.A.
 CSN - Cia Siderúrgica Nacional
 CZM Indústria de Equipamentos
 Dass Calçados e Artigos Esportivos Ltda
 D H B Indústria e Comércio Ltda.
 DOHLER
 Duas Rodas Industrial

(continued)

DURATEX SA
Eldorado
ELETROBRAS
Eliane S/A Revestimentos Cerâmicos
Embraco
EMBRAER
Embrapa
EMS.
ENCORPAR
Estre
ESTRELA S.A.
EUCATEX S.A.
Eurofarma Laboratórios S.A.
EVORA AS
FANEM
FIBRIA CELULOSE
Fitesa
FORJA TAURUS
Fras-le S.A.
GAMA PART
GAUSS Industrial
GERDAU
GPC PART
GRENDENE SA
Griaule Biometrics
Grupo Camargo Corrêa
Guerra S.A. - Implementos Rodoviários
Haco
Ibope
IDEIASNET
Indusparquet
Indústrias ROMI
Indústria de Material Bélico do Brasil
INEPAR
Inplac Indústria de Plásticos S.A.
Intercement Brasil S.A.
INTERNATIONAL ME
Intertechne
IOCHP-MAXION
ITAUTEC SA
ITSA LTD
JB DUARTE
JBS
JHSF PART
JSL SA
KLABIN S.A.
LA FONTE TEL
LAEP-BDR
Lar Cooperativa Agroindustrial
Light Infocon
LOJAS HERING
LUPATECH SA
M. Cassab
M. Dias Branco
MAGNESITA REFRA
MAORI SA
MARCOPOLO
MARFRIG GLO FOOD
Marisol
Master Sistemas Automotivos Ltda.
MELHOR
MENDES JR
Metagal
MET GERDAU
METALFRIO
Método Engenharia S.A. (International Engineering S.A.)
MINERVA SA
Módulo Security Solutions S.A.
Mobile Internet Móvel S.A.
MONTEIRO ARANHA
MV Participações S.A.
NATURA Cosméticos S.A.
NEOGRID
Nexxera Tecnologia e Serviços S.A.

(continued)

NORDON MET
NORTCQUIMICA
OAS
O Boticário
Odebrecht
OGX PETROLEO E G
OLEO E GAS PART
Opto Eletrônica S/A
Ouro Fino Part.
Oxiteno
Padtec
Paquetá The Shoe Company
PETRO MANGUINHOS
PETROBRAS
POLPAR SA
Portobello S.A.
Pratica Participações SA
Procable
Progen
Promon S.A.
Queiroz Galvão Construtora S.A.
RANDON Implementos e Participações S.A.
ReceptaBio
REIVAX Automação e Controle
Renner Sayerlack S.A.
RIOSULENSE SA
Sabó Indústria e Comércio de Autopeças Ltda.
Santana Têxtil S.A.
SANTANENSE
SCHULZ
Seculus da Amazônia/Seculus International S.A.
SID NACIONAL
Smar Automação Industrial
SPRINGER-PREF A
Stefanini Consultoria e Assessoria Em Informatica S.A.
Sucocitrico Cutrale
SUZANO PAPEL E CELULOSE
Santista Textil S.A. (Tavex)
Systemhaus
TECEL
TEKNO S.A.
Tigre S.A.
TIME FOR FUN
TOTVS SA
TUPY
Tramontina S.A.
ULTRAPAR
UNIPAR CARBOCLOR
VALE S.A.
Vicunha Têxtil
VIGOR ALIMENTOS
Votorantim Cimentos
Votorantim Metais
Votorantim Siderurgia
VULCABRAS AZALEIA S.A.
Xseed
WEG SA
WETZEL SA-PREF

Appendix II – Brazilian Industrial Activities Classification

Industrial Activity	CNAEs Description	CNAEs Classification
I	Traditional or related to natural resources	Extractive industry
	Manufacture of wearing apparel and accessories	01 a 03; 05 a 09
	Manufacture of Wood products	14
	Manufacture of paper and paper products	16
	Manufacture of non-metallic mineral products	172, 173, 174
II	Supplier dominated	23
		Steel products
		241, 242, 243
		Manufacture of food products
		10
		Manufacture of beverages
		11
		Manufacture of tobacco products
		12
		Manufacture of textiles
		13
		Leather, leather goods and footwear
		15
		Editing, printing and recording
		18, 580
		Nuclear fuel, alcohol and coque
		19
III	R&D intensive	Manufacture of rubber and plastic products
		22
		Non-ferrous metallurgy Metalworking
		244, 245
		Manufacture of metal products
IV	Scale Intensive	25
		Automotive (except parts and accessories)
		291, 292, 293
		Manufacture of furniture
		31
		Manufacture of other products
		32
		Water transportation
		50
		Maintenance and repair of machinery and equipment
V	Electronic complex	330
		Manufacture of pulp and paper pulp
		171
		Manufacture of machinery and equipment
		27
VI	Services	Manufacture of equipment, communication equipment
		263
		Medical and hospital instruments, optical precision
		265, 266, 267, 268
		Manufacture of chemical products
		20
		Manufacture of pharmaceutical products
		21
		Manufacture of machinery and equipment
		28
		Manufacture of accessories for vehicles
		294, 295
		Manufacture of other transport equipment
		30
		Office machines and computer equipment
		262, 264
		Manufacture of basic electronic material
		261
		Telecommunications
		610
		Information Technology Services Activities
		621, 622; 6201 a 6204
		Activities of Information Services
		631
		Architecture and Engineering Services, Testing and Technical Analysis
		710
		Research and Scientific Development
		720