Productivity, Heterogeneity and Brazilian multinational firms

Pedro Henrique Cavalcanti Rocha [*]

Hélio de Sousa Ramos Filho [†]

Resumo

O processo de globalização produtiva, especialmente após a década de 2000, reconfigurou a dinâmica dos fluxos de investimentos internacionais. As firmas multinacionais tiveram, e ainda têm, um papel fundamental neste novo cenário internacional. Um ponto interessante, da perspectiva microeconômica, é entender o que leva a essas firmas a expandirem suas operações em outras economias. Com base no modelo de Yeaple (2009), busca-se avaliar se o nível de produtividade das firmas multinacionais brasileiras e outras variáveis exógenas impactam as decisões de investimento estrangeiro direto (IED). Ao utilizar microdados e diferentes modelos empíricos, conclui-se que há, de fato, uma tendência das firmas brasileiras mais produtivas em estarem presentes em um maior conjunto de países e, sobretudo, em maior escala. Verifica-se também que as características-país, tais como Produto Interno Bruto (PIB), PIB *per capita* e distância são relevantes, na maioria dos casos, em explicar as decisões de IED das firmas brasileiras.

Palavras-chave: Produtividade, Firmas multinacionais, Brasil.

Abstract

The process of the globalization of production, especially after the decade of 2000, reconfigurated the dynamics of foreigns investments flows. Multinational firms had, and still have, a fundamental role in this new international economic scenario. An interesting point, on the microeconomic perspective,is to understand what it takes these firms to expand it's operations in other economies. Based on the model constructed by Yeaple (2009), we aimed to evaluate if the level of productivity within the firms and other exogenous variables impact the decisions of foreign direct investment (FDI). Using microdata and diferent empiric models, we concluded that there is, in fact, a tendecy in the most productives brazilian firms to be present in a larger set of countries and with higher levels of scales of operations. It is also verified that the country-charactheristics, such as Gross Domestic Product (GDP), GDP *per capita* and distance are relevant, in most cases, in explaining the decisions of FDI of brazilian firms.

Key-words: Productivity, Multinational companies, Brazil.

---

[*]Graduate Program in Applied Economics,UFPB, Brazil. E-mail:pedrohenriquecavalcantirocha@gmail.com.

[†]Professor of the Department of Economics,UFPB, Brazil E-mail:helioramos@gmail.com.

1 Introduction

The technological gains achieved since the 1990s have encouraged the economies to turn to foreign trade in the pursuit of trade gains. The globalization process has mitigated trade barriers and encouraged investment foreign trade, promoting greater freedom to trade goods and services between countries. Thus, the role of multinational firms in this phase of economic integration has assumed a strong relevance in determining the flows of foreign direct investment (FDI).

Brazilian FDI outflows in the early 1990s, according to Amal e Kegel (2012), was regarded as relatively insignificant. From the late 1990 and early 2000, due to the economic reforms carried out previously, brazilian firms moved towards the international markets through foreign direct investment. This process has accelerated since 2001, driven by a new cycle of business in the world economy. Since then, brazilian companies has been more actively involved in global value chains through its subsidiaries and has increasingly promoted foreign investment direct.

Studies carried out by Yeaple (2009) suggest that the most productive firms promote foreign direct investment in a larger set of countries and, in general, the revenues obtained from these investments are greater in relation to the lesser productive firms. In addition, countries with a specific set of characteristics, such as large GDP and GDP per capita, population size, smaller distances, bilateral or multilateral trade agreements, have a greater number of subsidiaries of multinational firms, with a relatively lower level of productivity, compared to countries with less attractive individual characteristics.

For Brainard (1993) and Yeaple (2009), the direction of the investment flows of multinational firms tends to the markets with more proximity (in terms of distance) and fewer economic restrictions to the movement of international investments. Using data for the United States, evidence was found that more productive firms have subsidiaries in a larger set of foreign economies and, in general, have higher revenues. In addition, the results showed the presence of a pecking order of FDI, i.e., more productive firms are present in countries with less attractive characteristics, while, on the other hand, less productive firms engage in FDI only in attractive localities.

Therefore, this paper seeks to test if the predictions described by Helpman, Melitz e Yeaple (2004) and, especially, by Yeaple (2009), fit for the case of brazilian multinational firms. The lack of scientific work that specifically addresses the outflows of Brazilian foreign investment, taking into account the economic theory developed about multinational firms, is the main motivation of this research. Furthermore, the paper has two central goals: to find how the subsidiaries of Brazilian multinationals are spatially distributed; and what are the determining factors in the decision of multinational firms to serve foreign markets and how level of productivity and the other variables determine this decision paradigm.

The article is divided into 5 sections, in addition to this introduction. The second section

deals with the revisions of the theoretical literature and its contributions to the development of the theory of multinational firms. The third section deals with the empirical literature developed in recent years. The fourth section is the methodology of the work, divide in obtaining the data and the empirical strategies adopted. The results section is divided into 5 sub-sections: descriptive analysis, scope, scale, country characteristics and cutoff point. The final section is devoted to the final considerations.

2   Literature Review

Dunning (1977) reinforces the role of multinationals in investment flows. In the initial starting point of the traditional theory of multinationals, multinational firms have a set of specific advantages vis-à-vis domestic firms that justify the establishment of a subsidiary in another country. Dunning denominates these advantages as OLI.

The first advantage concerns about the sub-paradigm of property. Multinationals have, in most cases, competitive advantages over domestic firms. These advantages are a result of the possession of technological assets - such as technology and differentiated products - in a monopolistic competition structure. The locational advantage consists of the natural and fixed inputs in a foreign country which, together with the technological superiority, logistics and administration of multinational firms, favors foreign investment in these localities. Finally, internationalization refers to the advantage of which multinationals benefit from the differences in the prices of factors of production between countries, in order to reduce production costs as well as to obtain economies of scale.

The eclectic approach of FDI and the role of multinationals encompasses a multitude of factors from the OLI advantages. Other studies with a more specific approach on the different modalities of FDI were carried out during the 1980s. These studies addressed two types of foreign direct investment: *Vertical FDI* and *horizontal FDI*.

Helpman (1984) assesses the decision-making processes of multinational firms regarding vertical FDI. In his article, Helpman (1984) analyzes the conditions necessary for firms to internationalize their production processes through FDI in order to identify the role of multinational companies in the determination of international investment flows. The main contribution of Helpman (1984) regarding the theory of multinational firms is the theoretical clarification of the determination and movement of international investments. Countries differ in the allocation of factors of production and multinationals have the capacity to exploit these divergences in the remuneration of production factors, diversifying its production activities in lower cost areas.

Markusen (1984) departs from Helpman's approach of FDI. Markusen (1984) proposes that the decisions of multinational firms to promote FDI are not based on the relative endowment of factors, but on the degree of technological instruction of the firm. In addition, the horizontal FDI derives from the interactions of companies at the plant level with firms activities such as RD, marketing, advertising and distribution.

Markusen (1984) develops a model in which multinational (multi-plant) companies can compete with domestic (single-plant) companies. In many respects, the model presents some key elements, such as the role of multinationals in the determination of FDI, given technical superiority, as well as the income gains of the recipient countries, due to the effects on the intersectoral allocation of economic activity.

2.1 Foreign Direct Investment Theory: the 1990 decade

Several contributions were made about the theory of multinational firms in the 1990. While the 1980s theorists considered the divergence between the remuneration of factors of production as the main driver of FDI, the approach adopted by the authors during the 1990s attached greater importance to technological capabilities and economic incentives in determining foreign direct investment. One of these authors were Brainard (1993).

Brainard (1993) analyzes the decision-making process of multinational companies facing two possible choices: on the one hand, maximizing the proximity of the consumer market of their products and, on the other hand, concentrating the productive process aiming for economies of scale.

The traditional approach of the 1980s predicted that the decisions of multinationals are based on the difference in the allocation of production factors and, therefore, the prices of these factors between the countries, which would encourage the firms to promote vertical FDI.

Not taking into account the existence of differences between prices of production factors, Brainard (1993) states that firms will be more likely to use resources to open a branch in a foreign country the higher are the costs related to trade barriers and transportation costs, and lower are the costs related to barriers to foreign investment and the size of economies of scale at the industry level at the corporate level in aggregate terms. In short, given that factor prices do not differ, firms choose to produce abroad or export by comparing the additional fixed costs of opening a subsidiary in a foreign country and the variable costs of exporting.

2.2 FDI and heterogeneous firms

The Helpman, Melitz e Yeaple (2004) model deals with the behavior of multinational firms regarding direct foreign investment decisions, in the context of inter-sectoral heterogeneity. Initially, the authors work with the conception of horizontal FDI that was highlighted in Markusen (1984) and the choice of firms between promote this type of FDI and exclusively serve to the foreign market via export. The model differentiates inter-sectoral productivity among domestic firms, exporters and firms which promote FDI. In general, the authors' initial observations are four:

1. Only the most productive firms undertake activities abroad;

2. Among firms operating in other economies, only the most productive firms engage in foreign direct investment (FDI);

3. Assuming a high intra-firm heterogeneity, the sales of the firms that operate under FDI are substantially higher than those of firms that carry out exports;

4. Firms with low productivity operate only in the domestic market of their nationality.

A firm in a country i will, in all cases, serve the domestic market through local production. Nevertheless, it may also expand its commercial activities to foreign markets, through exports or foreign direct investment.

The graph constructed by HMY demonstrates analytically the main proposition of the authors: the relation between the profit functions and the degree of productivity, and the impact of this relation in the decision of investment. At first, all profit functions are linearly increasing at the same level of demand, given the same labor productivity. Secondly, the profits of firms that opt for FDI are initially lower than the others, given the fixed operating costs. In addition, the profit function of exporting firms is less inclined due to transportation costs.

Figure 1: Profit Linear Functions
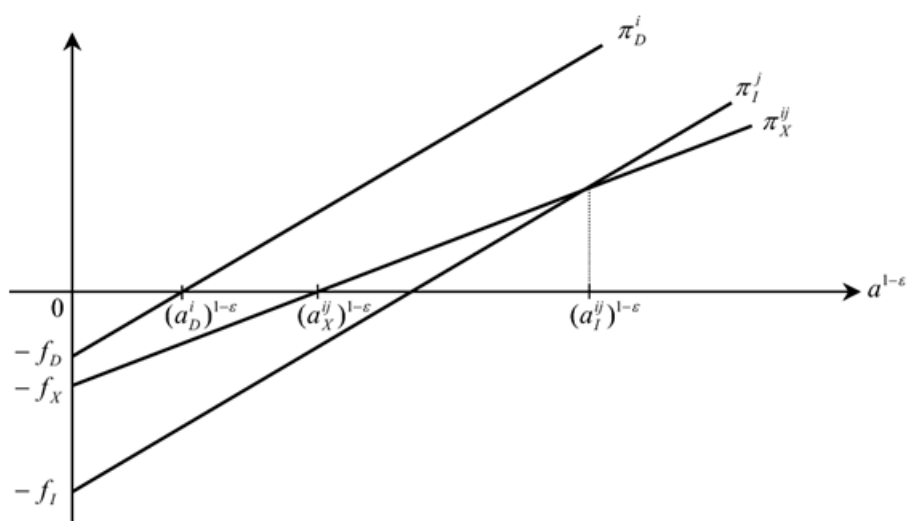
Source:Helpman, Melitz and Yeaple(2004)

Firms with a level of productivity lower than $(a_D^i)^{1-\varepsilon}$ opt for not starting productive activities once they obtain negative profits. Firms that operate in the interval between $(a_X^{ij})^{1-\varepsilon}$ and $(a_I^{ij})^{1-\varepsilon}$ exclusively serve the domestic market.

At the point of intersection between the profit functions of exporting firms and firms that prioritize FDI, the level of profit is the same for both. However, firms with productivity higher than $(a_I^{ij})^{1-\varepsilon}$ have higher profitability than others.

5

2.3 Empirical Evidence

Brainard (1993) extensively addressed the trade off faced by multinational firms on one hand, concentrating productive activities in one location, aiming at economies of scale and, in the other, the proximity of the consumer public.

Brainard (1993) analyzed activities directed abroad, both on the share of exports and the share of sales of affiliates in the with the purpose of evaluating the idiosyncrasies of recipients of exports and foreign direct investment by US firms. Then, she promoted empirical tests related to the activities of foreign companies in the United States. Similar to the initial estimates, the purpose of this phase is to quantitatively analyze the characteristics of the US economy in order to draw conclusions about the determinants of foreign firms' decisions to export and carry out FDI. The results suggested that a higher level of trade barriers and transportation costs would reduce export incentives while making it more attractive to open an affiliate in another country, as her theory indicates.

Head e Ries (2003) proposed an adaptation of the HMY model in the case of firms of the Japanese manufacturing sector with the objective of evidencing the parity between predictions of the HMY model and the model alternative. The HMY model suggests a positive correlation between the degree of dispersion of productivity among firms in a sector and the relative sales of firms that promote FDI in relation to exporting firms in foreign markets.Nevertheless, the degree of productivity determines the level of operation of a firm, such that only the most productive firms serve the foreign markets by direct investment.

However, Head e Ries (2003) have shown that there are several ways of estimating productivity and, therefore, the relationship between export decisions and direct investment is subject to the parameter used to quantify the productivity.

In addition, the empirical model of Head e Ries (2003) showed that the heterogeneity in the firm's productivity seems to interact with the heterogeneity in market size and factor prices of potential recipient countries. Finally, the relationship between firm size and the market in which it operates is similar to that predicted by the HMY model.

Yeaple (2009) took a different approach to the HMY model. In dealing with US firms, Yeaple (2009) divided the analysis in scope (number of a firm's subsidiaries in a foreign market), and scale (size in terms of sales of the affiliates of the firms). One of the main predictions resulting from Yeaple's contribution (2009) is: as the productivity of the multinational increases, the same happens with the scope and scale of operations of their affiliates, that is, more productive firms have subsidiaries in more countries, and obtain higher revenues from the sale of their products.

Futhermore, Yeaple (2009) considers the effect of individual characteristics of countries in determining the range that makes foreign direct investment relatively more profitable than export. Thus, more attractive countries receive direct investment from firms that are both productive and less productive, whereas only firms with high levels of productivity supplies

countries considered to be less attractive.

As the empirical results of Yeaple (2009) suggest, for US firms, there is a pecking order in relation to the level of productivity of firms and the scale of operations of their affiliates. The results of the tests also point out that economies with larger GDP?s, higher GDP per capita and closer to the United States tend to reduce the average productivity of the incoming affiliates of US firms.

Fariñas, Martín-Marcos e Velázquez (2018) analyze the HMY model, allied with the Yeaple model (2009), in the case of the multinational activities of the European firms. The authors seeked to demonstrate the existence of a relationship between the degree of productivity of European firms and the decisions of expansion in foreign markets by FDI or exported activities, (given by the cut-off point shown in Figure 1, presented in section 1.2) and also to analyse the order of chain of firms in relation to the scale and scope of multinational activities, given the level of productivity and the individual characteristics of the countries

Unlike Helpman, Melitz e Yeaple (2004) and Yeaple (2009), who used only the United States as a reference country in their research, Fariñas, Martín-Marcos e Velázquez (2018) proposed an analysis with several european countries, controlling the heterogeneity from the variability of the data. Another contribution of the authors was the distinction between ownership - ownership of the majority subsidiaries -, and control - direct control of affiliates - of multinational firms.

3 Empirical Strategy

3.1 Methodology

3.1.1 Scope and Scale

The empirical strategy is used to measure the scope and scale of brazillian multinational activity. Statistical methods of linear regression and linear probability models were used to promote the estimations. Most of the equation used in this empirical strategy were derived from Yeaple (2009) and Fariñas, Martín-Marcos e Velázquez (2018).

To examine the relation between scope of operations and productivity, controled by sector and country, Yeaple (2009) used:

$$DN_{hjj} = \beta_0 + \beta_1 * lnPN_{hjh} + \theta_p + \theta_s + \varepsilon_j \tag{1}$$

Onde:

DN_{hjj} : Binary variable. If the multinational firm from country h is present in country j, it equals 1. Else, it equals 0;

$lnPN_{hjh}$: the natural log of domestic firms revenue. It is a proxy for productivity; θ_p : country j fixed effects ;

θ_s : sectorial fixed effects.

ε_j is the regression error.

The estimation of the scale of operations by the multinational firms is given by the TOBIT model. The equation that describes the model is:

$$SN_{hjj} = \beta_0 + \beta_1 * PN_{hjj} + \theta_p + \theta_s + \varepsilon_j \tag{2}$$

Onde:

SN_{hjj} : affialite sales in a country j by firm from country h which have an affiliate in country j;

PN_{hjj} : domestic firm revenues;

θ_p : the country fixed effects for country j ;

θ_s : sectorial fixed effects for country j.

ε_j is the regression error.

For McDonald e Moffitt (1980), the use of the TOBIT model is generally adequate to model data with the presence of corner solutions, that is, a frequency distribution with right asymmetry and a large number of observations with null value. In this context, the traditional method of Least Squares becomes inadequate given the regression bias to negative values.

3.1.2 Country characteristics

Next, it is estimated if the individual characteristics of the countries are decisive factors for the decision making of the multinational firm, when choosing between entering foreign markets via export or FDI. In this context, countries with individual characteristics considered attractive to multinational companies would reduce the gap where export profitability is higher than FDI profitability, encouraging the latter. Thus, the empirical strategy is based on the use of the Ordinary Least Squares model for three different equations.

The first equation consists in the estimation of the number of branches, as a dependent variable, by the set of variables related to the characteristics of the countries. In this case, the aim is to evaluate if the characteristics of the countries impact the FDI decisions of firms in expanding their multinational activities through new affiliates.

$$N_i = \beta_0 + \beta_1 * GDP + \beta_2 * GDPpc + \beta_3 * DIST + \beta4 * RTA + \varepsilon_i \tag{3}$$

Onde:

N_i is the number of affiliates in country i;

ε_i is the regression error.

The second equation associates the revenues of the subsidiaries with the country char-

acteristics, as follows:

$$SN_i = \beta_0 + \beta_1 * GDP + \beta_2 * GDPpc + \beta_3 * DIST + \beta_4 * RTA + \varepsilon_i \qquad (4)$$

Onde:

SNi is the affiliate revenue in country *i*;

ε_i is the regression error.

Finally, the third equation deals with the average productivity of multinationals with country characteristics, that is, the logarithm of domestic revenue of firms that have a subsidiary in the same set of country characteristics, divided by the number of subsidiaries that they have in a country *i*. The equation is given by:

$$(lnPN_i^j/N_i) = \beta_0 + \beta_1 * GDP + \beta_2 * GDPpc + \beta_3 * DIST + \beta_4 * RTA + \varepsilon_i \qquad (5)$$

Onde:

PN_i^j is the average productivity of firm *j* in country *i*. ε_i is the regression error.

3.1.3 Cut-off point

According to Yeaple (2009), the cut-off point of multinational activity (PN) is the point in which FDI profitability exceeds the profitability of other foreign trade activities [1]. It represents the lowest level of productivity in which a multinational firm promotes FDI in a foreign economy. The estimation seeks to verify if the characteristics of the countries reduce or enlarge this cut-off point. Thus, the equation defined by:

$$lnPN_i = \beta_0 + \beta_1 * GDP + \beta_2 * GDPpc + \beta_3 * DIST + \beta_4 * RTA + \varepsilon_i \qquad (6)$$

Onde:

lnPN_i is the logarithm of domestic revenue of firm *i*;

ε_i is the regression error.

3.2 Data

The present work is based on the collection of data from a sample of 112 Brazilian multinationals with the purpose of analyzing and, above all, evidencing the decisions of firms to practice foreign direct investment, given their sectoral characteristics, their productivity levels

---

[1]vide graph 1.0

and, and finally, the relations with the macroeconomic variables of the countries whose firms have commercial activity.

In this way, it is configured in a quantitative research. It should be emphasized that the analysis proposed by this work only covers the year 2016, due to the restriction of information regarding previous years. Finally, the data obtained are in cross-section format.

Table 1 shows the variables used, the acronyms adopted for these variables, as well as the measurement format and the location where they were obtained.

Table 1: Data source

Variables	Digits	Measure	Source
GDP	GDP	US$	World Bank
GDP per capita	GDPpc	US$	World Bank
Population	POP	1000	World Bank
Distance	DIST	Km	NBRE*
Domestic Revenue of the	PN	US$	Balanços Patrimoniais**
Affiliates Revenue	SN	US$	ITC/ Investment Map***
Number of Affiliates	N_i	Unit	ITC/ Investment Map
Commercial Deals	RTA	1 ou 0	ITC/ Investment Map

Source: Own elaboration (2018)

Note: *National Bureau of Economic Research; **Brazillian website; ***International Trade Centre

4 Results

4.1 Descriptive Analysis

The organizational structure of Brazilian multinational firms and their subsidiaries, according to the various theoretical arguments made in the course of this research, should follow a pecking order, of which, more productive firms, that is, with a larger number of domestic sales, serve a greater number of external markets and, in addition, have a higher average value of revenue in these markets. On the other hand, firms with low productivity enter less countries and the average value of their revenues is lower.

Graph 2 shows the distribution of Brazilian branches in foreign economies. Of the 61 multinational firms, 74% have only one branch in an overseas market, while only 2% have more than 6 affiliates. We can see here a high concentration of firms with only one subsidiary, indicating that, on average, these firms have lower productivity than the others and, consequently, have lower revenues.

Figure 2: Distribution of the number of brazillian affiliates
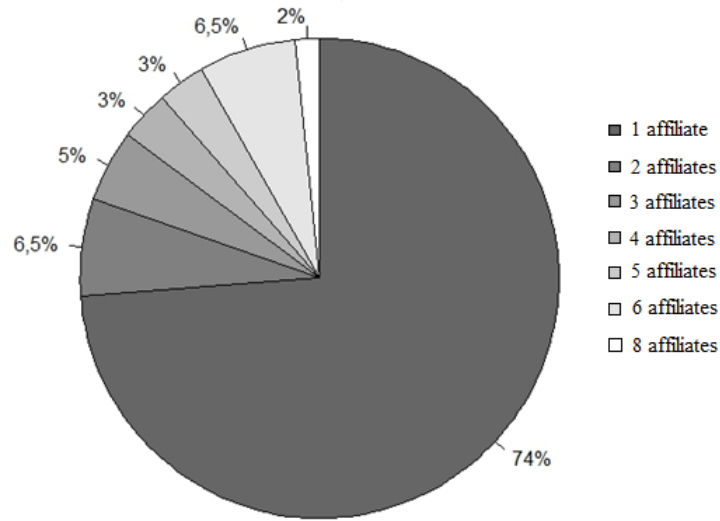
Source:Own elaboration

Graph 3 shows the composition of the Brazilian affiliates in the countries analyzed. From the 61 Brazilian firms, 31 are located in Argentina and 15 are located in Mexico. Thus, 75% of the Brazilian multinational companies are concentrated in these two countries. This implies that these a set of characteristics - economic, social and political - that make them more favorable to the entry of the Brazilian subsidiaries

Figure 3: Geographic Distribution of brazilian affiliates
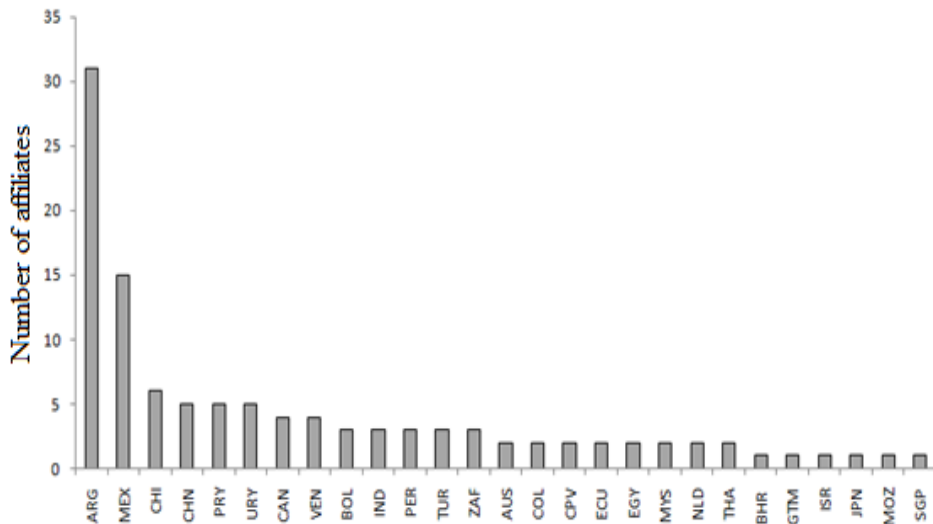
Source:Own elaboration

It should be noted that given the individual characteristics of the countries - such as distance, GDP of the recipient country, GDP per capita of the receiving country, size of population

and level of country productivity - those with higher productivity levels are more likely of having fewer Brazilian branches in their economies, while countries with low levels of productivity are more likely to have a greater presence of these.

Graph 4 shows the number of Brazilian branches by sector. The Chemical and Food sectors are distinguished from the others, presenting, in that order, 16 branches each. Next, we highlight the Metals sector, which has 15 branches. In total, three sectors jointly represent 41% of the multinational activity of Brazilian firms.

In addition, figure 5 shows the number of countries in which the Brazilian branches of a certain sector are inserted. It is noted that the food industry branches are the most dispersed internationally, distributing in 11 countries, while the branches of the lumber sector are concentrated in only 2 different countries.
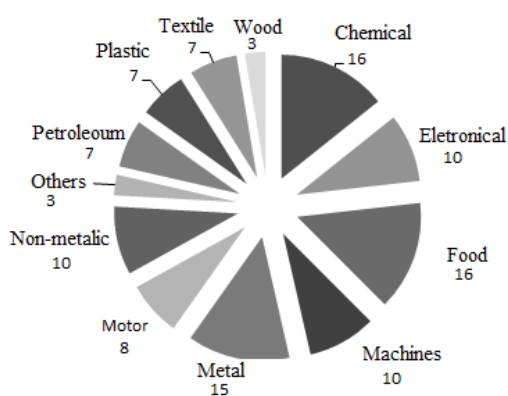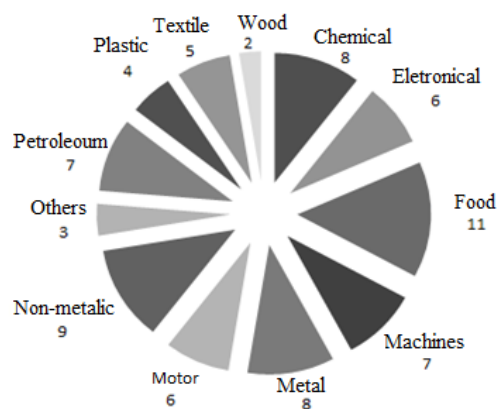

Figure 4: Number of affiliates by sector

Figure 5: Number of countries by affiliate/sector

Source:Own elaboration

The sectorial distribution of the Brazilian subsidiaries is a fundamental aspect of the analysis of inter-sectoral heterogeneity, especially with respect to the level of productivity of a given industry and the extension of the multinational activity of the Brazilian subsidiaries, within a specific sector, in foreign economies.

Graph 6 lists the aggregate domestic revenues of Brazilian firms by country group (5 countries per group), ranked in ascending order by number of subsidiaries present. Group 1, for example, has the smallest number of subsidiaries in a given country, while group 5 presents a group of countries with a greater presence of subsidiaries.

The behavior of the revenue logarithm is in a chaining order with a moderate growth trend. However, this order is only partially obeyed. In this case, the assumption that the most productive firms - higher levels of domestic revenue - invest in a larger set of countries, regardless of the individual characteristics of these firms fairly adjust for the brazilian case.

Figure 6: Logarithm of the aggregate domestic revenue by country group
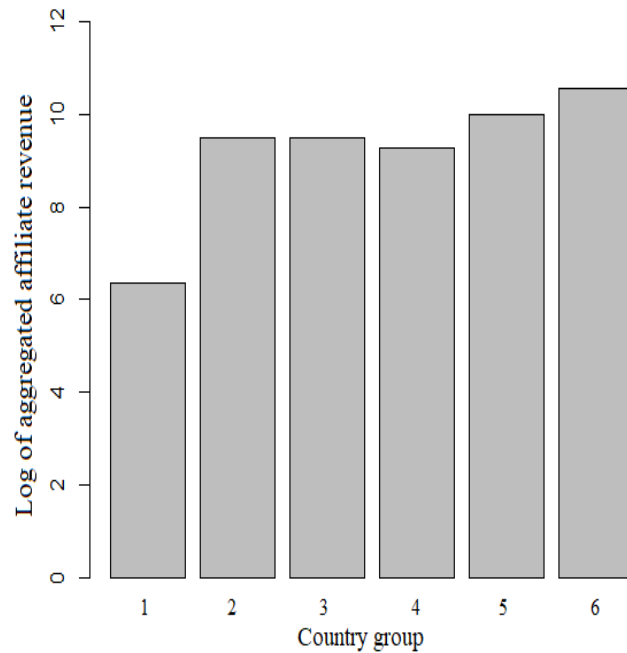
Source:Own elaboration.

Graph 1, presented in section 2.2, is based on the assumption that firms differ in productivity in such a way that more productive firms opt for foreign direct investment from a certain cut-off point, as they obtain larger profits through sales revenues of its subsidiaries, while firms with lower levels of productivity access foreign markets via export.

Thus, countries with individual characteristics that reduce the level of productivity required to become direct investment at least as profitable as exports will have a greater presence of multinationals. This hypothesis about the effect of the country characteristics on the cut-off point of the level of profitability and, consequently, on the investment decision of the multinational firms will be tested empirically.

Next, econometric tests will be carried out to estimate the relationship between the degree of productivity of Brazilian firms and the scope and scale of the firms operations in foreign markets.

4.2 Scope

Table 1 shows the results of the estimation of the scope of multinational activity of Brazilian firms in relation to productivity. In the first column, the linear probability model was used to estimate the scope in relation to the level of productivity of the firm, controlling the fixed effects country and sector.

Thus, the firm's participation in a given market is determined by its productivity, whose dependent variable is binary: 1 if it participates and 0 otherwise. In the second column, the PROBIT model is applied in order to verify the robustness of the model treated in column 1.

Table 2: Scope of brazillian multinational activity

	Scope: OLS (1)	Scope: OLS (2)
Productivity	0,0075** (0,0036)	0,05418** (0,0247)
Country fixed-effect	Yes	Yes
	Yes	Yes
N Industry fixed-effect	1116	1116
R^2	0,014	0,029

Source: Own elaboration (2018)

Note: The values in parentheses are the regression errors. The values of the columns (1) e (2) are in logarithm. (**) represent statistical significance in 10% e 5% levels, respectivatly.

The results in column 1 are statistically significant and positive. They suggest that the greater the domestic proceeds of Brazilian firms, proxy for productivity, the more likely these companies to open a subsidiary in a foreign market.

Column 2 presents the result of the estimation of the same equation proposed for column 1, but in this case, using the PROBIT model. In this configuration, the result suggests that, controlled country and sector fixed effects, there is statistical significance and positive relation between domestic revenue and affiliated sales, corroborating with the results found in the column 1.

4.3 Scale

Table 2 shows the scale of the multinational activity of Brazilian firms. Columns 1 and 2 include the results of the estimations of equation 2 by the OLS model. In column 1, the sector fixed effects were inserted in order to test the specification bias that this variable could cause in the regression. Column 2, on the other hand, does not include sector fixed effects. This procedure has the purpose of evidencing the robustness of the independent variable, similar to the PROBIT model in the estimation of the scope of the Brazilian firms. Column 3 presents the result of the estimation of the scale of the Brazilian firms on the productivity proxy, using the TOBIT model.

Table 3: Scale of brazillian multinational activity

	Scale: OLS (1)	Scale: OLS (2)	Scale: TOBIT (3)
Produtividade	0,2549*	0,2019*	13,7807**
	(0.1331)	(0,0110)	(5,5198)
Country fixed-effect	Yes	Yes	Yes
Industry fixed-effect	Yes	No	No
N	112	112	90
R^2	0,627	0,037	

Source: Own elaboration (2018)
Note: The values in parentheses are the regression errors. The values of
the columns (1) e (2) are in logarithm. Values in column 3 are in units
(*), (**) represent statistical significance in the 10% e 5% levels, respectivatly.

The results of column 3 indicate that the estimated values are statistically significant and positive. In the specification of the model, there is a positive relationship between domestic revenue and revenues of the subsidiaries of Brazilian multinational firms. Thus, the greater the productivity of multinational firms - resulting in higher domestic revenues - the higher the revenues of these firms' branches from commercial activities in a given economy.

4.4   Country Characteristics

Table 3 presents the results referring to the estimated values parameters of the regressors estimates that associate the characteristics of the countries in relation to the variables of the Brazilian multinational firms.

Given the restriction of the number of observations of the country characteristics (limited to the number of countries analyzed), it was decided to disaggregate the data in the country-industry sample format. This approach allows, on the one hand, to indirectly control intra-sectoral heterogeneity and, on the other hand, to extend the sample so that it is possible to produce a statistically significant linear regression model.

It should be noted that industrial dummy variables were included in the models presented to control the industrial fixed-effect, but these were suppressed in Table 3, to facilitate the visualization of the results.

Table 4: Multinational activity disaggregated by component

	Number (1)	Affiliate sales (2)	Average productivity (3)
GDP	0,1065***	1,8395*	1,4309***
	(0,0407)	(1,0631)	(0,4066)
GDPpc	0,0807*	-0,1220	-1,7463***
	(0,0516)	(1,4260)	(0,6775)
DIST	-0,3535***	-5,1624**	-2,5276**
	(0,1111)	(2,5524)	(1,075)
RTA	0,0677	-12,070***	-1,0920
	(1,439)	(2,6013)	(1,2004)
Industry fixed-effect	Yes	Yes	Yes
N	76	76	76
R^2	0,4158	0,2822	0,3709

Source: Own elaboration (2018)

Note: The values in parentheses are the regression errors. All variables, except RTA, are in logarithm. (*),(**) e (***) represent statistical significance in 10%, 5% e 1% levels, respectivatly.

Column 1 shows the results of the estimation of the number of subsidiaries by country-industry in relation to the characteristic variables of the countries. The estimated coefficients of the disaggregated sample for column 1 have the predicted signal. In this case, countries with larger markets (higher GDP), richer in terms of per capita (higher GDP per capita) and less distant (less DIST) have a higher number of Brazilian subsidiaries. All variables are statistically significant at the significance level of 10%, but only GDP and DIST are statistically significant at the significance level of 5%. The binary variable representing the existence of commercial agreements (RTA) was statistically insignificant.

In the specification of the linear regression model for affiliated sales, shown in column 2, only the per capita GDP coefficient is non-significant. Estimates for GDP and DIST have the predicted signal and are statistically significant, indicating that a 1% increase in GDP results in a 1.71% increase in revenue from affiliated sales of Brazilian subsidiaries, while a 1% increase in distance (DIST) reduces the revenues of subsidiaries by 4.52%. Nevertheless, the RTA coefficient, although statistically significant, did not obtain the predicted signal.

Column 3 presents the coefficients of the regression of the average productivity in relation to the country characteristics. In this context, the average productivity is the ratio between the domestic revenue of Brazilian firms - proxy for productivity - and the number of subsidies, in the sample disaggregated by country-industry.

All variables except RTA are statistically significant. However, only the sign of GDP per capita is similar to that predicted, that is, contrary to the sign of the coefficient of the variables of column 1. The results indicate that the average productivity of firms is increasing for GDP and decreasing for GDPpc and DIST. Thus, countries with higher GDP, lower GDP per capita (China, for example) and closer to Brazil receive brazilian subsidiaries with increasing

productivity, in average.

4.5 Cut-Off Point

The purpose of this section is to test whether country characteristics determine the cut-off level of multinational activity. The cut-off point, in the context of firms that participate in the international market, is the point at which FDI profitability outperforms export profitability. Thus, only the most productive firms would be able to go beyond this point and engage in foreign direct investment. However, Yeaple (2009) states that the characteristics of the countries would induce a reduction or increase of the cut-off point, such that more productive firms would perform FDI independently of the country characteristics, while less productive firms would only promote FDI in the most attractive locations.

The results of the estimation of the cut-off variable with the country characteristics are shown in Table 4. According to Yeaple (2009), the cut-off variable, representative of the cut-off point, is the value minimum of the logarithm of the domestic revenues of a Brazilian firm that has a subsidiary in a given country-industry. In this way, it represents the lowest level of productivity required to promote FDI in a sector of a foreign economy.

Table 5: Cut-off productivity level

	Cut-off	Standard error
GDP	1,076**	0,4458
GDPpc	-1,887**	0,6454
DIST	-1,856**	1,0256
RTA	-0,7471	1,0849
Industry fixed-effect	Yes	-
N	76	-
R^2	0,1512	-

Source: Own elaboration (2018)
Note: All variabels are in logarithm.
(*),(**) e (***) represent statistical significance
in the 10%, 5% e 1% levels , respectivaly.

The results obtained for the coefficients are statistically significant at the significance level of 10 %, except the RTA. The signs of the coefficients are similar to those in column 3 of table 3. Following the results, the productivity cutoff point is higher in countries with larger markets (GDP), with lower per capita income (GDPPC) and greater distance from Brazil (DIST).

5 Conclusion

This paper aimed to demonstrate the relationship between the heterogeneity of productivity levels and the decisions of multinational firms to participate in the international market through FDI with a greater or lesser degree of intensity. In a broader context, the aim was to evaluate if the characteristics of the countries affect the minimum level of productivity to perform FDI in a certain sector of a foreign economy, with positive profits and higher than the export alternative. For this, the models of Helpman, Melitz e Yeaple (2004) and Yeaple (2009) were used as theoretical and empirical basis for the case of Brazilian firms.

It was analyzed whether the Brazilian multinationals met the pecking-order hypothesis, from which more productive firms engage in higher FDI levels in locations considered less attractive to foreign investment than the others, less productive. In this sense, it was evidenced that more productive companies participate more actively, through a greater presence of subsidiaries, for a certain set of countries. However, it should be noted that the strong presence of zeros in the data regarding the domestic revenues of the firms implies that the productiviy pecking-order found is not a sufficient condition to evaluate the foreign investment flows of Brazilian firms. That is, the economic significance of zero-value revenues may not have been captured by group aggregation, thus requiring an additional method to assess the robustness of results.

To verify the effect of productivity on the scope and scale of the multinational activity of Brazilian firms, the PROBIT and TOBIT models were used on the number of subsidiaries and affiliated sales of the Brazilian multinationals, respectively. The results presented suggested a positive relationship between productivity and number of subsidiaries, and productivity and affiliated sales, thus providing a favorable argument for the pecking-order of multinational companies.

The results found in this study met, for the most part, the objectives proposed initially. However, it is worth mentioning that there is an informational problem about data on Brazilian FDI. As Calderón (2014) pointed out, it became difficult to identify the final sectors and recipient countries of FDI of Brazilian firms.

New research carried out in this field should take into account the fact that more robust techniques for the treatment of the strong presence of zeros and the concentration of the data are employed in order to generate even more precise results.

Appendix

The country groups in Graph 3 are:

Table 6: Group of countries

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Bahrein	Austrália	Bolívia	South Africa	Chile	Argentina
Guatemala	Colombia	Egypt	Canada	China	México
Israel	Cape Verde	Netherlands	India	Paraguay	
Japan	Ecuador	Malaysa	Peru	Uruguay	
Mozambique	Singapore	Thailand	Turkey	Venezuela	

Source: Own elaboration (2018)

The descriptive statistics of the groups are presented in table 7:

Table 7: Descriptive statistics of groups of countries

	Number of affiliates firms		Level (Aggregate revenue)	
	Mean	Standard deviation	Mean	Standard deviation
Group 1	1	0	1,85	2,805
Group 2	1,8	0,45	6,11	3,602
Group 3	2,2	0,45	6,78	2,279
Group 4	3,2	0,45	7,08	4,358
Group 5	5	0,71	8,09	0,908
Group 6	23	11,31	9,88	0,040

Source: Own elaboration (2018)

The frequency distributions of domestic revenues and affiliated sales of Brazilian multinational firms are shown in Figures 7 and 8, respectively.
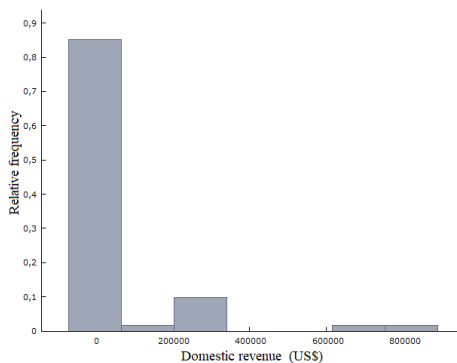
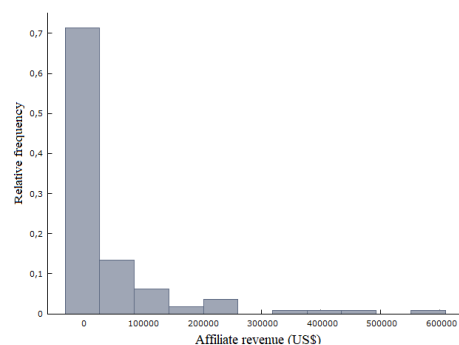

Figure 7: The frequency distributions to domestic revenue

Figure 8: The frequency distributions of affiliate firms sales

References

AMAL, M.; KEGEL, P. L. Determinants of brazilian outward foreign direct investment: a home country perspective. In: *Impacts of emerging economies and firms on international business*. [S.l.]: Springer, 2012. p. 168–188.

BRAINARD, S. L. *An empirical assessment of the proximity-concentration tradeoff between multinational sales and trade*. [S.l.], 1993.

CALDERÓN, A. A. B. Outward fdi in brazil: A matter of economic growth and institutional configuration. In: *FLACSO-ISA Joint International Conference, Buenos Aires, Argentina*. [S.l.: s.n.], 2014.

DUNNING, J. H. Trade, location of economic activity and the mne: A search for an eclectic approach. In: *The international allocation of economic activity*. [S.l.]: Springer, 1977. p. 395–418.

FARIÑAS, J. C.; MARTÍN-MARCOS, A.; VELÁZQUEZ, F. J. Multinational activity of european firms and heterogeneity. *The World Economy*, Wiley Online Library, v. 41, n. 5, p. 1166–1195, 2018.

HEAD, K.; RIES, J. Heterogeneity and the fdi versus export decision of japanese manufacturers. *Journal of the Japanese and international economies*, Elsevier, v. 17, n. 4, p. 448–467, 2003.

HELPMAN, E. A simple theory of international trade with multinational corporations. *Journal of political economy*, The University of Chicago Press, v. 92, n. 3, p. 451–471, 1984.

HELPMAN, E.; MELITZ, M. J.; YEAPLE, S. R. Export versus fdi with heterogeneous firms. *American economic review*, v. 94, n. 1, p. 300–316, 2004.

MARKUSEN, J. R. Multinationals, multi-plant economies, and the gains from trade. *Journal of international economics*, Elsevier, v. 16, n. 3-4, p. 205–226, 1984.

MCDONALD, J. F.; MOFFITT, R. A. The uses of tobit analysis. *The review of economics and statistics*, JSTOR, p. 318–321, 1980.

YEAPLE, S. R. Firm heterogeneity and the structure of us multinational activity. *Journal of International Economics*, Elsevier, v. 78, n. 2, p. 206–215, 2009.