

R&D Investments in an Emerging Economy – an analysis on driving forces versus type of R&D in Brazil

Abstract

This paper aims to present an analysis of the relationship between the driving forces that directed and maintained R&D activities in subsidiaries of multinationals enterprises (MNE) in Brazil and their complexity. For this, we used two complementary lines of investigation in a multiple case study with 54 subsidiaries of foreign MNE. First, a cross-sectional analysis is made between the complexity of R&D and the driving forces (market or technological) to choose those subsidiaries in which to allocate technological innovation functions. In the second line, a cross-sectional analysis is done between the driving forces and the type of product developed by the subsidiary, especially in relation to its geographic scope (local or global product). The results showed that the valorization of technology-oriented factors is inversely proportional to the complexity of R&D activities conducted by the subsidiary in the country. We also observed that subsidiaries which are product or technology owner in the corporation valued less technology-oriented factors and more market-oriented factors than the ones whose R&D is for local product development. The conclusion is that market is what attracted and maintained R&D at Brazilian subsidiaries with more competence created. They do not consider the technological potential installed at the local environment.

1. Introduction

Multinationals companies (MNE) are organized in differentiated subsidiaries networks (Frost et al., 2002; Birkinshaw et al., 1998; Bartlett & Ghoshal, 1989; Nohria & Ghoshal, 1997). These subsidiaries play specific roles in the corporations (Bartlett & Ghoshal, 1986; Gupta & Govindarajan, 1994), which contribute towards defining the type of positioning (strategic or not) the subsidiary will have within the global corporation, that are not stable and can be altered over time (Bouquet & Birkinshaw, 2008).

These alterations occur because of the variations in two considered factors in the typologies of subsidiary roles, such as Bartlett and Ghoshal (1986) and Ferdows (1997) point: the competences (firm specific advantage) and the strategic relevance of the subsidiaries for the MNE; the country in which the subsidiary is installed (country specific advantage). According to these typologies, subsidiaries that have important roles in the corporate network are located in an environment/country of strategic importance. The specificity and complexity of the competences would indicate the degree of positioning it would have in role classification. More technological competences a subsidiary has, more important its role for technological innovation in the corporation.

Therefore, the factors that would direct and maintain corporate investments for technology related activities in the subsidiaries, such as Research and Development (R&D), would be tied to technology, for both environment (ex. existence of skilled labor, centers of knowledge, etc.) and competences (ex. partnerships with local research institutions, among others).

The objective of this paper is to analyze the relationship between the factors (driving forces) that directed, maintained R&D activities and improve the competences' building - and competences' complexity – in subsidiaries of foreign MNEs in Brazil. This is done by

two complementary lines of investigation. First, a cross-sectional analysis is made between the type and complexity of R&D and the prioritized driving forces – market or technological – to choose those subsidiaries in which to allocate technological innovation functions. In the second line, this cross-sectional analysis is done between the driving forces and the type of product developed by the subsidiary, especially in relation to its geographic scope (local or global product).

The main differential of this paper is that it is not only an analysis of factors leading foreign MNE to invest in R&D in Brazil, as previously treated by other works (Galina et al., 2005; Consoni & Quadros, 2006; Boehe, 2007), but it also shows a deep analysis of these factors depending on the activity of R&D carried out locally. This is done from the analysis of Brazilian subsidiaries, which also differentiates this study, since analyzing the transnational corporation as a whole from the perspective of headquarters has been the basis of literature on management of R&D internationalization (von Zedtwitz & Gassmann, 2002; Bartlett & Ghoshal, 1986).

It is also to consider that Brazil, a emerging country, is our focal point, while most of literature on R&D offshoring “focused on the scenarios of developed economies, thus meaning the issue still needs to be studied from the perspective of developing countries” (Wu, 2007: 298). Having Brazil as focal point allows us to evaluate what indeed supports and sustains R&D activities by foreign MNEs in developing countries.

Besides to provide a better understanding on the attraction factors versus kind of R&D carried out - a well-researched area (driving forces for international R&D) - our contribution for existing literature is to shed light on attracting and sustaining R&D activities in developing countries, a less explored issue.

Thus, in order to contribute to existing literature, this paper analyzes foreign MNEs in Brazil in order to understand if there is relationship between their local technology competences and their valorization of technology-oriented factors to maintain R&D investments. The research was based on in-depth interviews conducted between 2007 and 2008 with 54 subsidiaries of foreign multinational installed in Brazil. For this, the following questions about International R&D are investigated:

- 1) What is the relationship between the type of R&D carried out in Brazil and the reasons that led MNEs to locate them there?
- 2) What is the relationship between the factors that led MNEs to maintain R&D activities in Brazil and the insertion of Brazilian subsidiaries in global product development networks from their respective corporations?

This paper is structured in four sections, besides this introduction. In the following section, we present the literature discussion about several classifications focused on determining the role of MNE subsidiaries, some of them very similar to the analyses elaborated decades ago by Bartlett & Ghoshal (1986) and Dunning (1988). This discussion clarifies the debate about the relationship between factors of attraction and the type of activity carried out is very centered on developed countries, which reinforces the importance of an investigation from the perspective of developing countries, in this case, Brazil.

In the third section we introduce the methodology. Section 4 focuses on the determining factors in Brazil for R&D location and the relationship between such factors and the type of R&D companies carry out in the country. Patent and bibliometric data are used to reinforce these analyses. The conclusion section highlights the main finding: the valorization of technology-oriented factors is inversely proportional to the complexity of R&D activities carried out by the subsidiary in the country.

2. Literature Review

It is a consensus in international business literature that MNEs structure themselves in differentiated networks (Frost et al., 2002; Birkinshaw et al., 1998; Bartlett & Ghoshal, 1989; Nohria & Ghoshal, 1997). For such, the subsidiaries have strategic roles and responsibilities that enable differentiated contributions from national units in integrated global operations.

There are several existing classifications for the roles of transnational company subsidiaries (Bartlett & Ghoshal, 1986; Birkinshaw, 1996; Ferdows, 1997; Gupta & Govindarajan, 1991; Pearce & Papanastassiou, 1996; Roth & Morrison, 1992). The seminal work by Bartlett & Ghoshal (1986) presents a classification made by intersecting strategic and organizational considerations, generating four roles. The main strategic consideration is the importance of national environments for global strategy and the fundamental organizational consideration is the national subsidiary's competence – in technology, production, marketing or any other area.

Like Bartlett & Ghoshal (1986) typology, other classifications also establish roles for subsidiaries by crossing the same two related factors: firm specific advantages (competences) and country specific advantage (environment). In other words, these taxonomies are mainly based on the principles of the eclectic paradigm or OLI (Dunning, 1988), more specifically on “O” (Ownership Advantages) and “L” (Location Advantages)¹.

In the 1990s, Kuemmerle (1999) affirms that the majority of investments in manufacturing and marketing are determined by this category of FDI, which he calls home-base-exploiting FDI (HBE). Kuemmerle (1997) argues that in this type of FDI, a company seeks to invest in other countries to explore their own competences in the host country. Kuemmerle (1997) also introduces another factor that motivates companies to invest abroad, called home-base-augmenting FDI (HBA). This factor explains the FDI of MNEs that aim at expanding their capacity and knowledge by investing in countries/regions where it is possible to learn with local firms and institutions. In other words, some subsidiaries receive investments in R&D with the clear intent of being near environments with intense scientific and technological development. These are the advantages of the host country considered determining factors for HBA investment.

There are several other studies that address the reasons why R&D resources are directed to other countries other than the company headquarters. They are diverse, but in general, literature presents two major aspects to align them (Chiesa, 1995; Florida, 1997; von Zedtwitz & Gassmann, 2002): Market-oriented factors and Technology-oriented factors. The market-oriented factors mainly concern adapting products to foreign markets and to technical support for local manufacturing units.

Florida's (1997) work indicates a relationship between the types of factors prioritized by affiliates and the density of more or less innovative activities conducted by them, disregarding the sectorial specificities, which end up differentiating the sources of innovation for each industry. Based on the results of an analysis of a survey with 186 foreign multinational laboratories installed in the USA, from 13 different sectors, mainly engaged in research, development and design activities, Florida (1997) establishes a

¹It is worth mentioning that Rugman et al. (2011) question the simplification of typologies that address only these two dimensions and their adaptation to current MNEs, however they do not disregard their importance, but rather just orient the need to insert other dimensions.

dialogue with literature (Vernon, 1966, Abernathy & Utterback, 1978, Utterback, 1989) that affirms that technological factors are the main motivation behind FDI in R&D.

In dealing with emerging countries, no studies were found that make this relationship between factors prioritized by the MNEs in allocating R&D and the type of activity conducted in the chosen country. However, it is possible to indicate some signs, from diverse studies, on the type of R&D conducted in some of these countries, especially those that lead as the main receivers of this sort of investment: China and India.

In the case of India, considering the general context of industry, process development activities predominate, followed by product development and applied research; basic research is conducted in low proportion if compared to other activities. Investments in R&D began to arrive in India between the end of the 1980s and beginning of the 1990s, exclusively motivated by market factors, that is, support for the productive activity or adaptation of technologies to domestic markets. In the 2000s, an expansion of R&D activities can be observed from foreign companies in the country, aimed at making use of the country's comparative advantages, especially local labor costs, in order to supply the demands of technological development for the global market (Mitra, 2006). Growth occurred mainly in the software product and service sectors, and more recently in hardware for electronics and products and services for telecommunication.

In the case of China, the allocation of R&D activities to the country by foreign companies is a relatively recent phenomenon, dating from the mid-1990s, when companies like Microsoft, Nortel, Ericsson and Nokia installed laboratories in the country. Since 2000, the number of MNE R&D centers in China has grown drastically (Serger, 2006). Like India, in the beginning of this process, activities were geared exclusively to the development and adaptation of products for the local market. More recently, a sophistication of technological activities can be observed in foreign companies in the country. The nature and scope of such activities go beyond Chinese market needs (Serger, 2006). As an example, Nokia developed a significant part of the software for 3G cell phones at its Chinese center, after transferring technologies and personnel from its center in Finland.

These statements concerning India and China in a way go against the results of the NAS (2006) survey, since the companies affirm that part of the activities conducted there is to meet the global market. Thus, it becomes evident that the relationship between the factors of attraction and the type of activity conducted, especially in emerging countries, is still a field of study that can be expanded.

Thus, in this paper, we focus on Brazil, another strategic emerging country from the perspective of MNE R&D. Four propositions were established for the study to cross the factors that took and maintain R&D activities in that country and the characteristic of local subsidiaries and their respective subsidiaries. This was done based on the literature from types of subsidiaries and their aspects related to two of the eclectic paradigm pillars (firm specific advantage and country specific advantage):

Proposition 1: valorization of technology-oriented factors is directly proportional to the complexity of R&D activities conducted by the subsidiary in the country.

Proposition 2: valorization of market-oriented factors is inversely proportional to the complexity of R&D activities conducted by the subsidiary in the country.

Proposition 3: there is a directly proportional relationship between subsidiaries that develop products for the local market and market-oriented factors.

Proposition 4: there is a directly proportional relationship between subsidiaries that develop global products and technology-oriented factors.

3. Research Method

This is an exploratory research based on extensive in-depth face-to-face interviews conducted in 2007 and 2008 with R&D directors and/or CEOs of 54 MNE subsidiaries located in Brazil with 185 operational unities in the same country.

Three criteria were used to assure a representative sample of the MNEs' universe located in Brazil: (1) the largest R&D investors (MNEs) according to the "R&D Scoreboard (2005)" which also invest in R&D in Brazil; 2) MNEs that invest over 100 million pounds in R&D according to "R&D Scoreboard (2005)" and that are located in Brazil; and (3) as suggested by specialists considering: long-established MNEs in Brazil; MNEs which benefit from government R&D incentives; MNEs having acquired Brazilian companies with R&D activities in Brazil; among others.

The sample includes MNEs from 11 countries and encompasses 13 different industries²; 51% of the companies are from USA, 41% from Europe and 8% from Asia. The operation time of the subsidiaries is diversified: 63% have been in Brazil for over 40 years and present a fairly consolidated productive structure in the country; the remaining set up operations in Brazil after the 1970's, and only one company arrived after 2000.

The interviews followed a 26-question script. It aimed at investigating the main aspects indicated by a significant part of the studies on internationalization of R&D activities. Almost all script questions could be answered freely. Exception concerns the question related to the factors headquarters considers determining for investing in Brazil. The companies were presented to a table with a list of 23 factors according to Table 1. They had to score the four drivers that most influenced investment decisions in R&D in Brazil. These drivers factors was allocated in analytical categories (technological, market-oriented, economic and location).

We also proposed a typology of R&D carried out by MNE subsidiaries in Brazil based on definitions by Frascati Manual (OECD, 2002). It consisted of an aggregate analysis about the technological efforts of these subsidiaries in the country, in attempting to rank the companies by type of activity of Research ("R") and Development ("D") conducted in Brazil. It was based mainly on a question that inquired the "characteristics of R&D activities conducted by subsidiaries in Brazil", we used primary and secondary data.

Table 1 – Classification of the FDI attraction factors in R&D

TECHNOLOGICAL	MARKET-ORIENTED	ECONOMIC	LOCATION
Level of excellence in the academic sector and research	Market Size	Profitability of the local unit	Legislation

² Vehicles and Parts; Information and Communication Technology (ICT) and Semiconductors; Chemistry; Pharmaceutical; Food; Machines and Equipment; Metallurgy; Electrical Energy; Cosmetic; Electro-electronic; Electronics and Telecommunications; Paper and Cellulose; and Other Sectors including companies not classified above. Due to a formal confidentiality agreement with the interviewed companies we cannot mention their names.

Availability of personnel trained in quality Technical skill, proactivity, creative capacity and flexibility	Business need (proximity to market)	Cost of doing R&D in Brazil	Country's social-economic and political stability
Availability of personnel trained in quantity	Business interest	Cost of skilled labor	Legal Security of the Property
Ease of partnerships with Research Centers and Universities;	Market growth		Basic infrastructure
Favorable Incentives and Public Policies	Presence of factory unit in Brazil (investment in consolidated infrastructure)		Location (local or region)
Ease of partnerships with Research Centers and Universities;			Time zone
Company's prior experience in the country			
Structure of Intellectual Property favorable to the company			
Ease to import inputs and equipment for conducting R&D.			

Source: Onsite interviews with foreign multinationals (2007)

From the result of this analysis, we elaborated a typology with five categories (Table 2). The characteristics corresponding to companies of each type are listed in the second column. It is worth to observe that some characteristics are common to more than one type. For example some Type 4 subsidiaries issued patents in international offices, which represents a characteristic of Type 5 companies, but in a less intensive process than Type 5 ones.

Table 2 – Characteristics of companies R&D classified in each category/type (typology)

TYPE 1	<u>No R&D activity</u> - do not carry out any kind of R&D activities - hire isolated technological research from Brazilian research institutions
TYPE 2	<u>Sporadic development is present, but research is not carried out</u> - do <u>not</u> have a formal and structured R&D department: occasionally allocate employees for adapting products or processes according to local specific requirements - - have an engineering department connected to the corporation (linkage team) - hire isolated technological research from Brazilian research institutions
TYPE 3	<u>Continuous efforts for development are found, but research is not carried out</u> - <u>have</u> a formal internal structure of R&D and fixed personnel - hire isolated technological research from Brazilian research institutions (more sophisticated developments or punctual researches) - development focused on local/regional market demands: do not demonstrate accumulation of specific competences for global purposes
TYPE 4	<u>Continuous efforts for development are found, but research is carried out sporadically</u> - <u>have</u> a formal internal structure of R&D and fixed personnel, including Master's and Doctorate degrees - occasional research is conducted internally and/ or in cooperation with universities - R&D activities are mainly focused on local/regional market demands - have accumulated specific competences in some fields (distinguished in the corporation): competences are related to developments for local, developing markets and in some cases to developed markets
TYPE 5	<u>Besides continuous development efforts, carry out important research for the global corporation</u> - have a formal internal structure of R&D and fixed personnel, including Master's and Doctorate degrees

	<ul style="list-style-type: none"> - continuous research is strategic for local subsidiaries - developed products and technologies are sold in worldwide market - have capabilities: R&D excellence centers are recognized in the corporation - there are issued patents in foreign offices with Brazilian subsidiary as applier and/or as inventor
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4. Results and Discussions – Determining Factors for Locating R&D in Brazil

4.1. Important factors for attracting R&D

This section analyzes the following question: which would be the factors that guide headquarters' decision to invest in R&D in Brazil?

The proposal would be to identify what the company considers most important and attractive in the country that would justify investment in activities that demand scientific knowledge as well as presence of certain technological infrastructure at the local subsidiary. Table 3 organizes the most attractive factors that have influenced investment decision in R&D in Brazil according to the interviews.

From the Table 3 is possible to observe that the technological factor is the most important among the reasons that guide investments in R&D to Brazil. Factors tied to this category received more than 46% of all answers, while factors tied to the Market, 30%, the Economy, 15%, and Location, 8%, were mentioned.

Table 3 – Order of the attraction factors by importance received in % ($\Sigma = 100\%$)

TECHNOLOGICAL		MARKET-ORIENTED		ECONOMIC		LOCATION	
Σ Technological	46.3	Σ Market -based	30.3	Σ Economic	15.3	Σ Location	8.1
Availability of personnel trained in quality Technical skill, proactivity, creative capacity and flexibility	20.1	Business need (proximity to market)	7.6	Cost of doing R&D in Brazil	10.0	Basic infrastructure	3.1
Level of excellence in the academic sector and research in the area of interest	6.6	Market Size	6.8	Cost of skilled labor	4.4	Location (local or region)	2.4
Favorable Incentives and Public Policies	5.2	Market growth	6.6	Profitability of the local unit	0.9	Country's social-economic and political stability	1.7
Ease to import inputs and equipment for conducting R&D.	3.5	Presence of factory unit in Brazil (proximity with manufacturing)	5.9			Time zone	0.7
Ease of partnerships with Research Centers and Universities;	3.3	Business interest	3.5			Legal Security of the Property	0.2
Company's prior experience in the country	2.6						
Availability of personnel trained in quantity	2.6						

Structure of Intellectual Property favorable to the company	2.4						
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Source: Onsite interviews with foreign multinationals

This result leads us to infer that multinational corporations consider the possibility of access to scientific and technological assets in the country as a determining factor when directing investments in R&D in Brazil. This result corroborates the understanding of R&D attraction factors. Literature shows that investments in R&D for developed countries tend to be guided by technological factors (Florida, 1997). Literature also says technological drivers are the most relevant since it presupposes dependence of the MNE to the host region, especially local agents and innovation infrastructure.

It is the MNE's innovative performance and its commitment to producing innovations that would theoretically guide its search for technological factors when deciding to allocate R&D in locations other than the home.

“Availability of skilled labor” explains the central role of the technological driver for the Brazilian subsidiaries. The perspective that human resources equipped with technical competence, proactivity, creative capacity and flexibility are fundamental assets for the good performance of R&D activity contribute towards explaining the concentration of company answers in this category.

4.2. Analysis of factors by type of R&D conducted in Brazil

The previous section addresses the main reasons for investing in R&D in Brazil resulted from subsidiaries' interview analysis. It indicates that technology drivers matters more than the others. Moving forward, the next step is to investigate the importance of FDI drivers for companies that continuously conduct Research and/or Development in the Brazil - Types 3, 4 and 5 (see Table 2, Section 3) .

We show in this section the analysis made from crossing the type of R&D conducted in Brazil by the interviewed subsidiaries and the factors that motivate headquarters to invest in R&D in the country.

The featured result from this analysis is: as more complex the Brazilian subsidiaries' R&D activities, less important are technology-oriented drivers and more important are the market-oriented drivers . This is surprising because we expected that – in accordance to literature and propositions 1 and 2 (Section 2)as more technological activities the subsidiaries do, greater the local search for technological factors. Economic factors, or those related to cost, stand out little.

Table 4 shows aggregate scores by type of company for each class of factor and the representativeness' percent for these factors. It is worth underscoring that the technological factor achieves greatest representativeness (62%) in type 2 companies (19% of the companies is classified in this type), those that only conduct development sporadically in Brazil, but lose importance as R&D activities become more intense at the subsidiary. On the other hand, market-oriented drivers gains relevance: they go from 21% at type 3 companies (technological factors are 55%), to 38% in type 4 companies (technological factors tied at 37%) and 70% in type 5 companies (technological factors are at 15%) (see Table 4).

Table 4 – Distribution of weights attributed to attraction factors by type of R&D (in %)

R&D Type % companies	Type 1 7%		Type 2 19%		Type 3 37%		Type 4 33%		Type 5 4%	
Factor	Σ Score	%	Σ Score	%	Σ Score	%	Σ Score	%	Σ Score	%
Technology	1.1	55%	5.1	62%	9.1	55%	6.5	37%	0.3	15%
Market	0.4	20%	2	24%	3.5	21%	6.6	38%	1.4	70%
Economical	0	0%	0.4	5%	2.7	17%	3.7	21%	0.2	10%
Locality	0.5	25%	0.8	10%	1.2	7%	0.8	5%	0.1	5%

In order to understand these results and evaluate the reasons why investigated companies overestimate market-oriented factors instead of giving more importance to technological drivers, we analyzed interviews' additional information to understand what makes foreign multinational corporations locate R&D functions in Brazil³. The existing degree of innovation in R&D activities of each of studied companies were also evaluated in order to verify whether these activities require a local technology infrastructure or not, since technological factors are not important to these companies.

The results of these activities at Brazilian subsidiaries were raised in terms of patents issued abroad and bibliometric data.

According to Table 5, of the 20 "type 3" subsidiaries, only 6 have patents deposited at United States Patent and Trademark Office's (USPTO) with inventors residing in Brazil. The number of patents is very small and insignificant compared to the total number of patents by global corporations. Eight "type 4" companies have patents but only one subsidiary issued more than 1% (it has 1.9%) of the patents deposited at the USPTO with Brazilian inventors. For "type 5" companies, the highest percentage was achieved by a subsidiary that has 4.6% of its patents with Brazilian inventors at USPTO. These data on patents were compared to Chinese and Indian subsidiaries, emerging countries that compete with Brazil for FDI. For those same companies, although lightly higher, the numbers for China and India are not very different, indicating the situation could be similar for other emerging countries.

Table 5 – Issued Patents at USPTO with inventors residing in Brazil

R&D Type	Company's Industry	n° patents	% patents/ company total
Type 1	-	0	-
Type 2	-	0	-
Type 3 (Research is not conducted; Development occurs sporadically)	Cosmetics and personal care	6	0,49%
	Pharmaceutical	1	0,03%
	Pharmaceutical	1	0,07%
	Pharmaceutical	1	0,07%
	Construction	4	0,55%
	Chemicals	28	0,59%
Type 4 (Continuous development; sporadic research)	Chemicals	3	0,54%
	ICT	1	0,01%
	Auto & Parts	5	0,08%
	Auto & Parts	6	0,36%
	Auto & Parts	9	1,89%
	Auto & Parts	3	0,10%
	Auto & Parts	6	0,15%
	Auto & Parts	1	1,00%

³ This was only possible due to the characteristic of the methodology adopted in this study. Since it is a qualitative study, it was possible to cross results based on company answers to different open questions from the interviews.

Type 5 (R&D)	Cosmetics and personal care	45	4,62%
	Electronic	5	1,04%

Source: USPTO (1996 – 2005)

Most of the technology factors for type 3 companies refer to “Availability of Labor”. It is worth underscoring that 40% of the type 3 companies are from pharmaceutical industry. Most of them indicated this is the factor for attracting investments to Brazil. It is explained by the existence of extremely qualified professionals at partner institutions (usually hospitals and universities) where they conduct clinical tests, that is the main R&D activity of Pharmaceutical companies in Brazil.

In Type 4, the “Availability of Labor” is also prominent. One of the companies even cited the importance of the competitiveness of Brazilian engineering labor compared to countries that compete directly for FDI in R&D, affirming “it is more expensive, but more experienced and better trained than in China and India”.

However, in Type 5, the “Availability of Labor” was not cited by the interviewed companies. It may indicate that, at least for such subsidiaries that have been already doing relevant research in the country, the skilled labor factor has been already taking care of (that is, acknowledged at the corporation) and is no longer a competitive differential.

Another technology-oriented factor that surprisingly did not appear among type 5 and type 4 companies is "Excellence of the academic sector" – it was cited by only one type 4 company. On the other hand, is one of the most frequent factors among type 3 companies, emphasizing the strong presence of pharmaceutical companies.

From the comparison of these results with the type of R&D conducted by companies locally, we achieve our main conclusion: that knowledge from universities and local research institutes does not bring FDI to R&D of companies that carry out important research for the global corporation (Type 5) or research in a sporadic manner (Type 4).

In order to qualify this conclusion, we also investigated the relations of companies with universities and research centers, an issue addressed in two specific questions from interviews.

A significant number of type 3 companies access universities or research institutes in Brazil to acquire technological services as clinical research (pharmaceutical firms, employees training etc. A ICT firm, for instance, obliged by law to cooperate in the country, contracts universities or research institutes to conduct sporadic development.

Both “type 5” and “type 4” companies do not consider Brazilian technological environment as a driver for attracting FDI in R&D; technological factor that matters is the existence of skilled labor; drivers related to access local knowledge to support R&D, especially "partnerships with universities and research centers", are not valorized. Only one “type 4” ranked (in fourth) company point out the "Level of excellence of the academic and research sector” factor, other companies made no reference to these kind of factors.

Thus, complementing the main conclusion, it can be inferred that the interaction with the local Science and Technology structure for MNEs that truly conduct R&D in the country is not strategic for attracting FDI.

In order to still corroborate the main conclusion, bibliometric data were also evaluated for Type 3, 4 and 5 companies. For that we consider articles whose authors’ addresses were Brazil, China or India (for comparison) and at least one of them was company employee (table 6). We observed that Brazil has less representative data than China and it is similar

to what is found in India. For type 3 companies, both number and paper's growth were bigger than for the other two types.

Table 6 – Number and growth of papers (from 1996 to 2005)

	Brazil			China			India		
	Per 1	Per 2	Growth (%)	Per 1	Per 2	Growth (%)	Per 1	Per 2	Growth (%)
Type 3	59	155	162,7%	39	219	461,5%	22	56	154,5%
Total	214			258			78		
Type 4	28	46	64,3%	38	107	181,6%	66	46	-30,3%
Total	74			145			112		
Type 5	4	14	250,0%	3	8	166,7%	1	5	400,0%
Total	18			11			6		

Source: Institute for Scientific Information (ISI)/Thomson Reuters

Period 1 (Per1) - 1996-2000

Period 2 (Per2) - 2001-2005

The biggest difference between representativeness of technological and market-oriented drivers was indicated by type 5 companies, for which market-oriented factors had a representativeness of 70%. For type 5 companies, the most important drivers to invest in R&D in Brazil is "business interest". One of the interviewed companies (which operate in various sectors in Brazil, including personal and personal health care products) revealed that Latin America (including Brazil) is the fastest growing region, in percentage, in the corporation. For that company, the investments' expansion in R&D in Brazil is directed towards emerging markets, with product development targeting lower purchasing power classes.

Another type 5 company (of electronics industry) says the country's continental dimensions and each region's peculiarities (different climates, different consumer profiles, with diversified purchasing power, with or without logistics problems, with or without water and electric power rationing, etc.) permit testing diverse environments for products developed locally, attending to world niche markets. We also observed that type 5 companies indeed specialize in the development of technology and products for market niches similar to Brazil, including geographic (for Brazil or Latin America), climate and economic (for lower income consumers in emerging countries) ones. Type 4 companies also have R&D activities very focused on products and technologies for market niches; in many cases converging towards adapting the products to the regional market and technical support for local manufacturing units, market-oriented factors as pointed out in literature. One of the most cited factors by type 4 subsidiaries is the "Presence of a manufacturing unit in Brazil (proximity to manufacturing)". It indicates that the companies try to attend to the existing manufacturing system in the country, installing R&D units and speeding up understanding and the meeting of local/regional market needs.

From the technological perspective, R&D activities by type 4 and 5 Brazilian subsidiaries are still of little relevance in the corporation if we just consider information on patents and bibliometric data reinforces this ascertainment.

On the other hand, types 4 and 5 are comprised mostly of subsidiaries that participate in corporate R&D activities, that is, conduct R&D for global products and/or have a mandate for global products.

Therefore, these results let us strongly consider that technological factors are less relevant than market-oriented ones for subsidiaries that develop global products in the country.

Thus, to better understand these relations, we develop another mechanism for analyzing data, shown in the following section.

4.3. Analysis of factors by scope of R&D conducted in Brazil

Aimed at better understanding the results obtained from the analysis of attraction factors by type of R&D and mainly analyze the type of product developed by the subsidiary, especially in relation to its geographic scope (local or global product), we created another classification with the same sample. Thus, companies that conduct any type of local R&D were put into three groups: those that develop products for the local market (called group A); those that participate in global product development (GPD) and thus conduct phases of GPD (group B); and those that besides developing global products, have a mandate for at least one global product or technology (product owner or technology owner) (group C).

In this classification (see table 7), the results show that subsidiaries of group C valorize technological aspects less than those of group B. For these companies in group B, factors like availability of skilled labor and level of excellence of the academic and research sector in the area of interest are more valorized than in the other two categories of subsidiaries. This in contrary to what we expected in propositions 3 and 4 as mentioned in section 2.

It is worth a discussion in order to understand why this happens and to point out to new questions. Once again, the weight of the pharmaceutical companies must be considered. As mentioned, they conduct clinical research in the country (one of the stages of GPD, group B) in partnership with local institutions and they valorize the level of excellence in the academic sector and quality of specialized labor, which are classified as technology-oriented factors.

The market factors, on the other hand, are more valorized at companies with product mandates, and this can be explained by two perspectives. Both of them are related to subsidiaries initiatives, in what Birkinshaw (1997) considers intra entrepreneurship characteristics of the unit. First, these companies have a history of operating in Brazil, and the global products they own generally have some relation with their historical path in the country. For example, one of the cosmetics and personal care companies has a sun protection development center in the country for the global market, since Brazil's climatic conditions were optimal for it to develop expertise continually in the area. Another example is that of a subsidiary from the automotive sector, which owns technology in the country for multi-fuel engines (which function with various fuels, such as ethanol and gasoline), which currently has a large share of the market for light vehicles in the country. Various companies list the existence of a manufacturing unit as an important factor when installing an R&D center in the country. There is also the fact that some of these companies bought Brazilian companies and maintained the R&D centers to meet the existing market needs for products and technologies developed by them, and that later became global platforms at the corporations, as stated in literature (Ronstadt, 1977; Hakanson & Nobel, 1993). For example, the subsidiary of an European metallurgical company that purchased a Brazilian company in the 1990s, maintains two competence centers from the acquisition which are unique in the corporation in special steels for a specific segment of the automotive industry, which in turn has an important market in Brazil.

The greater valorization of market-oriented forces by companies that have a global product mandate can also be explained by a second perspective, which is the characteristic of the Brazilian and South American markets, specifically due to the size and growth potential and its diversity, attracting the corporation's global product development units not only because the subsidiary would have greater financial autonomy for investments (from

achieved profitability), but also because the market enables different experiences (due to cultural and economic diversity of the Brazilian consumers). This potential of Brazilian and Latin markets is used by companies to test products for different niches of consumers, which may be also found around the world. Thus R&D centers located next to these markets may streamline global product development process.

Table 7 – Distribution of weights attributed to attraction factors by scope of product development conducted by the subsidiary

Scope of Product Development	Local Product (Group A)		GPD Stage (Group B)		GP mandate (Group C)	
	Σ Score	%	Σ Score	%	Σ Score	%
Technology	3.5	39%	5.5	54%	5.8	36%
Market	2.8	31%	2.3	23%	6.7	42%
Economical	1.9	21%	1.4	14%	3.2	20%
Locality	0.7	8%	0.9	9%	0.4	2%

5. Discussion and Conclusions

In this article we investigated if attraction factors are closely tied to the type of R&D conducted in the host country, Brazil. And, contrary to the propositions 1 and 2, extracted from literature, that the type of prioritized factor (market- or technology-oriented) has a direct relationship with the type of activity conducted (less or more complex), we found that the more complex the R&D conducted by the subsidiary, the less value the local unit gives to technology-oriented factors and the greater the valorization of market-oriented ones. This complexity of activities was evaluated in terms of the characteristic of efforts for conducting research and development of products/processes in the country.

In groups of companies that do not conduct research activities and conduct product development in a sporadic or continuous manner, technology-oriented factors are more valorized. This valorization diminishes considerably at subsidiaries that conduct continuous development and have sporadic (type 4) or continuous (type 5) research in Brazil, for which technological factors are not underscored as important.

One of the evidences found to explain this is that the groups of companies that do not conduct research, but that conduct sporadic (type 2) or continuous (type 3) development in Brazil is mainly comprised of companies that conduct little internal R&D and contract technological services locally. Thus, when conducting less complex R&D activity, the subsidiaries valorize factors that complement their local necessity for technological resources, such as the existence of skilled labor, partnerships with universities and the existence of public incentives and policies.

Two sets of subsidiaries stand out in these groups. 1) companies of the pharmaceutical sector that conduct clinical research in the country in partnership with local entities as part of the process for developing new global medications for the corporation, and 2) those obliged by law to invest part of earnings in technological innovation activities. This mainly occurs in sectors like ICT and Electric Energy. The obligatory nature forces them not only to conduct R&D in Brazil, but to do so in partnership with local institutions, and this reflects on the valorization of technological factors by these subsidiaries. They are usually involved with projects to attend local or niche demand of products for specific segments, such as emerging country markets that demand products with less technological content.

It is worth pointing out that integration with local research institutions, a characteristic of these sets of companies, is not exactly characterized as cooperation for technological development, as cited, but rather are more related to the contracting of sporadic technological services and training of labor.

On the other hand, the strongest explanation for companies that conduct continuous development and sporadic or continuous research in Brazil (types 4 and 5) to valorize technological factors less than the market-oriented factors is related to the companies' historical path in the country. Local expertise already developed by companies is mainly related to two determining points. 1) these companies have had a production unit in Brazil for decades (95% of the companies have been in the country for at least 4 decades), which permitted them to develop competences, and 2) they developed a significant market and thus play an important role in the global corporation.

Facing these unexpected results, we tried to understand it by other analyses. Thus it was related the factors that led MNEs to maintain R&D activities in Brazil and the insertion of Brazilian subsidiaries in global product development networks from their respective corporations. And, once again, contrary to prepositions 3 and 4 based on literature, the results obtained showed that subsidiaries which are product or technology owner in the corporation valued less technology-oriented factors and more market-oriented factors than the ones evolved in the global process and the units whose R&D is for local product development or adaptation.

Thus, we concluded that the market is indeed what attracted and maintained R&D at Brazilian subsidiaries of foreign companies that conduct activities with more value-added technological content and participate in global networks for product development. They do not consider the technological potential installed at the local environment, because this does not seem important for these companies choices. Therefore, the infrastructure installed in Brazil for technology and innovation does not seem to be a determining factor for attracting R&D units of foreign companies that conduct more complex R&D activities on a global scale.

From these finds, it arises the question whether subsidiaries located in other emerging countries that carry out more complex R&D valorize existence of technology-oriented factors of host country when deciding for those investments. The answer is negative for the companies here analyzed, but it requires additional research to achieve further conclusions.

Therefore, this paper points not only to the necessity of wider researches with emerging countries, but also to a lack of studies about competence-creating subsidiary. Here, we have addressed the issues of the roles of subsidiaries and motivations for R&D internationalization in MNEs in a new way. Whereas most of the literature has focused on competence of subsidiaries and strategic importance of environment, we have crossed directly the driving forces for R&D with the technological competences and roles of subsidiaries (complexity of R&D carried out by subsidiaries). The main difference is that, for understand what MNEs indeed consider of local environment when deciding R&D investments, we have conducted this research using the roles subsidiaries already have on corporations instead of create a role taxonomy based on competences *versus* environment.

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