

R&D internationalization: a typology for the Brazilian subsidiaries of multinational companies*

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Resumo

O Brasil é uma economia bastante conhecida por seu potencial de atração de investimentos de empresas multinacionais (MNs) em atividades produtivas. A questão é saber se o Brasil também é atrativo quando se trata de investimentos em atividades de pesquisa e desenvolvimento (P&D). A partir de entrevistas com 54 subsidiárias de MNs, esse artigo apresenta uma caracterização das atividades de P&D conduzidas no país, a partir de uma tipologia com cinco níveis de complexidade. Resultados revelam que a maioria das empresas MNs entrevistadas conduz atividades de desenvolvimento de forma contínua no Brasil; entretanto atividades de pesquisa raramente são feitas. Casos em que as subsidiárias são responsáveis por parte do desenvolvimento de algum produto ou sistema na rede de P&D local foram identificados, porém em números bastante limitados.

Palavras-chave

R&D global; empresas multinacionais; subsidiárias brasileiras

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Abstract

When considering Brazil as an attractive economy for investments of multinational companies (MNCs) in manufacturing and in resource-based activities, it is relevant to identify whether it is also considered as a host for R&D. Thus, this paper presents a characterization of the R&D activities carried out by the Brazilian subsidiaries of foreign MNCs, based on case studies with 54 companies. A typology classifying local units by the kind of R&D performed in Brazil was developed. Most of the sampled companies conduct development activities consistently, but research is rarely carried out. We also observed that few of the subsidiaries are responsible for part of the development of product or system in the global R&D network.

Key words

Global R&D; multinational corporations; Brazilian subsidiaries.

Classificação JEL: o32

1 Introduction

Foreign Direct Investment (FDI) has increased steadily worldwide and Brazil is now one of the most attractive economies for multinational companies (MNCs). Inflows to Brazil rose by 25% in 2006 compared to the previous year (World Invest. Rep., 2007) and most of FDI inflows to Brazil are in manufacturing and in resource-based activities (World Invest. Prosp. Surv., 2007). Considering this context, the aim of this paper is to present a characterization of R&D activities carried out by the Brazilian subsidiaries of foreign MNCs, based on case studies with 54 subsidiaries of foreign MNCs located in Brazil.

In order to characterize the activities carried out by these MNC affiliates, we have structured an R&D typology based on what was observed. We intend, with this initiative, to present an aggregated analysis based on qualitative research regarding activities accomplished by the interviewed companies, in the sense of classifying these by the kind of R&D performed in Brazil. The typology is divided into five categories defined by the kind of activities performed (or not) by the

companies, with the intent of identifying which company accomplishes only development activities in Brazil and which also conducts research activities either continuously or sporadically. This typology was developed in order to aggregate and, in a certain way, to simplify the classification of R&D activities developed by Brazilian subsidiaries, once they are very varied. The growing share of multinationals in the productive structure of the Brazilian manufacturing industry and the fact that MNCs account for almost half of private R&D expenditures in the country, according to the Brazilian Technology Innovation Research by Brazilian Institute of Geography and Statistics, are the basis for the proposed analyses.

This article is the result of a broad research project¹ aimed at contributing to the understanding of the general context of MNC activities in Brazil and to the formulation of public policies that could be effective to foster MNC technological investments in the country, especially in R&D. It is important to mention that studies related to the internationalization of R&D in Brazil are usually focused on either aggregated dates derived from quantitative analyses, specially surveys researches (Boehe, 2007; Gomes; Consoni; Galina, 2007) and specific industrial sectors (Dias; Salerno, 2004; Galina; Sbragia; Plonski, 2005; Consoni; Quadros, 2006; Gomes, 2006; Radaelli, 2006); there is no qualitative research as broad as the one shown here.

The paper is organized in four sections, including this introduction. The second part presents the methodology, focusing on interview work and sample definition, which are part of several other research activities developed in the scope of the project. The third section approaches some aspects of R&D internationalization based on literature, emphasizing those which contribute to understanding the type of activities that are carried out by MNC subsidiaries and providing elements to support our classification. The fourth section focuses on the typology description as well as on analyses and results for each group of Brazilian subsidiaries (Types 1 to 5). The last section — conclusion — brings the article to a close.

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2 Methodology

This study was based on extensive in-depth face-to-face interviews conducted with R&D directors and/or CEOs of 54 MNC subsidiaries located in Brazil. The interviews were conducted in two phases: during the first phase we interviewed 46 MNC subsidiaries from February to July 2007. After that, we analyzed those interviews and reformulated some questions to look more thoroughly into aspects of the R&D internationalization, conducting 8 additional interviews with other companies, from January to March 2008.

Three criteria were used to assure a representative sample of the MNCs' universe located in Brazil: (1) the largest R&D investors (MNCs) according to the "R&D Scoreboard (2005)" which also invest in R&D in Brazil according to the ranking of companies published by **Valor Econômico 2005**, one of the most important Brazilian business newspapers; (2) MNCs 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 our research group members considering: long-established MNCs in Brazil; MNCs which benefit from government R&D incentives; MNCs having acquired Brazilian companies with R&D activities in Brazil; among others.

In terms of capital origin, the sample includes MNCs from 11 different countries (USA, Canada, Austria, Holland, France, Germany, Switzerland, Italy, United Kingdom, Japan and India). Approximately 51% of the companies are from USA, 41% are from Europe, and 8% are from Asia. The operation time of the sampled subsidiaries is diversified: around 63% of these have been in Brazil for over 40 years and present a fairly consolidated productive structure in the country; the remaining of the sample set up operations in Brazil after the 1970's, and only one company arrived after 2000. Consequently, most of the interviewed MNCs accumulate several years of operation in the Brazilian territory.

The sample of Brazilian subsidiaries encompasses 13 different sectors: Vehicles and Parts; Information and Communication Technology (ICT) and Semiconductors; Chemistry; Pharmaceutical; Food; Machines and Equipments; Metallurgy; Electrical Energy; Cosmetic; Electro-electronic; Electronics and Telecommunications; Paper and Cellulose; and Other Sectors including companies do not classified in the mentioned above. Although the number of studied companies and sectors is significant, tendencies could not be outlined by sector due to the small number of MNCs in each sector. Therefore, the expressive number of interviewed MNCs allowed us to draw a broad overview of the R&D activities developed in Brazil. It should be noted that the results reflect the opinion of Brazilian subsidiaries. Furthermore, we should mention that we have a formal

confidentiality agreement with the interviewed companies to prevent disclosure of their names.

3 Internationalization of R&D activities: some aspects approached by literature

3.1 Aspects of global R&D

The literature in internationalization of R&D deals with different nature of works. Some of them are related to the strategies adopted by MNCs to globalize R&D considering local advantages offered by countries (Ronstadt, 1977; Terpstra, 1977; Hakanson, 1990; Bartlett; Ghoshal, 1989). Influencing such strategies are the factors which orient investments to specific countries/regions (Cantwell, 1992; Reddy, 2000; Gerybadze; Reger, 1999; Patel; Vega, 1999).

Another research line considered by literature refers to management of R&D global centers (De Meyer; Mizushima, 1989; Chiesa, 2000; Zedtwitz; Gassmann, 2002), mainly directed to data/information exchange between global units (ex. type, costs, infra-structure for communication, etc.) and to the organization of work teams spread globally (ex. organizational structures, leadership, team formalization, etc.). Thus, most researches evaluate the role that MNC subsidiaries hold regarding R&D in each country (Ronstadt, 1977; Chiesa, 2000; Hegde; Hicks, 2008; Frost; Birkinshaw, 2002), which will be thoroughly discussed in the next section of this paper.

Nevertheless, whatever the focus of the works mentioned above, they all start from the assumption that the roles of MNC subsidiaries outside their home countries are not restricted to servicing the local market, they are also arranged into integrated networks to provide them with the necessary skills or knowledge to operate in each country not only for production but for development of technology as well (Cantwell; Santangelo, 1999).

In order to be more competitive, companies have structured their R&D activities globally (Ghoshal; Bartlett, 1988; Reddy, 2000); several studies show that MNC investments in R&D are increasingly oriented toward subsidiaries located outside the home country (UNCTAD, 2005; Doz et al., 2006). The MNCs recognize that different parts of the company may develop R&D activities with different skills. The exposure of a global company to a variety of environmental stimuli is a great advantage over a national company. Thus, there are several arguments pro-internationalization of R&D, not only to support local production, but also to create interfaces with local innovation systems (Ohmae, 1990), among which

are: opportunity to have contact with new knowledge and technologies; flexibility and agility to adapt products; better customer service; lower development costs; tax incentive grants in some countries/regions; local demands and others.

However, it is worth emphasizing that regardless of the reasons which lead the process of R&D internationalization, “[...] the home country of the transnational company is usually the most important place for the technological development of the corporation” (Cantwell, 1995, p.172), despite strong indications that R&D spending in foreign subsidiaries are growing strongly. For instance, according to UNCTAD (2005) they rose from 10% to 16% of all investment in R&D from 1993 to 2002. The same study shows that spending on R&D are geographically concentrated, for instance, in 2002, the ten economies that invested most in R&D account for 86% of the world total, being eight of them located in developed countries (China and Korea are the exceptions).

According to the study of UNCTAD (2005), the type of R&D conducted abroad also varies depending on the region, where: Asia prevails with the most innovative R&D (especially China, India and Korea); some new members of the European Community have attracted activities of technological innovation; Latin America and the Caribbean have little direct investment in intensive technological development and focus on adaptation of technology or products to the regional market; some countries of Africa (especially South Africa and Morocco) attract limited investments in R&D. There is a competition between countries to receive investments in R&D, among which the BRICs (Brazil, Russia, India and China) and some smaller countries of Asia and Eastern Europe.

Studies on R&D carried out by foreign companies in Brazil show these activities are focused mainly on adaptation of products or processes. However, some studies point out that Brazil has been considered by multinational companies for guidance on investment in R&D. The Brazilian industries of telecommunications equipment (Galina; Sbragia; Plonski, 2005; Gomes, 2006) and automotive (Dias; Salerno, 2004; Consoni; Quadros, 2006) are noticed examples, both for (re)defining the mandate of the subsidiary within the corporate network, or for the introduction/extension of technological activities by these subsidiaries (Gomes; Consoni; Galina, 2007). Boehe (2007) based a survey administered via Internet with 146 Brazilian multinational product development units, identified that the majority of them carry out new product development activities and about 50% can be considered contributors for the global product development activities of their MNCs.

The methodology used in the study presented in this paper (case studies), differently of quantitative methods, allowed us to make deeper analyses of the R&D activities that are really being done by MNCs in Brazil. This was possible not only because of interaction with the interviewed employees (president or/and

R&D chief of the subsidiaries), but also because we crossed secondary information with the one obtained through the cases, which led us to evaluate the role of local subsidiary in global corporate R&D. On the other hand, it is different of other qualitative studies previously mentioned because we did not focus on a specific industrial sector like most of the others did, making the analysis broader in scope.

3.2 Types of R&D Activities in foreign subsidiaries

The discussion about the competition for investments between countries also approaches the type or “quality” of R&D activities that are attracted to each region or subsidiary. In general, countries and subsidiaries tend to choose investments with higher value-added activities, which could possibly make the global corporation more dependent on the local subsidiary, and therefore on the country where it is located. For innovative Research and Development, it means the subsidiaries attempt to attract activities from the initial stages of the R&D process, which are, in general, those which receive substantial investments, allowing local units to take more risks and enabling closer relations of cooperation between the company and other players from the National Systems of Innovation (ex. Local firms, universities, research institutes, government agencies). Besides, these activities may also allow subsidiaries to develop pioneer innovation for the whole company. The general goal of the subsidiary is, of course, to improve its financial revenue and to have its importance recognized by the global corporation.

There are some studies focused on the differences of roles for R&D in foreign subsidiaries in multinational firms (Ronstadt, 1977; Frost; Birkinshaw; Ensign, 2002; Hegde; Hicks, 2008). Ronstadt (1977) classified different types of R&D activities carried out abroad by MNCs:

- Technology Transfer Units (TTUs) - to facilitate the transfer of corporate parent technology to subsidiary, and to provide local technical services;
- Indigenous Technology Units (ITUs) - to develop new products for the local market, drawing on local technology;
- Global Technology Units (GTUs) - to develop new products and processes for major world markets;
- Corporate Technology Units (CTUs) - to generate basic technology of a long term or exploratory nature for use by the corporate parent.

This typology also offers an idea of the difference in importance or hierarchy between each unit, from TTU to CTU, in this order, the relevance of the subsidiary role increases. Hegde and Hicks (2008), attempting to capture broad trends in the phenomenon of global R&D based on the related literature over the last five

decades, created a structure for subsidiary R&D to function. Table 1 organizes their findings: it presents the evolution of a foreign subsidiary based on its R&D activities over the last decades (column 1) and the factors and driven forces that stimulated these changes (column 2).

The first type ("Market customization") is related to units with R&D functions designed to understand and to support foreign market customizing. "Listening post" is an R&D unit whose existence reflects the strategy and need for businesses to absorb foreign know-how. In both models, Market customization and Listening post, overseas R&D sites were auxiliary outposts, subservient to home R&D laboratories. In subsidiaries having functions which are "Sources of innovation", particularly emerged since the 1990's, we see "three categories of increasing sophistication — incremental innovation, multi-technology product innovation and use-inspired basic research" (Hegde; Hicks, 2008, p. 393).

When classified in the first category — incremental innovation — subsidiaries are focused on small technical changes and on increasing product or process development which continuously advance the process of change. For the second category — multi-product innovation — R&D functions involve experimental development applying different technologies already available, not focusing on the creation of new technological paths, but on the development of new technology. Finally, when an R&D unit is classified on the third type — frontier innovation — it is expected from it to be involved in new discoveries and researches. Applied researches — and in some cases, basic researches — are a regular practice of this last kind of affiliates.

In this classification, we can observe certain relations to the "classical" definitions of R&D and its activities which are worth mentioning. Definitions by Frascati Manual (OCDE, 2002, p. 30), widely used as a reference on R&D studies, are important to be considered:

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

Table 1

Evolution of Global R&D and of foreign subsidiary roles

SUBSIDIARY R&D FUNCTION	FACILITATING FACTORS AND DRIVER FORCES
Market customization	Learning to operate abroad Consumer Demand
Listening post activities	Decreased communication costs Industrial and technological strength specially in developed countries
Sources of innovation - Incremental innovation - Multi-product innovation - Frontier innovation	Increased variety in means of communication Proximity to manufacturing and to industrial customers Presence of S&T (Science and Technology) human capital in host country

SOURCE: Hegde; Hicks (2008).

Another important discussion related to the role of foreign subsidiaries is about Centers of Excellence, once some authors (Holm; Pedersen, 2000; Birkinshaw; Hood; Jonsson, 1998) consider them as a form of high value-added subsidiaries, allowing these to have a strategic role in the corporation. Thus, we return to the considerations presented in the beginning of this section: subsidiaries try to attract value-added investments (including R&D activities) that will make a difference in the evolution of their role as a member unit of the MNC.

Frost, Birkinshaw and Ensign (2002) advanced the definition of centers of excellence adding the idea that they represent a superior set of capabilities within the firm, including both tangible (ex. equipment, licenses, and patents) and intangible resources (ex. knowledge and experience). They also include that a center of excellence is explicitly recognized or declared as such by the global corporation and the subsidiary where it is allocated when these intend to derive value from that unit's capabilities for the broader organization. For their work, these authors distinguish three types of centers of excellence — manufacturing, research and development centers. They concluded that investment by the parent firm stands out with all three types of centers (compared to non-excellence centers), but particularly research and development centers. Another emphasis of the same research is related to the performance impact of centers of excellence, that also indicate superior performance (compared to non-centers) for these two types of centers.

Frost, Birkinshaw and Ensign (2002) also highlighted the conditions under which the centers are likely to be created in MNCs. Such conditions are closely related to the recognition of capabilities that provide a source of value beyond the boundaries of the originating unit. Their argument is based on the premise that centers of excellence “[...] can be viewed as the outcome of a combination of external and internal factors, the most important of which appear to be parent firm investment and linkages to sources of competence both within and outside the boundaries of the firm” (Frost; Birkinshaw; Ensign, 2002, p. 1016).

The same authors showed the relative importance of these factors varies across the three different types of centers. For manufacturing centers, internal actors (from inside the MNC) appear to play a more important role in the development of strong capabilities than do actors outside the boundaries of the firm. The standards are reversed for research centers and also for development centers, where external players are given more credit as important sources of competence development (for research centers it is even more important than for development centers).

4 Analysis and results

4.1 R&D typology

In order to both understand and characterize the technological activities carried out by MNC affiliates, we have structured an R&D typology based on what was observed in the Brazilian case. We intend to present an aggregated analysis regarding the activities carried out by the studied companies, offering a broad scenario of such activities in the sense of classifying the subsidiaries by the kind of R&D performed in Brazil.

The typology is divided into five categories defined by the kind of activities performed (or not) by the companies as shown in Table 2. The characteristics of the companies classified according to type are listed in the second column. We can observe that some types of companies share characteristics although differing from each other in at least one. For instance, all Type 5 subsidiaries have applied for patents with international offices, although only a few Type 4 companies have done so. Another example is that all Type 4 subsidiaries have accumulated some competences in specific fields. However we can find “type 3” companies which also developed these competences and do not display other characteristics of Type 4.

Table 2

Characteristics of companies classified in each category/type

TYPE 1	No R&D activity - Do not carry out any kind of R&D activities - Hire isolated technological research from Brazilian research institutions
TYPE 2	Sporadic development is present, but research is not carried out - 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	Continuous efforts for development are found, but research is not carried out - Have 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	Continuous efforts for development are found, but research is carried out sporadically - Have 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	Besides continuous development efforts, carry out important research for the global corporation - Have a formal internal structure of R&D and fixed personnel, including Master's and Doctorate degrees - 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

SOURCE: Interviews with subsidiaries of MNs (2007-2008).

This typology was developed in order to aggregate and, in a certain way, to simplify the classification of R&D activities in Brazilian subsidiaries, once they are very varied. We intended to identify the kind of Research (“R”) and Development (“D”) that are carried out by local subsidiaries. Thus, the proposed typology is based on the definitions of the Frascati Manual (OCDE, 2002).

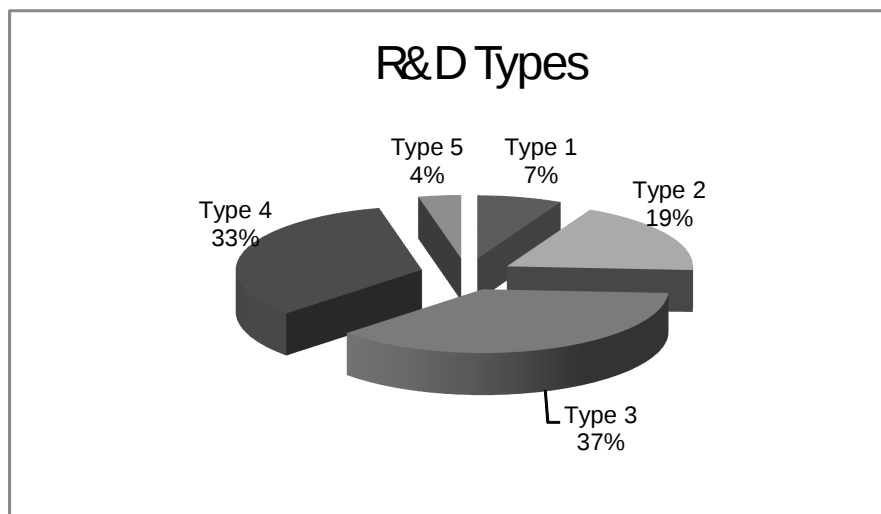
Considering the literature presented in section 3.2, we can observe that Types 1 to 5 have some “inspiration” from both classifications by Ronstadt (1977) and by Hedge and Hicks (2008), but do not reflect entirely the classes considered by these references once the activities of Brazilian studied subsidiaries are not applicable to the previously created classifications.

When specifically considering the evolution of foreign subsidiary roles by Hegde and Hicks (2008), we may find a closer relation between our proposed Types 3 to 5 and the function “Sources of innovation”, with its three classes: incremental innovation, multi-product innovation and frontier innovation, considered by the authors. We may say Types 3 reflect the function “incremental innovation”, because we considered this type of subsidiaries to be focused on incremental technical changes as well as on the increase of products or process development. Type 4 is related to the “multi-product innovation” class once its R&D functions involve application of available technologies, without focusing on the creation of new technological paths. And Type 5 is similar to “frontier innovation” class because it is also composed by applied research.

According to Graphic 1, we may observe that 26% of our samples do not carry out relevant R&D activities in Brazil (include Types 1 and 2). Among these, there are companies which do not conduct any related R&D activities in Brazil (7% of the sample). A little larger share (19%) declares carrying out development activities sporadically when there is a demand, which reflects product adaptation needs for the local and regional markets. On the other hand, 70% of companies deploy systematic and continuous efforts in development activities (Type 3 and Type 4). Type 3 concentrates the larger amount of sample (approximately 37%), indicating a considerable share focus solely on development activities. In Type 4, 33% of the companies declare doing research even though in isolated cases. Finally, only 4% of companies declare carrying out relevant research for the global corporation context. They are inserted in the global R&D networks performing in specific technologies as we will see below.

Graphic 1

Percentage of interviewed companies by type of activity



SOURCE: Interviews with subsidiaries of MNCs (2007-2008).

4.2 Characterization of the technology activities carried out by Brazilian MNC affiliates

Considering the developed typology presented above, this section aims at describing activities being performed by foreign MNCs in Brazil. Each of the five types is illustrated below, highlighting the characteristics of R&D activities for the studied companies.

TYPE 1 – No R&D activities

From the interviewed companies, there are four, or 7% of our samples that do not carry out any kind of R&D activities in Brazil. Two of them are from the ICT sector, one from the oil sector and another from the chemical sector (fertilizers segment).

One of the ICT companies — one of the largest semiconductors companies in the world — does not have manufacturing plants in Brazil: only a representation office and a sales team. As informed during the interview, Brazil is out of the

innovation and the productive global map for the headquarters. Consequently, the country has received a small amount of investment in relation to the other affiliates of the MNC group. It is important to note that the semiconductor industrial segment in Brazil has just started developing (in a slow pace).

The other ICT firm produces equipments for telecommunications. Years ago, during the boom of the telecommunications market in Brazil (1999-2001 years), the company employed around 180 people in R&D activities — annual investments in Brazilian R&D were around 15 to 20 million dollars then. Due to the contraction of the local market of telecom equipment the company has decided to abandon R&D activities in Brazil. The Brazilian IT Law² can provide understanding of such decision. This Law determines that all ICT/Telecommunication companies that have manufacturing activities in Brazil should invest annually at least 4%³ of their revenue in R&D activities (Brazilian Science and Technological Minister, 2008). So, the higher the internal sales of the company the larger the investments in R&D activities. It is clear that such MNC subsidiaries only invested in R&D in Brazil to comply with the Brazilian IT Law, showing clearly that such investment would not have been made without the Law incentives.

On the other hand, the oil company has plans for investing in R&D activities in Brazil. The company, which has been operating in Brazil since the early 20th century mostly in the fuel distribution segment, started to work in oil production after the Law of Petroleum (Law 9.478), that broke the monopoly of Petrobrás (Brazilian state-owned company) in oil exploration and production. It is worth mentioning that the concession contract for exploration of petrol with the Brazilian National Agency of the Petroleum (ANP) determines that this company must invest at least 1% of its total revenue in R&D activities in Brazil. The law was regulated in 2005 and up to the interview date (March of 2007) the company had not spent the resources accumulated in 2005 and 2006. However, the subsidiary considers investment in R&D in Brazil will be a natural tendency given the expansion of the exploration and production of oil in Brazil and the specificities of oil production in Brazil (exploration in deep waters). Petrobrás has accumulated decades of R&D investments in deep water exploration technology.

Finally, the fourth Brazilian subsidiary — Type 1 — is a fertilizer manufacturer, in Brazil since 1989. The firm has limited resources for R&D which are used to hire services from Brazilian universities. Since 2005, the board of the company has been considering the implementation of an R&D center in Brazil having as

² According to the 11077/04 Law, the incentives will be maintained until 2019 but will be gradually reduced after 2014. More information can be accessed at: <<http://www.mct.gov.br/index.php/content/view/2932.html>>.

³ Or 4.5% depending on the region where the company is installed.

main motivations: the size and the growth of the local market for agricultural defensives as well as the Brazilian climate and soil specificities. However, the decision to set up an R&D center in Brazil in less than two years remains undefined.

From the analysis of Type 1 firms, we should emphasize three aspects: (i) most of them are not inclined to implement an R&D structure in Brazil in the short term; the oil company may do so although only to comply with sector regulation requirements —; (ii) they have no internal R&D activity — not even a minimal structure to support it; (iii) three of these companies have hired technological services from universities, research institutes or specialized companies when necessary. The external services are used for adaptation of products and processes and specific developments according to local demands. Such interaction with Brazilian research institutes could not be classified as university-company cooperation; it has been a strictly commercial relationship once no internal R&D structure is in place to support such joint-research.

TYPE 2 – Sporadic Development

As Type 2 we classified 19% of the sample or 10 companies: five from ICT; two from the electrical sector; one from capital goods; one from vehicles and parts; and one from electro-electronics.

The activities of almost all the ICT companies classified as Type 2 are focused mainly on occasional improvement and customization of systems (software) to customer needs⁴. The Indian company, for instance, emphasized that the development of tools, an important part of software R&D, does not follow a regular and constant planning in Brazil. Sometimes, the Brazilian unit participates in a global event (contest) promoted by the headquarters to motivate and mobilize the subsidiary employees to enter new projects.

From all the ICT companies classified as Type 2, only two fall under the IT Law which offers incentives for companies investing in R&D as discussed above. One of the conditions for firms to be included under the Law is to have manufacturing activities in Brazil. In fact, an American firm has received the incentive indirectly: its hardware products are completely outsourced to a partner. Furthermore, the incentives received from the IT Law are not totally applied in R&D activities, being also used in workforce training as determined by the Law.

Similarly to the Type 1 telecom company, the Type 2 telecom company — a joint venture between two former telecom companies — has also abandoned

⁴ The exception includes one telecommunications equipment company that affirms developing hardware.

manufacturing activities in Brazil and lost the incentives for R&D provided by the IT Law, drastically downsizing their R&D team in Brazil. One of the companies, which in year 2000 had almost 100 employees in R&D activities, reduced the number to 12 people in year 2003 (Galina, 2005). The company developed small telecom switchboards — the technology came through the acquisition of two Brazilian companies at the end of the 1990's by the MNC. These R&D activities were interrupted and nowadays the joint-venture develops specific hardware and software projects in Brazil. There is a negative perspective for the future of R&D activities in the Brazilian subsidiary; isolated activities may be reduced due to problems related to the joint venture agreement.

For different reasons, the electronics company also has reduced the R&D activities in the country. Brazil was a development center for TV tubes until the 90's, when the company transferred the R&D activities to Singapore attracted by benefits as subsidized labor, agreements with universities and others⁵. It is evident that the Brazilian unit did not have any specific competence as the R&D center was easily transferred. Nowadays, there is no formal R&D structure in Brazil; just a receiving team. The company employs outsourced workforce or hires local universities when there is a demand for any specific development.

Both power companies are very similar to the cases analyzed above. The Brazilian National Agency of Electricity (ANEEL) is responsible for managing the Research and Technological Development Program for the Electrical Sector which obliges the company to invest a percentage of its revenue in R&D⁶. Although both interviewed companies have to comply with this program, their R&D investments are above the resources defined by the Program. It is worth mentioning that the R&D Program of ANEEL determines investments in more experimental areas such as alternative energies, for instance, but the resources have been applied in supplying local market demands or local client demands; not in R&D.

The R&D activities of the Type 2 — vehicles and parts company — are limited and follow the headquarters instructions. The technological activities are strictly aimed at product and process adaptation to Brazilian and South American conditions, including the use of alternative fuels (ethanol) or gasoline composition variations; the nationalization of some components and search for cheaper or more adequate materials. Although the company has been established in Brazil since year 1970, R&D has only recently been structured (2004). The size and the

⁵ Years later, the center was transferred again from Singapore to India.

⁶ The 10.848 Law determines that a small percentage of the net operational revenue (1% ROL) from power companies must be shared between R&D Programs and the CT-Energy Funding. The part of the resources of R&D Programs must be applied in internal R&D activities of the power concessionaires according to ANEEL Resolution number 271/00.

dynamism of the Brazilian market for Motorcycles have been the main influences in the corporation's decision. The corporation R&D is very centralized at the headquarters (Japan); only a small number of R&D activities are carried outside, in Taiwan. Even researches in fuel cells based on sugar cane ethanol (the Brazilian program is a benchmark) are under the head office command.

Finally, there is the case of the capital goods company. The company had affirmed that it does not carry out any kind of R&D activities in Brazil but we identified a team with over 200 engineers working in process and product adaptation, including software programming for robots and studies to identify the customer's technical requirements to electrical and automation projects. The same team has developed projects on a global scope (sporadically) which justifies the classification of the company.

To conclude we should emphasize at least two similarities among the Type 2 companies. Firstly, most of Type 2 interviewed companies do not have a formal and structured R&D department in Brazil. Whenever they need more knowledge intensive developments, they outsource employees from other companies or hire such activities from Brazilian universities. Furthermore, their R&D activities involve only local capability for adapting projects or process to the local market or production. All these activities are irrelevant for the corporation R&D network context. According to our conceptual framework (3.2 section), Type 2 companies could be compared to a Technology Transfer Unit, since the main function has been market customization.

TYPE 3 – Continuous development

Type 3 concentrates the larger amount of sample companies (approximately 39%). Among companies classified as Type 3, we can find: two from Cosmetic and Hygiene, two from Capital Goods, one from Metallurgic, one from Aluminum and Metals, one from Paper and Cellulose, one from Construction, one from Chemical, one from Food, one from Electronics and Telecom, one from Other Sectors and eight companies from the Pharmaceutical Sector.

Therefore, all eight companies interviewed from pharmaceutical industry stand out in the Type 3. The research activities of this industry have a peculiar dynamic. It is important to remember that the creation of a new medicine is divided into four successive stages: (i) discovery of a new molecule; (ii) pre-clinical tests; (iii) clinical tests; (iv) marketing and pos sale test. It could be unsafe to make such an assumption because the stages are interconnected, but we could say that the search for molecules with therapeutic intentions is considered 'research' (R) and the clinical tests (to verify the security, reliability, etc.) are considered "development" (D). A larger percentage of the resources is

applied in the first two stages that are highly concentrated in the headquarters. The clinical tests consume about 40% of the total R&D and along with production, are the most internationalized and distributed activities of the pharmaceutical industry (Radaelli, 2006).

Brazil follows this trend. The clinical tests are divided in four phases: (1) evaluation of the tolerance or security of the medication in a restricted number of health volunteers; (2) test of the medication to evaluate the therapeutic efficiency in a restricted number of volunteers with the disease; (3) test of the medication in a larger number of people with the pathology to verify benefits and risks; (4) additional tests for product follow up in commercialization. All interviewed pharmaceutical companies carry out Phases 2 and 3. Only two affirmed they conduct Phase 1 in Brazil, although limitedly and sporadically. Once the clinical tests that can be associated to the 'development' activities and this type of activity is highly internationalized, Brazil is not well ranked in the context of the entire corporate.

We find a similar situation for other companies classified as Type 3 (non pharmaceutical). The development activities of these subsidiaries are essentially focused on local market demands and none of them demonstrated accumulation of specific competences which might allow them to stand out in the corporation. In general, they start from formulations or existing products and develop new versions to attend the local and/or regional market (Latin America); they do experimental development as well as adaptation of products, processes and raw materials.

In the Type 3 group, there is only one company of capital goods whose activities also aim at the world market because of production scale. However, even in this case the activities are restricted to observation and incorporation of the market tendencies for their products and processes. The R&D center was created in the 2000 year so the subsidiary would remain competitive. There are also situations in which activities are more focused in the process for manufacturing of pre-defined products or incorporation of local raw materials. This is the case of the cellulose and paper company: the most relevant R&D activities developed in Brazil are related to the genetic improvement of the species to increase productivity.

Type 3 subsidiaries also "hire" services from universities and research institutes when there is a demand for a more sophisticated activity. Many companies declared it is cheaper to pay the university than to invest in the internal R&D structure. One of the companies from Hygiene and Cosmetic sector (North American), which intends to launch a nationally-formulated product in four years, was searching — when interviewed — for a local university to "order" the research. The company offers financial resources to the university and demands exclusivity in the results as a counterpart. The subsidiary, which has 23 graduates working

on this activity, does not intend to expand its internal R&D structure because of this new strategy of creating “national” products. The Brazilian unit may still act as a “support” R&D laboratory, following the guidelines of the marketing department.

Summing up, Type 3 companies rely on a formal internal R&D structure and fixed employees to conduct these activities. The number of employees in R&D varies by company but it is generally 20 to 30 people. These are mostly graduated and some also have a master's degree and a PhD — usually there are 2 post-graduates in each company. In all Type 3 companies, development activities are clearly based on local market demands, to ensure competitiveness or to increase their participation in an expansion scenario, depending on the sector.

TYPE 4 – Sporadic research

Thirty-three percent of the sample was classified as Type 4: eight from vehicles and parts, three from chemical sector, two from ICT sector, two from the food sector, two from metallurgic sector, one from another sector.

As well as Type 3 companies, the R&D activities of Type 4 companies focus on local and/or regional market demands — they are also “pushed” by the market, including for sporadic research activities. However, Type 4 companies have demonstrated more technology maturity than Type 3 companies. Most of the Type 4 subsidiaries have accumulated specific competences in similar fields which allowed them to distinguish themselves in the corporation. Moreover, some of them have developed products locally which were later incorporated into the corporation portfolio.

These competences are strongly linked to product development for developing markets. This situation is even more evident in the case of Vehicles and Auto-Parts companies. The automobile assemblers and the auto-parts producers have accumulated competences through adaptation and development of products for the local market — small and low cost cars — and for Brazilian roads, besides developments related to the use of alternative fuels (ethanol). These adaptation activities have required the development of new materials, products and processes, making local R&D activities more complex.

These companies are experiencing market expansion in Brazil as well as the consolidation of R&D activities (specifically development) carried out in the country. At one of the interviewed vehicle assemblers, for instance, the number of employees in the engineering product area leaped from 200 in 1997 to 1250 in 2007. The Brazilian subsidiary participates in global projects, although its role is mostly limited to the development of a given component or system for engines and consultancy on materials and fuels. Another Type 4 automobile assembler has demonstrated a more active insertion in the global research network. Brazilian

subsidiary was elected one of the five engineering global centers and will be responsible for the automobile project from the concept of the product, dominating all the automobile development cycle. In May 2007 (time of interview), it employed 1.100 engineers in product development, approximately 50% more than four years ago. The engineering areas of auto-parts companies are also globally organized. In general, the subsidiaries are responsible for a share of the development activities of a given product, working on innovation times by projects and product families in collaboration with subsidiaries from other countries.

When it comes to the three chemical companies classified as Type 4, all of them have expressive R&D structures in Brazil, employing more than 100 people each in these activities. As in other Type 4 companies, R&D activities are carried out in response to local and regional demands. Nevertheless, one of them, a tyre manufacturer, is recognized for being more actively inserted in the global research network. This subsidiary (employs almost 200 people in R&D) conducts joint development with other foreign subsidiaries, including products for developed countries such as USA and Japan. This R&D center was also created as an answer to the specific conditions of the local market, starting with tyres for trucks and autobuses, which concentrate the main competences of the local subsidiary. More recently, it has also excelled in motorcycle tyres.

On the other hand, the R&D activities of the two other chemical companies have a strong regional feature. One of them underlines the corporation strategy which proposes that each development center must supply the demands of its closest market — Latin America in the case of the Brazilian subsidiary. Although it has a considerable R&D structure in Brazil — employing 150 people (27 PhDs) — the R&D efforts are limited to the regional market. However, the Brazilian subsidiary has developed a number of products which were incorporated into the corporation portfolio. It has interacted with universities for occasional research; the university researchers are provided access to the company infrastructure and the project coordination is shared by the company and the researchers.

In the case of the two Type 4 ICT companies, both Brazilian subsidiaries are integrated to the R&D global network. Notwithstanding, it was evident that this integration results not only from competences acquired locally but also from the configuration of global R&D. The Brazilian subsidiaries carry out one part of the product development, but the research and the guideline outlining for local activities are conducted abroad. In both ICT companies, sporadic researches usually arise from technical challenges faced in the development process that end up originating new products and technologies.

In the case of the Type 4 food companies, the relevance of the Brazilian subsidiary for the corporation is different because of the R&D organization: more

or less centralized. One of these (from USA, produces ingredients for several food products) conducts a large share of development activities in Brazil. The subsidiary is considered a reference in the corporation for “developing new ingredients”. The other food company (dairy producer), although having a record of successful experiences in raw material and new product development (marketed in other countries as well), concentrates R&D activities in the headquarters (Japan) and the activities of the Brazilian subsidiary resulted from its own initiatives to become more competitive.

The metallurgic company (tubes manufacturer) conduct mainly non-destructive tests, experimental development and process and product improvement. The research is concentrated in Germany and France (headquarters). The main office has been demanding more investments in R&D activities in Brazil in face of its current diversification strategy. The demands of oil companies and vehicle industries (its main clients) are decreasing and the subsidiary has been taking advantage of its competences in tubes to find solutions for infrastructure companies (energy, construction and transport). The subsidiary has been interacting with a number of Brazilian universities to accomplish some applied research.

Type 5 – Continuous and relevant research

As Type 5 we classified 4% of the sample or just two companies: one from Hygiene and Cosmetics and one from Electronics — in fact an appliance manufacturer — both from USA. They distinguish themselves from all the sampled companies for accomplishing continuous research in Brazil — and this activity is strategic for maintaining and increasing their competitiveness — and because they have developed products and technologies that are sold worldwide (besides the local and regional markets). In other words, they are close to the Global Technology Units in the Ronstadt (1977) classification and are also excellence centers in the concept of Frost, Birkinshaw and Ensign (2002) presented in section 3.2. These “Type 5” Brazilian subsidiaries have a set of capabilities which allow them to be a research and development excellence center broadly recognized in the corporation. It should be noted that both have patents registered in the USPTO (United States Patent and Trademark Office) and EPO (European Patent Office).

In the Hygiene and Cosmetics Company, patent production has been one of the conditions for the Brazilian unit to be included into the corporation competences map. The Brazilian unit displays competences in four different areas: first aid dressing, sanitary napkins, body protection and oral hygiene. Some products were developed in Brazil and later introduced into other markets such as the US

and Asia. In this case, the local competences are concentrated on “solid” products; the Brazilian subsidiary only adapts the liquid products in order to reduce costs without altering the original product characteristics. The corporation's strategy is to create a balance between all R&D centers. Therefore the Brazilian subsidiary is supposed to complement the activities developed by the whole group.

The appliances company is a former Brazilian firm that was acquired in 2000 year by a foreign group. Thus, investments in innovation which had started before the acquisition process have been fundamental to reach the current position held by the subsidiary in the corporation. They own two technology centers in Brazil: one for vertical axis washing machines — the local unit leads this technology in the corporation. A second technology center is for refrigeration and cooking. These centers employed, at the time of the interview, 191 people, including 54 with master's degrees and 4 PhDs.

5 Final considerations

In response to the question employed as the title for this article — ‘What are subsidiaries of multinationals doing in Brazil?’, we may affirm Brazil is not widely considered when the attraction of FDI oriented to R&D is considered. Such conclusion was drawn from extensive research, which included detailed interviews with Brazilian subsidiaries of foreign MNCs. One of the results leads us to conclude Brazil has not yet joined the global R&D network of MNCs effectively and strategically.

Our analysis suggests that most of these Brazilian subsidiaries carry out development (‘D’) considering local or regional market, which is mostly product and process adaptation. In some of these companies it is not even continuous. The research (‘R’) activities impose themselves to companies occasionally to supply local markets as well. Only few firms were found to be carrying out research in Brazil without application commitment. Besides, the country currently accounts for a small number of R&D centers of excellence which are a reference in corporations.

The typology allowed us to draw a broad view and to find the answers to the title-question, as well as to embrace the specificities identified in R&D carried out by Brazilian subsidiaries. We have selected some features that characterize the local R&D activities and are the base of our typology: the kind of R&D department (formal and structured); size of R&D team; accumulation of specific competences; patents and others.

Firstly, we observed that R&D activities are not strategic for 25% of our sample (Type 1 and 2 companies). Such firms either do not carry out R&D activities

in Brazil or do only sporadic development. For instance, although we could identify an engineering team in a number of companies, no formal and structured R&D department was in place. When there are local requirements, some employees are allocated to adapt products or processes. In some industries, specially in the case of ICT companies, R&D activities in Brazil have been reduced or completely extinct. Stimulated by the IT Law requirements, the ICT companies used to have formal structures for R&D and cooperative agreements with universities and research institutes. However, these former investments have not contributed to the accumulation of specific competences by Brazilian subsidiaries allowing them to be differentiated in the corporation. The same occurs with energy and oil companies: although the government specifically obliges them to invest in R&D, we could not find relevant activities being developed.

Second, we identified the largest amount of sample companies (carry out development activities continuously) — among Type 3 and Type 4 companies. It is worth pointing out that Type 3 businesses do not carry out any development activity which is not specific or peculiar to Brazil. We can conclude that Type 3 affiliates accumulated competence in process although no specific or particular competence in products has been acquired. The case of the pharmaceutical companies illustrates this since businesses have competence in pre-clinical and clinical tests in Brazil. As we discussed before, clinical tests are the most internationalized activities of the pharmaceutical industry.

The case of type 4 businesses displays a different pattern. Both affiliates from Type 3 and 4 perform Development activities in Brazil, but Type 4 still do Research, although sporadically. Besides, we identified that most Type 4 affiliates have become strategic inside the corporation R&D network. This is best represented by the case of automobile companies: they are (specially the engineering team) increasingly recognized in product development which includes capability to provide cost-effective solutions (low-cost, reliable performance), design of small and efficient cars and engines, development of suspension modules and others. It is suggested that some Brazilian automotive companies are becoming partners of their headquarters in global product development.

We have also noticed that merely two companies among the 54 interviewed carry out Research consistently (Type 5). Only a small number of businesses conduct systematic R&D activities despite the number of MNCs installed in Brazil, which corroborates our statement that Brazil is not yet inserted in the multinational global map of R&D.

Third, it should be noted that the analysis of each Type has not been restricted to justifying company classification, but also intended to observe if these companies have some relevance in the global corporation context, considering locally accumulated competences, even in development activities. The analysis

has also allowed us to rescue the aspects approached by the literature discussed above identifying if Brazilian subsidiaries were in some way a source provider of value beyond the boundaries of the originating unit, in the sense approached by Frost, Birkinshaw and Ensign (2002). We have observed that companies which present some of these conditions have started to appear more frequently under Type 4: some of them are responsible for part of the development of some product or system in the global R&D network.

Finally, it is important to emphasize that the limited R&D investments and the small share of R&D-intensive activities of MNCs in Brazil occur despite several local advantages (comparative and competitive) presented in literature as drivers of R&D internationalization. For instance: most MNCs have been in Brazil for a long time (in general, for more than 30 years) which contributes to the technological learning process; the need to adapt to foreign technologies (taste, culture, climate, income, etc); the scale of operations considering a large domestic market (around 170 millions of inhabitants); highly qualified workforce; high quality standards of public higher education and a strong system of post graduation (Brazil granted around 30 500 master's degrees and 9 900 PhD degrees in 2007 in different knowledge areas); among other IDE in R&D driven forces. These characteristics have not become driven forces to attract IDE in R&D to the country.

Therefore, we would like to ask what is needed for Brazil to be considered by MNC corporations as a significant player in R&D activities. Certainly, there is a group of factors, inherent to the Brazilian national innovation system (intellectual property rights; political environment; government rules reliability; bureaucracy; qualified labor force availability, etc) and internal company factors (corporation-affiliates relationship; the role of the managers in attracting R&D investments; R&D configuration, etc.) that influence decision makers of MNC corporations. Such internal and specific Brazilian characteristics have become increasingly important.

In conclusion, both parties might bring a change to this scenario. Subsidiaries still lack an R&D culture in Brazil. As for the country, it is necessary to implement an aggressive strategy targeting its inclusion in worldwide R&D. It is important to develop a technological and institutional structure to stimulate, regulate and promote an effective interaction between the MNC technological strategies and national technological capabilities to promote investments in innovation.

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