

Internationalization of R&D by Brazilian Multinational Companies

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Abstract

Traditionally, most of previous studies on international R&D are not only conducted in advanced countries but also carried on with companies headquartered in developed economies. This paper presents an analysis of the R&D internationalization of Brazilian Multinational Companies (BMNCs) in terms of the major driving forces to globalize R&D and coordination of international R&D activities. This research was based on a multiple case study with seven BMNCs, which was leaded by a framework with specific issues on international R&D (driving forces, roles of subsidiaries, R&D management). We found out that BMNCs have internationalized its product development encouraged by both market-driven and technology-driven factors. Our conclusion is that, when compared to companies from developed countries (literature), BMNCs perform internationalization of R&D activities with very similar characteristics. These finds are additional evidences to contribute to the ongoing discussion about the internationalization of companies from developing countries.

Keywords: international R&D, innovation, Brazil, developing countries, emerging countries

1. Introduction

Internationalization of Research and Development (R&D) in multinational companies (MNCs) has grown rapidly over the last two decades (United Nations Conference on Trade and Development [UNCTAD], 2005). In part, this is a consequence of the need to intensify knowledge creation and to promote innovation, currently critical factors for international competition.

Traditionally, international R&D is a phenomenon of firms originating from advanced economies such as USA, European countries, and Japan (von Zedtwitz, 2005). Most of previous studies on this area focused on R&D not only conducted in advanced countries but also carried on by companies headquartered in developed economies. Therefore, studies on global R&D are neglected for developing countries (Wu, 2007).

We must consider that there is a clear dominance of international R&D by firms from advanced countries not only because the internationalization process of leading emerging country multinationals (EMNCs) is very recent, but also because they tend to belong to low-tech industries and their investments in R&D are weaker, even in home countries. However, "for the first time since the mid-1980s, when international R&D became a more widespread practice among technology multinationals, we are witnessing the emergence of a new class of high-tech companies from developing countries" (von Zedtwitz, 2005, p. 119). On the other hand, EMNCs are growing their investments in R&D abroad (UNCTAD, 2005). Thus, it is worth to study this phenomenon.

Even from less high-tech industries when compared to Indian or Chinese, Brazilian Multinational Companies (BMNCs) have recently internationalized some activities of technology and product development. Thus, this paper presents an analysis of the R&D internationalization of BMNCs, aiming to explore the following questions: What are the major driving forces to globalize R&D? What are the roles of subsidiaries in the implementation of R&D activities? How these international R&D is coordinated?

This is an exploratory study because, even investigating a well researched area (international R&D), it focuses on the perspective of developing countries and on the globalization of R&D by BMNCs, so far under-explored fields. Galina (2011) points out that BMNCs internationalize R&D, but since it is based on data from one case study, the same author highlights the necessity of deep research for this topic. The results presented in this paper contribute to the ongoing discussion about the internationalization of R&D by developing countries because it compares cases of BMNCs with the existent literature on the specific issues related to the questions above.

2. Theoretical and Empirical Background

2.1 Internationalization of R&D

Internationalized corporations have stepped up their R&D and innovation activities outside their countries of origin (Le Bas & Patel, 2005; UNCTAD, 2005), resulting in the establishment of new multinational R&D configurations (Gerybadze & Reger, 1999). Thus, the processes of science, technology and innovation became more and more dispersed, both geographically and functionally (Gammeltoft, 2006).

Notwithstanding, R&D internationalization cannot yet be associated with a homogenous distribution of innovation activities across the globe (Blanc & Sierra, 1999; Gerybadze & Reger, 1999; UNCTAD, 2005) because R&D offshoring is still much concentrated on the Triad countries (EU, USA, Japan), in South Korea, Singapore and other emerging economies of the Pacific Rim (UNCTAD, 2005; von Zedtwitz & Gassmann, 2002). Knowledge-generating activities—now often carried out outside the home country—revolve around centers of excellence, thus the more sophisticated R&D tend to be concentrated in developed countries (Gerybadze & Reger, 1999). By contrast, the R&D performed in developing countries was, until recently, of little significance in terms of scale, with sparse and disperse data (von Zedtwitz, 2005).

However, this trend reversed recently as multinationals began to make direct investments in offshore R&D and leading corporations began to allocate R&D to developing countries (Reddy, 2011; UNCTAD, 2005; Wu, 2007). Such changes can be observed by reference to data on overseas R&D by multinationals from the United States, which show a decline in the share of some developed countries that was picked up by developing economies, almost exclusively in Asia (UNCTAD, 2005). Another important fact observed recently is that EMNCs are also investing in R&D abroad (UNCTAD, 2005), both in developed and in developing nations.

2.2 Driving Forces to Globalize R&D

The literature on internationalization of R&D driving forces has been developed in the decades of 1990s and 2000s (Florida, 1997; Gammeltoft, 2006; Gerybadze & Reger, 1999; Inzelt, 2000; Kuemmerle, 1997; Ohmae, 1990; von Zedtwitz & Gassmann, 2002). First of all, it is important to highlight that some characteristics of MNCs influence their R&D offshoring, one of them being the nationality of the parent company (von Zedtwitz & Gassmann; 2002; Li & Kozhikode, 2009). It might determine, for instance, the need to find other knowledge-generating environments in order to obtain competitive advantages in technology (Doz, Santos, & Williamson, 2001) or to adapt to new markets as required. The company's industry is also an important factor behind decisions whether stimulate or not R&D internationalization. There are industries where the urge for rapid product development requires access to a wide base of knowledge (available worldwide), as in the case of technology-intensive businesses like information and communications technology industry. However a significant and consistent distribution of R&D activities can also be found in technologically mature industries (Filippaios, Papanastassiou, Pearce, & Rama, 2009).

Regardless of company attributes, R&D internationalization is a growing trend and there are reasons for that. The most frequent motivations found in multinationals are mentioned by various studies (Bertrand, 2009; Cantwell, 1992; Chen, 2008; Florida, 1997; Terpstra, 1977) and include the need to: transfer technology from the parent company to foreign subsidiaries; respond to pressures from the countries where their subsidiaries are located; improve international relations; obtain access to foreign talent; gain advantages via access to complementary technologies and contact with new lines of innovation (in different National Innovation Systems); cut product development costs by resorting to cheaper structures and resources; acquire access to skilled labor; gain advantages via local ideas and products; accelerate the process of product development by drawing on the efforts of several laboratories working simultaneously; continue the product development activities pursued by an offshore acquiree; exploit the advantages offered by certain local government incentives; and to support the requirements of an increased number of specialized manufacturing units.

These factors are frequently categorized. Gammeltoft (2006) summarizes them into six categories: market-driven, production-driven, technology-driven, innovation-driven, cost-driven, and policy-driven. In a general manner, the main reasons for internationalizing R&D can be divided into two groups (Florida, 1997): market-driven factors (the need to gain access to markets in order to respond to local requirements and increase customer proximity) and technology-driven factors (recruitment of qualified personnel, access to foreign talent, and gateway to superior technologies). The ramifications of the reasons for internationalizing R&D are usually classified into one of these two wide groups.

Market-driven factors are basically concerned to the adaptation of products to foreign markets and to the provision of technical support for manufacture plants. MNCs establish units abroad in order to serve their

customers better with more adequate product adaptations and, above all, with faster adaptations. By bringing their product development activities closer to the market, such companies become better equipped to understand the local needs and to meet those needs and offer products to their customers. This is particularly true in face of the fact that most MNCs possess huge and extremely bureaucratic organizational structures, which hamper the decision-making process. The technology-driven factors, on the other hand, are primarily related to the need to secure access to S&T (Science and Technology) and skilled human capital, and to create ties with local scientific communities. Both technology and market factors are important to attract local R&D investments, and companies consider some combination of these two types of drivers when choosing a location for their investments.

Kuemmerle (1997), based on John Dunning's eclectic paradigm and his contributions to international business theory (Dunning, 1988), proposed that global R&D investments could be classified as "home base exploiting" or "home base augmenting". Home base exploiting investments are used to exploit abroad existing advantages of the firm, they are mainly concerned to local adaptation of products and process and creation of peripheral products. Home base augmenting investments are those made to add new knowledge or skills to the company, they usually emphasize creation of core products or new process.

More recently, the literature on strategic aspects of international R&D categorizes motivations for locating R&D activities in foreign countries in technology adaptation (knowledge exploiting) and technology generation (knowledge augmenting) (Ambos, 2005; Edler, 2008). The adaptation approach is followed by MNC that exploit their technological strength in foreign markets using their R&D units for supporting local production because products are adapted to local demand. The generation perspective is for firms interested in augmenting their current specific knowledge by investing abroad for developing products for different countries (Schmiele, 2011). This recent research refreshes the ideas developed by Kuemmerle (1997) for home-based-augmenting (unit transfers host country's knowledge to the home base) and home-based-exploiting (unit transfers existing knowledge to R&D unit abroad for local manufacturing and marketing), now with the perspectives of local and global products.

Most of the researches mentioned above are concentrated on R&D units located in the Triad and made by MNCs from developed countries (DMNCs). Recently a number of studies have been published focusing emerging countries, especially in Asia (Chen, 2008; von Zedtwitz, 2004, 2005; Wu, 2007), but also other regions (Boehe, 2007; Galina, Sbragia, & Plonski, 2005). Wu (2007), studying companies from Taiwan, affirms that both developed and developing countries appear to have the same motivations and use similar methods in globalizing their R&D.

Thus, from the literature, we point out three propositions to be investigated in this paper:

- (i) *BMNCs internationalize their R&D;*
- (ii) *BMNCs internationalize their R&D motivated by both market and technology factors;*
- (iii) *BMNCs internationalize their R&D with similar characteristics when compared to MNCs from advanced countries.*

2.3 Strategic Roles of MNCs Subsidiaries

In order to operate globally, MNC subsidiaries assume certain strategic roles and responsibilities, and they are distributed across the globe so that the resources of each country can be exploited rationally. Some typologies have been created for the roles played by MNC subsidiaries (Bartlett & Ghoshal, 1986; Birkinshaw, 1996; Ferdows, 1997; Frost, Birkinshaw, & Ensign, 2002; UNCTAD, 1999). Most of them are based on two key assumptions underlying the companies' attitudes in relation to the roles and responsibilities to be assigned to their offshore units: (1) the level of local aptitudes and resources or the level of competence shown by the national subsidiary in technology, production, marketing or any other area; and (2) the strategic reasons for the choice of location as an environment where the company will do business, such as costs, market or access to knowledge.

These are the assumptions behind the classifications initially proposed by Bartlett and Ghoshal (1986) and later improved by other authors, including Ferdows (1997), whose typology is based on a cross between local competencies (high and low) and three clusters of strategic reasons for site choice: low production costs, market proximity, and access to skills and knowledge.

2.4 Coordination of Global R&D

In every one of the subsidiary role classifications mentioned in the previous section, there are company units in

charge of generating technology for the subsidiary itself or even for the entire corporation. Ronstadt (1977) shows different types of units that engage in offshore R&D activities for MNCs (i.e., outside the MNC's country of origin):

- Technology Transfer Units (TTUs)—facilitate the transfer of technology from the parent company to the subsidiary, and provide local technical services.
- Indigenous Technology Units (ITUs)—develop new products for the local market using local technology.
- Global Technology Units (GTUs)—develop new products and processes for key global markets.
- Corporate Technology Units (CTUs)—generate long-term basic exploratory technology for use by the parent company.

Adding to this typology developed by Ronstadt, Reddy (1997) offers, and quite appropriately so, another class of global R&D units as “certain regional clusters are also becoming stronger despite market integration around standards and technologies” (Reddy, 1997, p. 1822):

- Regional Technology Units (RTUs)—develop products and processes for regional markets.

Although this study by Reddy was carried out more than a decade ago, the author affirms in a more recent study (Reddy, 2011) that some finds of previous research remains the same.

Ronstadt's classification helps us to see that subsidiaries are assuming increasingly important roles in terms of innovation. Traditionally, technology has flowed from headquarters to subsidiaries, but now global companies not only consider overseas R&D activities as sources of knowledge and technology, including units located in emerging economies (Reddy, 2011), but also create mechanisms to integrate cross-border knowledge for transnational new product development (Subramaniam, 2006).

In order to decentralize R&D, companies resort to a variety of strategies to distribute the activities associated with this function as well as their control worldwide. Ronstadt's typology does not include intra-organizational relations even though it has been widely used as a standard for international R&D structures in MNCs. The literature shows several models for decentralized R&D management even where coordination is centralized (Behrman & Fischer, 1980; Chiesa, 1995; Gassmann & von Zedtwitz, 1999; von Zedtwitz & Gassmann, 2002).

Under the Internationalized R&D Management Model proposed by Gassmann and von Zedtwitz (1999), companies analyze the benefits and threats associated with R&D offshoring and accordingly decide whether or not to centralize this function. With regard to this decision, Gassmann and von Zedtwitz (1999) identified five different models of R&D offshoring configurations. Each one of these configurations takes into account the following variables: degree of centralization of decision making, and degree of cooperation/competition among the company's subsidiaries. They are:

- Ethnocentric Centralized R&D—Every R&D activity is concentrated in the headquarters.
- Geocentric Centralized R&D—It centralizes know-how acquired over the world and technologies available in overseas countries by means of sending R&D employees abroad in order to intensify relationships and collaborate to the local production, suppliers and key clients.
- Polycentric Decentralized R&D—It is characterized by local development laboratories with no supervision of the corporation center, whose relationship is restricted to the report of activities from the local labs to the headquarters.
- R&D Hub Model—The R&D central unit, usually located in the headquarters, is the corporation technological leader since it is the major advanced R&D laboratory.
- Integrated R&D Network—in this structure, each integrated network unit specializes in a product or technological field, thus becoming center of competency in its segment and has world product mandate.

3. Methodology

Since this is an exploratory study, as mentioned above, the use of case studies is an appropriate approach (Yin, 1994). At this paper we used an approach of interview-based multiple case study. Seven Brazilian Companies were selected for the sample according to the following criteria: to have manufacturing subsidiaries abroad and to conduct internal R&D activities. They are from very different industries (Table 1). The studied companies are: Embraco (Note 1), Gerdau, Marcopolo, SantistaTêxtil (Note 2), Smar (Note 3), Tigre, WEG.

As shown in table 1, the companies in the sample are truly multinationals since they operate in different regions; none of them have manufacturing units in South America alone. Two of them—namely Tigre and Smar—only

have plants in the Americas, but both do business in the United States, which is distant from Brazil in terms of psychic distance, “defined as factors that make it difficult to understand foreign environments” (Johanson and Vahlne, 2009, p. 1412), characterizing an international—and not only regional—performance. Gerdau has approximately twenty transformation plants, over twenty steel mills and four steel cutting and bending units offshore—in Latin America, the United States and Europe. Marcopolo operates globally through production facilities in four continents. Embraco has manufacturing units in the United States, Europe and China.

Triangulation is important to improve the validity of data collected. Although the process of triangulation in social sciences, since its origin with Campbell and Fiske (1959), usually refers to the use of multiple methods—mainly linking qualitative and quantitative studies (Jick, 1979), it allows researchers both to compare and contrast different sources of findings (Yeung, 1995). Thus, the data—both primary and secondary—used in this study are from different sources, and they were collected between the years 2007 and 2008.

Table 1. Studied Brazilian multinational companies (actualized in 2011)

Company	Industry Specification and products	Main manufacturing units	Foundation	First FDI*
Embraco (Whirlpool)	Electrical-electronic for cooling solutions, hermetic compressors, condensers and evaporators	Italy, China, Slovakia, Mexico	1971	1994
Gerdau	Long carbon steel, long specialty steel, flat steel, and cast parts	Uruguay, Canada, Argentina, Chile, USA, Colombia, Peru, Spain	1902	1980
Marcopolo	Bus-body manufacturer (heavy and light vehicles)	China, India, Colombia, Mexico, South Africa, Egypt, Argentina	1949	1991
Santista/Tavex	Textile production (denim, flats and workwear)	Argentina, Chile, Spain, Morocco, Mexico	1929	1994
Smar	Electronic and automation	USA (Nova York and Houston)	1974	1989
Tigre	Construction (pipes, fittings and accessories.)	Colombia, Uruguay, Peru, Ecuador Paraguay, Chile, Argentina, Bolivia and USA	1941	1977
WEG	Electric motors, variable frequency drives, soft controls, panels, transformers, and generators	Argentina, México, Portugal e China	1961	2000

Note: * Foreign Direct Investment in operations.

In order to analyze the internationalization of R&D activities by the aforementioned multinationals, we obtained primary data via interviews with their representatives both from the areas of internationalization and technological innovation. In each of the studied companies we interviewed at least one executive (director or manager) from the R&D area (or equivalent) and one executive from the internationalization sector (or equivalent). These interviews were conducted with a semi structured questionnaire which addresses specific issues to collect data that compose the variables listed in Table 2.

Table 2. Variables considered in the analysis

Specific issue on Variables	References
International R&D	
Driving forces	Market-driven (market access / support for local demand / adaptation to local market) Technology-driven (administrative heritage / qualified labor / Technology access)
Roles of subsidiaries	Local competences (High / Low) Strategic Reasons for local choice (low cost / knowledge access / proximity to market)
R&D Management	Subsidiary capacity for developing / transferring technologies or products Geographic scope of product developed: local, regional, global Centralization of decision making Existence of cooperation and competition amongsubsidiaries

The sources of secondary data included: news, scientific articles and companies’ reports that provided data on the internationalization process of these multinationals. Where permission was granted, the authors also collected documents or data belonging to such organizations: reports, contracts, plans, internal metrics/goals, and other.

This is important to ensure triangulation in order to check information mentioned in interviews (Ghauri, 2004). As the purpose of this study was to analyze the R&D function within the selected companies as well as its internationalization, we looked into the following: structure of the R&D function, its installations, how product development activities are conducted by each company in Brazil and, finally, how they are carried out abroad.

The determinant variables used to answer the questions raised in this research project were defined by reference to the literature on R&D internationalization (Table 2) as regards the specific issues contemplated in this study: the driving forces, roles of subsidiaries and R&D management internationally.

4. Results and Discussion

4.1 Driving Forces for Internationalization of R&D in BMNCs

Considering the studied BMNCs, we were able to see the two types of factors influencing the internationalization of their R&D activities: technology and market-oriented as showed in table 3. It should be noted that Product Development is what they internationalize, basically; research remains in the headquarters in Brazil. This finding is consistent with the work by von Zedtwitz and Gassmann (2002), who state that only corporations abounding in resources can actually opt for offshoring research (R) and development (D) simultaneously. Usually, the internationalization of R&D occurs at different points in time, one after the other. Alternatively, only one of them is globalized.

Most of studied companies do not supply directly to final consumer, thus some market-driven factors, like monitoring of local markets needs, are lightly observed since they are based on a B2B relationship. However, in general, companies use foreign production sites as provider of new market needs and customer feedback, similar to the observed by von Zedtwitz and Gassmann (2002). On the other hand, adaptation of products to local markets is frequently observed as factor that led the BMNCs to internationalize R&D. This factor was mentioned by all companies, but strongly pointed by WEG, Embraco and Marcopolo.

WEG do not only customizes products to meet local demand but also adapts them in order to comply with local/regional standards. The company maintains an R&D unit in Europe (Portugal) because the products marketed there must be certified by EU laboratories. Instead of developing products in Brazil and shipping them to Europe for certification, WEG has entrusted the responsibility for adapting, manufacturing and certifying them from its Portuguese subsidiary. Embraco has, with regard to technologies already dominated by the company, granted autonomy to its subsidiaries to adapt and customize products and manufacturing processes according to the characteristics of local plants and markets. The company has opted for decentralization because it needs to operate closer to the customer and respond more quickly, and this means identifying customer needs, translating them into projects and implementing these in a shorter time period than it would be possible if development were centralized. Marcopolo claims that subsidiary participation—when a project or product requires customization to the business market—shortens its local lead time. It established a development-engineering unit in Portugal because that market, in addition to reporting very small sales volumes, demands a product that is very different from the ones made by the parent company.

Besides using their foreign R&D subsidiaries to improve and let faster attendance to market needs, BMNCs also consider technology-driven factors when internationalizing R&D. One of these factors is development of partnerships with local suppliers to product or technology development. For instance, Gerdau maintains cooperation with automakers or auto parts suppliers in Europe for the purpose of developing and supplying specialty products (special steel for some specific industry, as the automotive) through the R&D center that was incorporated upon the acquisition of a company in Spain (Sidenor). Gerdau also uses the unit in Spain and its expertise to monitor and to access the development of technology by partners and suppliers. Embraco has a similar strategy, and also benefits from its subsidiary and local partners to monitor technology development. Another reason Embraco offshores R&D activities is searching for specialized labor. China received its investments due to the large number of engineering graduates and post-graduates entering the job market every year.

Acquisition of offshore units that already included technology development capabilities (administrative heritage or path) is usually considered by BMNCs. Gerdau incorporated a R&D department with approximately 30 employees upon the acquisition of a manufacturing plant in Spain. Marcopolo, in a joint venture in Colombia (with Fanalca), kept the development-engineering department for the purpose of designing new products due to its local partner technological competences.

Table 3. Main driving forces for internationalizing R&D in BMNCs

Driving Forces	Main factors for BMNCs
Market-driven	Monitoring (corporative) client needs
	Adaptation to satisfy local requirements
	Attend to local/regional standards or certifications
	Answer to local specific niche of market
Technology-driven	Technology access through supply chain network
	Searching for qualified labor
	Acquisition of foreign company with technology competences

4.2 Role of Foreign Subsidiaries

In order to determine the strategic role played by MNCs subsidiaries, were analyzed the reasons for country's choice and the site competences, two dimensions considered in typologies by Bartlett and Ghoshal (1986) and Ferdows (1997). Thus we classified the choice of offshore location in any specific country according to its interest in access to: low-cost production, skills and knowledge, proximity to market. With regard to unit competences, we used information collected on product (or technology, in few cases) development analysis. Units that developed their products to attend to company needs according to its strategic reason were considered high-competence units; conversely, if product (or technology) development was not a determinant characteristic for that subsidiary, then it were regarded as low-competence unit. This study analyzed 26 manufacturing units, most of which have competencies that can be improved so they may contribute more to their parent companies' international network.

On the whole, market proximity was the main reason for the choice of subsidiaries location. However, there are units whose strategic reason for site choice was access to skills and knowledge. Access to low cost operations is also a strategic factor for locating subsidiaries related to R&D.

More important than classify subsidiaries' roles was to identify a movement of BMNCs very similar to DMNCs, with development of strategies and local competences in an integrated global perspective. To illustrate what we found out into the companies, table 4 presents a summary of identified roles for them.

Smar has two offshore units, both located in the United States. These units are managed independently from their parent company in Brazil and play an important role in providing access to the knowledge available in that country and creating products or technologies for the corporation. In WEG's case, there are six plants dedicated to produce for the local market and one unit which has its own process engineering and products for the local market; the subsidiary in Portugal ranks higher in competence than the other units because it already manufacture explosion-proof products, which is a differential useful for final stages of product development process (or tests). Of Gerdau's several plants, the one analyzed in this study was the plant in Spain, which makes specialty steels, business unit cited by company as the most dependent of technology innovation. It is installed in a high-competence region and the strategy behind this choice of location was the company's desire to gain a strong foothold in the specialty steels business, mainly for the automotive industry, in which case it needed to gain access to the skills and knowledge available in that area. Acquired towards the end of 2006, this plant can manufacture specialty steel products; in addition, it has partnered up with European institutions for the development of automotive products.

Marcopolo runs five manufacturing units, three of which can be described as serving local market. The other two (in Portugal and Colombia) have high competence in process engineering and product development/adaptation but they operate without any coordination from the parent company, so they are mainly dedicated to local market.

Notwithstanding, Santista's case is slightly more complex because its relationship with the Spanish company Tavex, which dates back to 2006, changed the group's global configuration. The Brazilian business groups Camargo Corrêa and São Paulo Alpargatas had a total shareholding of 81.6% in Santista. Then, they sold their total interest to Spanish Tavex Algonodera, and the resulting company became Tavex Group. Following the integration in July 2007, Camargo Corrêa and São Paulo Alpargatas held between them 52% of the shares in Tavex; 42% are in the hands of Spanish equity funds, and the remaining 6% remain with companies belonging to Brazilian Companies.

As a result, the Brazilian subsidiary (former headquarters), which runs an R&D center in São Paulo, has become one more unit within the group. This R&D center is responsible for the activities of several plants in Brazil and

to the offshore units in Argentina and Chile. However, Tavex Group's operations are distributed regionally (South America, Europe, and North America), and its R&D activities are centralized in three countries—Brazil, Spain, and Mexico—one in each region. Both the research center in São Paulo and the future R&D facilities in Mexico should report hierarchically to Spain, where the company's head office is now located. Thus, from the perspective of Tavex Group, these three countries have units with high competences in strategic sites to access specific knowledge. Additionally, it is important to note that Tavex Group has opted for a regional division of research centers, whereby Europe is responsible for research in the Jeanswear segment, and South America for the Sportswear and Workwear segments.

This analysis of considered companies describes paths that can lead subsidiaries of BMNCs to more complex strategic roles, as pointed by literature (Asmussen, Pedersen, & Dhanaraj, 2009; Birkinshaw, Hood, & Jonsson, 1998). This can be achieved by improving their competence and focusing on intangible assets, such as the possibility of learning with suppliers, customers and competitors, the development of research centers, and the ability to attract talents globally. These paths can be used to analyze changes in strategies and plant competence, which in turn allows parent companies to understand their dynamics and, consequently, decide whether or not to build a new R&D center where the plant is located.

Table 4. Role of subsidiaries related to product or technology development

Company	Strategic Roles observed for foreign subsidiaries
EMBRACO	High competence to access local skills or knowledge, creating new products and technologies for the corporation
GERDAU	High competence to access local skills or knowledge to the entire corporation
	High competence for producing to local market needs
TIGRE	No subsidiary related to product or technology development
MARCOPOLO	High competence for producing to local market needs
SMAR	High competence to access local skills or knowledge, creating new products and technologies for the corporation
WEG	High competence for producing to local market needs
SANTISTA/TAVEX	High competence to access local skills or knowledge, creating new products and technologies for the corporation
	High competence for producing to local market needs

4.3 Coordination of International R&D

This section shows that BMNCs present characteristics of global R&D coordination that are similar to the stated by literature. Companies determine roles for their offshoring units and coordinate them according to their stage of R&D internationalization. For this, it is compared the research results with two theoretical models derived from the literature: (i) Ronsdadt model (with Reddy's addendum), which characterizes offshore R&D units; and (ii) Gassmann and von Zedtwitz's, which describes different types of R&D management.

4.3.1 Types of Offshore R&D Units—the Rosntadt (and Reddy Addendum) Model

This model analyzes the offshore units of companies according to the types of activities that they perform. In order to classify the case studies, we took into account characteristics of the product development activities carried out by the said units. First, we analyzed each subsidiary to determine whether they were capable of developing technologies and new products for use by the headquarters or merely operated as units for technology transfer. Then, we gauged the geographic impact of the technology developed by such units, i.e., the importance of their product development activities for local, regional or global markets.

Smar's subsidiaries in USA were both classified as global and corporate technology units because, in addition to developing products for the global market, they generate long-term basic technology for corporate use. Gerdau's affiliate in Spain develops products and processes for most of its markets in one of its business unit (specialty steel), and has competencies of its own that are exploited by the parent company. It was therefore characterized as global and corporate technology unit.

Marcopolo's two offshore units that have their own product development capabilities were classified as indigenous technology units, while the remaining subsidiaries were classified as technology transfer units. WEG's plant in Portugal was classified as a regional and corporate technology unit because, in addition to manufacturing explosion-proof products for the European market, it develops this kind of product and transfers the related competencies to the parent company. The remaining subsidiaries were classified as technology transfer units.

With regard to Tigre, all the units were classified as technology transfer units as they are basically used to

transfer technology from the parent company to the subsidiaries, especially in what concerns to processes technology. As for Embraco, the Italian subsidiary is a global technology unit while the one in Slovakia can be regarded as a regional technology unit. Finally, the plant in China is a regional technology unit that may become a global and corporate technology unit as the company plans to expand the R&D function there.

Although Ronstadt and Reddy produced together a classification comprising five types of units, we identified subsidiaries that embody the attributes of more than one type. For instance, Gerdau's unit in Spain not only generates long-term basic technology for the parent company but also develops products and processes for most of its markets, because it deals with recently acquired knowledge that is being internalized.

Another finding in this research is that the classification of units may change over time, as pointed out in the literature (Bouquet & Birkinshaw, 2008). Thus, a unit doing development to local purposes today may be assigned new activities that lead to product development for global markets. Conversely, a subsidiary may cease to perform certain activities and thereby have its strategic focus changed.

4.3.2 Gassmann and von Zedtwitz' Internationalized R&D Management Model

Of the studied BMNCs, Smar and Embraco were the only companies that, in addition to locate globally their manufacturing activities, also internationalized product development intentionally (according to a strategic corporate plan). Smar's foreign subsidiaries showed a high degree of autonomy vis-à-vis the parent company, dominant product R&D and a low level of coordination across the units, which would characterize the configuration adopted as an extreme case of polycentric decentralization.

Embraco shows two R&D configurations: one for the development of company-dominated technology, and another for new (not yet dominated) technology. In the first case, the offshore units are free to engage in product development activities with very little coordination from the parent company because the purpose there is to streamline products and processes for local markets. This configuration could therefore be described as polycentric decentralized. With regard to technologies not yet dominated by Embraco, however, R&D is almost entirely conducted by the parent company in Brazil. The purpose here is to allow the organization to internalize the knowledge first. Once the technology has been mastered, it is then internationalized to the manufacturing units. Thus, this configuration was regarded as R&D Hub Model.

Santista/Tavex, with its structure for division of competency centers in its segment (Jeanswear, Sportswear and Workwear), have a management configuration which is similar to integrated R&D Network.

For WEG, Marcopolo and Gerdau, it was acquisition of manufacturing units abroad that provided them with international product development facilities, not having R&D offshoring as a corporation proposes. WEG's subsidiary in Portugal operates under a decentralized management model, but its activities are coordinated by the parent company. The R&D performed by this unit is specific to a type of product commercialized in Europe; all other R&D activities remain in the hands of the headquarters in Brazil. With respect to Marcopolo, the units in Portugal and Colombia are decentralized to the extent that they operate independently from their parent company when it comes to developing products for the local market. The remaining R&D is entirely conducted by the parent company. Gerdau's subsidiary in Spain integrated to the company's R&D activities recently, could therefore be regarded as similar to geocentric centralized. Finally, Tigre was the only company in this study whose product development is totally concentrated in the hands of the parent company. As a result, we have different strategies in these four companies with ethnocentric centralized being the most usual product development model, with some variations as attempts at a more internationalized R&D.

4.4 Final Discussion

In order to close discussion of findings according to the propositions of this paper, the results presented above are summarized here.

Existence of overseas R&D (proposition 1): The studied cases show that research is still conducted by the headquarters in most cases, while development is internationalized, albeit not on a large scale as commercial and production activities. Offshoring occurred in new plants (Embraco, Smar), in acquired plants (Embraco, WEG, Marcopolo, Gerdau) and in plants resulting from joint ventures (Marcopolo, Santista). The globalized portion of their R&D activities is still small in most of the cases.

Motivation for R&D internationalization (proposition 2): On the whole, the studied companies internationalized development of their product in order to adapt them to regional/local market needs or to regulations requirements (WEG, Marcopolo, Embraco, Gerdau, Smar), and also for the purpose of gaining rapid access to specific resources (Smar).

The BMNCs studied here indicated that the development of proprietary technology was also a decisive factor behind internationalization. Embraco and WEG claimed to have signed contracts with competitors to acquire technology for the ultimate purpose of developing products of higher quality. In other words, these companies attempted, from the very beginning, to monitor the overseas technology environment. Many of the technological competencies were found abroad and internalized by these companies, which then perfected them until they were able to develop their own. Thus, one might speculate that initially these companies expanded internationally in order to acquire a body of required technical knowledge, and subsequently internalized the said competencies in their home countries.

International R&D characteristics (proposition 3): We may prove the proposition 3, that international R&D in BMNCs has similar characteristics of what we find in existent literature, i.e., it is similar to international R&D in DMNCs. And besides, R&D internationalization processes in BMNCs are also similar to the EMNCs, for instance we found out that R&D subsidiaries of BMNCs are located in both developing and developed countries, as affirmed by von Zedtwitz (2005) for EMNCs. For the studied companies, although subsidiaries located in developed economies, mostly Western Europe, have a higher added value unit for developing products, there are some R&D structures in developing countries which are important as technology income post (like China and Colombia).

Regarding the management of international R&D, the studied companies, except for Smar and Embraco, have settings similar R&D, centralizing most R&D in the headquarters and having a few (or none) technology development units abroad. Smar has set up their R&D units independently of the headquarters, which is counterproductive in accordance to the literature (Chiesa, 2000; von Zedtwitz & Gassmann, 2002), because this can result in duplication of work and unnecessary increase in costs of coordination. In the case of Embraco, the company's division in dominated-technology and not-dominated-technology proved to be an interesting approach to the management of technological innovations. This company centralizes R&D activities for not-dominated-technologies at the same time that it establishes mechanisms for transferring this technology, when dominated, to foreign subsidiaries. It allows dissemination of knowledge throughout the organization and enables that further developments of this technology are also carried out abroad.

5. Conclusion

This paper presented a study about internationalized R&D in Brazilian multinational companies. Corroborating the literature, we found out that BMNCs, even still in the initial stages, have internationalized its product development considering the two most important reasons for the internationalization of R&D of MNC from developed countries (Florida, 1997), which are market-driven and technology-driven.

Another conclusion from this study is that BMNCs internationalization of R&D is performed similarly to DMNCs. It includes the roles of foreign subsidiaries, which are determined by studied companies the same way as DMNCs determine specific contributions of affiliates for integrating a global corporative network. Finally, management of global R&D also follows established rules observed in the literature.

These finds are additional evidences to what achieved by Wu (2007) in the study with Taiwanese companies, showing that "firms in developing countries appear to follow a similar path towards the globalization of R&D activities" (Wu, 2007, p. 308).

Considering this reality, it arises the question whether companies from emerging countries that recently have been globalized (the called late movers) may follow, some decades later, the same steps to consolidate MNC in terms of R&D internationalization. The answer is positive for the Brazilian cases here analyzed, but it requires additional research to achieve further conclusions.

It is worth to highlight that the limitations of this research are inherent in the methodology employed as the results obtained from case studies do not lend themselves to generalization. Each one of the BMNCs has its own history; the decisions made by their management led them to different and often unique situations. However, results of deep analysis of companies were important to understand some of questions never before explored within academic research proposes. Thus, although limited to a few Brazilian MNCs, the contribution of the conducted study is to shed lights on R&D internationalization by emerging countries.

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Notes

Note 1. Embraco was acquired by Whirlpool Group. It is therefore a U.S. company, but the control of R&D management remains in Brazil, this being the reason why it was selected to make up our sample.

Note 2. SantistaTextil merged operations to the Spanish Tavex in 2006, forming the Tavex Corporation, after an operation of stock exchange between both corporations.

Note 3. Although Smar has only two manufacturing plants abroad (in one country - USA), it has own sales and support units in more than 60 countries.

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