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Innovation and foreign multinationals established in the state of Paraná (Brazil) between 1960 and 2015

RODRIGO ALCÂNTARA BETIATI
Knapp Sudamérica, São José dos Pinhais, Brazil
rabetiati@hotmail.com

ARMANDO DALLA COSTA
Universidade Federal do Paraná, Brazil
ajdcosta@uol.com.br

RODOLFO COELHO PRATES
Universidade Federal do Paraná, Brasil; Middlebury College, United States
rodprates@hotmail.com

Abstract. Subsidiaries of multinational companies have played an important role as agents of industrialization processes in the state of Paraná, Brazil. Since the 1960s, more than 500 foreign companies have located in this state, mainly in the Curitiba metropolitan area. Their economic impact includes generation of employment, wealth, innovation, and technology diffusion. The purpose of this paper is to analyze the relationship between innovation and internationalization, and whether the subsidiaries of multinationals are innovative. The methodology employed in this study was the analysis of documents and interviews. The results demonstrate that at least one-third of these subsidiaries have innovated.

*Keywords***:** Innovation; internationalization; multinationals; Paraná economy.

Acronyms and abbreviations

AGV	Automatic Guided Vehicle
BNDES	National Development Bank (Banco Nacional do Desenvolvimento)
CIC	Industrial City of Curitiba (Ciudad Industrial de Curitiba)
CNH	Case New Holland

CNPJ	National Register of Legal Entities (Cadastro Nacional de Pessoa Jurídica)
DFI	Direct foreign investment
FAPESP	Research Support Foundation of the State of São Paulo (Fundação de Amparo à Pesquisa do Estado de São Paulo)
FECOMÉRCIO/PR	Commerce Federation of the State of Paraná (Federación del Comercio del Estado de Paraná)
FIEP	Federation of Industries of the State of Paraná (Federação das Indústrias do Estado de Paraná)
FINAME	Funding for Machines and Equipment (Financiamiento de Máquinas e Equipamentos)
FINEP	Studies and Projects Financing Agency (Financiera de Estudios y Proyectos)
IBGE	Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística)
ICMS	Tax on the Circulation of Goods and Services (Imposto sobre Circulação de Mercadorias e Serviços)
INPI	National Institute of Industrial Property (Instituto Nacional da Propriedade Industrial)
LABMOR	Microbiology and Ornitopathology Laboratory (Laboratorio de Microbiología y Ornitopatología)
MCTI	Ministry of Science, Technology, and Innovation (Ministério da Ciência, Tecnología e Inovação)
MDIC	Ministry of Development, Industry and Commerce (Ministério do Desenvolvimento, Indústria e Comércio)
MERCOSUR	Southern Common Market (Mercado Común del Sur)
NSN	Nokia Siemens Networks
PINTEC	Innovation Research of the IBGE (Pesquisa de Inovação del IBGE)
PLC	Programmable logic controller
PR	Paraná
PUC-PR	Pontifical Catholic University of Paraná (Pontificia Universidad Católica de Paraná)
R&D	Research and development
R&D&I	Research and development and innovation
REPAR	Araucária Petroleum Refinery (Refinería de Petróleo de Araucária)
RMC	Curitiba Metropolitan Region (Región Metropolitana de Curitiba)

TELEPAR	Paraná Telecommunications (Telecomunicaciones de Paraná)UEM State University of Maringá (Universidad Estadual de Maringá)
UFPR	Federal University of Paraná (Universidade Federal do Paraná)

1. Introduction

The arrival of multinationals to Paraná at the beginning of the 1960s was fundamental for the development of the state's industrial structure as it exists today, in the middle of the second decade of the 21st century. Curitiba's automotive center, which has attracted firms such as Volvo, Renault, Volkswagen, Nissan, and Bosch, among others, is an example of the process of internationalization of foreign multinationals in this state. At the same time, local economic development also brought with it innovation prerogatives, laboratories, and R&D&I (research, development, and innovation), which are incubators of new enterprises, public and private universities, and organizations that promote innovation, among other agents that play an important role in research and the development of new products and processes.

Paraná is the sixth state in terms of population and the 15th in terms of size. Its economy contributed 6.3% of all the wealth generated in Brazil in 2013, behind only São Paulo (32.1%), Río de Janeiro (11.8%), and Minas Gerais (9.2%). The change in Paraná's economy is historic, given that it has occupied fifth place in the Brazilian economy since 1949 (Paraná. Agência de Notícias do Paraná, 2015). The state's current economy is based on services and industry, as well agro-industrial activity of national importance. Its geographical proximity to MERCOSUR countries, transportation infrastructure, and access to the port of Paranaguá, the second-largest export port in Brazil, are other characteristics that help attract subsidiaries of multinationals.

There have been other studies that analyze the innovation that resulted from the presence of multinational subsidiaries. Queiroz and Carvalho (2005), for example, demonstrate that the subsidiaries established in Brazil are active in R&D and that their technological efforts are, on average, greater than those of Brazilian-owned enterprises (Fundação de Amparo a Pesquisa do Estado de São Paulo, Fapesp, 2010). Arruda, Cozzi, Souza and Barcelos (2013) corroborate this research and emphasize the importance of government incentives. Goncalves, Lemos, and Fajardo (2005) come to the conclusion that multinationals are more likely to invest in R&D according to their global positioning, even if they are not always likely to construct research centers in "peripheral countries." In addition, Boehe (2007) analyzes research in various states: São Paulo, Río Grande do Sul, Minas Gerais, Paraná, Río de Janeiro, and Bahía, identifying typologies in relation to the innovation experiences found.

It is estimated that Paraná hosts more than 500 firms whose capital is from international sources. Because these enterprises are more dynamic, it

is natural that they carry out some form of innovation, whether creating new products and processes or adapting these to Brazilian needs. Based on this assumption, the objective of this study is to analyze the innovation activities of subsidiaries in Paraná.

After this introduction, the article goes on to discuss theories related to the internationalization of enterprises and to innovation. This is followed by a presentation of the methodology used to discover whether, and in what way, multinationals located in Paraná innovate. Then, descriptions are provided of these enterprises and their sectors, what they produce, and the regions where they are located. This is followed by an analysis of the enterprises' innovation practices and a discussion of this study's research questions: that is, whether the multinationals innovate and how they do so. The last section provides final considerations.

2. Theoretical references

This section discusses theoretical issues related to the subject of this study. It starts with a broad overview regarding the relationship between the subsidiaries of multinational enterprises and innovation. This is followed by basic information about the subsidiaries located in the state of Paraná.

2.1 Multinational subsidiaries and innovation

The subject of internationalization appeared in the economic, administrative, and management literature some time ago, especially in reference to the activities of European, North American, and Japanese enterprises. The literature was based on the experience of groups and developed a series of explanations, such as, for example, the product lifecycle theory (Vernon, 1966), transaction costs (Williamson, 1975; Reid, 1983), internationalization (Buckley & Casson, 1976, 1998), the eclectic paradigm (Dunning, 1977, 2001), the entry of enterprises to external markets by stages (Bilkey & Tesar, 1977), networks of relationships (Johanson & Mattson, 1987), as well as issues related to international entrepreneurship (Jones & Coviello, 2005; Johanson & Vahlne, 2006; Welch & Welch, 2009).

These theories can be grouped together into two approaches: the economic theory of internationalization, and behavioral theory. However, with the advent of globalization and of communication technologies and due to the repositioning of countries in the geopolitical context, internationalization received new treatments. Outstanding among these are Born Global (MacDougall & Oviatt, 1996; Knight & Cavusgil, 2004; Rennie, 1993) and the nonlinear forms of internationalization (Vissak & Francioni, 2013, for example). In addition, consolidated themes in other areas of study regarding internationalization have been taken into consideration, such

as the issue of sustainability (Haro & Bitektine, 2015), while others were looked at in-depth following the example of the importance of knowledge (Ahammada, Tarba, Liu & Glaister, 2016) and of innovation (Wu, Wang, Hong, Piperopoulos & Zhou, 2016).

Though there is consensus that internationalization theory has advanced considerably, it has yet to be consolidated as a robust theory. Teece (2014) states that such a theory should be capable of explaining why some enterprises grow and become global while others remain domestic. A second issue is geographic identity and its objective. Finally, this author suggests that the manner and time of entry, as well as who is in charge of direct investment and the role of subsidiaries, should also be taken into consideration.

In recent decades, theories about multinationals postulated that expansion to other countries had as its purpose the exploration of market failures (Dunning & Lundan, 2008). Hymer's (1976) explanation, for example, was that multinationals exist to take advantage of the power and advantages of monopoly. Buckley and Casson (1976) affirm that multinationals minimize transaction costs, principally those related to the transfer of technology, which they develop for their own units and not for other enterprises, thus avoiding problems related to property rights and opportunism.

Teece (1981) argues that the effectiveness of multinationals is more related to the transfer of technological capacities than to the minimization of transaction costs. In the same vein, Kogut and Zander (1992) understand multinationals as a form of transferring technology and industrial knowledge to other nations. The administration of an enterprise's technology, as well as its capacity to transfer it over borders, can be understood as a capacity within a broader perspective of the business process (Teece, 2014) that is focused more on opportunity than on opportunism. Teece adds that multinationals not only seek "internal transfer of technology and intermediary products, but also to create and manage cospecialization and, if necessary, to create new markets and expand the existing ones" (2014, p. 12).

The same author also argues that dynamic capacities flow fundamentally from R&D activities and learning processes, whether internal or through partners. The objectives of these capacities are precisely to overcome the difficulties related to technological diffusion across industries or systems of innovation, principally due to the restricted mobility of knowledge (Zander & Sölvell, 2000).

Innovative activities within subsidiaries are not a new subject in the literature on international business. Dunning (1994), for example, notes the presence of innovation in subsidiaries operating in small markets. From the viewpoint of internationalization, innovation implies mixing knowledge and resources from various countries (Yamakawa, Peng & Deeds, 2008).

Innovation originating in the subsidiaries of foreign multinationals is not a common practice and depends on a series of variables. According to Chesnais (1996), when it comes to R&D&I, internationalization provides three advantages associated with the organization as a group because it allows for greater protection of technology and access to the synergies that are characteristic of interdependent activities. In this case, the factor that influences location options is the quality of the infrastructure and externalities of each country or region (R&D&I, legislation and incentives for innovation, etc.).

Zander and Sölvell (2000) propose two situations related to technological capacities. The first, called international duplication of technological capacities, occurs when the headquarters and its subsidiaries have the same level of technical knowledge. The second, the diversification of technological capacities, occurs when headquarters and its subsidiaries have different capacities.

A study carried out by Queiroz and Carvalho (2005) shows that subsidiaries located in Brazil are very active in R&D and their technological efforts are, on average, greater than those of similar enterprises with domestic capital (FAPESP, 2010). The authors demonstrate the importance of subsidiaries for the national system of innovation and suggest that the government develop more active policies so that subsidiaries can play a more direct role in creating new technologies.

Arruda et al. (2013) corroborate Queiroz and Carvalho's (2005) finding regarding the importance of subsidiaries in R&D activities in Brazil. This study also highlights the limitations of public policies that support technological development by multinationals. In this regard, they highlight incentives intended to reduce costs and other obstacles to importing research tools, relationships with universities, the Law of Goods (Lei do Bem[1]), and the challenges of the problem of control of incentives and promotions. In addition, Gonçalves *et al*. note that "multinational enterprises are more likely to innovate, despite the fact that this is not verified in the decision to invest in R&D"[2] (2005, p. 19).

Government or institutional support is thus an important factor in innovation by subsidiaries. According to Wu *et al*. (2016), the level of a host country's institutional development positively influences innovation by enterprises.

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1 Law N° 11.196/05, better known than as the "Law of Goods" establishes tax incentives that enterprises can automatically take advantage of when they engage in technological research and the development of technological innovation.

2 Translation by *Apuntes*.

Boehe (2007) identifies the behavior of subsidiaries in product development, employing a survey applied to enterprises in São Paulo (primarily), Río Grande do Sul, Minas Gerais, Paraná, Río de Janeiro, Amazonas, and Bahía. Boehe defines five categories: local adapters, nascent innovators, local innovators, innovators for emerging markets, and global innovators. These distinctions are related both to the strategies of multinational enterprises as well as their integration into the national context.

2.2 Subsidiaries in the state of Paraná

Multinational enterprises started arriving to the state of Paraná in the mid-1960s. Their presence created a new dynamic in the productive structure of the state, bringing it closer to others, such as São Paulo, where the industrial structure is highly consolidated and developed (Brum, 2002).

Three economic movements in the recent history of Paraná (Firkowski, 2009) were fundamental to the configuration of basic structures and to the process of attracting foreign direct investment (FDI):

a) The 1950s and 1960s: investments in logistical infrastructure (highways and public storage systems); energy infrastructure, with the construction of more powerful hydroelectric plants and the creation of COPEL (Paraná Electrical Energy Company, Compañía Paranaense de Energía Eléctrica); and the telecommunications network, with the founding of the Telecomunicaciones de Paraná (TELEPAR).
b) The 1970s: agricultural and agro industrial modernization; the cement center in the Metropolitan Region of Curitiba (RMC).
c) The 1980s: the creation and development of the Industrial City of Curitiba (Ciudad Industrial de Curitiba, CIC) and the Araucária Petroleum Refinery (REPAR).[3]

The reasons for FDI in Paraná are varied; nevertheless, the principal mechanisms adopted by the Paraná government to attract foreign enterprises were oriented towards the concession of public services, tax incentives, and

3 There are many studies on the economic, political, and cultural history of Paraná. Here, we cite only the best known texts, which include detailed bibliographies. For a wide-ranging view of the evolution of land occupancy in the state, see Balhana, Machado, and Westphalen (1969); for a condensed history of occupation and development, see Wachovicz (1988); on the evolution of economic cycles, see Padis (1980/2006); for an explanation of the interaction between politics and economics, see Magalhães Filho (2006); for the relationship between urbanization and industrialization, see Oliveira (2001); for the history of the production of food and urban supply, see Santos (1995); on the export of maté, coffee, and other products, see Westphalen (1998); on growth and regional inequalities, see Raiher (2012); for essays on the economies of Paraná and Brazil, see Dalla Costa, Gelinski Junior, and Lopes (2012).

investment in infrastructure. These efforts promoted the development of the entire state, but it is the creation of three centers that stands out:

> The first center includes the city of Curitiba, adding to the potential of the Centro Industrial de la Transformación in Ponta Grossa. The second is made up of the cities of Maringá and Londrina, which serves the whole north of the state. The third is situated in the axis of the cities of Cascavel and Guaíra, promoting the concentration of those activities necessary to support and promote the dynamism of the southeast and west of Paraná.[4] (Firkowski, 2009, p. 133)

The first industrial FDI was recorded in 1973, with the establishment of foreign capital enterprises in the CIC. In 1995, there was a new influx of FDI to the RMC, followed by the internalization of these investments. The main hypothesis is that the decisive factor for industrial FDI were the municipal and state public policies providing incentives, influenced by the national and international scenario (Devai, 2005).

The majority of the subsidiaries are located in the RMC. The proximity of the port of Paranaguá and the Afonso Pena de São José dos Pinhais international airport and the rest of the physical and institutional infrastructure, combined with the cultural diversity of the region, are the main factors in attracting these investments (Ferreira & Rodrigues, 2004).

3. Methodology

Generally, the studies that deal with innovation in Brazilian subsidiaries, such as that of Queiroz and Carvalho (2005), use survey data provided from the IBGE Innovation Survey (Pesquisa de Inovação del IBGE, PINTEC). Although these make it possible to compare foreign capital and domestic capital enterprises, for example, some of the data is aggregated, making it difficult to clarify other issues. A second possibility is to study this subject using surveys such as that applied by Boehe (2007).

Information can also be obtained through documents; this is the methodological procedure used in this study, which is based on five principal sources.[5]

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4 Translation by *Apuntes*.

5 These sources were used in the preparation of tables 1, 2, and 4 and Map 1.

- Base 1, Brazil. Ministério do Desenvolvimento, Indústria e Comércio, MDIC (2014)[6]
- Base 2, *Revista Exame* (2014; issue title: "Melhores & maiores" [The Best and the Biggest])[7]
- Base 3, the 100 Best ICMS[8] Taxpayers in Paraná Prize (2013) (Premio 100 Mayores Contribuyentes ICMS Paraná)[9]
- Base 4, the 500 Best in the South of Brazil Prize, 2014 (Premio 500 Mayores del Sur del Brasil, 2014[10]
- Base 5, MCTI (Ministry of Science, Technology and Innovation)[11]

During the present study, 186 subsidiaries were identified in the state of Paraná. This is the number employed in the rest of this analysis.

In relation to the question of how innovation takes place in multinationals based in Paraná, this study includes cases of enterprises that demonstrate a characteristic that qualifies them as innovators. The decision of which enterprises to include was linked to the availability of information collected during the research, and the intention is to present qualitative data to validate the existence of innovation activities and how these take place at the enterprises. The information was obtained from primary and secondary sources, directly (through interviews by email, telephone or in person), and indirectly (from institutions that promote innovation).

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6 During a preliminary phase, the origin of the 999 major importers in 2014 was investigated, according to MDIC data available on its website. The filters used for the preparation of the database were: a) import enterprises; b) the year 2014; c) state of Paraná; d) import volume over US $10 million.
The second phase was to consult each of the 999 firms via the website of the Federal Treasury of Brazil or in their country of origin.
(for more see http://receita.fazenda.gov.br/PessoaJuridica/CNPJ/cnpjreva/Cnpjreva_Solicitacao.asp). Not all the firms researched made available information on partners and administrators and about the origin of capital (QSA).

7 This source led to the addition of ten more enterprises on our list due to their size and economic representativeness; among these, the French Renault assembly plant and the Stora Enso paper and cellulose industry stand out.

8 Tax on the circulation of goods and services.

9 The 100 Best ICMS Taxpayers of Paraná Prize was awarded by the Commerce Federation of the State of Paraná (Federación del Comercio del Estado de Paraná Fecomércio/PR) and the daily *Industria y Comercio* to enterprises that collected ICMS in 2013. In this group, made up of 100 enterprises, 17 were multinationals (see also: *Indústria & Comércio*, 2013).

10 The 500 Best in the South of Brazil Prize is awarded annually by the journal *Amanhá* based on business performance indicators. In the last edition, 18 foreign multinationals located in Paraná were included, with Bunge, CNH, and Electrolux excelling (see: *Amanhá*, 2014).

11 Since 2005, 29 foreign multinational enterprises located in Paraná asked the MCTI for a tax waiver to deduct R&D expenditures when calculating their taxes, citing the Law of Goods. It should be noted that the companies Mondelèz (in the food industry) and CNH were those that reported the most research projects under this law in the last five years.

4. Foreign multinationals located in Paraná

4.1 General characteristics of the consolidated database

The largest number of foreign subsidiaries located in Paraná are German (27 in total); 22 are from the United States; 19 are Spanish; and 17 are Italian (see Table 1). European countries predominate and most of these are located in the RMC.

The large number of German enterprises in Curitiba stands out. They began to arrive in the 1970s after the CIC was created, and as a result of trips to Germany by government representatives accompanied by Paraná entrepreneurs who sought to demonstrate that, like São Paulo, Paraná was a good place in which to invest. As a result, Siemens established itself in Curitiba and other companies followed. [12]

Table 1
Foreign multinationals located in Paraná, by country of origin, 2015

Country	Number
Germany	27
United States	22
Spain	19
Italy	17
Argentina	14
Holland	14
France	11
Sweden	9
Uruguay	8
England	7
Chile	6
Denmark	6
Austria	5
Finland	4
Luxemburg	3
Mexico	3
Panama	3
Portugal	3
Hong Kong	2

(Continues)

12 See: “A indústria paranaense tem sotaque alemão” (Junges, 2013a).

(Continuation)

India	2
Ireland	2
Paraguay	2
Others	17
Total[1]	206

Note:
The "total" of 206 enterprises provided here varies from the total of multinationals analyzed (186) since there are enterprises whose capital comes from more than one county.
Sources: see those mentioned in Section 3: "Methodology."

The predominant areas of activity are: wholesale commerce (38 enterprises), chemical industry (30), manufacture of machinery and equipment (28), and the automobile industry (vehicles and parts) (24). Together, these enterprises represent two-thirds (65%, 120 companies) of the whole sample (see Table 2).

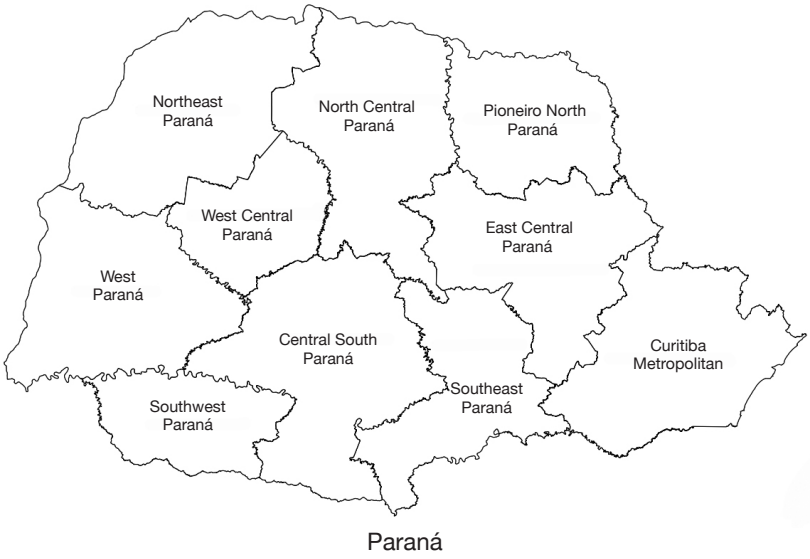
Table 2
Foreign multinationals located in Paraná, by economic activity, 2015

Economic Activity	Number
Wholesale commerce	38
Chemical industry	30
Manufacture of machines and equipment	28
Automotive industry	24
Food industry	10
Electrical appliance industry	9
Other metals industry	7
Cellulose paper industry	5
Mineral products industry	5
Computer industry	4
Automotive sales	4
Textile industry	3
Services and maintenance	3
Wood industry	3
Pharmaceutics industry	2
Leather industry	2
Other	9
Total	186

Sources: see the sources mentioned in Section 3: "Methodology."

Foreign multinationals were consolidated in ten regions of Paraná. However, 79.7% are in the RMC, followed by the North Central Region (8.0%), and the East Central Region (7.5%). Together these areas are the locations for 95.2% of the foreign enterprises established in the state. Nevertheless, multinationals do exist in all the regions of the state as can be seen in Map 1 and Table 3.

Map 1
Geographical concentration of foreign multinationals in the regions of Paraná



Sources: see sources mentioned in Section 3: "Methodology."

Table 3
Foreign multinationals in Paraná, by geographical region, 2015

Region	Number of multinationals	Percentage By region
Curitiba Metropolitan (RMC)	149	79.7
North Central	15	8.0
East Central	14	7.5
Southeast	3	1.6
Pioneiro North	2	1.1
West	2	1.1
Northeast	1	0.5
Southwest	1	0.5
Central South	0	0.0
Southwest	0	0.0

Sources: see sources mentioned in Section 3: "Methodology."

5. Innovation in foreign multinationals located in Paraná: an overview

In order to estimate innovation in the subsidiaries located in Paraná, Table 4 provides two indicators: the first is related to those enterprises that had or have projects financed by the Law of Goods: the second is related to the patents that subsidiaries applied for.

Table 4
Multinationals in Paraná financed by the Law of Goods and those that applied for patents, 2015

Enterprise	Financed by the Law of Goods[1]	Patent Applications[2]
Adama Brasil	No	6
Alltech do Brasil Agroindustrial	Yes	1
Amcor Flexibles	No	1
American Glass Products do Brasil Ltda	Yes	1
Ap Winner Industria e Comércio de Produtos Químicos	Yes	6
Arauco Forest Brasil SA	Yes	7
Basf Agricultural Specialities	No	6
Beauieu do Brasil Indústria de Carpetes Ltda	Yes	

(Continues)

(Continuation)

Enterprise	Financed by the Law of Goods[1]	Patent Applications[2]
Blount Industrial	No	5
Bosch	No	94
Branco Motores	No	2
Bundy Refrigeração Brasil Indústria e Comércio	Yes	4
Case New Holland (CNH)	No	1
Colson do Brasil	No	4
Denso do Brasil Ltda	Yes	5
Dynea Brasil SA	Yes	
Electrolux do Brasil SA	Yes	256
Fermax Indústria de Componentes para Esquadrias	No	5
FGVTN Grasil	No	21
Furukawa Industrial SA Produtos Elétricos	Yes	37
GDM Genérica do Brasil Ltda	Yes	
Gemalto do Brasil Cartões e Terminais Ltda	Yes	1
Gestamp Paraná SA	Yes	
Global Village Telecom	Yes	
Grasp Indústria e Comércio	No	1
Hafele Brasil	No	1
Hexion Química Indústria e Comércio Ltda	Yes	9
Impress Décor Brasil Indústria de Papeis Decorativos Ltda	Yes	1
Incepa Revestimentos Cerâmicos Ltda	Yes	
Ingersoll-Rand	No	1
Komatsu Forest Indústria	No	1
Landis+Gyr Equipamentos de Medição Ltda	Yes	4
Masisa do Brasil	No	1
MBF Embalagens	No	2
Mondelez Brasil	Yes	1
Munters Brasil Indústria e Comércios Ltda	Yes	
Nissan do Brasil Automóveis Ltda	Yes	
Nordtech Máquinas e Motores	No	1
Novozymes Latin América Ltda	Yes	3

(Continues)

(Continuation)

Enterprise	Financed by the Law of Goods[1]	Patent Applications[2]
Philco Eletrônicos	Yes	
Philip Morris Brasil Indústria e Comércio Ltda	Yes	1
Praxair Surface Technologies	No	12
Pronefro	No	1
Renault do Brasil SA	Yes	
Siemens Enterprise Communications	Yes	1
Solabia	No	4
Sulzer	No	1
Textel Telecomunicações	No	1
Thyssenkrupp Presta do Brasil	Yes	
Volvo do Brasil Veículos Ltda	Yes	
Westaflex Tubos Flexíveis Ltda	Yes	5

Notes:
(1) "Yes" indicates that the enterprises had or still have resources obtained through the Law of Goods; "No" indicates those that did not or do not have such resources.
(2) The third column provides the number of patents applied for by each enterprise.

Carrying out an innovation project requires significant resources. In addition, since it is an activity that is on the frontier of knowledge, it also involves high risk. Generally, it is accepted that the more the subsidies and financial resources that are available, the greater the tendency to innovate. Thus, the Law of Goods has been a tool employed by the federal government to support R&D&I initiatives.

As can be seen in Table 4, around 15% (29) of the enterprises have taken advantage of the Law of Goods through innovation projects. It is the largest multinationals in a sector that most take advantage of this law for innovation projects.

The existence of patent applications (according to the National Registry of Legal Entities [Castro Nacional de Pessoa Jurídica, CNPJ]), to the National Institute of Private Property (Instituto Nacional da Propriedade Industrial, INPI) is one of the main indicators of enterprises that engage in innovation. A study by the INPI (2016) found that about 22% (39) of multinationals had at least one innovation project that led to a patent application. The most important of these included: Adama, Alltech, Arauco, Basf, Bosch, CNH, Denso, Electrolux, Furukawa, Komatsu, Masisa,

Mondelèz, Novozymes, Philip Morris, and Siemens; Electrolux alone has 256 registered patents in Brazil.

The difficulty of inferring the success of innovation activities lies in discovering whether all innovations that could be patented are registered with the INPI by the subsidiary. Thus, while many of the enterprises located in Paraná have local innovation projects, a significant number of these may be registered by other subsidiaries and research centers or by the controller. Nokia Siemens Network (NSN), for example, has a research center in cooperation with the Pontifical Catholic University of Paraná (PUC-PR), but their patent applications are made in Europe. Other examples are the automotive industries, which patent their innovations outside Brazil.

The information available is restricted and therefore it is difficult to provide a more precise analysis. Nevertheless, using the data related to the two variables (the projects applied to the Law of Goods and the number of patents requested), a Spearman correlation was calculated between them.[13] The result (-0.3007) indicates something suggestive: access to the Law of Goods is associated with a smaller number of patents. Although not the object of this study, this finding could be related to imprecisions in the law or in its implementation.

Documentary research revealed that 22 (12%) of the 186 enterprises researched have engaged in these practices, including product innovation and development, among other characteristics of innovation; only six had no patent applications or project applications under the Law of Goods. Those that stand out are: Adama, Aker Solution, Ap Winner, Arotubi, Basf, Bosch, CNH, Electrolux, Faurecia, GVT, Mondelèz, NSN, Pepsico (Elma Chips), Renault, Sandoz, Volkswagen, and Volvo.

While recognizing the lack of precision, the information obtained through this research makes it possible to affirm that at least 32% of the subsidiaries carried out some innovation activity: 58 out of 186. The automotive sector stands out, with nine of 58 enterprises. When it comes to the country of origin, the United States leads with eight enterprises, followed by Germany with seven.

If we remove the group of 20% (38) enterprises engaged in commercial activities, since one would expect them to engage in little to no innovation activities, the percentage of innovative firms rise to almost 40%.

The most innovative sectors were the automotive industry, with 16% of enterprises innovating, followed by the metallurgical industry with 14%,

13 The Spearman correlation is appropriate when there are qualitative variables, including ordinal and nominal variables.

and chemical products with 10%. This demonstrates the importance of these industries for the economic development of Paraná.

6. Cases of innovative multinationals

6.1 Methodology of innovative projects

In order to develop new products and processes, it is fundamental for innovative enterprises to adopt a process or a methodology which assists them in carrying out their innovation plan. With the dissemination of these projects around the world, there was a need to develop standardized models that aid in understanding and conceptualization of innovation. This led to the first Frascati and Oslo manuals, which still today continue to help R&D&I enterprises and institutions to adopt best practices in project development. Nevertheless, many of the innovators studied here opted not to follow particular models and used their own methodology.

Bundy Refrigeration, for example, a manufacturer and supplier of industrial machines and equipment, has operated in Curitiba since 1994. This enterprise develops innovation projects[14] and has a department dedicated to R&D&I, but does not use a specific methodology. Basically, their innovation management has two tracks: a) through their engineering department which, in cooperation with the client, develops new products for the refrigeration sector; b) through the revision of procedures and internal processes that assure greater efficiency or economy in the manufacture of products, with the aim of maintaining their competitive status. Innovation may take place through automating a process that was previously done manually, by searching for and trying out new materials, or altering the layout of machines. One of their examples is innovation in tools – automatic bending devices to create parts using straight pipes or welded parts – using sequential commands through PLC.[15] In this way, Bundy has been able to reduce the number of machine operators from eight to two.[16]

Another example is Arotubi Componentes, an Italian company that since 1997 has been producing aluminum tubes as components for refrigeration and cooking equipment. This enterprise has an engineering department with professionals trained in the development of products and processes. The innovations are developed following the principles of lean manufacturing,

14 Information on Bundy Refrigeration's innovation projects was provided by its employee, Mr. Leandro de Camargo, in an online questionnaire (answered June 26, 2015).

15 Programmable logic controller (PLC) is one of the most used controllers in industry. Conceptually, PLC is a device used to command and monitor machines or industrial processes.

16 For two shifts.

the objective of which is to refine processes. Arotubi also has the support of technological partners such as the U.S. enterprise, Brazeway.

Finally, CNH, a manufacturer of agricultural machines and implements located in Curitiba, uses a product-development methodology that follows the steps of the model applied in the Law of Goods.

6.2 Support for institutions that promote innovation

Grasp, a German chemical company, established an alliance with the Universidade Federal do Paraná (UFPR) for the construction of the Laboratory for Microbiology and Ornitopathology (Laboratorio de Microbiología y Ornitopatología, LABMOR). In like manner, this company carries out research with other institutes and universities in Brazil and abroad, generating information about its technologies and products and, at the same time, making its accumulated knowledge available to society-at-large. Many research projects are disseminated through dissertations and master's theses, helping to train human resources.

NSN, the fruit of a joint venture with the Finland-headquartered Nokia and the German firm Siemens, develops professional services in technology for the Latin American market. In 2010, NSN and PUC-PR signed an agreement for the creation of a R&D center at the university, named Tecnoparque.[17] Since then, a variety of innovation projects have been developed there. In total, the center has 340 professionals on all levels dedicated to the diverse technologies within its purview. The idea is for the center to bring the enterprises closer to the university to create a system of innovation.

Basf, a German chemical industry enterprise, engages in innovation in various areas, from agriculture to the textile, leather, and shoe industries. The enterprise's Paraná subsidiary is associated with its agricultural products division, and has a R&D policy that is shaped by the natural demand of the sector in each region. The majority of its products are tested, adapted, and sometimes developed to fulfill the requirements of the climate, soil, and crops grown in Paraná. Thus, Basf understands that innovation is not only a competitive differential but also vital for business continuity. In the face of the constant challenge that the need to innovate entails, this company develops products, services, and processes locally. It also acts as a research and development facilitator in cooperation with teaching and research institutions. In addition to its association with the Universidad Estadual

17 Interview with the Development, Teaching and Learning Manager of the Nokia Siemens R&D Center in Tecnoparque, Mr. Márcio Machado (*PUC-Inovação*, 2013).

de Maringá (UEM), it also develops projects with EMBRAPA.[18] Together, they carry out research and technology transfer for the cultivation of sugar cane (Basf, 2014).

6.3 Internal projects promoting innovation

In 2012, the Chilean group Arauco initiated an innovation program at its Brazilian subsidiary (Arauco, 2015), with the purpose of promoting and integrating innovation activities. This would be achieved directing managerial, operative, and administrative areas and systematizing innovation through new ideas and multidisciplinary teams. In the same year, 1,542 projects were submitted; 580 of these were focused on the core business, 465 on shared value, and 497 on social innovation. After an evaluation, four were chosen for implementation.

Volkswagen, located in São José dos Pinhais and in association with Universidad Positivo, created an upper level course in the Management of Automotive Industrial Production to train manpower specialized in technical knowledge related to materials, processes, and quality control. This initiative triggered the diffusion of technology in the automotive sector in Paraná. For example, in 2012, a group of interns incentivized to innovate developed a new concept electric vehicle to transport car parts (Volkswagen, 2012). Called AGV (Automatic Guided Vehicle), this robot is used for the transport and provision of parts inside a factory without the need for an operator. The new model is more rapid and can carry more cargo than those on the market and permits remote monitoring of its battery levels. The work was monitored by Volkswagen engineers and technicians, and added to the assembly line at the end of 2012. The project is important to the automotive market because it allows for greater efficiency in the logistical supply through innovation, and implementation and maintenance cost savings of up to 70%.

At Volvo, innovation in basic operating processes and activities encompasses solutions developed by each employee, which are registered and entered into an idea database. These ideas are read and discussed, and the majority become projects. In an interview, Carlos Morassutti, Director of Human Resources and Institutional Relations at Volvo Brazil, described this experience at the company:

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18 EMBRAPA (Empresa Brasileña de Investigación Agropecuaria) was "created in 1973 associated with the Ministry of Agriculture, and produces technological innovation targeted at the generation of knowledge and technology for Brazilian agricultural [production]." (Empresa Brasileña de Investigación Agropecuaria, Embrapa, 2015). Translation by *Apuntes*.

> For Volvo Curitiba, the concept of innovation is the idea, execution, and result involved in any activity that can bring benefits to the company.[19]

Volvo holds an annual innovation fair called Muestra de Majorías, which is like a science fair but with a playful atmosphere intended to awaken creativity. All employees are invited to participate in the development of new processes and products free of the bureaucracy of projects in R&D&I centers. As Morassutti said in an interview:

> We want the 4,000 employees to have this culture of innovation in their heads and to have an atmosphere that is favorable to practice these ideas.[20] (*Gazeta do Povo,* 2014).

6.4 Investments in their own laboratories and research centers

Bosch, which has operated in Curitiba since the beginning of the 1990s, opened a new diesel motor laboratory in the CIC in 2013 with an investment of €6 million (Brodbeck, 2014). The objective was to cover the growing demand for specialized engineering services for the development of innovation and energy efficiency improvement projects. Since then, the laboratory has carried out testing on the performance, emission, and durability of motors and exhaust aftertreatment systems.[21] The new facilities are used both for the development of internal projects as well as for projects for clients. The laboratory's infrastructure brings more efficiency and productivity to the company, which has engineers specialized in motor instrumentation, electronics, and calibration.

CNH, located in Curitiba, is the only factory in the group that produces harvesters and tractors, and exports its production to various countries. Its R&D&I center in Paraná has more than 300 researchers. Between 2012 and 2014, CNH invested around 500 million reals in R&D&I activities for new products. It is worth noting that the CR line of harvesters won innovation prizes for the Curitiba subsidiary.

Electrolux produces appliances and electrical-power tools for Latin America. As part of its innovation work, it created the Electrolux Design Center[22] in 1996, believing in the talent of its Brazilian innovators for the development of its products. The Design Center carries out some

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19 Interview in Curitiba on November 3, 2015.
20 Translation by *Apuntes*.
21 Institutional information from Bosch (Bosch Imprensa, 2014).
22 Centro de Diseño Electrolux, report produced by the newspaper *Gazeta do Povo* (Junges, 2013b).

160 projects simultaneously. The teams are divided into designers and professionals that work on intellectual property, registering and assuring legal protection for the products developed. Around 70 professionals work at the center. The products are launched in 14 Latin American countries at a rate of about 150 a year. After the design and prototype-creation stage, around 70% of the products go on to the testing and evaluation stage; each product takes an average of two years to reach stores. The Design Center has a virtual reality room where project drawings can be displayed in three dimensions; this technology reduces the time necessary for project development by 50%, in addition to making it possible for engineers to make functional and aesthetic changes more efficiently, also reducing costs. Only 0.3% of Electrolux's budget in Brazil is assigned to the Design Center, but it brings a positive return to the company nonetheless.

In 2014, Faurecia, a French enterprise and automotive sector supplier located in Quatro Barras, opened its first R&D center in Latin America specializing in automotive seats, under the name of "I+D+I Center Seating." The laboratory has equipment for the entire process, from concept development, style definition, and prototype creation to the implementation of new processes and the validation of products. The idea is to autonomously fulfill orders from Brazilian assembly plants that require personalization with exclusive methods and specific raw materials. This technology center is part of the global operations of Faurecia, allowing the alignment of locally developed concepts with the group's other R&D centers around the world.

In 2005, Mondelèz, which owns the Lacta brand in Brazil, opened the first Kraft technology center in Latin America in the CIC: The Tech Center (R&D center for chocolates, drinks, deserts, and cheese) (Milknet, n.d.). The 1800 square meter structure cost 5.5 million reals and provides room for a staff of 80. The Tech Center is tasked with developing the main products for Latin America in terms of innovation, and expanding the global line of products. This center in Curitiba has laboratories for packaging, creating and testing products, carrying out tests measuring acidity, aroma, sweetness, as well as physicochemical analysis. These tests enable reductions in costs, time, and materials, in addition to great agility in consumer product testing. Currently, stock ownership and the administrative structure of subsidiaries are independent of each other. Each one has the autonomy to develop its processes and products, thus using the decentralized R&D&I model.

Grasp, which offers animal nutrition market solutions, commenced its activities in Curitiba in 2001, focusing on R&D (Grasp, n.d.). The R&D team is made up of agronomists, veterinarians, zootechnicians, food, chemical, and pharmaceutical engineers with specialized training, master's

degrees, and/or doctorates. This multidisciplinarity provides competitive advantages in the development of products and services that add value and fulfill market needs.

6.5 Incentive laws and lines of credit for innovation

NSN benefits from government measures to promote innovation in Brazil. According to their executives, laws that provide incentives for innovation, such as the Informatics Law, are essential for innovation since they help attract the product chain and generate local technical content.

Aker Solutions is the main supplier for the petroleum and gas producers based in Paraná. Located in the CIC, it provides submarine equipment for oil drilling – Petrobras is its principal client.[23] The company has a R&D department dedicated to new solutions for petroleum exploration. In 2013, it received close to 50 million reals in funding from the federal government through the Inova Brasil program, Studies and Projects Financing Agency (Financiera de Estudios y Proyectos, FINEP),[24] with the support of the Federation of Industries of the State of Paraná (Federação das Indústrias do Estado do Paraná, FIEP).[25] These funds were assigned to R&D of equipment for oil exploration in Brazil's pre-salt layer.

At Volvo, R&D activities are promoted through specific laws related to automotive activities. The government program Inovar-Auto[26] imposes the so-called quadrennial automotive regime on the industry – a set of laws that regulate the economic exploitation of the sector in Brazil, applying pressure to have assembly plants develop local content, invest in R&D&I, and carry out at least six of the 12 stages of the production process locally, among other actions. Brazilian law restricts the number of vehicles imported yearly by assembly plants, in addition to regulating the percentage of energy efficiency and emission of CO2 gases, with a reduction in fuel consumption. Although these measures are obligatory according to the law, insofar as an enterprise invests in the development of new products or in research, it will generate profits that are reinvested in new projects. Another characteristic is dependency on local content; for example, the law requires that at least 60% of parts per truck be produced locally for a special line of credit to be

23 Aker Solutions, *Gazeta do Povo* (Jasper, 2013).
24 FINEP is a federal government financial institution that foments science, technology, and innovation (Financiera de Estudios y Proyectos, Finep, n.d.).
25 Aker Solution (Finep, n.d.).
26 The Program for Incentives for Technological Innovation and Densification of the Production Chain of Automotive Vehicles (Inovar-Auto) was created by Law N° 12.715/2012 and is valid for the period 2013-2017 (Inovar-Auto, n.d.).

extended by the National Development Bank (Banco Nacional do Desenvolvimento, BNDES): Financing of Machines and Equipment (FINAME).[27]

In addition, Volvo Curitiba already received BNDES resources through FINEP to finance R&D&I in cabins and motors, with the objective of justifying the local projects required by law.

6.6 Interrelationship of the Paraná subsidiary and its respective economic group: the case of Volvo

Volvo came to Curitiba in 1980. It employs 4,000 people and is one of the largest in its sector in Brazil.[28] Volvo's product and process innovation benefits from being part of an economic group that invests in R&D&I, comprised of brands including Mack, Renault, Eicher, Donfeng, and others. This process creates opportunities for developing a variety of products. When Volvo starts work on a new vehicle, several R&D&I teams work on its development for the next 10 to 20 years. In Brazil, there is an engineering area made up of between 200 and 300 employees, highly-regarded by Volvo as individuals with competency and international experience. This area is responsible for developing some of the products. The subsidiary, by itself, does not have the capability to develop a completely new truck since it makes no sense to invest in creating a vehicle for a single isolated market. Basically, the investments are made in Sweden (and in France in the case of Renault trucks) and the Volvo Curitiba subsidiary partly contributes to the development of new projects according to the level of local competency.

The development that takes place in Volvo Curitiba is oriented toward the "tropicalization" of products and the specific demands of the local market. Nevertheless, this is not a simple process; it is not a mere facelift or the substitution of a one tire for another, since generally a high level of sophistication is required. When a new truck is launched worldwide, meeting market needs on any given continent, it goes through a process of local adaptation. One example of this were Volvo's Euro 6 trucks, developed in Sweden, which have higher gas emissions than those developed in Brazil and required modifications.

Another example is Volvo Curitiba's main project – its bi-articulated bus, which is produced in cooperation with the community and the municipality. In the local development of the Medio VM truck, while many of its components had been developed by the group's other enterprises, Volvo

27 FINAME is a credit line from BNDS for the acquisition and sales of buses, trucks, and executive planes (see BNDES, n.d.).

28 For innovation at Volvo see Waltrick (2014).

Curitiba was the unit responsible for overseeing the essentially Brazilian final product.

In product and process innovation, Volvo's R&D&I decisions are created, coordinated, and evaluated through a work process on a global scale. There are individuals who have the responsibility to think about innovation on a macro scale, who operate out of a kind of R&D&I headquarters that makes strategic decisions about which subsidiaries will participate in the development of new products, parts or components, thus taking advantage of the location of the best resources among the subsidiaries. This reinforces the argument that the Curitiba subsidiary is within a group subordinated to global directives with definitions and assignments. The projects that are proposed are placed in specific innovation fora under the supervision of the world R&D&I.

The configuration of Volvo's global R&D&I structure has undergone an evolution since the Curitiba subsidiary was created. When the bi-articulated bus was developed at the end of the 1980s, Volvo Curitiba had a different hierarchical structure, which gave it local decision-making powers with a global impact. According to Marassutti: "This was possible because this was how the world worked, with regional powers."[29,30] Decisions did not depend on a global structure like they do now. Given the current structure, with almost 100,000 employees and 200 of these reporting worldwide and to different positions, global processes had to change. In the 1980s, a buyer in Curitiba was assigned only to Brazil. Today, the same buyer can be buying in any other country. It is no longer possible for a subsidiary to develop complex innovation projects without being aligned with the Volvo group.

On the other hand, Volvo's intercompany innovation network provides new possibilities from the point of view of a subsidiary. The considerable diffusion of technologies is due to the level of competency of Volvo Curitiba. This is the result of an exchange of knowledge among local personnel and the international technical team. When Volvo Curitiba initiated its first projects (1980), almost half of the participants were foreigners. Currently, this percentage is much smaller, with some 4,000 Brazilian employees and only 20 foreigners. At the beginning, technology had to be transferred on a large scale; later, as this know-how was absorbed by the subsidiary, this approach was no longer necessary. Currently, there are Brazilian technicians working on projects outside Brazil in training programs conceived on the global level.

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29 Translation by *Apuntes*.
30 Interview with Carlos Morassutti (see above).

7. Final considerations

Innovation and internationalization of enterprises are two economic variables with different perspectives. Nevertheless, when an enterprise internationalizes it undergoes different stages of development that are often associated with innovation. Taking this into account, this study sought to verify the main characteristics of innovation in the subsidiaries of foreign multinationals in Paraná.

As noted in the introduction, in contrast to other studies that perform general analyses on the national level (Queiroz and Carvalho, 2005; Arruda *et al.* 2013; Gonçalves *et al.*, 2005; Boehe, 2007) or even on the international level (Dunning, 1994; Yamakawa *et al.*, 2008; Chesnais, 1996; Zander & Sölvell, 2000), this article sought to understand the micro reality, based on a single Brazilian state. Paraná was chosen both for its economic importance as well as for the large number of multinational corporations with subsidiaries there. It was evident that multinationals innovate, but the majority (70%) do not do so on the local level. However, those that do innovate locally acquire the know-how that allows them to launch new products and production processes, which guarantee the continuity of their activities in a given location in the host country.

Initially, foreign multinationals were drawn to Paraná primarily by the creation of the CIC in the mid-1970s, which made available the infrastructure necessary for the establishment of large-scale factories. The first to arrive were German, such as Siemens. Others, from various countries, followed such as the Swedish Volvo and the Finnish Electrolux: together, they were fundamental in creating the base for industry in Paraná. The motivations for their arrival are also discussed in the book *A mundialização do capital* (Chesnais, 1996), which points out the main advantages of internationalization. In the case of Paraná, three of these are worth mentioning: a) increased access to the local market; b) reduced psychological distance, given the European colonization of the state; c) the efforts of Paraná leaders in searching out and convincing European multinationals to come to the state.

As a result, most of the multinationals in the state (about 80%) are concentrated in the RMC. The majority are German, followed by those from the United States. The automotive sector attracts the most multinationals. Companies such as Volvo, Renault, Volkswagen, and Bosch make Curitiba the third largest automotive center in Brazil.

The technologies that multinationals brought and disseminated, both in training and transfer of the labor force and in the development of local suppliers, were fundamental for the transformation of the state. The matu-

ration of the first multinationals was also important for the generation and development of new products in Paraná.

As they grew, these enterprises began to carry out R&D locally. This is reflected in the results of this study, which shows that 58 (32%) of the 186 multinationals researched engage in innovation. It was found that innovation – in the majority of multinationals – was the consequence of their high levels of knowledge and the maturation of their innovation processes and routines.

In many cases, enterprises were found to have R&D departments, including Adama, Bundy, Bosch, CNH, and Electrolux. R&D&I structures varied considerably among companies – some more autonomous, some less so – according to the strategies chosen by each economic group.

The importance of the existence of organizations that promote innovation in the state of Paraná is also evident in the associative relationships formed with the main universities, federations, laboratories, and research institutions. Various alliances between companies, such as Volvo and Renault; universities, such as UFPR and PUC-PR; and institutions, such as the FIEP system were observed over time through their joint R&D projects.

Some of the enterprises use tax incentives, such as the Law of Goods (15%). This reinforces the idea that they take advantage of federal public incentives to invest in innovation. In addition, government measures, such as the Inovar-Auto, pressure industries to innovate in order to obtain advantages in lines of credit and import terms and conditions.

The innovation observed in this study varies in its conceptualizations and its applications. Some enterprises such as Arauco and Volvo believe that small innovations by employees in work processes can impact their business. For others, such as Mondelèz and CNH, strengthening innovation and the development of new products, is essential to developing their businesses from a Schumpeterian viewpoint.

Finally, we conclude that foreign multinationals located in Paraná innovate, though the enterprises that innovate are fewer than those who do not. Schumpter's (1941/2008) premises can be observed in the following: a) new products emerge from the combination of other products and methods in various situations, from Electrolux's line of refrigerators to Lacta chocolate products; b) they also emerge through entrepreneurs who are motivated to implement certain transformative activities, such as Mr. Wilmar Eppinger, who led the multinationals exploration committee in Germany and succeeded in bringing Siemens to Paraná; and finally, c) new products arise from the injection of risk capital into the innovation projects of AkerSolutions and Volvo, financed by BNDES (FINEP), in addition to federal laws providing incentives for innovation, such as the Law of Goods.

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