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Intellectual property rights in production fragmentation context: Exploring some IPRs data from Brazil and South Korea

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ABSTRACT

From an empirical perspective and using some historical elements, we speculate about the role of intellectual property rights in production fragmentation context and global value chains and the challenges they impose on learning. We use evolutionary economics theoretical framework to understand the importance of 'learning' in a competitive economy where firms that absorb knowledge increase their opportunities to innovate and to possess bigger market shares. Exploring data from Brazil and South Korea we find similarities in both countries regarding the intellectual property balance payments: both have an intellectual property balance payment deficit. However, data from National IPRs Offices shows that residents in South Korea are more apt to generate knowledge than residents in Brazil, what can be attributed to the difference importance given by both countries in what regards their industrial policies and the way both have integrated global value chains.

Keywords: intellectual property rights, technology transfer, global value chains, catch-up, Brazil, South Korea.

JEL Code: O10, O25, O30, O33, O34

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INTRODUCTION

From an empirical perspective and using some historical elements, we speculate about the role of intellectual property rights (IRPs) in the context of production fragmentation and global value chain (GVC) and the difficulties they impose on learning process. We make use of evolutionary economics theoretical framework to understand the importance of 'learning' in a competitive economy where firms that absorb new knowledge increase their opportunities to innovate and then to possess bigger market shares.

We organized the paper as follows. Section 1 briefly analyzes IPRs in the context of GVCs. In section 2 we present the data set. In section 3 we explore the intellectual property balance of payment for both Brazil and South Korea. We chose to explore those two countries because, South Korea (considered today a 'high income country') has reduced its technological gap and Brazil (considered today an 'upper middle income country') still lives in inertia of the Second Industrial Revolution. Notwithstanding that both countries have the same pattern in what regards the intellectual property balance payment: both have negative intellectual property balance payment. In section 4 we explore data regarding patents and utility models registered in intellectual property offices in Brazil and in South Korea.

We explore in section 5 some particularities of the development process of Brazil and South Korea. Before proceeding, we make two important caveats. Firstly by no means does this section constitute a comprehensive compendium on the Brazil and South Korea's development trajectories. We want to show that, although Brazil and South Korea have different features in what regards their culture, history, area and population size, both countries had pretty much the same GDP per capita until the beginning of the 1980s from when they start to differ (ROMERO *et al.*, 2015). Secondly, an article on such a complex topic must necessarily be limited in scope. We acknowledge, following the study of Etkowitz and Brisolla (1999) that the development experiences of Brazil and South Korea were distinct due to differences in: education investment; R&D investment; income distribution; and, presence of an earlier industrializing country in the region.

Besides the above we stress that two other important factors are important to explain the differences: learning capacity and the integration in global value chains.

Finally, we conclude this article with some final remarks.

1 IPRs AND GVCs

Four different factors are critical to understanding how global value chains complicate the relationship between IPR and learning within countries:

i. The distribution of innovative activities of multinational companies which control the GVC:

Given the central role that IPRs have in the profitability of innovative firms (TEECE, 1986), it should be considered that the distribution of activities that give rise to such IPRs tends to follow the distribution of the funds necessary for the better performance of these activities. In other words, the innovative activities tend to be located in each country capable of enhancing their results (SILVA, 2014).

Notwithstanding that, due to strategic reasons, these activities tend to be located close to the command center of the GVC (PATEL; PAVITT, 1991). Although the literature shows some devolution of R&D activities (CANTWELL, J. , 1994; CANTWELL, J., 1995; PATEL; PAVITT, 2000) in favor of new technology producing countries (ATHREYE; CANTWELL, 2007), because of the origin of the modern multinational companies, since the late 19th century and from the second half of the 20th century (DUNNING; LUNDAN, 2008), it can be said that the location of the best environments to perform innovative activities and the location of the controls of GVC are largely overlapping elements.

As a result, IPRs tend to be concentrated on more developed countries, leaving the newly industrializing countries with the role of technology importers registered, which can be corroborated by their production technology indicators of non-residents, as will be showed in section 4. Of course, the difference between developed and newly industrializing countries in what regards technology production is also reflected in the differential amount paid for the use of technology protected by IPR.

The fact that has become increasingly clear is that foreign direct investment (FDI) itself can transfer (in a limited way) to newly industrializing countries some capability to carry out R&D activities – either to adapt products and services to the local markets, either for efficiency issues related to the specialization of some countries, or by the importance increase of the developing country to multinationals firms (CHESNAIS, 1996; 2010).

In this sense, developing countries may be the original place where IPR was created, but the remuneration of such IPR will still be subject to the rationalization strategy of the multinational company, which may lead to distortions on the distribution of pecuniary results of R&D activities. On the one hand, these results may be in the form of profit for the subsidiary located in developing countries where the use of technology protected can be embodied in goods or services. On the other hand, the transfer of protected technology can yield the subsidiary resources in the form of royalties, as this is transferable to third parties. In the end, the net contribution to developing country in terms of its balance of payments depends on the multinational strategy to protect technology.

ii. Forms of GVC governance:

Multinational companies can organize their GVCs in different levels of activity internalization. Pietrobelli and Rabellotti (2011), for instance, noted that a better structured and efficient country reduces the complexity of the transactions, decreasing the need for GVC hierarquization. This suggests that more complex activities (such as R&D) tend to be carried out in more developed countries, and also that these more complex activities can be performed, at least in part, by external agents.

iii. Possibility of affecting transfer prices:

Transfer prices are those charged within the firms' hierarchy (i.e. transactions between a subsidiary and a mother company or among subsidiaries). Price manipulation occurs when prices in these internal transactions differ from normal market (external to the firm) (IETTO-GILLIES, 2012).

The motivation for such a practice is the ability to use domestic markets (instead of the hierarchy of the firm) to enhance the rationalization of the activities, resulting in greater efficiency and overall profitability. In addition, Ietto-Gillies (2012) points out as reasons for the manipulation of transfer prices, the possibility of the multinational firm: *a*) minimize the tax burden globally; *b*) avoid the restrictions imposed on profits transfer; *c*) take advantage on currency fluctuations; *d*) facilitate the entry into specific markets by reducing the costs of components; *e*) record low profits in specific locations to avoid pressures for higher wages.

Despite the long list of incentives, the manipulation of transfer prices is an illegal and strongly countered practice as well as being difficult to implement. However, it is exactly the knowledge intensive products market that this manipulation is more present and there are two main reasons for this to occur. First, the fact that firms prefer to keep transactions related to knowledge (technology) within its hierarchy to prevent knowledge leakages (and possible loss of advantage the possession of this knowledge). Second, such knowledge intensive assets have little comparison base with external prices, which facilitates the transfer pricing purposes without further fear of legal penalties for the firm. The ability to manipulate transfer prices ultimately impacts any measurement of innovative activities and IPR associated with them when taken in the context of countries, regardless of the individual strategies of firms that control GVCs.

iv. Possibility available to companies that control GVCs to concentrate the income from IPRs payments (royalties) in a third country other than the company's home country or location of innovative activity:

This practice may be motivated by the greater flexibility it gives the IPR holder company for the movement of global resources. Added to this, when the location of the concentration of IPR or their compensation offers favorable conditions in terms of taxation and privacy, own FDI strategy of the company will become more efficient because of the reduction of resource transfer costs and the greater agility for their application. An important result of this is a tendency to mismatch between innovative activities and IPR and their remuneration to the extent that companies adopt this practice, which will depend on the net benefits obtained by comparing each possible location of R&D and IPR.

These factors demonstrate that there are limitations to observe the relations between learning and IPR when GVC is considered. Overcoming these limits can be achieved only insofar as they are considered information on individual firms and their strategies. However, there are serious difficulties in obtaining disaggregated information by firm, since they are, in general, valuable business secrets. Furthermore, the amount of information increases significantly compared with the information for the countries and therefore also increases the need for verification and validation of the information, more prone to measurement error problems and incompleteness. Finally, one must consider that even obtaining reasonably accurate and complete information on a significant number of firms around the world, it is possible to identify some usual and tactical practices used by firms, while the correct identification of their strategies is a much more difficult task.

2 INTELLECTUAL PROPERTY DATABASE

We use secondary data from the World Bank regarding intellectual property balance of payment and also intellectual property data from the National Institute of Industrial Property (INPI) for Brazil and from the Korean Intellectual Property Office (KIPO) for South Korea. We also use some data available at the United States Patent and Trademark Office (USPTO).

In some cases, historical data regarding intellectual property is not available at the national offices; in those cases we make use of the compilation available at the World Intellectual Property Organization (WIPO). This difficulty is due to the different ways to analyze patent data. We use three different data regarding patent figures:

i. Patent application (or deposit): it is a request pending at INPI or KIPO for the grant of a patent for the invention described and claimed by that application/deposit. An application/deposit consists of a description of the invention and it does not guarantee that the property right will be granted;

ii. Patent publication: Prior to publication (generally patents are published 18 months after the earliest priority date of the application) the application is confidential to INPI and KIPO. After publication, depending on each office rules, certain parts of the application file may remain confidential. The publication of a patent application marks the date at which it becomes publicly available;

iii. Patent granted (or issued or registered): once the patent application complies with the requirements of INPI and KIPO, the patent will be granted/issued/registered.

For example, we could not use data from KIPO regarding a historical series about patents application or granted by technology once they are not publicly available. So, we used the data available at WIPO for the second case; there is no information available regarding patent application by technology for South Korea. It is worth mentioning that the data available by WIPO frequently do not correspond exactly to the data available by the official intellectual property office of South Korea, which is the reason why we opt not to use WIPO's data throughout the paper even though they offer a historical set of patent applications, patent publications and issued patents. We only used WIPO's data when official source was not available. Even with this pitfall, the figures presented here seem to be adequate and seem to be very close to the real figure.

Another example that we used WIPO's database is due to the difficulty in finding historical data by patents of technology areas granted in Brazil; INPI offers only historical data regarding patent applications by technology areas. So we present patent application by technology areas just for the Brazilian case.

After presenting the data, we show two important findings which are not properly addressed in the literature of newly industrializing countries: *i*) Brazil and South Korea have the same pattern in what regards their intellectual property balance of payments: both have trade deficit (from 2005 to 2013); *ii*) INPI receives more patent applications from non-residents while KIPO does from residents (from 2000 to 2012). This may result in more patents granted to non-residents for the former and to residents for the latter.

From the previous findings we show elements to validate our proposition: both Brazil and South Korea depend heavily on knowledge produced abroad but South Korea is more capable of absorbing this knowledge to create new relevant ones if compared to Brazil. One explanation for this is that South Korea is more integrated to GVC if compared to Brazil, implying that South Korean companies have more opportunities to innovate and a better worldwide insertion.

Before proceeding we make a caveat: we use patent figures (applications, publications and grants) as a proxy for innovative and technological capabilities. We are aware of the limitations of inferring innovative efforts by the number of patents[1].

[1] Patel and Pavitt (1985) present a critical view of using patents to infer innovation.

3 INTELLECTUAL PROPERTY BALANCE OF PAYMENT

The importance of intellectual property rights falls on the obstacles it may impose on imitators in what regards the learning process. Knowledge protection is centrally linked to diffusion, which in turn is related to the imitation process. Therefore, the more protected the knowledge is (the more private it is), the more difficult it is to be diffused throughout the economy, the slower it is the rhythm of imitation, the less reduced it is the opportunities for learning from copying.

Imitating a product is relatively easier than imitating a process or a procedure. Codified knowledge embodied in a product can be imitated through reverse engineering. Knowledge embodied in processes or procedures are intangible and result from investments in corporate culture, climate and organization mechanisms which are relatively more difficult to be copied. Therefore, imitation concerns products, firms' strategies, organization models and processes (VALDANI; ARBORE, 2007).

If firms learn from copying knowledge produced outside its borders and with this they are more able to create better capabilities to innovate, if knowledge is 'fenced', then it becomes more difficult for firms to use important sources of learning and capability building. For newly industrializing countries, imitation is the beginning of the catching-up processes (NIOSI, 2012).

In the TICs paradigm, knowledge protection became an important strategy of leading firms. This can be shown by patents figure, for instance. Worldwide, patent applications (non-residents) have grown considerably: in 1990, there were 243,000 provisional applications for patents in the world according to data from the World Intellectual Property Organization (WIPO) and in 2010, there were 667,000 new applications, representing a 174% growth. Notwithstanding that, it should be noted that most patent applications come from 'high income countries', although the share of applications from 'low & middle income countries' has increased in the period 1990-2010. For example, we find that in 1990 the share of 'low & middle income countries' in total worldwide patent applications was 15.40% and in the period 1990-99 was 20.09%, while in 2010 was 30.07% and the period 2000-10 was 27.29%.

Analyzing global transactions (using data from the World Bank) in relation to the authorized use of intellectual property rights[2]; for the use, through licensing agreements, of original products or prototypes[3]; and related rights produced[4], evidence shows that (for comparable data available) for both 'high income' and 'low & middle income countries', expenses for the use of intellectual property are not only high but also growing. Interestingly, the charges for the use of

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[2] Such as patents, trademarks, copyrights, industrial processes and designs including trade secrets and franchises.
[3] Such as copyright books and manuscripts, computer software, films and sound recordings.
[4] Such as for live performances and television, cable or satellite transmission.

intellectual property (payments)[5] in 'high income countries' (2005-12) were always higher than the ones in 'low & middle income countries'. For example, in 2005, the former totaled US$ 124 billion, while the latter about US$ 19 billion. Although 'low & middle income countries' always have lower payments than 'high income countries', the former increased their share in world. Also, receipts for the use of intellectual property were always higher in 'high income countries', which concentrated more than 97% of all global receipt (in the period 2005-12), according to the World Bank data

Although international payments for the use of intellectual property in 'high income countries' are very high, they receive a more compensation for the use of their own technology in other countries. Therefore, they have a positive intellectual property balance payment. In 2005 'low & middle income countries' had a US$16 billion deficit, that increased considerably by 2012, reaching US$ 40 billion (Table 1).

The USA is the world's largest debtors in terms of intellectual property, but it is also the largest creditors for its use. In net terms, the USA has a positive balance in this regard of US$ 90,162 million (in 2013, Table 1). The group of 'high income countries' has positive balance in terms of intellectual property (US$ 27,304 million in 2013) however, 'low and middle income countries' have a structural deficit (Table 1). An obvious conclusion can be found from these figures: most of new technological knowledge is produced in 'high income countries', while paying more for the use of intellectual property, they receive much more than those 'low and middle income countries' with their low innovative and learning capabilities.

Table 1 – Intellectual property balance payment, Million, US$, selected countries, 2005-2013.

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Brazil	-1.302,83	-1.513,37	-1.940,02	-2.231,73	-2.078,24	-2.453,04	-2.710,32	-3.155,77	-3.071,31
South Korea	-2.684,40	-2.661,50	-3.507,60	-3.389,10	-4.100,20	-5.994,50	-3.016,00	-4.713,70	-5.520,00
USA	48.871,00	58.512,00	71.323,00	72.503,00	67.109,00	74.971,00	87.246,00	85.991,00	90.162,00
Japan	3.001,77	4.595,20	6.550,81	7.389,04	4.863,31	7.911,67	9.816,53	11.994,73	13.755,81
Germany	-1.461,43	-1.920,68	-1.191,47	-1.297,33	204,74	1.161,34	3.340,54	3.542,77	4.508,55
High income	15.394,19	24.868,09	36.931,51	16.040,81	12.578,05	17.865,28	31.616,03	27.401,98	27.304,03
Low & middle income	-16.828,40	-18.198,18	-23.605,38	-27.006,57	-27.878,83	-30.728,90	-34.281,17	-39.813,37	-42.257,67

Source: Authors' own. Data sourced from the World Bank.

South Korea (considered a 'high income country' according to the World Bank) has growing the payments for the use of intellectual property rights. In 2005, South Korea has spent US$ 4,720 million and in 2013 US$ 9,752 million, which represents an increase rate of 107%. Equally, Brazil (considered an 'upper middle income country') has growing the payments for the use of intellectual property rights: from US$ 1,404 million (in 2005) to US$ 3,668 million (in 2013), an increase rate of 161%. Both countries seem to rely heavily and increasingly on knowledge produced abroad.

[5] 'Charges for the use of intellectual property (payment)' are the expenses between residents and non-residents for the authorized use of property rights, licenses and related rights produced.

Looking at the receipts for the use of intellectual property, Brazil follows the pattern of ‘low & middle income countries’, that is, they have been receiving an increasing compensation for the use of their own technology in other countries. In 2005, Brazil received US$ 101 million and in 2013 US$ 597 million (an increase rate of 487%) (Figure 1). Putting together these data with the previous one, it is possible to find the intellectual property balance payment for Brazil: it has a structural deficit, which has been increasing since 2005 (Table 1).

South Korea, on the contrary follows the ‘high income countries’ pattern if it were considered only the payments for the use of intellectual property (expenses for the use of intellectual property are not only high but also growing). However, South Korea does not have the same pattern of ‘high income countries’ regarding receipts for the use of intellectual property. On the contrary, South Korea has the same pattern of ‘low & middle income countries’, such as Brazil: it has been receiving an increasing compensation for the use of its own technology in other countries (from US$ 2,035 million in 2005 to US$ 4,232 million, that is, an increase rate of 108%). However, it is lower than the amount paid for the use of exogenous technology (Figure 1). That said, South Korea has, as Brazil does, negative intellectual property balance payment: from US$ 2,684 million (in 2005) to US$ 5,520 million (in 2013) (Table 1).

South Korea relies more on international knowledge than Brazil. This can be shown if we take a closer look and the payments for the use of intellectual property as a proportion of GDP. While Brazil a stagnated payment/GDP, South Korea has an increasing tendency. For instance, in 2005 Brazil spent 0.16% of its GDP to use intellectual property from abroad, while South Korea spent 0.53%. In 2013, the first spent 0.16% while the second spent 0.75% (Figure 2).

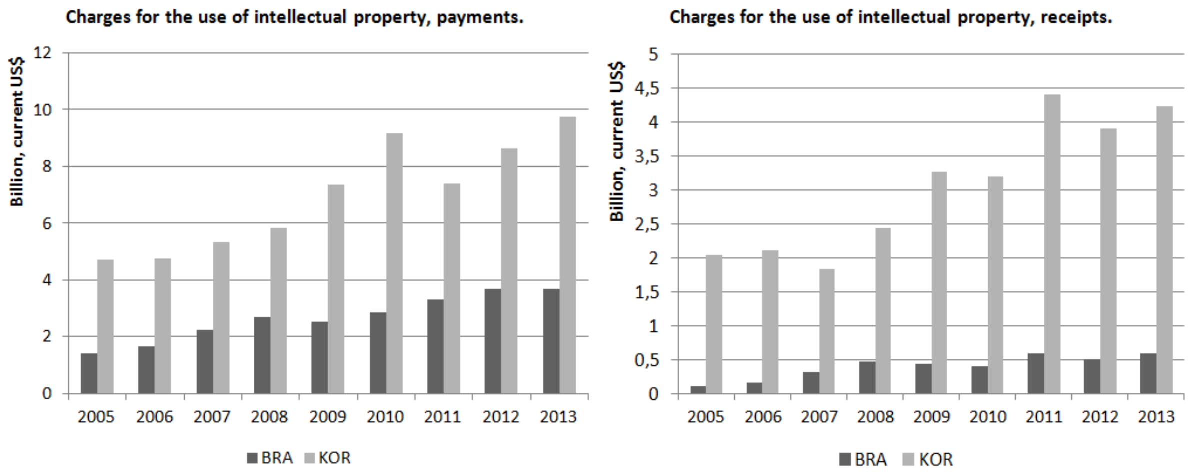

Figure 1 - Charges for the use of intellectual property (payments on left and receipts on the right), current US$, Brazil (BRA) and South Korea (KOR) 2005-12.

Source: Authors’ own. Data sourced from the World Bank and IMF. Note: ‘Charges for the use of intellectual property (payment)’ are the expenses between residents and non-residents for the authorized use of property rights, licenses and related rights produced.

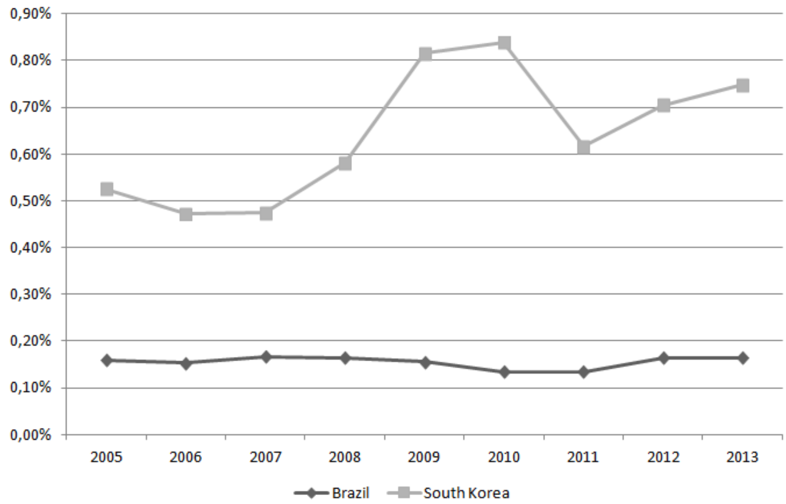

Figure 2 - Payments for the use of intellectual property as a proportion of GDP, Brazil and South Korea, 2005-2013.

Source: Authors' own. Data sourced from the World Bank.

From the previous figures, we need to make an important caveat: spending less than one percent of current GDP seems to be little compared to other important expenditures; however, if this value were spent domestically in R&D research or other S&T activities to enhance technological capabilities, for instance, it would generate many important spillovers and positive externalities. For example, in 2012, public R&D spending as a proportion of GDP reached 0.64% in Brazil[6], so if we add to this value 0.16% of GDP spent in payments to use of foreign knowledge, we would have 0.80% of GDP in activities that could eventually generate new knowledge in the country. In the same year, France, for instance, spent 0.80% of GDP on public R&D and the USA 0.86%.[7]

History does tell us that South Korea had heavily counted on international transfer of technology to catch-up. The main channel used then to transfer technology was the import of capital goods (KIM, E. M., 1997; VIOTTI, 2002; PACK, 2005). According to Viotti (2002), the import of capital goods played an important role in the Korean process of technical change suggesting that the acquisition of innovations generated in advanced industrial countries (incorporated in new crops of imported capital goods) contributed decisively to South Korea maintain a dynamic technology absorptive rate.

When intellectual property rights were still in force, with the help of public R&D institutes, some South Korean companies were able to develop capabilities to 'discover' technological secrets. In the case of emerging technologies, foreign companies protected them and they were even more reluctant to transfer to South Korean companies (KIM, L., 2005).

Before finishing this section, we have an important remarc: all the figures presented in this section are imperfect estimates first because royalty statistics do not necessarily capture

6 Data from Brazilian Minister of ST&I (MCTI).

7 Data from Organisation for Economic Co-operation and Development, Main Science and Technology Indicators, 2014/1.

technology transfer. Secondly, especially the figures related to ‘low & middle income countries’, because the payments for the use of intellectual property maybe be intended to produce exports for international corporations or may be used to remit profits to the headquarters.

4 INTELLECTUAL PROPERTY RIGHTS IN BRAZIL AND IN SOUTH KOREA

According to Penrose (1973), there are good reasons for the unequal treatment of residents and non-residents, especially in late industrialized nations. First, there are advantages to protect domestic inventors’ ideas and inventions, which can be taken by foreign companies without their consent. Secondly, non-residents make use of the patent system in less industrializing countries primarily to maintain their monopoly position in the local market as a means of transferring funds and in order to facilitate restrictive practices. For Penrose (1973), intellectual property granted to non-residents in less industrializing countries cannot provide support for industrialization or benefits to local industry.

The pattern of increased patenting of non-residents in less industrializing countries has been pointed out by Vaitsos (1972), when he found out that most patents in these countries are owned by non-residents (foreign companies and inventors). This finding has an unneglectable implication: non-resident patents do not reflect national inventive activities and obviously have no (positive) direct influence on the inventiveness of the country. According to Cassiolato et al. (2010), developed nations today with their innovative and learning capacity have been able to internalize the activities of the industry based on science, that is, they have productive structures for innovation in the sciences and technology sectors built into their social, political and economic practices.

Considering the patent application (or patent deposit) data, in the case of Brazil, we can notice an increase of applications from 17,258 in 2000 to 30,399 in 2012. In 2000, residents claimed 18.41% of total patent applications while in 2012 residents’ share accounted for 15.78% of total applications at INPI. It is worth recording that a patent deposit is just a request pending at the patent official office for the grant of a patent and the process of analyzing this claim may take a long period and it does not guarantee at all that the patent will be granted at the end of the process.

Table 2 - Share of invention patents deposited by technology area by residents, Brazil, 2000-2012.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Electrical Engineering	13.34	14.90	16.26	18.12	20.42	14.68	16.53	14.20	14.10	12.37	9.49	7.24	7.11
Instruments	23.06	22.16	27.19	28.95	28.83	26.68	21.23	20.50	20.19	20.20	14.94	11.17	8.58
Chemistry	8.84	8.51	9.87	12.43	12.87	11.97	11.37	12.02	10.94	11.31	9.94	7.44	7.48
Mechanical Engineering	23.58	25.49	26.59	28.41	31.14	30.49	26.61	25.43	23.21	24.91	19.04	14.68	11.78
Other fields	45.57	47.58	48.36	51.86	51.81	49.37	46.05	42.05	41.67	38.72	28.64	24.04	19.99
Unknown	28.87	35.27	37.73	45.67	27.22	30.92	45.16	67.54	92.44	89.97	78.91	66.18	31.78
Total	18.41	19.29	20.85	23.54	24.19	21.93	19.95	19.38	18.48	19.06	16.93	16.43	15.78
Total patent deposits	17,258	17,828	16,668	16,404	16,702	18,455	19,832	21,638	23,098	22,356	24,958	28,630	30,399

Source: Authors’ own. Data sourced from INPI.

Even knowing that patent applications may not result in patent grants, using patent application data give interesting insights: most of the new inventions deposited at INPI is done by non-residents, therefore, non-residents use legal instruments to protect their knowledge in Brazil.

Breaking the previous data by technology it is possible to evidence that there are important differences according to each one of them: electrical engineering, instruments, chemistry and mechanical engineering. For instance, in 2000, 91.16% of patents deposited at INPI in chemistry (organic fine chemistry, biotechnology, pharmaceuticals, macromolecular chemistry, polymers, food chemistry, basic materials chemistry, metallurgy, surface technology, coating, micro-structural and nano-technology, chemical engineering and environmental technology) belonged to non-residents; in 2010 this percentage fell slightly to 90.06% (Table 2).

At INPI were deposited more patent recognition requests of non-residents in the area of biotechnology than for residents (Table 8). Throughout the 2000s, no more than 10% of deposits related to this technology were done by residents. For example, in the year 2000, INPI received 667 requests of each only 35 were of residents (that is 5.25% as shown in Table 2), while in 2010, INPI received 1,228 deposit requests, almost two times as the requests done in the year 2000. Despite the total increase of deposit requests, the participation of residents continued to be little: of the 1,228 deposit requests only 75 were of residents (that is 6.10%).

Considering pharmaceuticals, we find figures that show that in 2000 of the total patent deposits (888) at INPI of this technology, only 6.31% were of residents while in 2010 of the total 1,440 deposits, 9.24% were of residents.

Still considering the Brazilian case, in 2012, 92.89% of patents deposited in the electrical engineering field at INPI were of non-residents (Table 8). This includes electrical machinery, audio-visual technology, telecommunications, digital communications, computer technology, information technology methods for management and semiconductors. To illustrate, in 2000, 63 patent recognition were deposited by residents in ‘telecommunications’, while 883 were of non-residents (6.66% versus 93.34%); in 2012 there were only 22 patent recognition deposited by residents, while 287 were deposited by non-residents. The figures of semiconductors are surprising: while the residents deposited in 2000, only 2 patent recognition requests, non-residents had 12 times more; and in 2012, while residents had 6 recognition requests, non-resident had 131.

The previous findings are quite worrisome, since it is claimed that biotechnology and pharmaceuticals are technological areas that ‘lead to the future’ with high intensity of knowledge and innovation. In addition, the health industry (chemical-based subsystem and biotechnology involving pharmaceuticals, vaccines, blood products and reagents) is considered a high intensity knowledge and innovation field, developing and incorporating strategic technologies whose impacts affect both the productive health system itself and the promotion of the economic and productive system (CASSIOLATO *et al.*, 2010). Moreover, electrical engineering technologies form the focal point of the ICTs Paradigm.

The incapacity of Brazilian residents to create new ideas and inventions and submit them to legal protection can represent the low ability to produce new relevant knowledge in Brazil due to the features of the Brazilian Innovation System. We believe that this low ability is a result of the Brazilian industrialization process, which used the growth potential of the internal market and little emphasis was given to the ability to compete globally. The focus on exports was almost always an emergency nature to solve problems in the balance of payments (PACHECO; ALMEIDA, 2013). This emphasis was 'crystallized' in Brazilian industrial culture and, up to today, the international integration of the domestic industry is fragile and there is a huge effort to promote the internationalization of Brazilian industrial firms.

The lack of foreign competition generated little 'eagerness' to compete globally, implying no need for constant innovation, reflecting the low innovative tradition of Brazilian companies. When there is not a competitive market, there is little investment in innovation activities (which are usually uncertain and risky) (KIM, L.; DAHLMAN, 1992). This resulted in products and processes' quality below the world average (DAGNINO; THOMAS; DAVYT, 1996).

A different development path was used by South Korea. The South Korean model did not rely on the presence of transnational companies, with an explicit policy of promoting independence from them (KIM, L., 2005 [1997]). The Korean government has undertaken active trade and industrial policies, which were responsible for stimulating the technological dynamism of industrial enterprises (VIOTTI, 2002). It is noteworthy to highlight that South Korea used considerable industrial policy, import protection, export subsidies, credit targeting, foreign direct investment restrictions and slack IPR rules (LALL, 2003). This model have influence the culture of creating new ideas and inventions in South Korea, which can be corroborated by the figures bellow.

Table 3 – Patent applications, residents and non-residents, South Korea, 2000-2012.

Year	Residents		Non-residents		Total
	Applications	%	Applications	%	
2000	72.831	71.4	29.179	28.6	102,010
2001	73.714	70.5	30.898	29.5	104,612
2002	76.570	72.1	29.566	27.9	106,136
2003	90.313	76.1	28.339	23.9	118,652
2004	105.250	75.1	34.865	24.9	140,115
2005	122,188	64.7	38,733	20.5	160,921
2006	125,476	61.3	40,713	19.9	166,189
2007	128,701	74.6	43,768	25.4	172,469
2008	127,114	74.5	43,518	25.5	170,632
2009	127,316	77.9	36,207	22.1	163,523
2010	131,805	77.5	38,296	22.5	170,101
2011	138,034	77.1	40,890	22.9	178,924
2012	148,136	78.4	40,779	21.6	188,915

Source: Authors' own. Data sourced from KIPO.

In 2000, KIPO received 102,010 patent claims of each 71.4% were of residents. In 2012 KIPO received 188,915 of each 78.4% were of residents (Table 3). South Korea witnessed an increase in total patent applications and also in increase in the share of residents. This was not the case of Brazil as already suggested: Brazil has also increased the number of patent applications in the same period (from 17,258 to 30,399) but the share of residents has reduced (from 18.41% to 15.78%).

Now if we turn our analysis to registration grants, not surprisingly we find that more residents are granted registrations in South Korea and non-residents in Brazil. In terms of numbers of patents and utility models registered in intellectual property offices in Brazil and in South Korea it is possible to see that South Korea grants more registrations than Brazil. Table 4 summarizes the total number of invention patens and utility models granted in both countries from 2000 to 2012.

Table 4 –Invention patents and utility models granted/registered, Brazil and South Korea, 2000-2012.

Ano	Brazil							South Korea						
	Invention Patent			Utility Model			Total	Invention Patent			Utility Model			Total
	Residents	Non residents	Unk.	Residents	Non residents	Unk.		Residents	Non residents	Unk.	Residents	Non residents	Unk.	
2000	649	5.556	50	397	22	1	**6.675**	-	-	-	-	-	-	**76.701**
2001	379	2.879	34	312	10	2	**3.616**	-	-	-	-	-	-	**78.517**
2002	337	3.996	89	338	19	1	**4.780**	-	-	-	-	-	-	**85.255**
2003	403	3.778	88	441	27	5	**4.742**	30.525	13.640	-	36.597	675	-	**81.437**
2004	279	1.949	34	251	12	5	**2.530**	35.284	13.784	-	33.629	553	-	**83.250**
2005	247	2.201	21	343	21	5	**2.838**	53.419	20.093	-	32.104	612	-	**106.228**
2006	231	2.243	36	256	14	5	**2.785**	89.303	31.487	-	29.031	705	-	**150.526**
2007	198	1.444	8	185	12	3	**1.850**	91.645	32.060	-	2.739	56	-	**126.500**
2008	233	2.283	5	277	11	2	**2.811**	61.115	22.408	-	4.875	100	-	**88.498**
2009	340	2.440	10	336	20	-	**3.146**	42.129	14.603	-	3.880	69	-	**60.681**
2010	313	2.931	7	343	17	1	**3.612**	51.404	17.439	-	4.199	102	-	**73.144**
2011	380	3.064	7	332	17	-	**3.800**	72.258	22.462	-	5.705	148	-	**100.573**
2012	363	2.467	5	281	10	1	**3.127**	84.061	29.406	-	6.151	202	-	**119.820**

Source: Authors' own. Data sourced from INPI for Brazil and from KIPO for South Korea.

Analysis of patent data issued by INPI, shows that on average 89.34% (for the period 2000-12) of them were granted to non-residents (Figure 3). Patents by Brazilian residents are therefore a small proportion of the total, and only some of them have actual industrial importance. South Korea has a different pattern: KIPO grants more patents to residents. For the period 2003-2012, KIPO granted 73.42% as an average to residents (Figure 3). This has certainly different implications in both industrial developments.

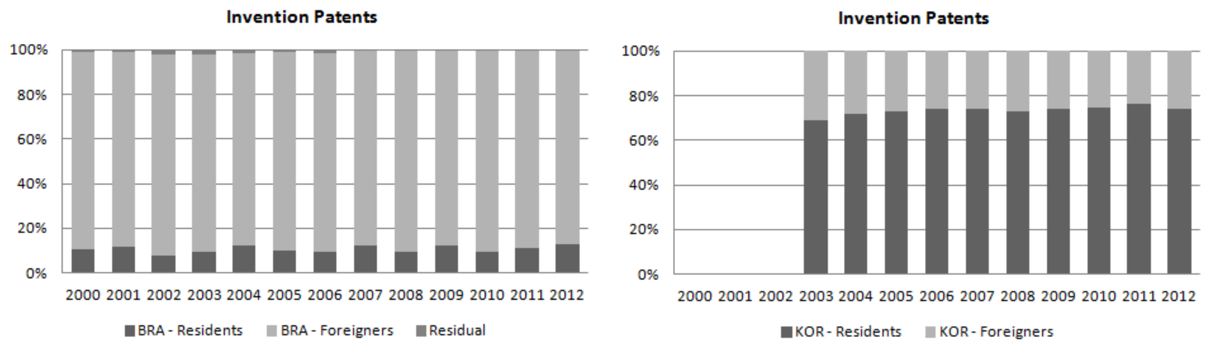

Figure 3 – Comparison of domestic and foreign registrations of invention patents, Brazil and South Korea.

Source: Authors' own. Data sourced from the National Institute of Industrial Property (INPI) for Brazil and from the Korean Intellectual Property Office (KIPO) for South Korea.

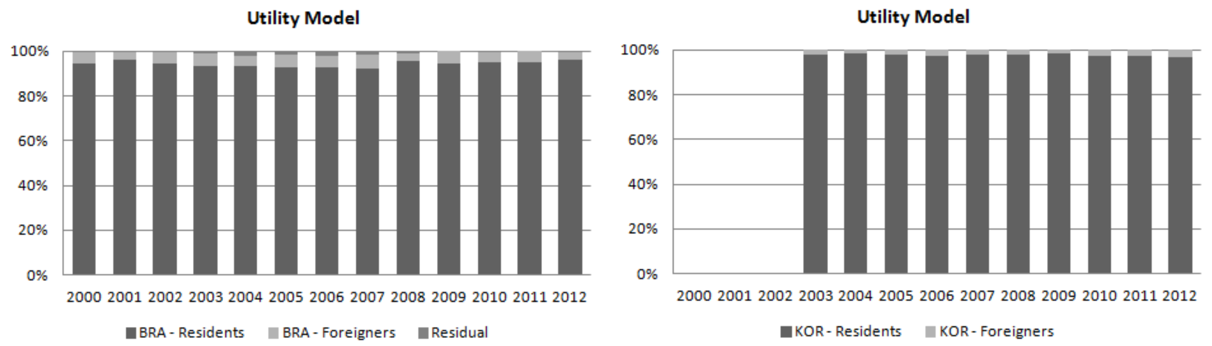

Figure 4 – Comparison of domestic and foreign registrations of utility model, Brazil and South Korea.

Source: Authors' own. Data sourced from the National Institute of Industrial Property (INPI) for Brazil and from the Korean Intellectual Property Office (KIPO) for South Korea.

This could reflect three things: *i*) South Korean office is more efficient than the Brazilian one in analyzing more applied intellectual property applications; *ii*) South Korea produces more inventions than Brazil; therefore, South Korea has more opportunities for innovation once they have more technological capabilities reflected in the number of intellectual properties it protects; and *iii*) South Korea is more integrated in GVCs with a great deal of leading companies; while Brazil is somewhat integrated in GVC in less privileged positions, so the multinationals that control de GVC apply for IPR at INPI.

In 2012, for example, INPI granted 2,835 patents, of which 87.01% were granted to non-residents. American residents (mostly American companies) were responsible for 32.87% of patents granted to non-residents. Americans are followed by Germans (with 16.34% of patents), Japanese (7.99%) and French (7.74%) (Table 5).

Table 5 – Registration of Invention Patents by country, Brazil and South Korea, 2012.

INPI/Brazil	%	KIPO/South Korea	%
USA	32.87%	Japan	44.14%
Germany	16.34%	USA	28.58%
Japan	7.99%	Germany	7.05%
France	7.74%	France	3.40%
Switzerland	6.04%	China	1.49%
Netherlands	5.51%	Switzerland	2.57%
Italy	4.46%	Taiwan	1.60%
United Kingdom	3.49%	Netherlands	2.16%
Sweden	3.24%	United Kingdom	1.26%
South Korea	1.42%	Italy	0.69%
Finland	1.34%	Sweden	1.27%
Canada	1.26%	Canada	0.87%
Norway	0.97%	Finland	0.98%
Belgium	0.85%	Singapore	0.43%
Austria	0.77%	Belgium	0.66%
Others	5.72%	Others	2.86%
Total	**100.00%**	**Total**	**100.00%**

Source: Authors' own. Data sourced from the National Institute of Industrial Property (INPI) for Brazil and from the Korean Intellectual Property Office (KIPO) for South Korea. Note: Total invention patents granted to foreigners in Brazil in 2012 was 2,467 and 29,406 for South Korea.

KIPO's patents granted to non-residents totaled 29.406 (of a total of 113.467 patents granted in 2012), that is, 25.91%. Of these 29.406 patents, 44.14% were granted to Japanese non-residents, 28.58% to Americans, 7.05% to Germans and 3.40% to French (Table 5).

Interestingly the same four that have received more patent protections by INPI were the same four that have received legal protection by KIPO. This has two important implications: *i*) the USA, Germany, Japan and France are important nations regarding knowledge creation, what confirm the thesis of knowledge concentration in the world (CHESNAIS, 1996); *ii*) Brazilian firms patent less than South Korea due to less effort of national technology and innovation generation in Brazil. Zucoloto and Cassiolato (2014) noted that although South Korea had a more restrictive policy regarding FDI, data of US multinational firms in South Korea indicate that they have been increasing their technological performance in the country (what justify the greatest number of patents of non-residents).

Considering utility models granted, INPI and KIPO act alike: both grant more rights to residents (Figure 4). Normally utility models have less stringent patentability requirements and they are more suited to incremental inventions.

If more than 90% of patents is granted to non-residents it inhibits the power of small business innovation, as the cost of getting it is high, with the likely risk of wide-spread exclusion, as these companies do not have the financial means to afford such costs (TIGRE; RIPPER; ROSELINO, 2010)[8]. This can result in market concentration.

Patents granted to non-residents in less developed countries are unlikely to have an effect on the rate of invention or innovation in developed countries, so the ‘myth’ that patenting has a positive effect on innovative rate has to be accepted with reservation, especially because it is unlike that non-residents patenting new knowledge in Brazil, for example, will affect the innovative rate in their countries[9]. The use of patents in this case can cause an ‘incremental innovations lock’ instead of creating more incremental opportunities in Brazil. History is full of examples that prove that the restriction of access to knowledge through patents can inhibit improvements and enhancements, thus depriving society of the benefits of technological advance.

The patents granted in the US to foreign residents by the United States Patent and Trademark Office (USPTO) help to: *i*) give an idea of the level of technological capability of a country; *ii*) understand the degree of integration with the international economy.

Table 6 presents figures on patents granted by USPTO to Brazilian and Korean residents. There is a clear increase in the number of patents granted in the period 1990-2012 to both Brazilians and South Koreans, though the latter had rapid growth, which can be confirmed by Figure 5.

8 “Small businesses would not be able to compete on an equal basis with large corporations that rely on lawyers and request hundreds or thousands of patents annually and file lawsuits indiscriminately, with intimidation” (TIGRE; RIPPER; ROSELINO, 2010, p. 97).

9 “There is also little to be gained by the less-developed countries from obtaining ‘national treatment’ for their own patents in industrial countries since they have little occasion to patent inventions of their own abroad. Hence, the only economic advantages to be gained from granting foreign patents lies in the possibility that in one way or another such grants will induce the introduction of foreign technology and capital.” (PENROSE, 1973, p. 770).

Table 6 – Intellectual property granted by the US to non-residents, 1990-2012.

Year	Brazil	South Korea	Total	Year	Brazil	South Korea	Total	Year	Brazil	South Korea	Total
1990	38	236	45,201	**2000**	122	3,699	81,675	**2010**	209	11,811	117,264
1991	61	413	46,978	**2001**	127	3,783	86,203	**2011**	232	12,858	124,252
1992	55	543	49,968	**2002**	113	3,755	83,97	**2012**	261	13,956	138,607
1993	58	789	47,927	**2003**	150	4,198	89,701				
1994	57	941	49,149	**2004**	192	4,59	89,258				
1995	66	1,175	49,679	**2005**	93	4,811	80,245				
1996	65	1,428	50,159	**2006**	152	5,835	87,014				
1997	72	1,828	53,683	**2007**	112	6,882	89,759				
1998	79	3,052	68,796	**2008**	131	8,41	90,713				
1999	87	3,477	70,047	**2009**	146	9,401	96,395				

Source: Authors' own. Data sourced from USPTO. Note: Data includes Utility Models, Industrial Designs and Patents.

In 1990 the patents[10] granted to Brazilians by USPTO represented only 0.08% of all patents granted in USA to foreigners, while South Korea did not have a much higher performance: during the same period the patents granted to South Koreans accounted for 0.52%. After two decades, the South Korean patents granted amounted to 10% of the total granted to foreigners, while Brazilian residents were granted a patent volume representing 0.18% (in 2010).

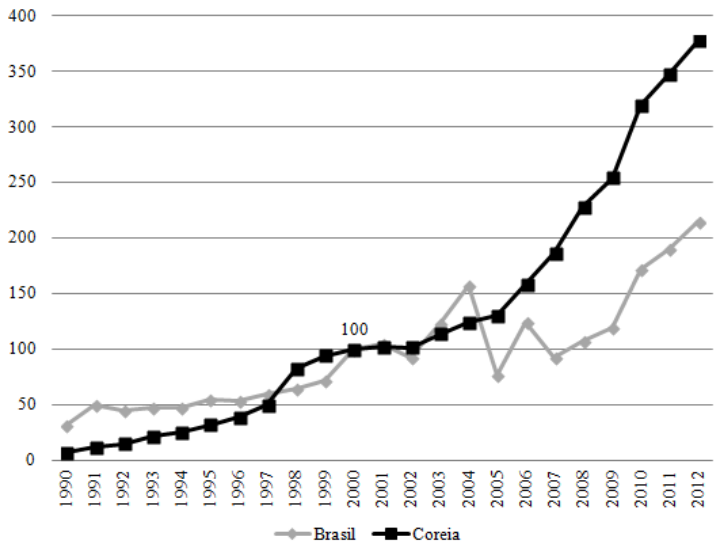

Figure 5 – Patent variation index granted by the US to Brazil and Korea, 1990-2012.

Source: Chiarini and Silva (Forthcoming).

5 INDUSTRIAL POLICIES IN BRAZIL AND SOUTH KOREA

The figures presented in the previous sections can be justified with the low ability to produce new relevant knowledge in Brazil due to the features of the Brazilian industrializing process. This low ability is a result of the Brazilian industrial policy, which used the growth potential of the internal market and little emphasis was given to the ability to compete globally (unlike the South Korean case). The focus on exports was almost always an emergency nature to

10 Data includes Utility Models, Industrial Designs and Patents.

solve problems in the balance of payments (PACHECO; ALMEIDA, 2013). This emphasis was 'crystallized' in Brazilian industrial culture and, up to today, the international integration of the domestic industry is fragile and there is a huge effort to promote the internationalization of Brazilian industrial firms.

Because of short run objectives of economic policies in Brazil, the development process led to a considerable technological dependence. The goal of quickly economic development and modernization was seen as possible through the flow of capital and technology transfer with the entry of transnational corporations (THOMAS et al., 1997). Often new technologies acquired from outside Brazil were followed by some degree of improvement in the efficiency of the process and product performance with relatively minor adjustments and learn-by-doing and learn-by-using , but the intensity of the incremental technique was often inadequate to sustain international competitiveness in technologically dynamic markets and rarely created new bases of competitiveness in progressively higher value-added activities (BELL; CASSIOLATO, 1993)**.**

The development path based on 'welcoming policy' to transnational generated the possibility that foreign companies (and local ones) needn't local S&T institutions since they relied heavily on technology produced abroad (THOMAS et al., 1997). The attraction of foreign companies' policy was possible due to protectionism and special treatment to foreign investors. These strategic elements encouraged companies to set up in Brazil (DAHLMAN; FRISCHTAK, 1990).

The lack of foreign competition generated little 'eagerness' to compete globally, implying no need for constant innovation, reflecting the low innovative tradition of Brazilian companies. When there is not a competitive market, there is little investment in innovation activities (which are usually uncertain and risky) (KIM, L.; DAHLMAN, 1992). This resulted in products and processes' quality below the world average (DAGNINO; THOMAS; DAVYT, 1996).

The industrialization pattern with high protection of the economy did not result in an active learning process (VIOTTI, 2002), at best it resulted in partial learning. The adopted protectionism was a 'frivolous protectionism', which did not favor a learning process led by national groups. The protection was never a result of a strategy designed by domestic agents and targeted to the future conquest of the international markets. (FAJNZYLBER, 1983).

The openness of the economy did not favor the development of new capabilities and Brazilian firms had to face the competition of more modern and more efficient international firm that entered the country. This wave of openness was accompanied by the strong imposition of the World Trade Organization and other international agencies to promote strict IPRs.

In what regards the South Korean case, South Korea, has heavily counted on international transfer of technology to catch-up and the main channel used was the import of capital goods, while foreign direct investment had a minor role (VIOTTI, 2002; PACK, 2005). According to Viotti (2002), the import of capital goods played an important role in the Korean process of technical change suggesting that the acquisition of innovations generated in advanced industrial countries (incorporated in new crops of imported capital goods) contributed decisively to Korea maintain a dynamic technology absorption rate.

The South Korean development model did not rely on the presence of transnational companies, with an explicit policy of promoting independence from them (KIM, L., 2005 [1997]). Another channel used by South Korea to acquire technology from abroad was the import of technological products from relatively more advanced nations like the US and Japan (VIOTTI, 2002). Beside the imports of capital goods and technological products, the Korean government has undertaken active trade and industrial policies, which were responsible for stimulating the technological dynamism of industrial enterprises (VIOTTI, 2002). It is noteworthy to highlight that South Korea used considerable industrial policy, import protection, export subsidies, credit targeting, foreign direct investment restrictions and slack IPR rules (LALL, 2003).

According to Viotti (2002), Korean public policies made it possible to overcome the limits imposed by a ‘passive learning’. Therefore, the South Korean State took active part in the implementation of the Korean industrialization strategy (KIM, L., 2005; LAPLANE; FERREIRA, 2013). Fostering the *chaebols* (Korean version of the Japanese zaibatsu) boosted industrial locomotive: the *chaebols* have played significant role in accelerating technological learning of the industrial sector when financing the technology transfer taking advantage of their ability to obtain explicit and implicit knowledge of high level from international community (KIM, L., 2005).

According to Kim (2005), despite the concentration of economic power, the *chaebols* promoted the strengthening of local technological capabilities and the leadership of the globalization of South Korean enterprises, as had the necessary organizational, technical and financial resources. He points out that as Korea gets closer to the technological frontier, other challenges are present, such as increasing difficulty acquiring necessary technologies from foreign suppliers. When technologies were relatively simple and tied to a technological standard type of Fordist paradigm and patents had expired, the South Korean companies with sufficient capabilities performed the reverse engineering of foreign products, producing cheap copies.

When technologies have become relatively more complex, the licensing was the main channel of technology transfer used, allowing South Korean companies to acquire tacit knowledge – via training and supervision – and explicit knowledge – through technical plan , product specifications and production manuals (KIM, L., 2005). When intellectual property rights were still in force, with the help of public R&D institutes, some South Korean companies were able to develop capabilities to ‘discover’ technological secrets. In the case of emerging technologies, foreign companies protected them and they were even more reluctant to transfer them to South Korean companies (KIM, L., 2005), which proves the argument in the literature that the relatively more advanced nations hinder the transfer of technology to keep their privileges structures. In the words of Chang (2004), the relatively more advanced nations ‘kick away the ladder’.

FINAL REMARKS

The economic benefit to a developing country of stronger IPRs depends on the presence of local agents capable of purchasing, absorbing and deploying the new technologies. If no such agents exist, strict IPRs offer no benefits. If they exist, the size of the benefits depends on two things: the extent to which IPRs raise the cost of technologies, and if the alternative of copying would have been cheaper and more rewarding in building local capabilities. (LALL, 2003).

Some difficulties developing countries face that we can point out: *i*) Process of acquiring technological capabilities in the course of continuous technological change: in which areas should investment be focused? Should it be focused in the new paradigm, that is ICTs? Or in the next probable paradigm related to nanotechnology, new materials and renewable energy? *ii*) Developing countries, in the past and now, have to develop national capabilities to generate indigenous technology. FDI did not play a significant role in Brazilian technological capabilities construction but seems to be, now, important to South Korea. The differences presented regarding IPRs figures in two countries comparison can be explained by the development and construction of National Innovation Systems regarding innovation and knowledge generation in firms. The database presented in the paper shows that NSI features are very important even to attract multinationals firms.

Finally we want to say that the development process is unique in each nation. South Korea and Brazil had different strategies, and there were particularities in each country that shaped this process as special features closely related to its historical, geographical, social, cultural, political and economic aspects (FERREIRA Jr.; CANUTO, 1990). National innovative capabilities, investments, institutional configurations and national policies decisions shape both Brazil and South Korea in their development process.

The countries analyzed in the paper have been taking divergent positions in public policy on how to conduct their economic development and definition of the role of transnational companies in this process. Brazil has approached these issues in a closed manner and for a long time had protective policies regulating the domestic market, particularly in the field of ICT. As a consequence, it did not accompany the knowledge development in this field. From the mid-90s things have changed in some ways (offer statistics). On the other hand, South Korea adopted the attitude of becoming part of the international supply chain. However, Brazil’s economy is based on commodity production (agriculture).

The industrialization pattern of Brazil with high protection of the economy did not result in an active learning process (VIOTTI, 2002), at best it resulted in partial learning. The adopted protectionism was a ‘frivolous protectionism’, which did not favor a learning process led by national groups. The protection was never a result of a strategy designed by domestic agents and targeted to the future conquest of the international markets. (FAJNZYLBER, 1983).

On the contrary, according to Viotti (2002), Korean public policies made it possible to overcome the limits imposed by a ‘passive learning’. Therefore, the South Korean State took active part in the implementation of the Korean industrialization strategy (KIM, L., 2005; LAPLANE; FERREIRA, 2013). Fostering the *chaebols* (Korean version of the Japanese zaibatsu) boosted industrial locomotive: the *chaebols* have played significant role in accelerating technological learning of the industrial sector when financing the technology transfer taking advantage of their ability to obtain explicit and implicit knowledge of high level from international community (KIM, L., 2005).

So South Korea was able to articulate an industrial policy oriented towards the GVC to leverage and boost international interactions in GVCs (GEREFFI, 2014), also increasing its innovative and learning capacity. In turn, Brazilian industrial policy settled in attracting FDI without an integrate strategy to get in GVCs.

Finally, we can conclude saying that South Korea was able to leverage the interactions in GVCs in order to improve the country’s performance in terms of learning capacity. This policy goes beyond the import substitution industrialization strategies, which try to recreate the entire supply chain within the national territory. This new type of industrial policy explicitly uses the extraterritorial interactions that affect the positioning of the country in global and regional value networks. Brazil, on the contrary, bet on import substitution industrialization policies and was not able to catch-up with the technological paradigm.

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APPENDIX

Table 7 - Patent grants by technology, Brazil, 2000-2012.

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Electrical Engineering	Electrical machinery, apparatus, energy	308	158	193	85	34	21	48	18	44	71	76	118	63
	Audio-visual technology	86	44	139	78	28	25	20	7	31	41	26	41	42
	Telecommunications	107	34	261	92	32	23	12	6	9	49	21	26	33
	Digital communication	23	9	48	14	6	5	5	0	4	2	12	14	20
	Basic communication processes	23	7	55	9	4	2	1	2	5	5	7	6	17
	Computer technology	47	25	75	57	11	10	14	8	13	21	16	25	42
	IT methods for management	0	0	0	0	0	0	0	0	1	2	0	0	1
	Semiconductors	2	3	11	4	2	3	0	0	3	0	3	3	4
Instruments	Optics	78	21	60	22	8	6	13	13	35	48	29	31	35
	Measurement	96	28	91	30	22	12	20	10	51	56	41	45	65
	Analysis of biological materials	4	8	8	5	2	2	4	1	6	6	7	3	9
	Control	48	18	42	21	6	11	9	4	23	25	22	34	24
	Medical technology	185	231	292	223	71	104	133	112	178	198	169	126	169
Chemistry	Organic fine chemistry	524	138	167	141	139	131	120	81	110	147	279	188	171
	Biotechnology	101	26	38	38	28	21	26	15	20	49	69	69	32
	Pharmaceuticals	52	16	25	44	61	44	42	17	31	43	59	42	16
	Macromolecular chemistry, polymers	392	181	212	260	146	176	158	85	126	130	199	238	141
	Food chemistry	41	14	16	36	20	22	15	15	18	30	36	37	17
	Basic materials chemistry	486	235	224	256	173	169	163	100	155	183	183	218	235
	Materials, metallurgy	447	173	170	271	138	173	185	68	86	151	164	207	144
	Surface technology, coating	171	85	99	100	45	68	57	48	50	53	67	99	111
	Micro-structural and nano-technology	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chemical engineering	261	154	153	164	106	125	99	47	99	98	198	250	117
	Environmental technology	113	75	60	58	32	40	47	24	34	39	70	71	69
Mechanical Engineering	Handling	392	221	245	277	156	143	166	123	154	147	171	155	244
	Machine tools	286	103	132	177	102	130	131	94	78	67	121	142	68
	Engines, pumps, turbines	162	122	137	195	69	63	78	87	108	114	116	190	162
	Textile and paper machines	316	189	169	203	84	108	85	62	125	139	126	149	131
	Other special machines	289	168	167	227	127	143	165	104	231	177	264	269	180
	Thermal processes and apparatus	141	80	93	98	50	67	51	43	39	50	71	63	24
	Mechanical elements	368	184	304	385	173	134	226	123	168	175	196	220	58
	Transport	294	206	281	325	166	242	205	113	199	182	182	162	168
Other fields	Furniture, games	33	70	72	46	34	29	28	30	46	39	37	24	19
	Other consumer goods	96	130	148	123	72	60	61	43	76	71	76	69	67
	Civil engineering	162	113	193	153	91	139	98	127	143	149	101	87	126
	Unknown	121	23	42	52	24	18	25	20	22	33	37	30	11
	Total	6,255	3,292	4,422	4,269	2,262	2,469	2,510	1,650	2,521	2,790	3,251	3,451	2,835

Source: Authors' own. Data sourced from INPI.

Table 8 - Share of patents deposited by residents by technology, %, Brazil, 2000-2012.

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Electrical Engineering	Electrical machinery, apparatus, energy	21,36	28,80	23,34	29,50	31,08	28,46	28,66	21,68	22,03	23,32	15,44	10,69	8,76
	Audio-visual technology	21,77	20,55	22,12	24,62	31,93	14,94	19,91	17,97	20,46	12,50	11,11	7,45	5,51
	Telecommunications	6,66	7,37	12,20	12,97	16,74	12,40	9,55	12,13	8,50	7,13	7,25	8,33	7,12
	Digital communication	5,19	2,62	4,31	4,35	6,23	3,37	4,00	4,73	3,71	4,08	2,36	2,35	4,36
	Basic communication processes	7,92	11,76	13,73	11,67	7,84	17,78	13,16	17,78	21,82	14,29	9,26	10,00	10,20
	Computer technology	11,76	7,32	11,34	12,88	13,07	8,35	12,28	11,45	10,84	12,06	9,61	7,32	6,16
	IT methods for management	58,33	66,67	66,67	62,50	52,94	72,73	43,37	25,00	30,41	18,58	19,35	13,78	17,60
	Semiconductors	7,69	2,94	14,29	24,00	34,78	22,73	19,05	15,69	7,94	12,04	7,69	0,71	4,38
Instruments	Optics	6,79	9,33	11,83	20,45	16,20	12,11	14,65	8,29	7,56	12,78	7,66	4,68	3,11
	Measurement	22,82	25,93	27,94	30,34	29,34	31,27	26,74	27,40	20,50	20,70	14,38	13,41	9,75
	Analysis of biological materials	8,77	11,96	28,30	16,92	24,05	28,41	12,87	10,37	15,85	12,41	11,05	7,95	5,56
	Control	46,62	43,96	48,12	48,95	53,39	48,62	39,63	31,39	37,46	42,91	35,11	24,38	20,80
	Medical technology	20,38	17,58	23,51	24,97	24,70	21,77	17,79	18,24	18,96	17,49	12,90	9,56	7,57
Chemistry	Organic fine chemistry	1,34	1,82	1,54	2,31	2,18	3,46	3,51	4,69	4,86	4,40	4,37	3,79	4,38
	Biotechnology	5,25	2,64	6,14	8,02	7,37	6,82	6,32	8,91	8,18	4,93	6,11	4,33	5,77
	Pharmaceuticals	6,31	7,69	8,25	11,01	8,89	7,15	6,72	8,31	7,13	9,05	9,24	7,41	7,96
	Macromolecular chemistry, polymers	3,87	1,96	3,88	5,32	8,65	5,70	6,94	7,01	4,53	8,13	5,58	5,78	4,37
	Food chemistry	29,17	21,32	28,27	28,85	28,15	29,98	25,54	24,95	21,43	25,00	27,22	15,94	14,32
	Basic materials chemistry	7,25	9,18	12,74	13,34	16,59	17,70	16,30	18,20	15,40	13,05	7,72	8,53	7,23
	Materials, metallurgy	13,99	15,61	15,01	21,11	20,96	20,89	22,06	18,96	18,32	19,79	14,74	10,49	9,39
	Surface technology, coating	10,19	9,91	12,70	12,54	14,69	16,71	19,81	9,67	10,35	14,74	12,30	7,18	7,89
	Micro-structural and nano-technology	0,00	0,00	0,00	100,00	75,00	13,95	50,00	58,33	66,67	77,78	62,50	30,77	11,11
	Chemical engineering	18,55	17,02	17,92	22,82	23,03	20,64	17,95	19,30	20,14	16,94	15,06	10,09	10,98
	Environmental technology	31,98	35,38	31,86	41,89	43,19	36,14	30,34	36,13	23,73	25,28	22,60	11,59	11,56
Mechanical Engineering	Handling	27,00	28,55	28,07	29,65	31,35	30,13	24,45	27,84	25,27	25,89	18,81	17,27	13,04
	Machine tools	17,60	21,55	22,97	25,76	26,53	23,47	24,36	20,39	20,63	19,63	16,63	9,14	7,37
	Engines, pumps, turbines	22,15	22,69	25,62	26,42	31,11	29,26	27,47	23,98	18,75	22,61	14,55	11,99	10,57
	Textile and paper machines	12,24	13,79	19,09	16,03	19,04	16,36	14,26	12,92	10,34	13,40	11,55	11,61	6,05
	Other special machines	28,77	29,07	30,99	37,14	42,86	40,10	37,89	34,27	32,87	31,51	29,10	22,09	20,10
	Thermal processes and apparatus	35,20	46,06	38,97	40,38	38,77	45,95	35,25	31,67	31,60	37,75	23,39	20,73	13,73
	Mechanical elements	18,90	20,75	21,30	21,10	21,90	23,25	19,10	19,46	17,11	21,07	16,45	12,15	9,11
	Transport	27,21	25,61	28,10	31,63	34,66	34,91	28,81	28,67	24,50	26,24	18,40	13,07	10,79
Other fields	Furniture, games	57,95	61,26	60,00	63,64	62,89	63,88	54,31	52,53	54,65	53,40	45,01	32,49	29,80
	Other consumer goods	42,24	42,46	49,73	50,13	48,04	42,71	45,55	41,19	39,11	36,68	31,54	26,02	20,75
	Civil engineering	40,33	44,04	40,19	45,64	46,07	45,15	41,23	35,86	36,59	33,33	20,73	20,04	16,03
	Unknown	28,87	35,27	37,73	45,67	27,22	30,92	45,16	67,54	92,44	89,97	78,91	66,18	31,78
	Total	**18,41**	**19,29**	**20,85**	**23,54**	**24,19**	**21,93**	**19,95**	**19,38**	**18,48**	**19,06**	**16,93**	**16,43**	**15,78**
	Total patent deposit	**17,258**	**17,828**	**16,668**	**16,404**	**16,702**	**18,455**	**19,832**	**21,638**	**23,098**	**22,356**	**24,958**	**28,630**	**30,399**

Source: Authors' own. Data sourced from INPI.

Table 9 - Share of patents granted to residents by technology, %, South Korea, 2000-2012.

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Electrical Engineering	Electrical machinery, apparatus, energy	64,08	92,31	89,57	63,49	67,07	80,89	82,36	81,13	77,07	76,70	76,57	77,80	76,45
	Audio-visual technology	69,12	93,45	87,84	62,01	65,71	84,15	83,54	80,44	74,84	67,49	66,02	70,63	69,80
	Telecommunications	84,20	97,60	95,24	75,37	81,05	91,04	91,86	87,75	80,24	72,70	71,56	71,18	68,93
	Digital communication	87,02	97,81	95,05	77,66	83,23	89,45	88,68	83,05	77,48	70,31	60,70	61,95	52,21
	Basic communication processes	64,28	93,46	84,51	53,39	56,88	81,60	72,12	65,50	60,51	54,92	51,45	59,37	52,66
	Computer technology	64,77	95,76	92,02	65,49	72,90	84,40	79,41	77,37	74,55	72,44	65,39	69,36	66,48
	IT methods for management	76,56	100,00	100,00	88,89	85,23	88,13	89,34	91,48	92,84	92,78	91,10	93,30	91,22
	Semiconductors	72,30	87,02	83,68	63,05	68,48	81,99	80,89	76,76	74,85	69,07	71,18	71,24	65,12
Instruments	Optics	63,78	88,97	83,26	57,40	64,66	75,84	74,31	71,00	66,52	66,60	70,03	70,41	70,94
	Measurement	61,42	96,77	91,34	71,24	74,43	84,59	79,34	77,43	75,57	79,90	79,52	82,92	80,83
	Analysis of biological materials	28,77	88,24	75,00	60,64	59,78	80,25	76,13	83,39	77,73	78,19	78,35	84,51	80,67
	Control	63,08	97,06	91,89	74,30	75,86	85,14	81,33	82,94	77,60	80,79	80,36	83,75	83,60
	Medical technology	32,41	96,72	80,00	63,87	62,75	86,24	81,96	74,84	70,14	72,51	76,53	79,55	74,18
Chemistry	Organic fine chemistry	27,11	63,16	69,39	42,34	49,49	80,65	77,12	70,33	55,07	46,28	49,73	52,02	48,67
	Biotechnology	55,97	87,65	89,80	68,95	80,14	88,27	87,07	86,88	80,07	69,19	77,78	77,91	74,45
	Pharmaceuticals	24,69	77,03	79,63	42,34	43,24	81,35	77,32	72,04	57,10	48,07	52,97	61,00	56,28
	Macromolecular chemistry, polymers	35,17	60,94	82,91	56,93	56,42	83,95	77,56	69,84	56,07	49,06	49,32	47,83	49,48
	Food chemistry	79,38	94,44	91,03	92,23	91,12	96,35	95,52	95,06	92,52	92,30	92,05	93,48	91,88
	Basic materials chemistry	39,15	82,11	88,89	62,89	58,60	84,10	79,94	74,16	64,09	66,45	68,74	63,62	62,51
	Materials, metallurgy	63,44	95,70	96,82	75,99	73,09	85,72	80,83	77,39	76,91	77,99	75,83	75,56	76,24
	Surface technology, coating	44,25	92,49	90,63	55,19	59,05	77,53	69,61	63,21	61,45	62,89	63,60	61,93	63,30
	Micro-structural and nano-technology	25,00	100,00	-	76,47	86,30	88,60	84,86	91,53	88,30	84,80	88,15	83,66	80,18
	Chemical engineering	43,46	81,32	80,39	54,49	63,19	82,41	80,03	80,08	75,06	78,07	77,14	81,94	78,83
	Environmental technology	78,37	98,14	93,86	84,77	86,30	92,27	89,92	90,12	88,70	88,92	89,66	88,26	88,83
Mechanical Engineering	Handling	56,24	91,84	93,44	63,31	61,60	79,43	78,50	75,75	74,49	75,26	73,68	81,13	78,58
	Machine tools	56,43	96,88	96,67	69,06	77,00	84,40	81,47	81,20	80,21	83,36	82,11	81,80	78,71
	Engines, pumps, turbines	74,84	99,42	98,80	75,45	73,04	83,88	79,93	72,85	68,03	73,28	76,02	77,22	72,29
	Textile and paper machines	52,11	95,36	96,40	63,89	67,50	81,21	77,66	69,16	62,04	63,31	66,13	68,70	70,78
	Other special machines	62,69	92,90	92,97	71,40	75,41	88,35	84,38	82,34	79,41	81,87	81,05	84,92	82,55
	Thermal processes and apparatus	79,36	93,31	92,13	83,78	84,93	89,57	89,30	90,52	88,70	86,49	87,34	91,22	88,70
	Mechanical elements	65,56	98,58	95,24	65,15	68,07	80,20	75,95	76,49	77,12	75,71	77,59	79,75	76,86
	Transport	83,04	97,96	99,08	89,43	86,64	91,59	88,61	88,66	88,37	85,34	85,39	83,07	86,34
Other fields	Furniture, games	73,80	94,79	94,37	83,46	81,69	91,00	90,77	89,33	88,00	89,59	90,09	90,82	89,54
	Other consumer goods	77,05	97,26	93,64	80,58	80,69	88,93	87,70	88,37	87,41	87,49	87,45	90,73	89,27
	Civil engineering	79,62	98,70	100,00	89,80	89,52	95,12	95,49	95,03	95,46	95,92	95,51	95,93	96,41
	Unknown	93,57	98,40	89,47	96,97	98,78	99,16	99,36	96,52	88,97	78,79	64,29	100,00	100,00
	Total	**66,74**	**93,92**	**90,52**	**69,84**	**72,78**	**85,43**	**83,48**	**80,83**	**76,63**	**75,09**	**74,93**	**77,00**	**74,99**

Source: Authors' own. Data sourced from the World Intellectual Property Organization (WIPO). Note: We could not use the data from KIPO once they are not publicly available in what regards a historical series about patents granted by technology. It is worth mentioning that the data available by WIPO frequently do not correspond exactly to the data available by the official intellectual property office of South Korea, which is the reason why we opt not to use WIPO's data throughout the paper even though they offer a historical set. We just used WIPO's data when official source was not available, which is the case here. Even with this pitfall, the percentages presented here seem to be adequate and seem to correspond to the actual figure of South Korea.