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U.S. R&D captive offshoring in Brazil, China and India, 1997-2014.

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Abstract:

An exploratory analysis of the recent U.S. inward R&D-related FDI in Brazil, China and India is undertaken and we throw some light on the fact that despite the increase of U.S.R&D captive offshore in these countries, most R&D undertaken is directed to local adaptations and not directed to new product development. We conclude that it is still early to affirm that developing countries in general are playing increasingly important roles in U.S. R&D abroad. It is still uncertain if those U.S. corporates' R&D investments in developing countries will ever generate spillovers in both horizontal and vertical directions domestically.

Key-words: R&D captive offshore; economic development; R&D globalization

Jel code: O10; O33; O34; O51

1 Introduction

In this paper, we investigate the U.S. R&D captive offshore boost in emerging economies in the last decades. We notice an average increase rate of 15.9% per year (1997-2014) in emerging markets – Brazil, China and India – which is considerably higher than the U.S. R&D captive offshore in 'Triad' countries (4.5% per year). This fact *per se* justifies an exploratory analysis of the recent U.S. corporates' R&D captive offshore in Brazil, China and India. This is exactly the contribution of this paper, which throws some light on the fact that despite the increase of U.S. R&D captive offshore in those three countries; most R&D undertaken is directed to local adaptations and not to new product or new processes development. In other words, R&D captive offshore is focused mainly in activities devoted merely to adapting products/processes to local reality, that is, 'adaptive R&D' (Serger, 2006).

The paper is organized as follows. In the next section we make an appreciative theorizing, presenting briefly the importance of corporate R&D developed at home (onshore) and abroad (offshore) available in the literature. It is important to mention that by no means does this section cover all the studies available on corporate R&D efforts and its internationalization as it goes beyond the scope of this paper. The International Business studies literature has been covering the global sourcing phenomenon including R&D offshoring, therefore good reviews on the topic have been written elsewhere (see for example Dachs (2014)).

Section 3 presents stylized facts of U.S. R&D performed by business enterprises domestically and abroad in a very descriptive and exploratory fashion. We make use of secondary data from the Bureau of Economic Analysis – BEA – regarding majority-owned foreign affiliates of U.S. companies abroad. By majority-owned foreign affiliates, we refer to the foreign business enterprise in which there is U.S. direct investment, in which a U.S. entity controls more than 50% of the voting securities of an incorporated foreign business enterprise or an equivalent interest in an unincorporated foreign business enterprise. We use only data of majority-owned foreign affiliates, rather than of all foreign affiliates, because U.S. parents are more likely to influence and effectively control the management of majority-owned affiliates and we are interested to examine R&D captive offshore over which U.S. parents exert control. To illustrate the sample dimension, the number of U.S. majority-owned affiliates in 2014 is 32,763 spread all over the globe, of which 2,856 (8.72%) are located in Brazil, China and India[1].

Our objective is to present that U.S. R&D captive offshore is concentrated in 'Triad' countries; however, there is a mild deconcentration tendency through the years. Notwithstanding that, if we separate the countries according to their income level, U.S. R&D captive offshore is even more concentrated. In section 4, we review recent empirical evidences presented in the literature that shows that despite the increase of U.S. R&D captive offshore in Brazil, China and India, U.S. affiliates in those countries carry more low-value than high-value R&D activities. U.S. corporates' R&D developed in Brazil, China and India is still focused on product and processes adaptation to local

[1] Data sourced from the Bureau of Economic Analysis. The affiliate number counts presented exclude very small affiliates – those with total assets, sales, and net income (or loss) all less than USD 25 million. For methodological information regarding the Survey of U.S. Direct Investment Abroad conducted by BEA, check: <https://www.bea.gov/international/pdf/usdia_2009r/Introduction.pdf>.

conditions and activities, that is, ‘adaptive R&D’. Finally, conclusions are drawn in the last section.

2 Corporate R&D

R&D performed by companies can be understood as a ‘ticket of admission’ to an information network (Rosenberg, 1990). Being part of this sort of network provides flows of new knowledge and the interactivity it stimulates can contribute to the company’s learning process enhancing its capabilities. Thus, companies perform innovative actives in order to benefit from what are called ‘first-mover advantages’ (Cohen & Levinthal, 1989). Additionally, R&D may allow companies to act as a rapid ‘second mover’ in the face of spillovers from the competitor’s innovation (Cohen & Levinthal, 1989).

Learning is a cumulative process and allows companies to differentiate themselves in terms of their own characteristics and performance. These differences are the result of distinct strategies that provide companies with diverse structures and capabilities, including those related to R&D (Nelson, 1991). Companies’ learning strategies related to R&D vary. For example, companies may decide either to perform R&D in-house or to outsource it to a R&D provider. Companies may decide to perform R&D in the home country (onshore) or in a foreign country (offshore). In this regard, it is possible to identify four compatible possible R&D strategies:

i. R&D performed in-house in the home country;
ii. R&D outsourced to a provider in the home country (onshore outsourcing);
iii. R&D performed in-house but under an affiliated foreign subsidiary (captive offshoring); and,
iv. R&D outsourced to an unaffiliated provider located in a foreign country (offshore outsourcing).

Once companies have decided on onshoring versus offshoring their R&D activities, they can either decide to insource or outsource it. Historical facts show that before the 1980s, R&D activities were mainly centralized and concentrated in the home country (Kurokawa, Iwata, & Roberts, 2007) especially because of supply-side reasons such as scale economies (Vernon, 1966) and because of higher appropriability of R&D efforts (Granstrand, Håkanson, & Sjölander, 1993). Notwithstanding that, it was also possible to see a growing R&D outsourced to providers in the home country, especially to universities and research institutes (Nelson, 1990).

A strong trend towards the internationalization of R&D begins in the 1980s (Archibugi & Iammarino, 2002; Archibugi & Michie, 1997; Gerybadze & Reger, 1999; Niosi, 1999; UNCTAD, 2005a) both captive offshoring and offshore outsourcing, nevertheless empirical studies show that the former is still preferred to the latter (Albertoni & Elia, 2014). The increasing offshoring trend is driven in large measure by technology factors (Florida, 1997). Thus, companies perform R&D abroad to secure access to scientific and technical human capital (Florida, 1997) – even if they risk to have their R&D leaked to foreign competitors (Athukorala & Kohpaiboon, 2010) – in order to improve existing assets and to tap into knowledge around the globe (Dunning & Narula, 1995). Accordingly, this trend reflects the global character of knowledge assets creation and exploitation (Teece, 2004).

There are two centrifugal ‘forces’ capable of explaining the dispersion of R&D activities abroad. Firstly, because of the need to adapt production processes and products to suit local conditions and regulations, i.e., asset/competence exploiting or home-base-exploiting R&D (Dunning & Narula, 1995; Kuemmerle, 1999).

Secondly, in order to benefit from localized technology spillovers in these locations, that is, companies locate R&D facilities abroad, especially in prominent centers of excellence in specific technologies, in order to enable themselves to enrich their own R&D (Athukorala & Kohpaiboon, 2010), i.e., asset/competence augmenting or home-base-augmenting R&D (Dunning, 2009; Kuemmerle, 1999). This is the case to overcome lock-in traps, i.e., companies perform research abroad to have access to external knowledge available (Levinthal & March, 1993) and to benefit from potential knowledge spillover opportunities (Feinberg & Gupta, 2004) in different countries. Indeed, an empirical study with 21 OECD countries for which data on patenting activity, socio-economic indicators, and information on R&D offshoring investments towards emerging countries were collected come to the conclusion that developed countries complement their home R&D activities with offshore R&D in emerging economies (D’Agostino, Laursen, & Santangelo, 2013).

The decision of a company to offshore R&D may be affected by many factors. For example, different levels of territorial and social embeddedness may or may not motivate overseas R&D and its location (Cantwell & Piscitello, 2002). Therefore, the motivations and determinants to establish R&D labs in less developed economies may diverge from those of more developed ones. Studies show that multinational corporations(MNCs) perform R&D in the former economies to support local sales and production while in the latter to access new or complementary knowledge (Demirbag & Glaister, 2010).

There are many studies done in the last years trying to determine the locational factors attracting R&D offshoring. They differ in focus of analysis (home country versus host country advantages; firm-level versus national-level focus), industrial sector (pharmaceutical, etc.), method (descriptive data analyses, cross-section data analyses, panel data analyses etc.), and dataset (original survey data, micro data, macro data). Erken and Kleijn (2010) present a list of relevant empirical studies on R&D location factors. We complement their list including the following ones: Kuemmerle (1999), Bas and Sierra (2002), Ito and Wakasugi (2007), Demirbag and Glaister (2010), Song, Asakawa, and Chu (2011), Martinez-Noya, Garcia-Canal, and Guillen (2012), Belderbos, Leten, and Suzuki (2013); Castelli and Castellani (2013), Castellani, Jimenez, and Zanfei (2013), Yang and Hayakawa (2014) and Tamayo and Huergo (2017).

3 Stylized facts: U.S. companies’ R&D investments

U.S. companies invest huge amounts in creative activities to develop new technologies through the performance of R&D. In 1997, for example, U.S. companies’ expenditure in intramural R&D[2] summed USD 201.64 bi and USD 316.91 bi in 2014 (a 57.2% growth) (*Table 6*, in Appendix). The amounts invested represent 1.80% and 1.96% of U.S. GDP, respectively (*Table 7*, in Appendix).

[2] According to OECD definition, intramural R&D investments are all expenditures for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds.

By far, in absolute terms, U.S. companies are those that invest the most in activities to develop new technologies through R&D, way ahead of Japanese, German, French and British companies. For instance, in 2014 all investments in R&D performed by the companies of France, Germany and Great Britain summed USD 131.94 bi, that is, 41.6% of U.S. companies' total investment (*Figure 1*). Even Chinese companies, which have been experiencing an incredible growth of R&D expenditure of an average 21.3% per year (1997–2014) reached 84.1% of U.S. business enterprise R&D expenditure in 2014, that is, USD 266.43 bi (*Figure 1* and *Table 6* in Appendix).

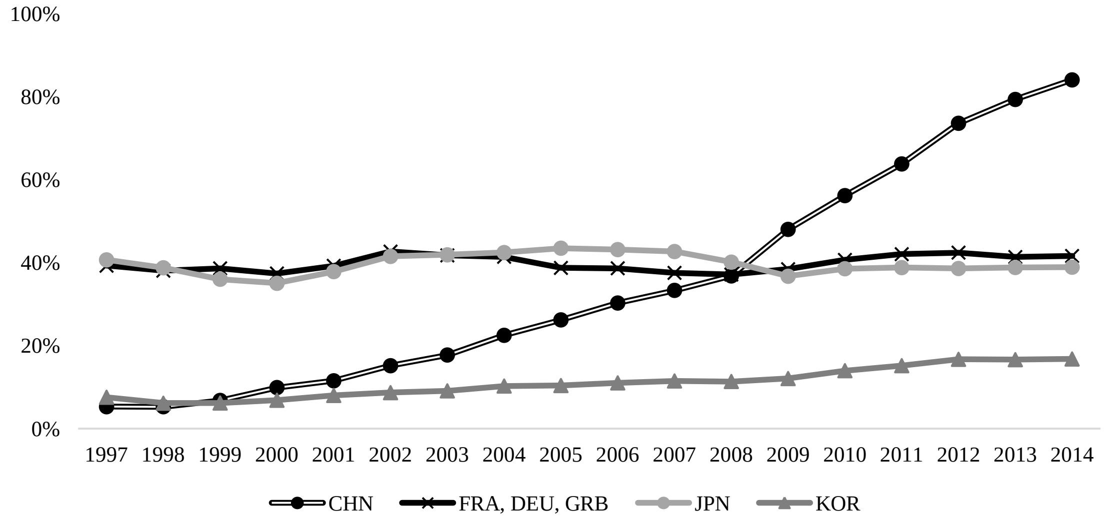

Figure 1 – Gross Domestic Expenditure on R&D (GERD) performed by business enterprise*, selected countries in relation to total U.S. GERD.

Source: Authors' own. Data sourced from UNESCO Institute of Statistics. Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. Note: (*) GERD performed by business enterprise consists of the total expenditure (current and capital) on R&D by all resident companies excluding R&D expenditures financed by domestic businesses but performed abroad.

U.S. companies have been undertaking R&D domestically in an average growth rate of 2.8% per year (1998–2014)[3]; however, R&D captive offshoring increases at a 5.9% growth rate per year for the same period. In 1997, U.S. R&D captive offshoring represents 9.4% of the R&D developed at home (USD 18,935 million) and it reaches 15.3% in 2014 (USD 48,527 million), in a clear increasing trend from late 1990s to 2010 (*Figure 2).*

Despite the increase of U.S. R&D captive offshoring, it is not evenly distributed among regions. There are numerous recent empirical studies which revel that R&D intensity of U.S. affiliates is determined mainly by the domestic market size, overall R&D capability and cost of hiring R&D personnel (Athukorala & Kohpaiboon,

3 R&D expenditure has been fluctuating together with the economic cycles. From 1998 to 2000, the average growth rate of R&D performed by U.S. business enterprise was 7.0% per year, however, with the Dot.com bubble burst in late 1990s, corporate R&D investment falls and the rate in 2001–02 was -3.4% per year. There is then a recovery and in the period 2003–2008 the R&D investment grows at 4.3% per year. Then there is a negative growth rate of 3.0% in 2009–10 as consequence of the 2008 global financial crises. The period 2011–2014 the average growth is 3.2% per year.

2010; Doh, Jones, Mudambi, & Teegen, 2005; Flores & Aguilera, 2007; Hegde & Hicks, 2008; Kumar, 1996, 2001; Thursby & Thursby, 2006). However, there are other relevant factors that should not be neglected such as domestic business environment aspects – availability of technical personnel, nature of property right legislation, tax concessions, political stability, foreign trade regime (Athukorala & Kohpaiboon, 2010) – and also institutional and cultural aspects – political system, legal system, cultural similarity and levels of trust (Flores & Aguilera, 2007)[4].

Therefore, there is an unequal distribution of innovative efforts of foreign affiliates of U.S. companies. For instance, the R&D undertaken by those companies in European countries represents 68.6% of total R&D captive offshore in 1997 and 59.0% of total in 2014 (*Table 1*). Contrarily, majority-owned foreign affiliates of U.S. parent companies perform relatively little R&D in African and Middle East.

Another possible way to see the distribution of U.S. R&D captive offshore is through the separation of countries in what is commonly called 'Triad' (Canada, European Countries and Japan) and the 'Rest'[5]. 'Triad' countries receive 88.5% of total U.S. corporate R&D captive offshoring in 1997 and 70.4% in 2010 (*Table 1*). Meanwhile, the 'Rest' receives 11.5% and 29.6% in the same period (*Table 1*).

On the same token, classifying the countries accordingly to their income level, figures become more drastic. This is done because countries, as Australia, are not considered part of 'Triad' in a *stricto sensu*. Developed countries (i.e., high-income countries according to the World Bank classification) concentrates 94.5% of U.S. R&D captive offshoring in 1997 and 81.6% in 2014. On the other hand, developing countries (middle and low-income countries) increased their share from 5.5% to 18.4% in the same period (*Table 1*).

Table 1 shows that the majority of U.S. corporate R&D investment abroad is still concentrated in 'Triad' and in 'developed countries'. This may suggest that the pattern on the internationalization of U.S. corporate R&D is determined by different locational factors and developed countries endow specific features that are more attractive than the ones endowed by developing countries. However, *Table 1*also shows that there is a relative increase of the 'Rest' and 'developing countries' ability in attracting U.S. R&D. Moreover, R&D intensity measured by R&D expenditures as a percentage of value added[6] is increasing in developing countries, as presented in *Figure 3*, even though it is smaller than in developed countries.

4 From a different perspective, other studies do not take into analysis the attracting factors from abroad but the internal repulsion factors that may influence U.S. companies to perform R&D abroad: the emerging shortage of highly skilled science and engineering talent in the U.S. (Lewin, Massini, & Peeters, 2009).

5 The 'Rest' is formed by all other countries from Latin America, Middle East, Africa, Asia and Pacific. The classification does not take into consideration the levels of GDP/capita nor the levels of industrial development of each country. Here, for example, Australia and New Zealand (both considered high-income countries according to the World Bank) are classified as the 'Rest'. This classification is pretty much inspired in Amsden (2001), however, her meaning refers to "a handful of countries outside the North Atlantic (…) [which] rose to the ranks of world-class competitors in a wide range of mid-technology industries" (Amsden 2001, p. 1). For her, the 'Rest' comprises China, India, Indonesia, South Korea, Malaysia, Taiwan, and Thailand in Asia; Argentina, Brazil, Chile, and Mexico in Latin America; and Turkey in the Middle East. For us, the 'Rest' is everyone else that is not located in North America (Canada and the U.S.), Japan and Europe.

6 According to BEA, value added (gross product) is "the portion of the goods and services sold or added to inventory or fixed investment by a firm that reflects the production of the firm itself. (…) It indicates the extent to which a firm's sales result from their own production rather than from production that originates elsewhere".

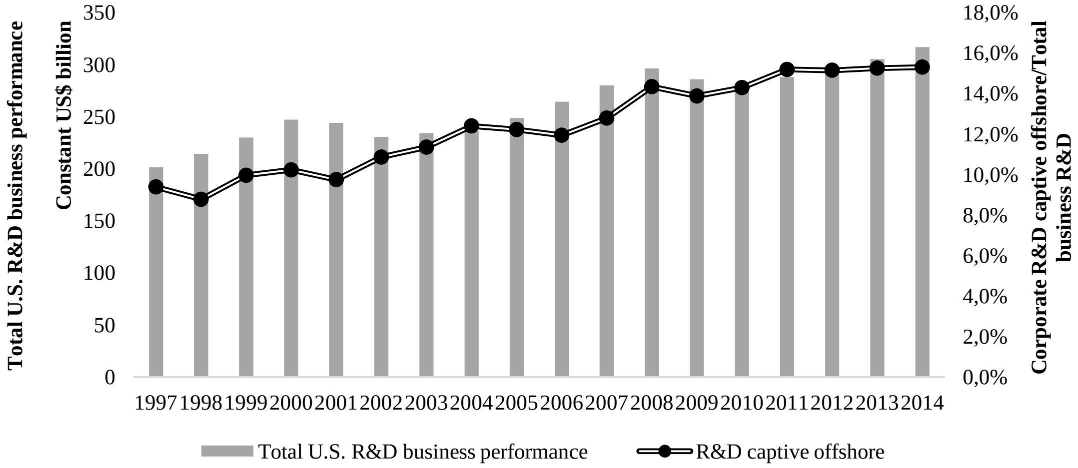

Figure 2 – Total Gross Domestic Expenditure on R&D (GERD) performed by U.S business enterprise and share of R&D performed abroad by majority-owned foreign affiliates of U.S. parent companies (all industries) of total U.S R&D business performance, 1997–2010.

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series) and from UNESCO Institute of Statistics. Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. Note: GERD performed by business enterprise consists of the total expenditure (current and capital) on R&D by all resident companies excluding R&D expenditures financed by domestic businesses but performed abroad.

This may reflect a changing strategy of U.S. multinational companies (MNCs) to develop integrated technological networks in developing countries. In fact, International Business studies literature shows that companies have changed their strategies taking into consideration the governance (outsourcing versus internal development) and geographical location (offshoring versus onshoring) of their innovative efforts (Martinez-Noya et al., 2012; Mudambi, 2008).

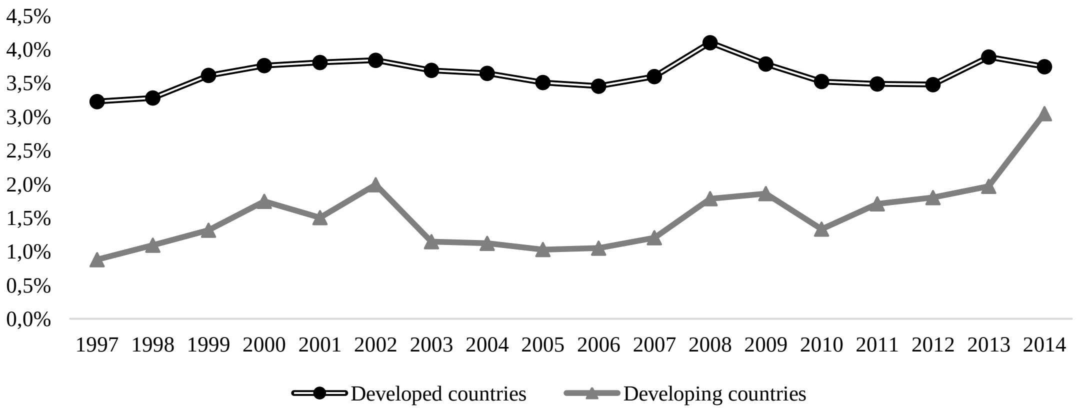

Figure 3 – R&D intensity (R&D expenditure as a percentage of value added), group of countries, 1997-2014.

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: 'Developed countries' refers to those countries classified as 'high-income countries' according to the World Bank and 'Developing countries' refers to those countries classified as 'middle-income countries' and 'low-income countries' according to the World Bank. Note that some countries historically changed their status to high-income countries: Czech Republic (from 2006 on), Poland (from 2009 on), Hungary (from 2007 to 2011 and 2014), Saudi Arabia (from 2004 on) and South Korea (from 2001 on).

Table 1 – R&D performed abroad by majority-owned foreign affiliates of U.S. parent companies (all industries), by region, percentage, 1997–2014.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Canada	12.5	11.9	9.3	11.4	10.8	10.8	10.7	10.6	8.8	8.2	7.9	7.7	7.4	6.9	6.6	6.4	6.4	6.6
Europe	68.6	70.8	67.3	62.9	61.2	63.9	65.3	65.3	68.0	65.3	66.0	63.6	63.9	59.9	61.3	59.4	60.6	59.0
Latin America	4.5	5.1	3.4	3.2	2.9	3.7	3.0	2.8	3.0	3.5	3.4	3.5	3.7	6.4	5.7	6.1	5.7	4.5
Middle East	1.4	1.0	2.1	3.1	3.7	3.5	3.0	3.4	2.8	2.8	3.0	4.8	4.7	5.1	4.6	4.5	4.4	5.6
Africa	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.3	0.2
Asia and Pacific	12.8	10.9	17.8	19.2	21.3	18.0	17.8	17.8	17.2	19.8	19.6	20.4	20.0	21.5	21.5	23.3	22.6	24.2
‘Triad’	88.5	89.3	85.0	82.3	79.7	82.0	83.3	82.2	83.0	79.9	79.4	76.0	76.0	71.4	72.8	71.0	71.9	70.4
‘The Rest’	11.5	10.7	15.0	17.7	20.3	18.0	16.7	17.8	17.0	20.1	20.6	24.0	24.0	28.6	27.2	29.0	28.1	29.6
Developed countries*	94.5	93.6	92.7	91.7	96.3	92.4	93.5	94.3	92.8	91.9	90.0	87.4	86.0	83.9	84.1	82.7	83.2	81.6
Developing countries**	5.5	6.4	7.3	8.3	3.7	7.6	6.5	5.7	7.2	8.1	10.0	12.6	14.0	16.1	15.9	17.3	16.8	18.4
Total (USD million)	18,935	18,822	22,938	25,287	23,811	25,071	26,600	29,349	30,429	31,582	35,821	42,529	39,684	39,887	43,780	44,073	46,600	48,527
Number of affiliates (majority-owned)***	20,477	20,439	21,042	21,289	22,026	22,612	22,023	22,819	23,126	24,168	24,840	24,404	25,037	25,153	26,674	26,308	26,608	32,763

Source: Authors’ own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. Note: (*) ‘Developed countries’ refers to those countries classified as ‘high-income countries’ according to the World Bank. (**) ‘Developing countries’ refers to those countries classified as ‘middle-income countries’ and ‘low-income countries’ according to the World Bank. Note that some countries historically changed their status to high-income countries: Czech Republic (from 2006 on), Poland (from 2009 on), Hungary (from 2007 to 2011 and 2014), Saudi Arabia (from 2004 on) and South Korea (from 2001 on). (***) According to the BEA Methodology, the number of majority-owned foreign affiliates are not strictly comparable with the number shown in different benchmarks and annual survey publications because of differences in the criteria for reporting on the different forms. From 2009 on the number of affiliates met the USD 25 million reporting criterion and earlier benchmark survey publications are based on the size criteria in those surveys, which differed from those in 2009. For example, the size threshold for foreign affiliates was USD 10 million in the 2004 benchmark survey and USD 7 million in the 1999. Therefore, the numbers of majority-owned foreign affiliates should be used cautiously once they exclude numerous very small affiliates, which have total assets, sales, or net income (loss) of USD 25 million or less from 2009 on. For more info regarding the number of U.S. foreign affiliates see the Benchmark Survey’s Methodologies from 1994, 1999, 2004 and 2009 available at <https://www.bea.gov/international>.

4 U.S. R&D internationalization towards Brazil, China and India

With the information presented previously, we can affirm the R&D performed by U.S. companies are becoming relatively more internationalized. It is true that U.S. R&D undertaken abroad has been increasing much faster than the one performed domestically (growth rates of 5.9% and 2.8% per year, respectively, for 1997–2014 period). However, U.S. R&D captive offshoring represents about 12.4% of total R&D performed at home (average of 1997–2014).

Despite the expansion of U.S. R&D abroad, only 17 countries in the world concentrate 85.3% (average of 1997–2014) of the share. Eight of them are located in Western Europe (Belgium, France, Germany, Ireland, the Netherlands, Sweden, Switzerland and the U.K.), one in North America (Canada), one in the Pacific (Australia), one in Latin America (Brazil), five in Asia (China, India, Japan, Singapore and South Korea) and one in the Middle East (Israel). Nevertheless, of these 17 countries, only four (Canada, France, Germany and the U.K.) concentrate 50.0% (average of 1997–2014). Therefore, even though U.S. R&D is becoming more and more internationalized, it is still far from being globalized.

According to Narula (2003), there is a high level of inertia in the location of R&D of firms. The analysis of U.S. R&D performed abroad corroborates it. Still according to Narula (2003), this inertia is due to the complexity of the learning process and the extension to which companies are embedded in systems of innovation. This way, U.S. companies may perform R&D abroad especially where they benefit from localized technology spillovers, improving their technological capabilities through learning. That may explain why most U.S. R&D is undertaken in countries with mature innovation system (Albuquerque, 1999).

Brazil, China and India, for example, together represent 61.4% in 1997 of total U.S. R&D offshore in developing countries and in 2014, they represent 75% (*Table 8*). Considering the share in relation to total corporate U.S.R&D captive offshore, Brazil, China and India received about 3.4% of total in 1997 and their share grows to 14.8% in 2014 (*Table 8*). Even though Brazil, China and India are not considered to have 'mature' national systems of innovation (Albuquerque, 1999), they have a relative robust infrastructure *vis-à-vis* other counterpart countries, they have also a considerable number of trained workforce, have enforced a reasonable intellectual property protection system and have appealing domestic markets (UNCTAD, 2005a). According to Thursby and Thursby (2006), the main attractors of U.S. companies' R&D in emerging economies are output markets, quality of R&D personnel and cost structures[7].

4.1 Some evidences from Brazil

In the middle 1990s, Brazil was by far the most important developing country receiver of U.S. corporate R&D (USD 567 million in 1997). South Korea received USD 53 million, Singapore USD 95 million and China and India together received USD 74

[7] There are a numerous recent empirical studies which revel that R&D intensity of U.S. affiliates is determined mainly by the domestic market size, overall R&D capability and cost of hiring R&D personnel (Athukorala & Kohpaiboon, 2010; Doh et al., 2005; Flores & Aguilera, 2007; Hegde & Hicks, 2008; Kumar, 1996, 2001; Thursby & Thursby, 2006). However, there are other relevant factors such as domestic business environment aspects – availability of technical personnel, nature of property right legislation, tax concessions, political stability, foreign trade regime (Athukorala & Kohpaiboon, 2010) – and also institutional-cultural aspects – political system, legal system, cultural similarity and levels of trust (Flores & Aguilera, 2007).

million (*Figure 4*). In 1990s the target of U.S. corporate R&D in emerging economies was focused in Latin American countries (huge investments in Brazil and incipient in Argentina and Mexico). However, in the 2000s there is a turn towards South Asian countries, especially towards China and India. By 2010, while Brazil loses its first position as an emerging economy R&D attractor (USD 1,372 million), both China and India surpass Brazil: USD 1,452 and USD 1,644 million respectively (*Figure 4*). The year 2010 is also a turn point for Brazil and signals its attraction decline reaching in 2014 USD 1,136 million while China and India reach USD 2,824 and USD 2,703 million.

Besides being considered emerging economies and not having yet developed a knowledge-based economy – what can be demonstrated by indicators of knowledge input (R&D expenditure) and knowledge output (scientific publications and patenting activities) – Brazil, China and India do not represent a homogeneous group of countries. Therefore, social, political, cultural and institutional characteristics have an active role in shaping each countries' innovation system and the ability to attract investment for R&D from abroad and the ability to build up local technological capabilities.

In Brazil, for example, a case study carried out with 54 subsidiaries of foreign multinational companies (not only U.S. companies) located in the country presented a characterization of their R&D activities (Galina, Camillo, & Consoni, 2010). The study shows that most of the Brazilian subsidiaries (not only U.S. ones) carry out development ('D') considering local or regional market (Mercosur), which is mostly product and process adaptation. Moreover, in some of the companies studied this is not even continuous. Only a few companies carry out research ('R') in the country and there is only a small number of R&D centers of excellence, which are a reference for their corporations (Galina et al., 2010). Galina et al. (2010) suggest that Brazil has not yet joined the global R&D network of multinationals effectively and strategically, therefore R&D remains at adaptive levels (Costa & Queiroz, 2002).

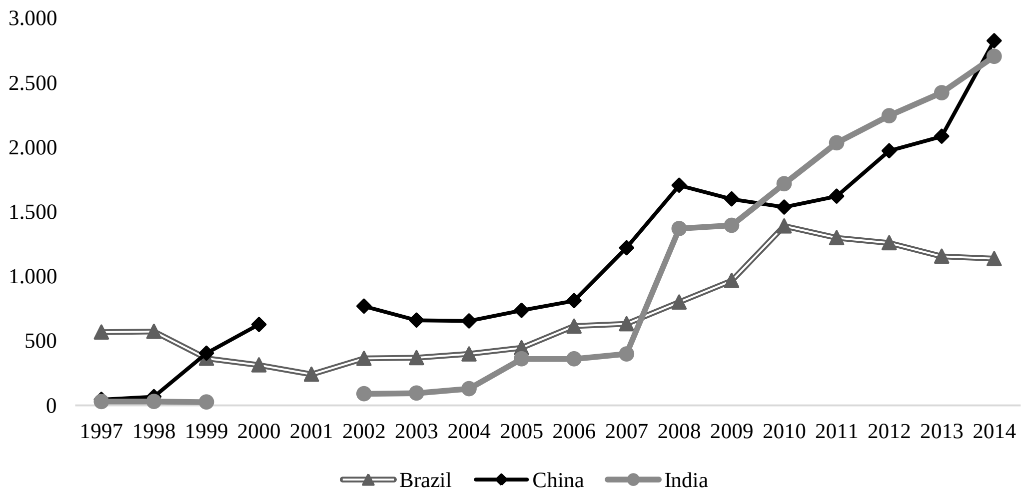

Figure 4 – Corporate U.S.R&D captive offshore performed in Brazil, China and India, in USD million, constant prices 1997-2014.

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database.

Moreover, in aggregate terms, R&D intensity of U.S. multinationals operating in Brazil (i.e., R&D expenditure/sales) is stagnant and relatively little if compared to other countries like South Korea. For instance, in 2008, R&D intensity of U.S. companies in Brazil is about 0.56% while in South Korea it is 1.85%. (Zucoloto & Cassiolato, 2014). Analyzing the relation between R&D expenditure and value added, Zucoloto and Cassiolato (2014) show the performance of U.S. multinationals operating in Brazil: low performance for all industrial sectors observed vis-à-vis the average performance of all U.S. companies abroad.

Other recent surveys regarding Brazil do not confirm the general overview presented before (Gomes, Consoni, & Galina, 2010). Answers from 88 subsidiaries of foreign multinational companies (not only U.S. companies) were analyzed and 63.4% of them declared they undertake both research and development in the country. Furthermore, 82% of those companies stated their positive intention in keeping or even increasing their foreign direct investments in Brazil (Gomes et al., 2010). However, the survey does not capture the content and the quality of R&D carried by them.

A case study of the automotive industry, for example, shows that even though carmakers subsidiaries in Brazil enhanced local product engineering and local design capabilities throughout time, they pretty much perform adaptation of products to local conditions ('tropicalization') (Consoni & Quadros, 2006; Costa, 2005). Ford, for example, adopted a more centralized approach leaving no place for local development of vehicles in Brazil and in the 1990s the product engineering team of Ford Brazil was dismantled and vehicles have to be adapted in the European plant (Queiroz, Zanatta, & Andrade, 2003). The American General Motors (GM) seems to be an exception. According to Queiroz and Quadros (2005) and to Consoni and Quadros (2006), GM relied on product development activities in its Brazilian subsidiary augmenting its investment in the country.

In fact, U.S. R&D investment in Brazil goes mainly to transportation equipment sector – motor vehicles, motor vehicles body and trailers, motor vehicle parts and other transportation equipment including aerospace, railroad and ship – and its share has been increasing from 32.2% to 49.8% of total U.S.R&D investment in manufacturing in Brazil (from 1999 to 2014). R&D to manufacturing represents 98.3% of total U.S. R&D captive investment in Brazil in 1999 and 87.4% in 2014 (*Table 3*). As indicated by Costa (2005), the automotive industry takes into account the preferences of consumers during the stages of conceptualization and development of new models, therefore, it explains the room for local performance of R&D activities by foreign affiliates. Thus, it is not only the need for adaptation to local conditions, but also the need for considering local particularities of local markets.

This previous findings may reflect the competencies accumulated in the automotive industry by local U.S. affiliates and their increasing role in MNCs' network, however, as pointed out by Queiroz et al. (2003), most of the investment is 'more of the same'.

In the same token, if we consider a R&D intensity indicator expressed by R&D expenditures as a percentage of value added, we can notice that for the Brazilian case, R&D investments of majority-owned foreign affiliates of U.S. parent companies generate less value added than those companies located in more developed countries since 1997. While in 2014, R&D expenditures as a percentage of value added for the group of developed countries was 3.74% (*Figure 3* and *Figure 5*), for Brazil it was 2.77% (*Figure 5*). However, considering only transportation equipment industrial sector, R&D/value added is much higher and in 2014, it reaches 14.81%, while computers and electronic products sector 3.31% and chemicals sector 4.35% (*Table 5*). What it is interesting to note is that in knowledge intensive sectors such as chemicals, U.S. R&D/value added ration in Brazil is relatively lower than China and India and this may represent a significant difference of the three emerging economies.

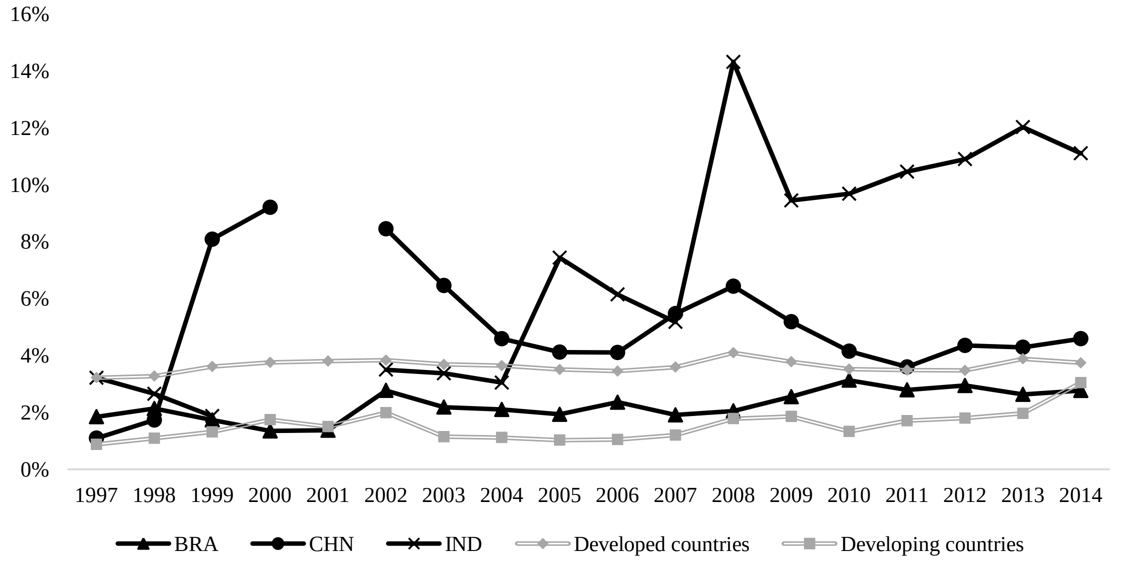

Figure 5 – R&D intensity (R&D expenditure as a percentage of value added), selected countries, 1997-2014.

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series).

Table 2 – R&D intensity (R&D expenditure as a percentage of value added), selected industries, Brazil, China and India, selected years.

	Brazil		China		India	
	2004	2014	2004	2014	2004	2014
All industries	2.10	2.77	4.59	4.59	3.05	11.11
Professional, scientific, and technical services	1.21	2.65	0.24	26.75	8.16[a]	12.96
Manufacturing	2.88	3.87	6.44	3.82	2.97	14.99
Food	0.71	1.10	0.25[a]	1.44	2.22	0.95
Chemicals	2.45	4.35	1.46	4.55	1.26	16.03
Primary and Fabricated metals	0.62	0.19	0.28[b]	1.23	2.50	0.00[f]
Machinery	2.02	2.61[f]	0.94	2.27	2.78	14.67
Computers and electronic products	10.66	3.31	18.27	4.29	11.06	52.51
Electrical equipment, appliances, and components	1.45[a]	0.10[e]	4.25	7.57	1.39[c]	6.06[d]
Transportation Equipment	7.71	14.81	1.26	3.63	3.37	12.81

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: some info do not refer to the years specified because some data from BEA regarding R&D investment were suppressed to avoid disclosure of confidential information, therefore we used the closest year available: ([a]) 2005; ([b]) 2006; ([c]) 2008; ([d]) 2010; ([e]) 2011; ([f]) 2013.

Table 3 – R&D performed in Brazil by majority-owned foreign affiliates of U.S. parent companies (manufacturing), percentage, 1999–2014.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Professional, scientific, and technical services	0.3	0.4	1.5	1.0	0.9	1.4	1.7	1.9	(D)	0.5	3.2	2.5	(D)	(D)	4.3	6.0
Manufacturing	98.3	98.0	96.0	97.0	96.5	96.3	95.3	94.3	97.0	97.4	93.4	93.4	91.0	88.0	85.1	87.4
Food	4.6	6.5	19.4	11.8	12.1	2.1	2.6	1.8	0.8	0.7	1.9	1.9	2.6	3.0	2.9	3.1
Chemicals	15.2	21.4	33.5	23.6	21.6	20.2	27.5	25.0	25.0	22.9	18.9	16.7	25.4	29.7	31.4	29.5
Primary and Fabricated metals	0.7	0.8	2.1	(D)	1.0	1.2	1.6	1.5	1.5	1.0	0.7	(D)	0.7	0.7	0.9	0.3
Machinery	8.1	10.1	8.9	8.8	9.5	7.1	13.2	8.9	4.8	4.6	(D)	3.9	8.7	7.9	7.8	(D)
Computers and electronic products	(D)	(D)	14.1	10.1	14.1	17.8	4.7	3.9	(D)	(D)	7.5	5.9	(D)	(D)	2.1	3.6
Electrical equipment, appliances, and components	(D)	(D)	(D)	(D)	(D)	(D)	1.0	0.7	(*)	0.0	0.1	0.1	0.1	(*)	0.1	(*)
Transportation Equipment	32.2	36.7	6.8	(D)	(D)	44.2	48.2	56.7	64.2	58.1	62.4	(D)	56.5	52.1	50.1	49.8
Total U.S. captive offshore in Brazil (USD million)	364	313	241	363	369	398	446	613	631	800	967	1,389	1,298	1,259	1,155	1,136

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. According to BEA, (*) = < $500,000; (D) = suppressed to avoid disclosure of confidential information.

Table 4 – R&D performed in India by majority-owned foreign affiliates of U.S. parent companies (manufacturing), percentage, 1999–2014.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Professional, scientific, and technical services	0.0	0.0	(D)	(D)	(D)	(D)	31.8	32.0	38.5	44.0	48.6	49.6	49.4	52.7	52.1	45.8
Manufacturing	80.0	(D)	(D)	20.0	43.2	40.7	54.1	38.6	(D)	32.9	33.8	25.9	27.7	28.6	29.3	31.3
Food	(*)	(*)	0.0	0.0	(*)	2.2	(*)	(*)	(*)	(D)	0.6	0.7	0.7	0.5	0.4	0.3
Chemicals	18.8	(D)	28.0	33.3	14.3	13.0	3.4	6.2	(D)	13.2	12.0	18.2	17.9	46.6	46.1	34.5
Primary and Fabricated metals	0.0	(D)	0.0	0.0	0.0	4.3	(D)	(D)	(D)	0.0	0.0	0.0	0.0	0.0	0.0	(D)
Machinery	25.0	(D)	(D)	20.0	25.7	13.0	1.7	10.0	(D)	(D)	(D)	(D)	(D)	(D)	7.7	17.4
Computers and electronic products	31.3	(D)	(D)	33.3	(D)	54.3	(D)	(D)	(D)	(D)	46.4	51.9	44.6	34.2	36.4	39.1
Electrical equipment, appliances, and components	0.0	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	0.2	0.2	1.3	(D)	(D)	(D)	(D)
Transportation Equipment	18.8	(D)	8.0	20.0	(D)	13.0	6.2	15.4	(D)	27.7	30.5	16.4	22.0	5.6	4.9	6.3
Total U.S. captive offshore in India (USD million)	25	(D)	(D)	89	95	128	360	360	397	1,369	1,394	1,716	2,033	2,243	2,421	2,703

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. According to BEA, (*) = < $500,000; (D) = suppressed to avoid disclosure of confidential information.

Table 5 – R&D performed in China by majority-owned foreign affiliates of U.S. parent companies (manufacturing), percentage, 1999–2014.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Professional, scientific, and technical services	(D)	3.2	(D)	(D)	3.5	0.2	(D)	(D)	(D)	21.9	25.8	34.3	36.2	35.6	34.3	34.7
Manufacturing	95.6	97.0	(D)	94.0	91.7	93.7	85.9	77.7	77.4	62.1	(D)	(D)	45.7	47.5	53.6	49.2
Food	0.0	0.0	(*)	0.2	(*)	(*)	0.2	0.5	0.2	0.4	(D)	(D)	1.7	1.6	1.0	1.5
Chemicals	8.5	2.6	(D)	4.8	3.1	4.5	4.7	5.1	3.6	(D)	(D)	(D)	17.2	24.1	22.7	26.7
Primary and Fabricated metals	(*)	(*)	(*)	0.0	0.0	(*)	(D)	0.2	0.2	(D)	(D)	(D)	8.9	11.7	9.6	1.0
Machinery	0.0	0.6	(D)	0.3	0.8	1.3	1.9	2.5	2.1	2.3	(D)	(D)	6.0	4.9	4.9	6.2
Computers and electronic products	(D)	(D)	(D)	(D)	(D)	86.5	(D)	76.8	81.5	79.3	(D)	(D)	37.0	34.2	37.5	31.4
Electrical equipment, appliances, and components	(D)	(D)	(*)	0.5	(D)	4.3	4.5	4.7	3.9	(D)	(D)	(D)	17.1	12.1	10.5	8.1
Transportation Equipment	(*)	(*)	(*)	0.2	1.2	0.9	(D)	5.1	4.1	3.9	(D)	(D)	12.2	11.4	13.7	11.6
Total U.S. captive offshore in China (USD million)	403	625	((D))	768	659	653	735	810	1,220	1,704	1,598	1,535	1,620	1,971	2,084	2,824

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. According to BEA, (*) = < $500,000; (D) = suppressed to avoid disclosure of confidential information.

4.2 Some evidences from India

Differently than Brazil, manufacturing is not the most important sector in U.S. R&D captive offshore in India. Indeed, its share in total U.S. R&D in the country has decreased drastically its importance from 80.0% to 31.3% (1999 to 2014) while scientific and technical services[8] have increased to 45.8% (in 2014) (*Table 4*) and its R&D/value added has reached 12.96% (*Figure 5*). Within manufacturing sector, the one that more receives U.S. R&D captive offshore investment is 'computers and electronic products' sector[9] (39.1% in 2014) followed by chemicals[10] (34.5% in 2014) (*Table 4*).

Despite the significant difference in sectors, by and large, the same pattern described for Brazil is also observed in India. That is, investments directed at R&D are limited and focused on modifications to Indian market conditions. Besides, subsidiaries are typically treated as cost centers reporting to the R&D and business managers of the multinationals in other counties (Krishnan, 2003).

However, since the 1990s, foreign companies are undertaking more significant R&D operations in India. The U.S. Texas Instrument subsidiary was the pioneer of innovative R&D followed by General Electric (GE), Intel, Cisco, Microsoft, Oracle, Hewlett-Packard and others (Mitra, 2007; Mrinalini & Wakdikar, 2008). In the last decade, 300 multinational companies have set up R&D labs in India utilizing local low-cost scientific manpower (Mashelkar, 2008).

According to TIFAC (2005) Report, U.S. companies are the ones with more R&D centers and more R&D workers employed in India if compared to other multinationals. As data compiled by the Indian Ministry of Communications and Information Technology shows, U.S. multinational subsidiaries have pledged investments of USD 9.8 billion dollars in the ICT sector for 2006-10 (IBM subsidiary alone has pledged USD 6 billion) (Mitra, 2007). Another demonstration of the Indian potential for U.S. R&D was the establishment in Bangalore of GE's second largest research center in the world: John F. Welch Technology (Krishnan, 2003; Mitra, 2007).

Differently than the Brazilian case, U.S. multinational subsidiaries in India have increased they R&D/value added ration from 3.22% in 1997 to 11.11% in 2014 (*Figure 5*). This may show that. U.S. companies' efforts in R&D in their subsidiaries in India are adding more value to their production, which may be a result of R&D quality and innovativeness.

4.3 Some evidences from China

[8] According to BEA, 'professional, scientific and technical services' are: legal services; accounting, tax preparation, bookkeeping, and payroll services; architectural, engineering, and related services; specialized design services; computer systems design and related services; management, scientific, and technical consulting services; scientific research and development services; advertising, public relations, and related services; other professional, scientific, and technical services.

[9] According to BEA, 'computers and electronic products' sector comprises computer and peripheral equipment; communications equipment; audio and video equipment; semiconductors and other electronic components; navigational, measuring, electro medical, and control instruments; manufacturing and reproducing magnetic and optical media; electric lighting equipment; household appliances; electrical equipment; and other electrical equipment and component.

[10] According to BEA, 'chemicals' is formed by: basic chemicals; resins, synthetic rubbers, and artificial and synthetic fibers and filaments; pesticides, fertilizers, and other agricultural chemicals; pharmaceuticals and medicines; paints, coatings, and adhesives; soap, cleaning compounds, and toilet preparations; other chemicals products and preparations.

With reference to China, U.S. R&D offshore is similar to the Indian case in what regards the industrial sectors. In other words, U.S. R&D captive offshore in manufacturing reduces from 95.6% (in 1999) to 49.2% (in 2014), while scientific and technical services increase to 34.7% (in 2014). Within manufacturing sector, 'computers and electronic products' (31.4%) is the most important followed by chemicals (26.7%) (*Table 4*).

Some international surveys show that multinationals (not only U.S. ones) rank China as the first most likely country where they intend to establish future R&D labs (UNCTAD, 2005b). A survey carried out by Thursby and Thursby (2006) shows that of 109 U.S. companies, 71 have either established R&D facilities abroad or in a planning phase, of which 42.2% are located in China. Indeed, an increasing number of international companies are investing in R&D in the country (Gassmann & Han, 2004; Serger, 2006) and the pace at which foreign R&D centers have been stablished in China is outstanding (Walsh, 2003, 2007). For example, the U.S. Microsoft was one of the pioneering companies to set up innovative R&D facilities in China in the 1990s and nowadays the Chinese subsidiary is part in Microsoft's global value chain and hosts the Advanced Technology Center in Beijing (Buderi, 2005; Serger, 2006). At its research center, Microsoft is conducting research on topics such as next generation multimedia and Chinese PC technology (Gelb, 2000).

Despite the above evidences, most R&D undertaken in China by multinationals are still concentrated on development activities ('D'). A research based on the 276 international R&D alliances established in China show that only 27% are research-oriented (Li & Zhong, 2003). Moreover, a recent econometric study based on data from the China Economic Census Yearbook shows that the majority of foreign R&D investments in China is largely involved in adaptive development rather than innovative research (Sun, 2010).

In what regards U.S. R&D expenditure as a percentage of value added, we can noticed it has increased from 1.10% in 1997 to 4.59% in 2014 (*Figure 5*).

5 Final considerations

R&D-related foreign direct investment from the U.S. may benefit economic growth in Brazil, China and India through the promotion of wealth-creating assets of U.S. subsidiaries and by the maintenance and improvement of indigenous capabilities. The first is a sort of ownership advantage and the second a location advantage (Narula, 2003). Both can help maintain and improve the country's locational attractiveness to conduct high value-adding activities (Narula, 2003) and may increase the potentiality for technology transfer opportunities.

Notwithstanding that, each country may benefit differently depending of the type of R&D undertaken and to the particularities of their national innovation systems. Therefore, even with the increase of U.S. R&D captive offshore in Brazil, China and India, only a considerably small number of affiliates perform relevant R&D that goes further beyond adaptive R&D and only a few of these centers are integrated into the overall innovative strategy of the multinational company. Still, even if R&D is integrated into global value chains, the benefits to local society may not be reached if domestic absorptive capacity (Cohen & Levinthal, 1990) is low and if there are mechanisms that do not permit the flows of tacit knowledge from those subsidiaries to indigenous companies, affecting the national overall learning process.

It is still very early to affirm that developing countries in general are playing increasingly important roles in U.S. R&D abroad. Moreover, it is still uncertain if those U.S. corporates' R&D investments in developing countries will ever generate spillovers in both horizontal and vertical directions domestically. Thus, it is ambiguous to assure that developing countries will be able to raise their living standards and solve their underdevelopment challenges by attracting R&D investment from multinationals. What we tried to emphasize is that the participation of U.S. R&D in developing countries is uneven and only three developing countries (Brazil, China and India) have emerged as important centers for U.S. companies' strategic competitiveness in the last decades.

On that track, U.S. R&D intensity (measured by R&D/value added) in Brazil, China and India vary considerably. Data showed that the index for Brazil is historically lower *vis-à-vis* China and India, even when Brazil was the main emerging country receiver of U.S. R&D offshore. In 1997 in Brazil, U.S. corporate R&D intensity was 1.85% while in China and India was 1.10% and 3.22% respectively. However, in 2014, Brazilian ratio has increased to 2.77%, while Chinese's and Indian's to 4.59% and 11.11%. This puts Brazil in a fragile position once U.S. R&D intensity is practically constant throughout time.

Important implications for policy arise from the above. In view of the globalization of R&D by MNCs, Brazil, China and India should induce multinational affiliates to invest more in knowledge-intensive activities and move beyond adaptive levels of R&D. This would make it possible that affiliates and subsidiaries join global R&D networks more effectively and strategically. To do so, empirical studies demonstrate that mature national systems of innovation are more able to attract R&D investment. This way, Brazil, China and India should strengthen their national system of innovation by upgrading their S&T competitiveness. Nevertheless, the internationalization of MNCs' R&D alone does not necessarily upgrade host countries' S&T competitiveness and host countries should stimulate the diffusion of knowledge of MNCs' R&D labs into the economy, avoiding the creation of islands of high-technology enclaves (Reddy, 2005).

That said, national policies should go from investing in S&T researches to augmenting the volume of qualified individuals for the innovation process in domestic companies, in order to ameliorate the national absorptive capacity. Therefore, host country governments should nurturer national learning[11] through massive investment in education (especially in engineering and hard sciences) and incentives for indigenous companies' investment in raising their dynamic capabilities.

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[11] Despite acknowledging investing in learning is important, it does not ensure success. This is so once learning processes have a stochastic nature. Both external environment and companies' actions affect the learning processes. (Archibugi & Pietrobelli, 2003).

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Appendix

Table 6 – Gross Domestic Expenditure on R&D (GERD) performed by business enterprise*, selected countries, in PPP USD billion, constant prices, 1997–2014.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CHN	10.69	11.36	15.69	24.52	28.19	35.03	41.62	53.25	65.28	80.10	93.36	109.17	137.34	156.74	183.89	214.06	242.34	266.43
FRA	23.22	23.51	24.75	25.69	27.62	28.86	27.13	27.35	27.02	28.52	28.92	29.79	31.03	32.18	33.60	34.23	35.71	36.00
DEU	38.53	40.15	44.55	46.63	47.34	48.16	49.48	49.78	48.73	51.80	53.37	57.28	56.57	58.40	63.45	65.73	65.52	69.16
JPN	82.05	83.19	82.94	86.63	92.45	95.84	98.17	100.43	108.26	114.14	119.56	119.01	105.03	107.58	111.89	112.29	118.67	123.37
KOR	15.31	13.19	14.25	16.96	19.59	20.06	21.38	24.35	25.89	29.21	32.22	33.75	34.57	39.03	43.78	48.64	50.82	53.27
GBR	17.48	18.03	19.69	20.18	20.90	21.51	21.23	20.91	20.70	21.92	22.89	23.10	22.30	22.92	24.16	23.46	25.14	26.78
USA	201.64	214.49	230.20	247.17	244.15	230.76	234.25	236.59	248.86	264.41	280.01	296.47	285.84	278.98	288.14	290.78	305.36	316.91

Source: Authors' own. Data sourced from UNESCO Institute of Statistics. Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. Note: (*) GERD performed by business enterprise consists of the total expenditure (current and capital) on R&D by all resident companies excluding R&D expenditures financed by domestic businesses but performed abroad.

Table 7 – Gross Domestic Expenditure on R&D (GERD) performed by business enterprise* as a percentage of GDP, 1997–2014.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CHN	0.29	0.29	0.37	0.54	0.57	0.65	0.70	0.81	0.90	0.97	0.99	1.06	1.22	1.26	1.35	1.45	1.53	1.56
FRA	1.34	1.30	1.32	1.30	1.35	1.37	1.32	1.32	1.27	1.29	1.27	1.29	1.36	1.37	1.40	1.44	1.44	1.45
DEU	1.47	1.50	1.63	1.68	1.67	1.67	1.71	1.69	1.68	1.72	1.71	1.80	1.84	1.82	1.89	1.95	1.89	1.95
JPN	2.00	2.05	2.04	2.06	2.19	2.24	2.28	2.28	2.43	2.53	2.60	2.62	2.45	2.40	2.50	2.46	2.52	2.64
KOR	1.66	1.51	1.47	1.61	1.78	1.70	1.79	1.94	2.02	2.19	2.29	2.36	2.45	2.58	2.87	3.13	3.26	3.35
GBR	1.02	1.03	1.11	1.07	1.07	1.07	1.02	0.97	0.96	0.98	1.02	1.02	1.03	1.02	1.07	1.02	1.06	1.10
USA	1.80	1.84	1.88	1.94	1.91	1.76	1.75	1.69	1.73	1.78	1.86	1.98	1.96	1.86	1.90	1.87	1.93	1.96

Source: Authors' own. Data sourced from UNESCO Institute of Statistics. Note: (*) GERD performed by business enterprise consists of the total expenditure (current and capital) on R&D by all resident companies excluding R&D expenditures financed by domestic businesses but performed abroad.

Table 8 – R&D performed abroad by majority-owned foreign affiliates of U.S. parent companies (all industries) in Brazil, China and India, 1997–2014.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Brazil	567	572	364	313	241	363	369	398	446	613	631	800	967	1,389	1,298	1,259	1,155	1,136
China	45	67	403	625	D	768	659	653	735	810	1,220	1,704	1,598	1,535	1,620	1,971	2,084	2,824
India	29	30	25	D	D	89	95	128	360	360	397	1,369	1,394	1,716	2,033	2,243	2,421	2,703
% in relation to other developing	61.4	55.3	47.2	45.3	29.1	66.2	65.4	71.6	71.5	70.6	63.0	72.8	71.3	73.3	72.2	73.1	73.6	75.0
% in relation to total	3.4	3.6	3.5	3.8	1.1	5.0	4.3	4.1	5.1	5.7	6.3	9.1	10.0	11.8	12.3	13.5	13.2	14.8

Source: Authors' own. Data sourced from the Bureau of Economic Analysis, Survey of U.S. Direct Investment Abroad (annual series). Note: Current USD was deflated by GDP deflator (year-base 2010) available at the World Bank database. Note: (D) = suppressed to avoid disclosure of confidential information.