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FDI and Technology as Levering Factors of Competitiveness in Developing Countries ☆

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ABSTRACT

Technology creation and absorption are two relevant processes that affect the role that multinational enterprises (MNE) may play in the competitiveness improvement of the developing economies. The importance of internal factors in local contexts, the increasing integration in the industrial international value chain and the access of firms from these countries to diverse external learning sources, constitute a suitable framework for the analysis of competitiveness shift. In this paper, we study how the integration of firms from developing countries in sophisticated high-tech markets can be defined by the combined action of MNE and the ability for technology absorption and creation. Our empirical analysis with panel data shows how the different dimensions of internal and external factors affect international competitiveness in high-tech industries.

1. Introduction

The competitive possibilities of developing economies in the most dynamic international markets depend on a fan of advantages that are defined at firm and national levels, being their productive and commercial specialization intermediated by the combination of technological capabilities and also by the influence of external factors. This paper develops the joint action of innovation and multinational enterprises (MNE) to explain the process of levering competitiveness in high tech industries with a special focus on developing economies.[1] Beyond the pioneering discussions of the concept of competitiveness and its application

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[1] The developing economies considered in this paper are included in the group of Middle-Income Countries (MIC): Accordingly to the criteria of *GDP* per capita, the *World Bank* classifies countries into three main groups: High, Middle and Low-income countries. Our target group of developing economies is integrated only by middle-income countries (from $936 to $11,455), group that is divided into upper-middle and lower-middle income groups. Serious data availability problems limit the inclusion of low income countries in the analysis.

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at the aggregated level (Krugman, 1994), the determinant factors of it are defined by the individual behavior, mainly by the firms' management and technology abilities in a given country.[2] For these reasons, our understanding of the competitive position of countries in this paper is closely linked to firm-level factors such as MNE strategies, technology and the integration level in the high-tech industries' international value chain (Cantwell, 2005; Luo et al., 2011).

The relative presence of developing countries in dynamic high-tech markets depends on the evolution of their industrial structure and the factors affecting their commercial and technological specialization, a process that is influenced by a more complex set of elements tied to the environment or national systems of innovation (Narula and Wakelin, 1995). In developing economies, upgrading is at least in the first stages of development (industrialization) mainly focused on the adaptation and use of the already available technologies (Lall, 1996, 2000); although the efficient use of them can be transformed into sustainable growth in the long run, it depends on the generation of absorption capabilities as well as in the adaptation of firm catch up strategies to the evolution of the environment (Kumaraswamy et al., 2012). These arguments justify that we adopt an approach at aggregated level with useful insights to develop firm-level theory in connection with the body of management and IB literature that uses the country context to develop arguments at the firm level.

The speed of economic internationalization process in last decades affects markets and hierarchies, and although the benefits among countries have not been equally distributed worldwide, we have assisted to the emergence of dynamic economies among the group of countries traditionally considered as developing. Although openness does not necessarily mean growth and development per se (Fagerberg and Srholec, 2008; Rodrik, 1999), the process of building capabilities is often graduated and reinforced by external factors as well. MNE play a crucial role in such a process, not only in the configuration and increase of international investment's flows but also in the definition of competitiveness conditions in both home and host economies. Foreign firms may contribute to the competitive results of developing countries due to technology transfer, the fact that foreign subsidiaries in some cases enhance the competition in local host systems, they can become very active export players, or because they contribute to promote specialized suppliers through intra-industry trade. On the other hand, data show not only the raise of FDI inflows into developing economies in last decades (UNCTAD, 2005, 2007) but also the emergence of outward FDI from these countries (Cuervo-Cazurra, 2007; Gammeloft et al., 2010; Meyer, 2004). The idea is that home-based MNE in developing economies can also play a relevant role to define their competitive patterns; a salient reason for this is how MNE arbitrage the diversity of location across countries, comparative advantages (national level) and competitive advantages (firm level), generating higher returns than pure domestic or non-specialized companies (Luo et al., 2011; Meyer et al., 2011). For these reasons, an updated look to competitiveness should integrate the role of MNE taking explicitly the argument of the international industry value chain in combination with technology. Differences across developing countries are more notable when the dynamism of the so-called emerging economies and those lagging behind is jointly considered in the analysis, being predicted that influential factors levering competitiveness differ not only between developed and developing economies but also inside the latter group.

Our proposition is to study competitiveness by means of the complex relationship between technology and MNE, trying to disentangle the diversity of influential factors that affects the different position of developing countries in the international high-tech markets and their dynamic possibilities to upgrade. This analysis tries to fill a literature gap related to the role that MNE from emerging economies play on the explanation of their internationalization in dynamic high-tech industries. It is expected that the catch up strategies in the world market of technology-intensive goods depend on a set of factors that would determine the threshold level of both the external orientation of MNE (outward FDI) and the internal technological possibilities of them, according to the national systems of innovation approach. Therefore, although the analysis is performed at aggregated level, the basic process is foremost defined at the firm level.

In the next section, the literature review will be based on the factors that affect competitiveness' levels, with a focus into developing countries, and the process model that explain how MNE can be key contributors for upgrading. In the third section, we develop our hypothesis integrated into a conceptual framework based on the relationship between MNE (host and home positions) and technology (absorption and creation). In the fourth section, we proceed with some simple data description and with the presentation of the main relationships among the variables included in the empirical model which, under a dynamic perspective, analyses the impact of both technological indicators and external factors of competitiveness shifts, making use of data from the World Bank and the UNCTAD for 1996–2010. The discussion of the results is found in section fifth and some concluding remarks are in section sixth.

2. Literature background

Competitiveness is a concept very discussed among academics and it has been applied to several levels of analysis; the most pertinent applications of it is at firm level because it refers to a comparative notion of competition or market gains, but it has also been broadly applied at the national level in last decades (Fagerberg, 1996; Nelson, 1993; Porter, 1985; Roessner et al., 1996). A general definition of competitiveness relates to productivity and growth of countries (Krugman, 1994) while the more tractable one focuses on the ability of a country to compete by exporting (Fagerberg, 1996; Lall, 2001). The globalization process has changed the markets functioning and also hierarchies, while technology has reshaped international firms, industries and trade; therefore, it can be assumed that the definition of national structural competitiveness is related to the ability to enhance collective

[2] Nonetheless, the adaptation of the competitiveness concept to the country-level of analysis is also methodologically accepted (Porter et al., 2008; Sala-i-Martin et al., 2008).

techno-economic capacities in the world market-place what implies to adopt a relative or comparative notion of performance that is shaped by a diversity of influential factors. Virtually all countries seek to take advantage of those structural and productive changes that permit to increase their competitive position in higher value-added industries; in other words, upgrading their world output' shares, employment and trade of technology-intensive products (Aharoni and Hirsch, 1997). In such a process, the choice between absorption and adaptation of existing technologies and the creation through the expansion of R&D and innovation are quite unique for each nation and also depend on its initial development level (Gerschenkron, 1962). In this sense, existing evidence of the evolution followed by trade patterns and the technological advance in developing countries argue that the relationship between commercial and technological advantages may be clearer in some economies (i.e. Hong-Kong, Singapore and South Korea) while is less evident in others (i.e. Philippines, Thailand and Indonesia). Differences across-countries are due among other reasons to the configuration of industrial structure in which coexist labor-intensive traditional industries and technologically complex industrial activities (Uchida and Cook, 2005).

Inside the heterogeneous group of developing countries, we find that one common aspect for those economies competent to catching up is the support provided by inward technology transfer (Alvarez and Magaña, 2007; Castellacci, 2008; Durlauf and Johnson, 1995; Mowery and Oxley, 1995). A myriad of examples are illustrative of the diversity among these economies. It is noticeable that the efforts made by South Korea and Taiwan to try to nurture technological advanced domestic firms in their industrialization process (Agosin and Machado, 2005; Kim, 1997), while in cases such as Malaysia and Thailand there was an expansion of their exports combined with low-cost labor levels and skills upgrading, allowing them to export high-tech components. In addition, in some larger economies such as India, they have adapted technology for local consumption to create local industries and this made possible to take advantage of the growing number of skills in computer programs. Kumaraswamy et al. (2012) show that domestic firms in the auto components industry in India needed to adapt their catch up strategies as their environment evolves: first through arm's length technology (licensing, collaboration, Joint venture), second through the integration into the industry global value chain and finally by progressing to knowledge creation through internal R&D. Some key aspects in the process are the interactions between the institutional environments, governments and catch up strategies. Therefore, the process of building capabilities would entail at least two main levels of action: on the one hand, national investments in scientific and technological skills, information flows, infrastructures and supporting institutions; on the other, the cumulative efforts at the firm level to develop new organizational and technological skills, absorptive capacities and the involvement in networks of differentiated nature — such as the interaction with customers, suppliers and other agents of the local and international environments (Alvarez et al., 2009; Cantwell, 1989; Fagerberg and Srholec, 2007; Lall, 1997; Lundvall et al., 2002). In a recent paper, Lorenzen and Mudambi (forthcoming) highlight how the global linkages of specialized clusters in developing context can generate opportunities for acceding to resources and knowledge flows that can facilitate upgrading and catch up.

Some emerging economies have even been able to develop their own technologies (i.e. Brazil in aircraft, electronics and computers; India in computers; Malaysia in electronics) and this has been the result of a combined action of States, institutions, foreign capital and domestic companies. In many occasions, the succeeding economies have based their development strategies on the adaptation of imported technologies and their local upgrade. As it is shown in the analysis carried out by Luo et al. (2011) for the BRIC cases, important differences in technological capability possession can be observed among them: India and China show strong capabilities in college graduates in engineering, technology and computer science, being helpful for the advance of these countries in ICT related industries. On the other hand, Brazil takes the advantage of US proximity to enhance capabilities in airplane and automobile industries while Russia benefits from defense industry related high tech activities.

The appropriate election of techniques in favor of competitiveness improvement and innovation is not in a vacuum but is a part of a continuous technological effort that would enhance risks' assumption in a context of imperfect information (Lall and Teubal, 1998; Teece, 1977). Hence, comparative advantages may be linked to the capabilities of technology deepening even in contexts of multiple specialization patterns where the efforts would be concentrated in upgrading the possibilities for the development of technology-intensive activities (Rodrik, 1996). The absolute advantages in production and trade, such as the infrastructure level and labor training, are some important determinants not only for the attraction of FDI but also for being able to attract component outsourcing (Dosi et al., 1990; Katseli, 1997). Consequently, competitiveness seems to be determined by the ability to integrate rightly in the global value chain in order to gain access and to use effectively a range of products and services related to the activities of MNE such as modern ICT, managerial and financial services and accounting methods (Aharoni and Hirsch, 1997; Rugman and Doh, 2008).

There is enough evidence in the literature to affirm that foreign companies may play an important role in the industrialization and modernization processes of developing economies, with notable effects in their productive transformations (Dunning, 1993, 2006). MNE are able to induce positive effects in host locations because they provide new production facilities, managerial practices and also technology transfer. As it is pointed out by Luo et al. (2011), the MNE effects in both host and home economies depend on some national level differences such as environmental, capabilities and strategic factors; these authors observe a sustained and systematic pattern of strategic management at national level that is illustrated by the analysis of firms in BRIC countries. It is also argued that MNE manage the complexity of interactions across locations and they tap into resources and capabilities from different multiple local contexts. Beyond company “replica” abroad, internationalized organizations are increasingly defining the relationship between parent companies and subsidiaries in a more complex and interactive way, more closely inspired by the emergence of international network conception (Bartlett and Ghoshal, 1998). MNE are indeed becoming multi-centric firms exploiting the diversity of locations accordingly to the setting of a new geography of value chain activities, i.e. in knowledge-intense industries, the higher fragmentation of production and the decentralization of core activities such as

R&D explain how MNE are relocating the more standardized parts of their productive activities in emerging economies (Mudambi, 2008). Those strategies emphasize the importance of both R&D and marketing intangible assets in value creation, reasons why MNE are becoming increasingly knowledge driven (Meyer et al., 2011).

These aspects have important implications for competitiveness studies since these organizational changes would permit the creation and enlargement of competitive advantages across borders. Subsidiaries could then adopt a key role in doing the exploitation of competencies from over the firm' network but also trying to create entirely new competencies and taking advantage of assets available in the diverse host locations such as knowledge resources (Rugman and Verbeke, 2001; Singh, 2007; Yang et al., 2008). Then, the management of international networks becomes also a very relevant aspect because of the implications associated with the more internationalized value chain (Kaplinsky, 2000). Particularly, an updated view of globalization and MNE that affirms the importance of local contexts (Meyer et al., 2011) seems to provide the foundations for our theory. The above reasons justify to adopting MNE as big players in a framework defined by the complex relationship between internationalization and competitiveness, highlighting the complementarities between FDI and trade (Lall, 2000; Ozawa, 1992). As it is known, the position of Malaysia and Thailand as active exporters in electronics has been accompanied by the improvement of technology capabilities as FDI evolved from the expansion of production operations to the process of technology development (Rasiah, 2003).

In turn, MNE can be seen as a vehicle that provides new technology and potential positive external effects in host economies in a first glance, while developing economies moving towards outflows FDI can be seen as a more direct access to foreign markets. However, at least in theory, the process of cumulative learning and know-how that is needed to get successful MNE operations requires a long time period until a developing country can create the conditions that will nurture the creation of home-based MNE as well. The idea is that companies from some of the so-called emerging economies are changing their international strategies and this could derive into competitive improvements (Brouthers et al., 2005; Gammeloft et al., 2010; Singh, 2007). The study of the dimensions of non-market advantages in developing countries MNE provided by Cuervo-Cazurra and Genc (2011) shows that the advantages and disadvantages of competing with MNE from more advanced countries in host economies depend on the characteristics of the dimension of the country environment. Accordingly, what determines the outcome would not be the level of development of home countries but the relative distance from the host country in question. This outward perspective provides some implications for the competitiveness of developing economies since large corporations affect the integration of dispersed and functionally separated markets and operating activities, and MNE constitute a highly efficient mechanism for creating firm-specific knowledge assets (Cantwell, 1989, 1995, 2005; Frost, 2001; McCann and Mudambi, 2005; Mudambi, 2008; Piscitello, 2004; Singh, 2007; Yang et al., 2008).

The consideration of the two directions of FDI seems then to be justified as well as adequate for the approach adopted in this paper, being possible to highlight the nation-specific systematic differences between innovation practices and its connections with competitiveness in host economies. This literature background comes to frame our questions about the peculiar competitive position of developing economies and their technological advantages, being understood not only from their productive structure shift but also from their integration in the international context as part of the global value chain.

3. Hypothesis development and analytical model

This study on competitiveness in developing countries follows an approach characterized by the relationship between the complexity of the interaction defined by the role of MNE in the integration of these economies in sophisticated international markets and national technological capabilities. Particularly, we explore to what extent the competitiveness shifts are associated to a set of factors already identified in the innovation and IB literature that can be recombined in two different but interrelated sides. On the one hand, there are internal factors or features of the national economies that obviously would contribute to define the competitive advantages of industries and nations (*à la Porter*); from this view point the choice is to focus on technology and innovation as main driving factors. On the other, there are some factors that are more closely linked to the international integration of production and other MNE activities. In this sense, the investment development path or IDP theory (*à la Narula-Dunning*) shows the relationship existing between the economic and technological advance of countries, their reception of FDI flows and their evolution through different stages of internationalization until they become an investor country abroad; in other words, becoming home-country of MNE. Such a framework is shaped by two main arguments: first, there is not a common pattern of evolution but on the contrary the path is quite unique for each country; and second, inward FDI does not necessarily guarantee growth in all the cases (Porter, 1990; Narula and Dunning, 2000, 2010).

Our theory contributes to the existing literature providing a particular study of the high-tech case that underlies the role of the international value chain and its effects in competitiveness based on the emergence of MNE and technological capabilities. International strategies of large MNE have evolved from the most traditional picture based on market and resources-seeking to efficiency and knowledge-seeking types where the relative importance of each of them interacts with the stage of economic development of countries (Dunning, 2006; Narula, 1996, 2004). This interaction and the increasing knowledge driven role of MNE contribute to provide a more detailed explanation of the competitiveness shift in high tech industries.

We propose a framework for the analysis of competitiveness in international high-tech markets that results from the combination of internal and external forces that observed at country level are useful to develop arguments at the firm level. We first assume that the importance of the complementarities existing between both FDI and trade flows because MNE can be seen as active creators and traders of tangible and intangible assets (Katseli, 1997; Ozawa, 1992). On the other hand, although the relationship between technological capabilities and competitiveness is widely agreed, as it was noted in the previous section, the

explicit inclusion of FDI allows us to contemplate the MNE effects according to the evolution of countries and how the necessary entrepreneurship capabilities for taking the risks of investing abroad and doing business in other countries are achieved (Cuervo-Cazurra and Genc, 2011; Narula and Dunning, 2010). In this sense, the process developed by Kumaraswamy et al. (2012) based on the case of auto components industry in India shows how the shift of successful catch up strategies from those relaying on technology licensing and joint-venture to those oriented to the integration within the industry global value chain favors knowledge creation process. The complexity of knowledge flows in the relations of globalized units supports the idea that outward FDI enlarges the opportunities for levering home economies that would end for affecting competitiveness. Nonetheless, we have to face the limitation imposed by the measurement of this aspect in a more accurate manner, an aspect that not being easy would require still further methodological developments.

Our proposition is illustrated in the matrix represented in Fig. 1 that shows the relationship between internal and external factors affecting competitiveness: Technology absorption (A) and creation (C) are assumed to be functions that economies perform internally while inward (I) and outward (O) FDI will capture the external side, the role of MNE and the potential effects they may generate to enhance competitive results. The idea is that the components in the vertical axis may affect differently the potential effect of MNE in competitiveness: regarding the first column, incoming MNE in the case of developing economies may likely derive into positive effects that would increase competitive results if there are technology creation abilities (local-based learning) while these effects will be inexistent if only mere technology adaptive strategies prevail (adaptation). On the other hand, the second column corresponds to the case in which there are some home-based MNE and this fact can denote the presence of two different processes: a knowledge-based upgrading process when technology creation is combined while a process of learning from abroad would prevail if technology absorption is still dominant.

Accordingly, the arrow in Fig. 1 would represent in a very simplified manner the general relationship postulated in the IDP hypothesis in extreme, showing the combination of inward FDI and technology absorption, and outward FDI in combination with technology creation. There are other two hybrid positions that would combine internal and external factors defining some sort of intermediate situations that would denote the heterogeneity that characterizes the group of developing economies (leaving the least-developed economies aside). Notwithstanding that CO cell likely corresponds to most developed and technological advanced economies, the different strategies of innovation and firm internationalization in the economies outside the world frontier will inflect the likelihood for shaping the alternative cells and hence the potential associated effects; we suggest that this discriminatory process depends on the relative importance of internal and external factors, the results being conditioned by the prevalence of one or another in the dimensions of technology and MNE activities.

The most traditional arguments about these relationships are found in the cells of the main diagonal (AI and CO). The "AI" situation combines the predominance of inward FDI and the absorption of technology; this would be representative of a FDI development assisted situation (Ozawa, 1992), more common for least-developed economies where there is a predominance of foreign technology adaptation strategies. The low development and technological capability level and the lack of local entrepreneurial capabilities do not concede enough space for positive externalities derived from foreign firms. In the opposite, the "CO" combination shows the complementary association between FDI outward and technology creation. This would be a typical economy of the world technological frontier or, in terms of the IDP, it would be a country moving upward across development stages, being plausible in such a framework to think that this situation likely exclude the least developed economies. Although some developing countries (emerging economies) could enter into this cell, available evidence confirms that FDI contributes to improve the level of sophisticated technologies although there are only few succeeding cases of licensors of technology with an impact worldwide (Athreye and Cantwell, 2007; Singh, 2007).

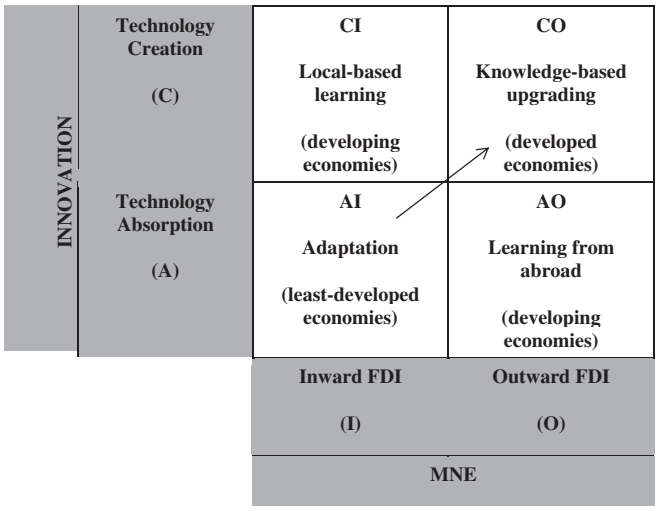


Fig. 1. FDI and technology for competitiveness.
Source: Own elaboration.

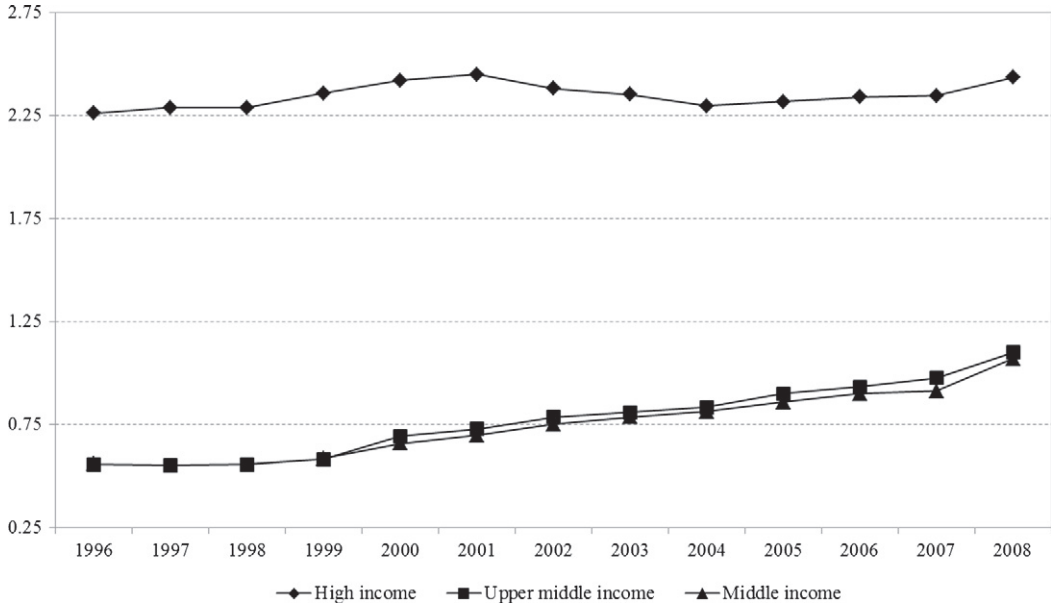
Looking now to the other two situations, the cell called CI defines those countries in process of catch up, developing economies have the sufficient innovation abilities to create technology and this is conditioned by a predominance of FDI inward that reinforced by local-based learning processes would generate positive effects for upgrading. The process is defined by the relationship between MNE and development capabilities that generally makes reference to the generation of involuntary spillover effects and technology transfer from foreign subsidiaries to other actors in host location (Rugman and Doh, 2008). The generation and size of these effects would be linked to both the technological superiority of foreign firms and the potential of domestic capabilities to benefit for knowledge leakage, claiming the importance of the level of absorptive capacities in host economies (Cantwell and Piscitello, 2002, 2007; Alvarez and Molero, 2005; Criscuolo and Narula, 2008; Narula and Dunning, 2010). For this reason, the most laggard countries still need the entrepreneurial and institutional setting to integrate this position at the upper-left cell. On the other hand, the AO cell is representative of those economies jumping into the international markets via outward FDI although they still present an important technology creation gap in comparison to countries in the knowledge frontier, learning from abroad would be the most relevant process.

Something else can be said in relation to the possible transition from cells in the bottom-left to a) the bottom-right cell and b) the upper-left one. The relative importance of technology creation and outward FDI would determine the transit possibilities of the more dynamic emerging economies from AO to CO and from CI to CO. For instance, it is remarkable how the increasing FDI outflows from the new industrialized Asian economies since the 1980s, primarily from South Korea, Taiwan and China, made possible the upgrading toward more competitive position, this being a relevant aspect explaining the possibilities for developing economies to catch up.

Therefore, our hypothesis is that competitiveness in high tech markets depends on external factors, such as the international interactions that MNE generate, and also on internal factors of creation and absorption of technology, the process being conditioned by the relative position of firms in the international value chain. Although the approach adopted is at the aggregated level, it provides some implications for theory development at firm level. For testing the hypothesis, the dependent variable is the relative importance of high-tech products in the manufacture exports. The regressors serve as proxies for the factors defined in our theoretical approach. First, a set of indicators for FDI inward and outward flows is included (as *external factors*). Second, the role of the international value chain is explicitly considered, revealing the increasing importance of intra-industry trade, this measured through imports of high-tech from high-income economies (Helpman, 1984, 2006; Helpman et al., 2004; Markusen, 2002). Third, there are some variables for the national innovation capabilities (as *internal factors*) that are specifically taken into account by mean of both creation and absorption capacities – measured through R&D national efforts, patents and the international acquisition and diffusion of technology – proxy by royalties' payments and receipts.

4. The empirical analysis

In this section we analyze the impact of the factors affecting competitiveness shift in high-tech exports, paying special attention to developing economies. The analysis is undertaken for the period 1996–2010, making use of data from the World Bank and the UNCTAD and it is carried out for 41 developing countries (all of them are middle-income economies) and 34 high-income or developed countries (the list of countries can be found in the Appendix A, Table A1).



Graph 1. R&D expenditure as share of GDP.
Source: Own elaboration, World Development Indicators (World Bank).

4.1. Basic data description

A basic description of the technological capabilities begins with a comparative of some indicators related to both absorption and generation of technology. First, considering R&D efforts (measure as R&D expenses as percentage of the GDP), Graph 1 shows the huge distance that separates developing economies from the most advanced countries; we observe that the group of middle-income economies is far behind the high-income one in this indicator. The average for this latter was about 2.31% of the GDP at the end of the 1990s, and it has achieved almost 2.40%; then, the evolution of most advanced countries has been rather stable in the last decade. On the other hand, average values of R&D effort for developing countries have shown a positive increasing trend, reaching an effort higher than 1.00% of GDP in 2008 and having experienced the highest cumulative rate of growth in this indicator (near 6%), reducing thus the distance with most developed countries.

Even more pronounced is the difference between these two groups of countries in the number of patent applications.[3] Patent applications can be taken as an indicator of technology creation as it is broadly agreed in both the economics and the innovation literature. Accordingly to the World Bank dataset (World Development Indicators), the average for high income countries is around 1 patent per each 1000 habitants while the average of middle-income economies gets a value that is inferior in more than fifteen times — below 0.1 patents per 1000 habitants. Although upper-middle income countries perform better than the lower-middle income economies, the latter has shown a higher cumulative rate of growth (near 17%) in patents and their behavior has been rather stable in this period.

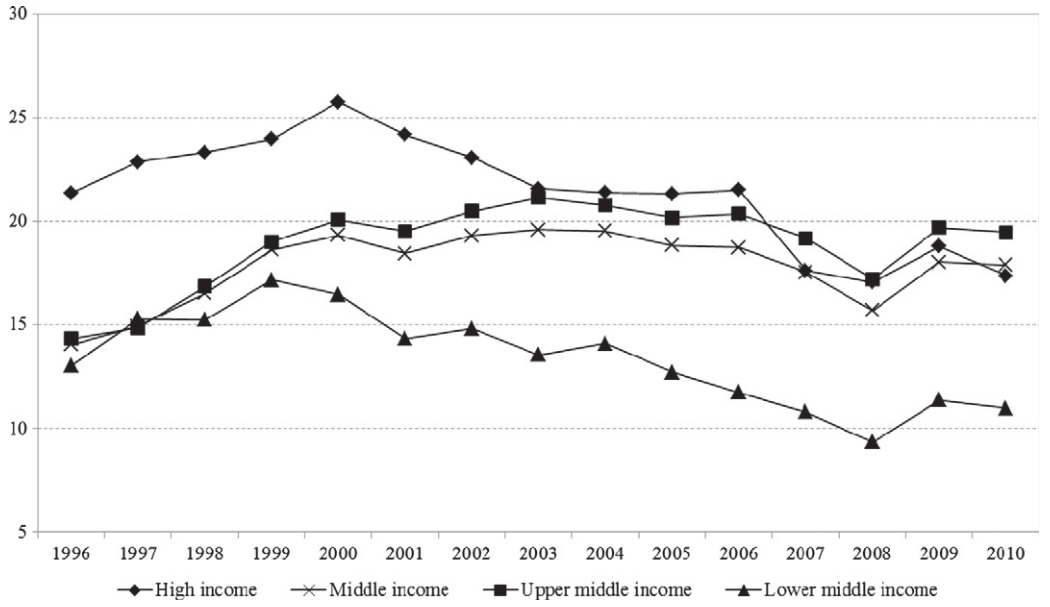
On the other hand, the indicator of high-tech exports in Graph 2 shows that the export levels of high-technology – as percentage of total manufacturing exports – are not so different between developing economies and the high-income group. Particularly, in the more developed countries, the average value of the indicator is over 21% while the level for upper-middle income group was this same value in 2003 and it is higher than high-income group since 2007. Besides, only this set of middle-income economies has shown a positive rate of growth in the period (around 4%). Regarding the evolution in this indicator, high-income and upper-middle income groups have reduced the relative importance of technology-intensive exports and the composition effect has been apparently in favor of those countries with the lowest income level; thus, a shift in the specialization pattern of manufacturing trade in developing economies can be observed.

In Graph 3 we can see that a smooth relationship between the R&D intensity and the exports of high-technology products in foreign markets exists — data corresponding to 2009. This would underline the role of national efforts in developing countries to achieve higher absorptive capabilities and how these could be dynamically translated into competitiveness gains in high-tech markets. Nonetheless, it is noticeable that the existence of differences across developing countries, being clear that some of the so-called emerging economies, such as China, adopts one of the best positions in building absorptive capabilities. There are other large economies of the BRIC group (Brazil and Russian Federation) doing especially well in terms of R&D as well as others belonging to some European transition economies such as Lithuania, Latvia and Ukraine. Among those countries positioned on the right hand side of the Graph 3, we found also some competitive economies such as Tunisia and South Africa, although they are not as intense in high-tech exports as it is also the case of India. On the other hand, there are some countries that show high values in high-tech exports but rather low R&D efforts; these are the cases of Philippines and Costa Rica. In a slightly better position we find Malaysia that presents a higher ability to export high-tech manufactures and also a rather high R&D effort. Nevertheless, there is a numerous set of countries that are still in a take-off phase regarding these two indicators; those positioned in the bottom-left corner of Graph 3 where they are characterized by a low proportion of high-tech exports and low absorptive capabilities, such as some Latin American and Middle-East economies.

Other factors different from R&D also affect the results of developing economies in high-tech exports, as it is revealed in some specific contributions based on firm level data for some developing countries, such as Thailand and Malaysia, that confirm the existence of a close connection between exports and technological capabilities (Rasiah, 2003). This would justify the inclusion of other indicators to explore the existing connections between innovation, MNE and competitiveness results in technology-intensive trade. Looking now at the international connections of developing countries for the generation and acquisition of technology, Graph 4 shows the volume evolution of royalty and license fees. This indicator reveals indeed a huge gap between high-income countries and the two sets of middle-income countries. The differences are also notable between country groups in technology creation capabilities, since developing economies are still in very low levels of royalties' receipts with regard to high-income economies. However, it can be noticed that the positive evolution described by upper-middle income countries, having multiplied by a factor near 3 the average value of the royalties' payment indicator, is reducing the distance to most developed countries since 2006.

To end this short data description, Graph 5 shows the evolution of FDI flows also by groups of countries. A first aspect to observe is the similar relative importance that FDI flows have in terms of the GDP for both high-income and middle-income economies, being rather stable the evolution of this indicator in developing countries during the period. On the other hand, the role of FDI outflows is still much higher for the most developed economies. However, the very positive and increasing trend of this indicator for developing economies can be noticed. The outward position can gain relevance in the explanation of the positive evolution followed by developing countries in high-tech international markets, being plausible to think on two different dynamics: the process of building absorptive capabilities and the international influence for competitiveness gains. From the

[3] See Álvarez et al. (2009) for more details.



Graph 2. High technology exports as percentage of total manufacturing exports.
Source: Own elaboration, World Development Indicators (World Bank).

combination of both, it might be thought that a diversity of factors may intervene in their evolution, conditioning the international integration of these countries in high-tech trade flows. A better understanding of such factors can be helpful for a more precise analysis of competitiveness and for the potential definition of strategies improving their international results.

4.2. The econometric model

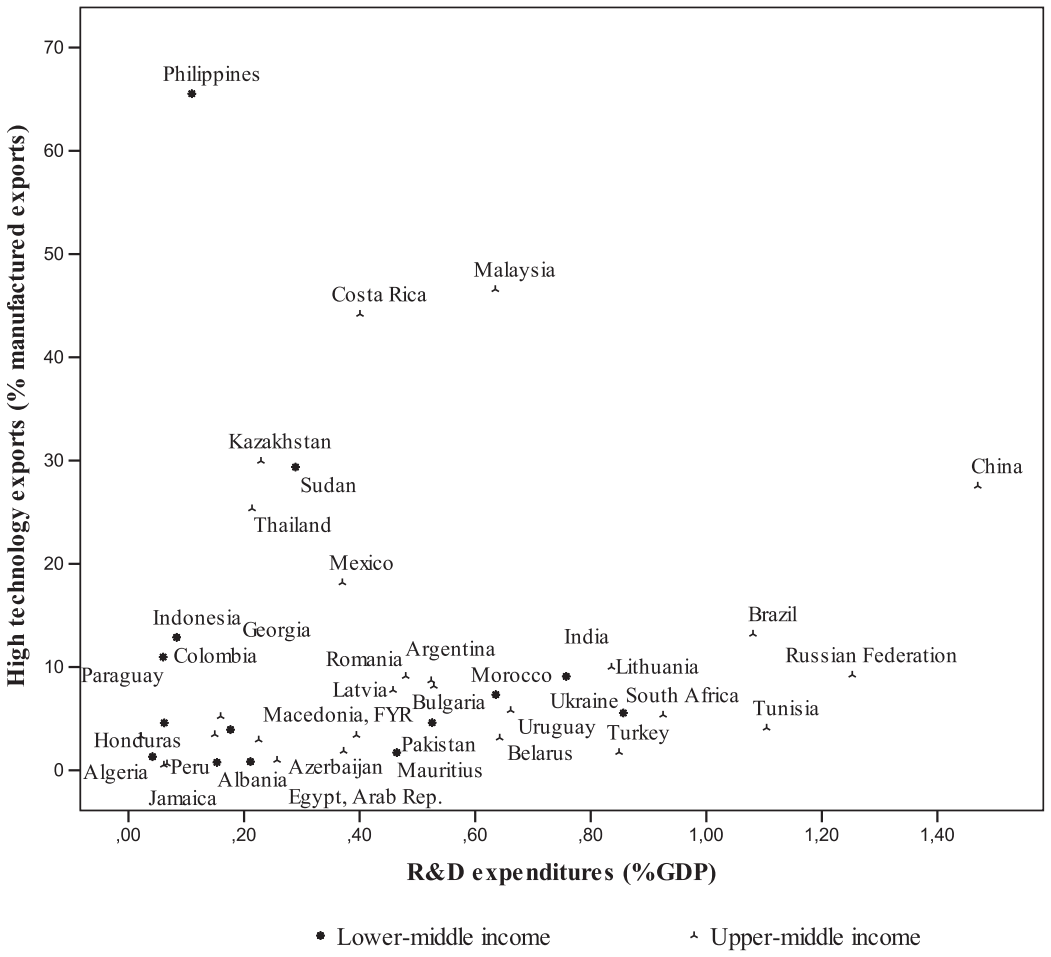
The relevance of technological capabilities in the competitiveness position of countries in the international scene – shown in previous sections – invites to analyze the competitiveness gains in high-tech markets as a function of a set of internal and external factors related to both technology and FDI that could contribute to define a country's competitive profile that can derive into interesting implications for both managers and practitioners. We specify an econometric model where the dependent variable is the high technology exports as a percentage of the total manufacturing exports. The relationship of this variable with the different internal and external factors can be broadly defined as follows:

$$Hightech_{it} = IF_{it}^{\alpha} EF_{it}^{\beta} X_{it}^{\delta} e^{\eta i} e^{\gamma t} \quad (1)$$

where $Hightech_{it}$ represents the percentage of high tech exports; IF_{it} and EF_{it} represent the internal and external factors, respectively; the subscript it refers to the country i in period t; X_{it} represents a set of other factors; η_i represents individual time-invariant effects (capturing the unobserved heterogeneity among countries); and γ_t represents time-variant effects.

As internal factors, we take the level of technological capabilities through a set of variables that is related to the national absorptive capabilities (R&D effort), the creation of technology (patent applications and royalty receipts) and the acquisition of technology (royalty payments) due to the potential role of technology transfer from the international context. As external factors we include inward and outward FDI stock in order to capture both the effect of foreign firms' presence and the relevance of MNE on competitiveness gains in the global high-tech markets. Besides, these two variables can be considered as proxies of the commitment and the integration of countries in the international scene. In addition, a proxy for imports of high-tech is included to capture the effect of intra-company trade and the position in the GVC and how this aspect may be of importance in the competitive performance of developing countries. Table 1 shows a summary and description of the variables included in the analysis.[4]

[4] Some descriptive statistics of the variables included in the analysis and the correlation matrix can be found in the Appendix A (Table A2 and Table A3, respectively).



Note to Graph 3: R&D data for India, Mexico, Thailand, and Philippines refer to 2008 and for Algeria, Georgia, Honduras, Malaysia, Mauritius, Morocco and Sudan data refer to 2007

Graph 3. High technology exports and R&D expenditure, 2009. Note to Graph 3: R&D data for India, Mexico, Thailand, and Philippines refer to 2008 and for Algeria, Georgia, Honduras, Malaysia, Mauritius, Morocco and Sudan data refer to 2007.
Source: Own elaboration, World Development Indicators (World Bank).

According to the theory, the model would explain high-tech exports as a function of foreign MNE (MNE_in) and national MNE (MNE_out) strategies, the relative position in the industry global value chain (GVC) and the role of different channels for technology creation (TECH_crea) and absorption (TECH_abs). That is to say:

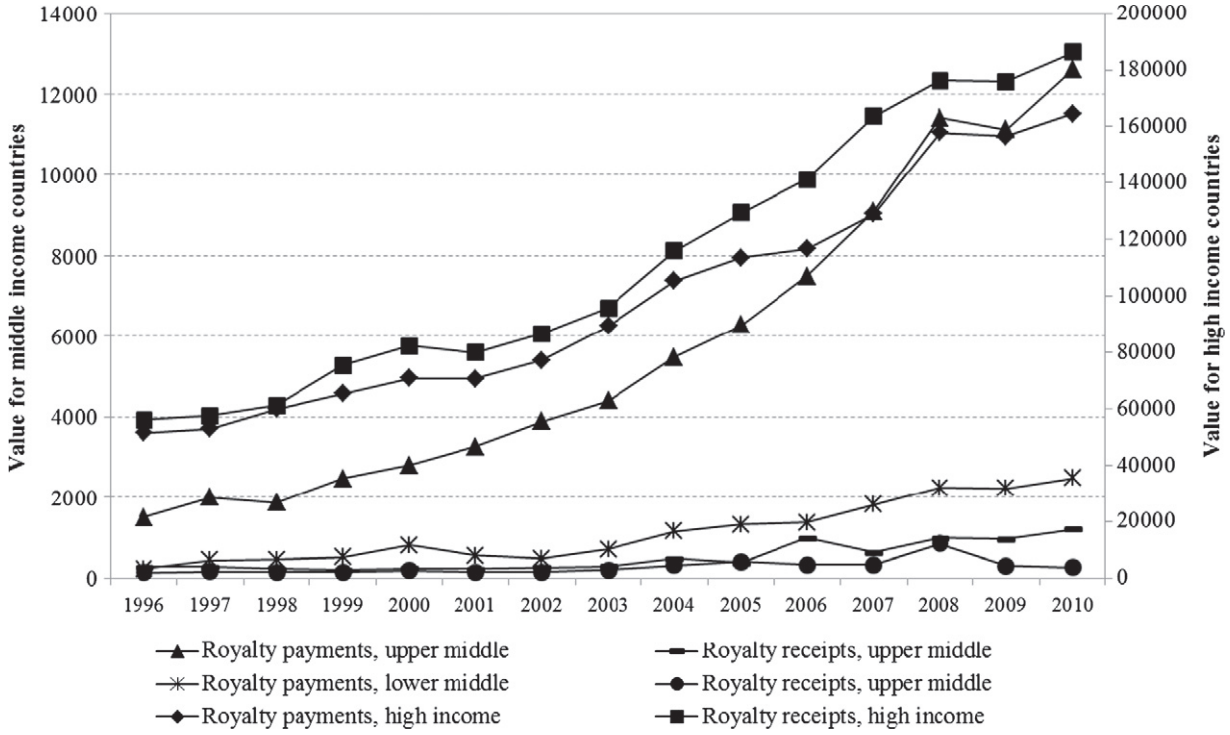
$$\text{Hightech\_X} = \text{f}\,(\text{MNE\_in}; \text{MNE\_out}; \text{GVC}; \text{TECH\_crea}; \text{TECH\_abs}).$$

For the estimation objective, we decompose each block of factors that are integrated by the variables summarized in Table 1. The general equation would state as follow in natural logarithms:

$$\begin{aligned}\text{LogHightech}_{it} = {} & \beta_0 + \beta_1\,\text{LogFDIinward}_{it} + \beta_2\,\text{LogFDIoutward}_{it} + \beta_3\,\text{LogImporhigh}_{\text{it}} + \alpha_1\,\text{LogR\&D}_{\text{it}} \\ & + \alpha_2\text{LogPatents}_{it} + \alpha_3\,\text{LogRoypayment}_{it} + \alpha_4\,\text{LogRoyreceipt}_{it} + \eta_i + \gamma_t + \varepsilon_{it}\end{aligned} \tag{2}$$

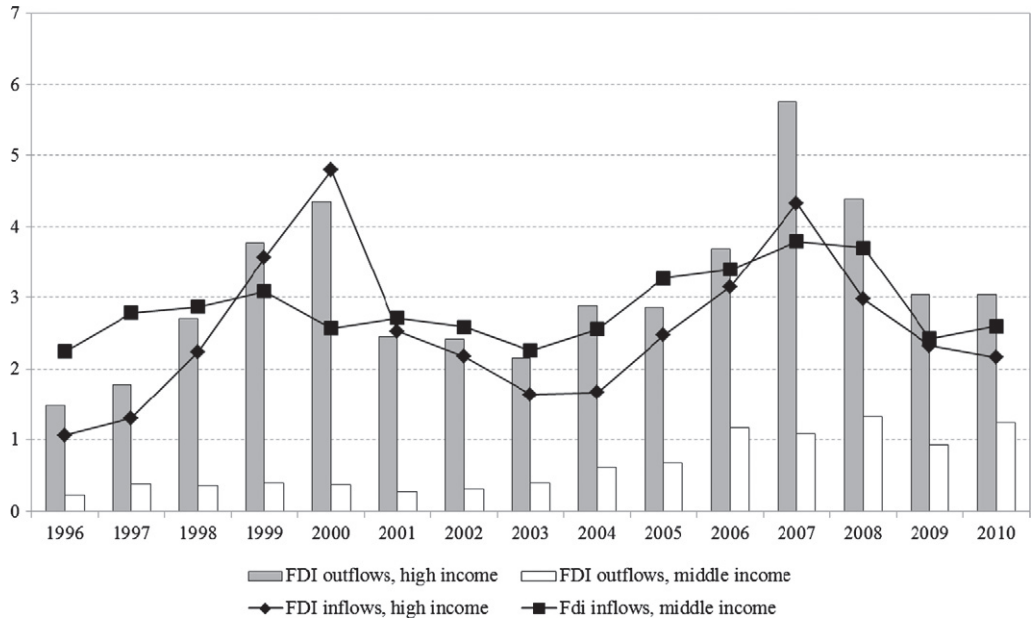
where the subscript *it* refers to the country *i* in period *t*, η_i and γ_t represent individual and time effects, respectively; ε_{it} is a random error term.

The availability of panel data makes relevant the selection of the estimation procedure due to the inherent endogenous structure of the model. In the selection of the estimation procedure we consider that the dependent variable and its lag may be correlated with the independent variables due to the dynamics in the underlying process of competitiveness gains; that is, past



Graph 4. Royalty and license payments and receipts per 1000 habitants.
Source: Own elaboration, World Development Indicators (World Bank).

results in terms of the absorption and creation of technology or in terms of integration in international markets via FDI may determine the high-tech exports in present times. The generalized method of moments (GMM) uses the first difference transformation and all possible lags of regressors as instruments to wipe-out non-observable individual effects and to eliminate possible correlations with the individual effect (Arellano and Bond, 1991).



Graph 5. FDI flows (as percentage of GDP).
Source: Own elaboration, World Development Indicators (World Bank).

Table 1
Definition of variables.

Variable	Definition
Hightech	High technology exports (as the percentage of the total manufacturing exports), country *i* year *t*
FDIinward	FDI inward stock (as the percentage of the GDP), country *i* year *t*
FDIoutward	FDI outward stock (as the percentage of the GDP), country *i* year *t*
Importhigh	High technology imports from high-income countries (as the percentage of the total imports), country *i* year *t*
R&D	R&D expenditure (as the percentage of GDP), country *i* year *t*
Patents	Number of total patents (per 1000 habitants), country *i* year *t*
Roypayment	Royalty and license fees, payments (current US$ by thousands of inhabitants), country *i* year *t*
Royreceipt	Royalty and license fees, receipts (current US$ by thousands of inhabitants), country *i* year *t*

On the other hand, the presence of predetermined variables as regressors gives rise to a potential autocorrelation problem; i.e. the creation of technology (measured by patents applications) is not usually sporadic but describes a cumulative process; so, this regressor may be determined by past disturbances and then is predetermined. In such a case, Arellano and Bover (1995) highlight the importance of identifying these variables and they propose the use of predetermined variables in first differences as instruments for equations in levels in order to obtain asymptotically efficient and consistent GMM estimators. Therefore, we adopt this GMM estimation procedure (called System GMM) because of its inherent advantages.

5. Discussion of results

The econometric model specified in the previous section is estimated for developing and developed countries in order to test our hypothesis and capture the diverse situations defined in the conceptual framework. As it was predicted, the estimation results for developing countries (column 1 in Table 2) show that their competitiveness improvement in high-tech markets seems to be clearly related to a combination of both internal and external factors. Particularly relevant is the role of absorptive capacities and technology acquisition from abroad, what can be observed in the positive and significant coefficients of R&D effort and royalty payment variables, respectively. There is also a positive effect of imports of high-tech, revealing the importance of the integration and the position of these economies in the international industry value chain. On the other hand, FDI outward stock is a significant explicative factor of the high-tech competitiveness for developing countries, what can be clearly associated to the development

Table 2
Estimations results.

	Developing countries (1)	Developed countries (2)
FDIinward	−0.1901	0.0024
	(0.0232)***	(0.0166)
FDIoutward	0.1506	0.0486
	(0.0317)***	(0.0143)***
Importhigh	0.9858	0.7587
	(0.3818)**	(0.2959)**
R&D	0.2442	0.0498
	(0.0406)***	(0.1054)
Patents	0.1580	0.2613
	(0.1289)	(0.0667)***
Roypayment	0.1210	0.0905
	(0.0445)***	(0.0652)
Royreceipt	−0.0460	0.1278
	(0.0180)**	(0.0691)*
Constant	−1.8304	−2.6740
	(1.7827)	(1.5797)*
Hansen test Chi^2	30.13	29.05
Arellano-bond test for AR(1)	−2.28**	−2.64**
Arellano-bond test for AR(2)	−0.42	−1.64
Number of observations	262	367
Time dummies	Yes	Yes
Country dummies	Yes	Yes

All variables are included in natural logarithms.
* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

path. However, the presence of MNE in these economies seems to have a negative impact that would reflect the absence of positive effects in high tech industries while technology creation does not relate to their competitive performance, this latter effect is captured by the patent indicator as well as by the royalty receipts. In fact, the latter indicator is negatively associated to exports of high-tech.

The picture changes when the econometric results for developed countries are observed (column 2 in Table 2). Although their competitive position in high-tech markets also depends on internal and external factors, technology creation capabilities gain explicative power in the competitiveness of these economies, while absorptive capacities and technology acquisition do not play a significant role. This result can be observed in the significant and positive effect of patents and royalty receipts and the non-significance of R&D efforts and royalty payments. The position in the global value chain is also a key determinant for the most developed country performance, considering the positive and significant coefficient of high-tech imports; this aspect would reflect the relevance of intra-industry trade in these economies. Finally, the stock of outward FDI reveals to be a significant factor although its impact on high-tech exports is relatively small. On the contrary, the presence of foreign MNE in these economies does not exert any effect.

Results come to highlight that developing the country performance in high-tech exports seem to be more related to their position in the industry's international value chain than with the positive effects that R&D-intensive activities carried out by foreign MNE could generate in host locations. What is more, the negative influence of the presence of MNE in developing countries in their global high-technology export performance could be explained by two main reasons: on the one hand, the fact that foreign subsidiaries follow local market-oriented strategies instead of international posts, especially when these firms have not developed internally technological competencies, or they are mainly active in more tradition industries not related to high tech industries. On the other, it is plausible to think that the activity of foreign firms can contribute positively to promote domestic entrepreneurial capacities in locations either because domestic firms can become specialized suppliers for the foreign units and this would positively impact competitiveness in high tech, or because foreign units can contribute to reinforce domestic companies as a result of the competition promotion in local industries. Moreover, our findings allow us to affirm the scarce role of developing countries as technology creators, as it is supported in Athreye and Cantwell (2007). By contrast, estimations corroborate the potential of developing economies as source of MNE and how this fact may be associated with the high-tech performance of these countries (Cuervo-Cazurra, 2007; Gammeloft et al., 2010). Therefore, our findings show a diversity of aspects related to capability building, being possible to highlight that developing countries seem to rely more on the location of subsidiaries abroad, this is revealed by the outward orientation of FDI, as well as on the acquisition and absorption of technology in order to obtain more advanced technologies and upgrade their technological competencies, what allow them to compete actively in more sophisticated global markets.

From this empirical analysis of the competitiveness evolution in technology-intensive industries, we find empirical support for the relationship between innovation and FDI integrated in our analytical proposition (in Fig. 1). As we postulate in the conceptual approach, a diversity of factors intervene positively in the dynamics of high tech exports: the development of absorptive capacities, the acquisition of technology capabilities and the firms' internationalization process. Meanwhile, accepting that these hold in general terms, it is expected that differences across countries exist. Regarding developing economies, it can be though that the presence of MNE together with both the efforts to adapt foreign technologies and to create own techniques can be seen as a suitable combination for the generation of positive effects in high tech competitiveness. However, some of these countries show a competitive dynamic that would be based on their integration in the international context via FDI and technology specialization. The relevance of emerging economies would explain the prevalence of the AO cell, a combination in our conceptual approach that prioritizes learning from abroad thanks to technology absorption strategies in combination with the presence of home-based MNE. Moreover, our findings would confirm that the group of emerging economies has begun to manifest an active competitive behavior although the absorptive capabilities building process is more important than their role as technology creators worldwide (Athreye and Cantwell, 2007). These findings would support the importance of defining new strategies oriented to obtain higher benefits from FDI and especially in terms of technology catching-up, what could promote the transit from AO to CO cell through knowledge creation.

On the other hand, the results for the developing economies reinforce the idea about their increasing internationalization although the variety of cases recall the relevance of the national specificity and the opportunities for national systems of innovation to integrate the external factors in favor of competitiveness (Alvarez and Marín, 2010; Alvarez et al., 2009; Cantwell and Molero, 2003; Lundvall et al., 2002). In this direction, actions and strategies could seriously consider the factors that contribute to consolidate more advanced systems of innovation that could take-off as investors abroad. Besides, the positive impact of imports on the participation of the developing countries in the international high-tech markets could reveal an indirect positive effect of foreign markets in the upgrading of their technological capabilities. Likewise, the interplay between foreign firms and national technological capabilities gain some ground in the improvement of their competitive dynamic behavior. This would derive into a direct implication that may accentuate those actions that enhance technology creation.

6. Conclusions

There is a set of developing economies that are considered as emerging economies or emerging markets because of the active growth and dynamism that they have shown in the last decades, revealing also important opportunities in terms of competitiveness; they are even ranked among the most developed countries in many aspects, a reason why they are increasingly

compared with the richest and developed countries club. Nonetheless, their rapid expansion in international markets is of interest for researchers and practitioners, even more if we think that there are still important elements of exclusion for similar emerging economies that do not show a clear behavior pattern that could indisputable characterize their position in the more dynamic international markets. Our proposition here is to provide a framework for understanding those competitive possibilities and differences in high tech internationalization by means of the combination of technological capabilities and the impact that MNE may generate. The objective has been to adopt this approach in an analysis of the diversity of internal and external factor that would determine their integration and position in international markets and to provide some new fresh empirical evidence about the relative explicative power of those factors affecting their competitive results in high-tech industries.

The results of our analysis reveal the existence of a close relationship between the competitive performance and the relative importance of internationalization forces that characterize the entrepreneurial capabilities of developing economies and the advance of their systems of innovation. This aspect is especially crucial and it is shown in the significant role of absorptive capabilities that emerges from the comparative analysis of developing contexts where the relevance of technology adaptation is also highlighted. We contrast this statement with different innovation, management and IB arguments found in these branches of the literature. Our findings allow us to underline that the ability to adapt technology developed elsewhere (mechanism more typical of least-developed countries) and their effort to innovate are important factors for competitiveness shifts. In addition, the integration of these countries in international markets via FDI is also detected as a relevant aspect in the explanation. Some of the key elements that act as engine of the levering process are the position in the global value chain, the outward FDI potential of these countries and the acquisition of technology in the international market. One main conclusion from our findings, would be that upgrading is not predetermined by the countries level of development but on the contrary competitiveness shift in high tech industries is a process that is defined by a diversity of factors that can be more or less pronounced by the relative importance of innovation and firm internationalization.

Finally, among the limitations of this study we would say that the analysis does not allow us to ascertain the existence of spillover effects, and we could not either explore the possibilities of potential reverse knowledge effects or how these can be translated in competitiveness results. The multiple specialization patterns of developing economies and how industrial diversity could derive into different competitive profiles in a given country are other interesting aspects that could improve the analysis carried out here. The competitiveness gains have been assimilated to the abilities of countries to export technology-intensive manufactures although the analysis of data at the industry level and even for intra-firm trade could provide a more complete picture in further research.

Appendix A

Table A1
Countries included in the empirical analysis.

Middle income countries		High income countries	
Algeria	Russian Federation	Australia	Malta
Argentina	South Africa	Austria	Netherlands
Azerbaijan	Thailand	Belgium	New Zealand
Belarus	Tunisia	Canada	Norway
Bosnia and Herzegovina	Turkey	Croatia	Poland
Brazil	Uruguay	Cyprus	Portugal
Bulgaria	Albania	Czech Republic	Singapore
Chile	Egypt, Arab Rep.	Estonia	Slovak Republic
China	Georgia	Finland	Slovenia
Colombia	Guatemala	France	Spain
Costa Rica	Honduras	Germany	Sweden
Jamaica	India	Greece	United Kingdom
Kazakhstan	Indonesia	Hong Kong SAR, China	United States
Latvia	Moldova	Hungary	
Lithuania	Morocco	Iceland	
Macedonia, FYR	Pakistan	Ireland	
Malaysia	Paraguay	Israel	
Mauritius	Philippines	Italy	
Mexico	Sudan	Japan	
Peru	Ukraine	Korea, Rep.	
Romania		Luxembourg	

Table A2
Descriptive statistics (variables included in the model).
Source: *World Development Indicators*, World Bank.

	Middle income countries				High income countries			
	Mean	Std. dev./mean	Maximum	Minimum	Mean	Std. dev./mean	Maximum	Minimum
High tech exports	10.44	0.70	74.99	0.00	18.51	0.73	71.74	1.67
Stock of Inward FDI	25.45	0.67	101.35	0.00	53.03	1.23	337.82	0.64
Stock of Outward FDI	3.83	1.66	41.29	0.00	41.54	1.53	296.90	0.43
Imports from high-income countries	60.08	3.49	96.23	16.53	78.13	0.14	98.45	42.57
R&D	0.48	1.53	1.47	0.02	1.73	0.56	4.8	0.22
Total patents	0.06	0.90	0.30	0.00	0.71	1.16	3.55	0.01
Royalty and license fees, payments	5973.61	0.69	52,476.74	0.00	263,102.31	3.26	8,451,964.9	1954.93
Royalty and license fees, receipts	1768.68	0.29	46,933.51	0.00	86,999.99	1.48	932,725.82	39.60

Table A3
Correlation matrix (variables included in the model).

	Hightech	FDIinward	FDIoutward	Importhigh	R&D	Patents	Roypayment	Royreceipt
High income countries								
Hightech	1							
FDIinward	0.1038**	1						
FDIoutward	0.2832***	0.5300***	1					
Importhigh	0.1269***	0.0920**	−0.0977**	1				
R&D	0.4121***	−0.2349***	0.2126***	−0.0436***	1			
Patents	0.4358***	−0.1711***	0.0107	−0.3844***	0.5225***	1		
Roypayment	0.3760***	0.2850***	0.5134***	−0.1528***	0.3191***	0.2028***	1	
Royreceipt	0.4660***	0.1822***	0.4984***	−0.1994***	0.5040***	0.2907***	0.5251***	1
Middle income countries								
Hightech	1							
FDIinward	−0.048	1						
FDIoutward	0.1902***	0.1611***	1					
Importhigh	0.0683*	−0.1037**	0.1536**	1				
R&D	0.4616***	−0.0076	0.1049*	−0.1028**	1			
Patents	0.3790***	0.2112***	0.2887***	−0.2302***	0.2845***	1		
Roypayment	0.2572***	0.1412***	0.3908***	0.1365***	0.1042**	0.4766***	1	
Royreceipt	−0.0147	0.0868*	0.1029**	−0.0299	0.0573	0.2610***	0.3598***	1

* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

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