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FDI AND TECHNOLOGY IN THE COMPETITIVENESS OF MIDDLE-INCOME COUNTRIES

Authors:

Isabel Álvarez[a, c]

Universidad Complutense de Madrid

Raquel Marín[b]

Universidad Europea de Madrid

[a] Departamento de Economía Aplicada II, Facultad de Económicas and Instituto Complutense de Estudios Internacionales. Universidad Complutense de Madrid.
Address: Campus de Somosaguas. 28223 – Pozuelo de Alarcón (Madrid), Spain
e-mail: isabel.alvarez@ccee.ucm.es

[b] Departamento de Economía de la Empresa, Facultad de Economía, Derecho y Empresariales, Universidad Europea de Madrid and Instituto Complutense de Estudios Internacionales.
Address: C/Tajo s/n, Urbanización El Bosque. 28260 – Villaviciosa de Odón (Madrid), Spain
e-mail: raquel.marin@uem.es

[c] **Corresponding author:**
Isabel Álvarez
Departamento de Economía Aplicada II. Facultad de Económicas. Universidad Complutense de Madrid. Address: Campus de Somosaguas. 28223 – Pozuelo de Alarcón (Madrid), Spain.
Tel: +34.91.394.24.58 Fax: +34.91.394.24.57 e-mail: isabel.alvarez@ccee.ucm.es

Title: FDI and technology in the competitiveness of middle-income countries

Abstract:

The diverse group of middle-income countries (MIC) is composed by some economies with a behavior in exports of technology-intensive goods that is strictly better than the group average. One of the factors explaining this result is the improvement of their national technological capabilities, aspect with a positive influence in the dynamism of their productive and trade structure. There are grounded reasons to think that this is also a consequence of external effects and the potential impacts that foreign direct investments (FDI) flows generate in those economies. In this paper, we analyze the integration of the MIC economies into the dynamic high-tech markets as the interplay between the role of FDI and their ability for technology absorption and creation. We will observe, based upon empirical analysis with panel data (1998-2005), the relative importance of internal and external factors for the improvement of the international competitiveness in these developing economies.

JEL: F23; O14; O33; O57;

Keywords: FDI; competitiveness; high-tech; middle income countries

1. Introduction

The possibilities that Middle Income Countries[1] (MIC) have to be more competitive and to integrate the most dynamic international markets are dependent on the advantages derived from their productive and commercial specialization. This is a consequence of their technological capabilities and also of the impact of external factors such as the influence of foreign direct investment (FDI). Beyond the interesting discussion about the concept of competitiveness and its application at the aggregated level (Krugman, 1994), our understanding of the competitive position of countries in this paper would be certainly linked to the combination of their own national abilities and their degree of international integration. These aspects, at the end of the day, are necessarily linked to the individual behavior, mainly to the abilities of firms and the scientific and technological institutional set-up of a given country to generate improvements in the technological advance levels; therefore, it is methodologically accepted both the adaptation of the concept of competitiveness and the analysis at country level.

Most of the economic explanations based either on factors' endowment or on technological opportunities and innovation, agrees on the role of domestic capabilities in the definition of specialization patterns, these becoming determinant factors of the firms' competitiveness. The evolution of international commercial patterns reveals that the shift in technological advantages specialization ultimately depends upon the industrial structure and a more complex set of elements integrated in the national systems of innovation (Narula and Wakelin, 1995). In the case of developing economies, those abilities would be at least in the first stages of development

[1] 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 is integrated by middle-income economies (from $936 to $11,455), that is also divided into upper-middle and lower-middle income groups (World Bank, 2009).

(industrialization) mainly focused on the adaptation and efficiently use of the already available technology (Lall, 1996; 2000); although, the efficient use of them that could be transformed in sustainable growth underlines the importance of the national efforts to build the appropriate absorption capabilities.

On the other hand, assuming that openness does not necessarily mean growth and development *per se* (Rodrick, 1999; Fagerberg and Srholec, 2008), we will defend here that it is not less certain that in an increasingly internationalized World Economy, those national capabilities can be often graduated and reinforced by external factors. In other words, production activities, the generation of value and even the technology transfer corresponding to large internationalized corporations in foreign countries enhance to considering their influence in the definition of competitive patterns in MIC. Then, a more updated look to competitiveness would require to integrate multinational companies (MNC) since these could become in many developing countries some of the more (if not the most) active export players or promoting them (through the international fragmentation of the value chain nowadays). However, it is certain that the deeper internationalization process in last decades has affected markets and hierarchies although the benefits among countries have not been equally distributed.

Therefore, MNC have had a crucial role in the large increase on the investment's flows among countries and has intervened in the definition of competitiveness conditions in both home and host economies; i.e. subsidiaries activities in developing countries can be seen as contributors to the competitive results of these economies. Moreover, data show not only the raise of FDI inflows into developing economies (UNCTAD, 2005; 2007) but also the emergence of outward FDI from these countries as well, a

phenomenon that, being more recent in time, should be integrated in our view in the study of international competitiveness.

Our conceptual construct is built upon the idea that competitiveness and technology defines a complex relationship that could be bidirectional, it is characterized by multiple loops and multiple possibilities for feedback and then, a diversity of factors can intervene simultaneously in both, the definition of competitive and technological patterns. The empirical objective in this paper is to try to disentangle that diversity, exploring the differences in the competitive positions of the MIC in the international high-tech markets and their dynamic possibilities to upgrade. Being aware of the heterogeneity that characterized the group of middle-income economies (Álvarez and Magaña, 2007), we will make a diagnosis about the relative abilities of this group of developing countries in the world market of technology-intense goods, trying to detect the factors defining the threshold level of both the external orientation (FDI flows) and the internal technological possibilities of them (national systems of innovation). The general proposition will be developed over the effects of international knowledge transfer in the competitiveness of the MIC.

In the next section, the literature review will be based on the factors that affect competitiveness levels, with a focus into developing countries. In the third section, we develop our hypothesis integrating them into a conceptual framework based on the relationship between FDI (inward and outward) and technology (absorption and creation). In the fourth section, we describe the main relationships among the variables integrating the empirical model and we analyze under a dynamic perspective the impact

of both technological indicators and external factors in the competitiveness shift of the MIC, making use of data from the World Bank and the UNCTAD for 1998-2005. We d discuss the results in section fifth and we conclude in section sixth.

2. Literature background

Competitiveness is a concept very discussed among academics; it allows for several level of analysis and there is not a common and undistinguished methodology to deal with. Although its most pertinent application is at the firm level and it refers to a comparative concept of competition or market gains, it has also been applied at the national level (Porter, 1985; Nelson, 1993; Fagerberg, 1996; Roessner et al, 1996). The more broad definition of competitiveness relates to productivity and growth of countries (Krugman, 1994) while the more tractable definition has been focused on the ability of a country to compete in trade by exporting (Fagerberg, 1996; Lall, 2001). The huge number of contributions on competitiveness is justified by the fact that this fashionable concept has been a facilitator for the discussion and definition of policies and actions to enhance national performance.

Notwithstanding that globalization has changed the markets functioning and hierarchies, technology has reshaped international firms, industries and commerce. Then, we assume that the national structural competitiveness definition seems to be related to a country's ability to enhance collective techno-economic capacities in the world market-place; this implies a relative or comparative notion of performance that is shaped by multiple and diverse factors that would define the competitive results of countries. Although the risk of becoming a "dangerous obsession" (Krugman, 1994) exits, it is certain that virtually all the countries seek to take advantage of the structural and productive changes that

increase their competitive position; or in other words, to improve their share of world output, employment and trade of technology-intensive products (Aharoni and Hirsch, 1997).

The competitive differences among countries are due to their technological capabilities, those defined by their ability for technology absorption, adaptation, efficiently use, and creation, aspects that depend on several factors such as the macro environment conditions, the strategies of business organizations and the institutional framework. 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 dependent on the level of initial development (Gerschenkron, 1962) or on its degree of modernization. In this sense, some empirical analysis of the evolution followed by trade patterns and the technological advance in developing countries (mostly Asian economies) argue that the relationship between commercial advantages and the technological advantages is more clear in some economies such as Hong-Kong, Singapore and South Korea and it is less evident in those like Philippines, Malaysia, Thailand and Indonesia; in a certain extent, differences across-countries are due to the industrial structure in which there is a coexistence of labor-intensive traditional industries and technologically complex industrial activities (Uchida and Cook, 2005).

As a matter of fact, some developing countries have been even able to develop their own technologies (i.e. Brazil in aircraft, electronics and computers; India in computers; Malaysia in electronics) and this is the result of a combined action of States, foreign capital and domestic capital. In many occasions, the succeeding economies have based their strategy on the adaptation of imported technologies and their upgrading locally

(most Asian NIC). Other empirical evidence, for Latin American countries, shows also the existence of a complementary relationship between technology imports and R&D effort (Katz, 1982), this making possible to argue that foreign know-how may stimulate the local absorption of technologies. Thus, the upgrading process can be conceived as the result of the efforts on building new capabilities that would entail two levels of action: the national investments in scientific and technological skills, information flows, infrastructures and supporting institutions, as well as the efforts at the firm level to develop new organizational and technological skills (Lall, 1997). In any case, acquiring technology expertise is a cumulative process that necessarily requires the development of absorptive capacities and the involvement in networks of differentiated nature: the interaction with customers, suppliers and other factors of the environment (Cantwell, 1989; Lundvall et al, 2002; Fagerberg and Srholec, 2007; Alvarez et al., 2009).

Regarding the relationship between foreign MNC and development, it is meaningless to try to find a univocal causal relationship between them (Narula and Dunning, 2000). Even though, FDI and the activities of foreign companies have had an important role in the industrialization and modernization processes of many developing countries, with notable effects in some of their productive transformations (Dunning, 1993; 2006). It is then suitable to underline the role of MNC as big players in the complex relationship between internationalization and competitiveness, recalling the existence of complementarities between both types of entry modes, namely FDI and trade, since MNC can be seen as creators and traders of intangible assets (Ozawa, 1992; Lall, 2002). The activities of such large companies and trade specialization in technology-intensive industries not always found a perfect match with the technological specialization of developing economies. For instance, the upgrading capabilities of Malaysia and

Thailand as active exporters of electronics have been accompanied by technology capabilities development while FDI has evolved from the expansion into production operations to the process of technology development (Rasiah, 2003). Hence, it is possible to ascertain that comparatives advantages are linked to the capabilities of technology deepening, even in contexts of multiple specialization patterns if the efforts were concentrated in upgrading the possibilities for the development of technology-intensive activities (Rodrick, 1996).

The appropriate election of techniques in favor of competitiveness improvements and innovations are not in a vacuum but they are all part of a continuous technological effort that would enhance risks' assumption in a context of imperfect information (Teece, 1977; Lall and Teubal, 1998). In addition, the attractiveness of countries are not only defined by the comparative advantages but also by the absolute advantages in production and trade, being the infrastructures level, labor training and discipline some important determinants of FDI and components outsourcing attraction, this latter mostly entailing intra-firm trade (Dosi et al, 1990; Katseli, 1997). Consequently, competitiveness seems to be determined by the ability of countries to integrate themselves 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 MNC such as modern ITC, managerial and financial services and accounting methods (Aharoni and Hirsch, 1997; Rugman and Doh, 2008).

On the other hand, being aware that MNC are able to provide new production facilities, managerial practices and also technology transfer to host locations, from an outward perspective there are also implications from investing abroad such as the potential

reverse flows from host economies to foreign subsidiaries since firms look to tap into new knowledge in host locations as well (Cantwell, 1989; 1995; 2005; Frost, 2001; Piscitello, 2004; McCann and Mudambi, 2005; Singh, 2007; Mudambi, 2008). Specifically, in a recent contribution based on the analysis of patent citation data, Singh (2007) demonstrates the existence of significant outflows back from the host country to foreign MNC, even in less advanced countries. The consideration of these two directions is 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.

It has been confirmed elsewhere (Álvarez and Magaña, 2007) that one of the main outstanding features of the technological capabilities in the MIC is its tremendous intra-group heterogeneity. Some of the middle-income economies have an important potential for catching-up in the economic globalization process while others share a set of features that are more similar to the laggard economies (Durlauf and Johnson, 1995; Alonso, 2007; Castellacci, 2008). The individual peculiarity is then an aspect of special relevance that would reinforce the need for carrying out specific analysis of competitiveness in developing countries. As a matter of fact, there are some examples of succeeding economies, such as some Asian economies, that have shown a spectacular growth and although they are diverse a common aspect is their support to inward technology transfer (Mowery and Oxley, 1995). It is noticeable the efforts made by South Korea and Taiwan to try to nurture technological advanced domestic firms in their industrialization process (Kim, 1997; Agosin and Machado, 2005). In the cases of Malaysia and Thailand, there was an expansion of their exports that combined with low labor costs, enhanced skills upgrading that allowed them to export high-tech

components. In some larger economies such as India, they have adapted technology for local consumption to create local industries and this has been able to take advantage of growing number of skills in computer programs.

This literature background comes to frame our questions about the peculiar competitive position of the MIC and their technological advantages, being understood from the shift in their productive structure but also from their integration in the international context as part of the global value chain that is a consequence of the MNC operations.

3. Hypothesis development and analytical model

This study on competitiveness in MIC is built over a conceptual approach defined by the relationship between the integration in the international market of these economies, their level of development and technology. Particularly, we explore whether competitiveness shifts in countries can be associated and to what extent to a set of factors already identified in the literature and that we group 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 competitive advantages of industries and nations (*à la Porter)*; from this point of view, the choice here is to focus on technology and innovation as main driving factors. On the other, the increasingly internationalized environment allows us to detect some factors that are more closely linked to the integration of production and activities as a consequence of MNC operations; the investment development path or IDP theory (*à la Narula-Dunning*) shows an existing relationship between the advance of countries in economic development, the reception of FDI and how it evolves through different stages of internationalization until it becomes an investor country abroad; in other words, becoming the home economy for MNC. Such a framework is delimitated 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 (Narula and Dunning, 2000; Narula and Dunning, *forthcoming*).

Technical change and globalization have definitively contributed to redefine the competitive advantages notion and has also been a helpful tool in reshaping organizational forms inside MNC; hence, it seems suitable to integrate FDI in the analysis to explore the factors affecting countries' competitiveness. The present understanding of MNC and their effects in both host and home economies would require the consideration of the role of international networks and the implications associated to the more internationalized value chain (Kaplinsky, 2000). Particularly, two more updated visions of globalization allow us to embrace in a more real fashion the interplay between technology and competitiveness. Furthermore, 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 networks conception (Bartlett and Ghoshal, 1998). MNC are indeed becoming multi-centric firms exploiting the diversity of locations and behaving accordingly to the setting of a new geography of value chain activities (Mudambi, 2008). This has important implications from the point of view of competitiveness 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 the assets available at diverse host locations (Rugman and Verbeke, 2001).

On the other hand, international strategies of large MNC have also gone beyond the more traditional picture based on the seeking of markets or resources and it extended to efficiency and knowledge seeking types of decisions (Dunning, 2006). The relative importance of each of them and the evolution of FDI flows interact with the stage of economic development of countries (Narula, 1996; 2004). Under the changing location patterns of the world economy, the search of new knowledge is understood as one of the more outstanding functions of FDI (Yang et al., 2008; Singh, 2007). Part of the justification of this point is found on the higher fragmentation of production and how MNC in knowledge-intensive areas are even decentralizing core activities, such as R&D, and relocating increasingly the more standardized parts of their productive activities in emerging economies (Mudambi, 2008).

The bulk of our analysis is to try to explore the competitiveness gains of countries in high-tech markets as a result of both internal factors (technological skills) and external forces (inward and outward FDI). We are voluntary not introducing here incoming trade flows assuming the important complementarities existing between both FDI and trade flows (Ozawa, 1992; Katseli; 1997). Although the relationship between the first set of factors and competitiveness could be seen in a more obvious and direct way, the second could be equally realistic from the point of view of present trends in the world economy. Particularly, it would mean that national economies have evolved until an advanced stage of the IDP that allow them to have the necessary entrepreneurship to be able to assume the risk to invest abroad and to begin doing business in other countries via FDI (Narula and Dunning, *forthcoming*). The complexity of globalized units and the importance of knowledge invite to think that in the present context, outward FDI may adopt an important function sourcing new knowledge from abroad while the

possibilities for reverse knowledge to the home country would finally end for affecting competitiveness. Nonetheless, the measurement of this aspect in an accurate manner is not an easy task but it is still a topic under development.

Our conceptual construct is illustrated in the matrix represented in Figure 1 that shows the relation between internal and external factors: Technology absorption (A) and creation (C) are seen as those functions that economies perform internally while inward (I) and outward (O) FDI will capture the external side of the mechanisms that would interact generating potential effects on competitiveness. To some extent, the arrow would be representative in a very simplified manner of the more clear relationship that is postulated by the IDP proposition, this combined in both cases with the state of the national technological development. On the other hand, there are two hybrid positions that would combine the factors defining some kind of intermediate situations that developing economies could easily fit. Notwithstanding that the most developed and technological advanced economies would likely shape the CO combination, the different development levels of the countries outside the world frontier would make differ the likelihood for shaping the alternatives in the two axis and hence the potential associated effects.

Figure 1 here

The more common and outstanding relationships are those 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 in less developed economies where strategies oriented to adapt foreign technology to domestic market conditions prevail. It is here assumed that there could be still a low level of development and the lack of local

entrepreneurial capabilities do not concede much 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 in the world technological frontier or, in terms of the IDP, it would be a country that has transited from most of the development stages in such a framework, being plausible to think that this situation would allow some degrees of exclusion for less developed economies. The evidence confirms that FDI contribute to enhance the emergence of some developing countries with more sophisticated technologies but there are very few succeeding cases as licensors of technology with an impact worldwide (Athreye and Cantwell, 2007; Singh, 2007). Nonetheless, the shift in FDI patterns shows the growth of outflows from the new industrialized Asian economies since the 1980s, primarily from South Korea, Taiwan and China. This is also an aspect that can be considered in the explanation of the competitiveness shift in developing economies and it could enhance the catching up possibilities for those MIC that follow a positive evolutionary path.

On the other hand, looking at the two situations, the cell called CI would reflect the indirect effects of the relationship between MNC and development that generally refers to spillover and technology transfer of foreign subsidiaries in location (Rugman and Doh, 2008). The possibility and size of these effects are irremediably linked to the domestic capabilities and its potential to benefit for the leakage of knowledge from foreign companies and it can be expected that absorptive capacities in host economies become crucial (Álvarez and Molero, 2005; Criscuolo and Narula, 2008; Narula and Dunning, *forthcoming*). For this reason, in more laggard countries the needed entrepreneurial and institutional capabilities would be missing to integrate this position

while the higher relative advance of the MIC makes more likely to be placed on it. It must be said that the AO cell is rather representative of those economies that jump into the international markets via outward FDI although they still present an important technology gap.

> *Proposition: Competitiveness can be explained as a function of national technology, technology transfer and international integration of countries via FDI.*

To make operational this proposition we will make use of a set of indicators at country level to explain the competitiveness of the MIC in high-tech markets: The relative importance of high-tech products in the manufacture exports of countries will be taken as the dependent variable and it will be regressed against a set of factors that would fit our conceptual approach. First, we will consider indicators for FDI inward and outward flows (*external factors*) as well as the level of openness as control variable. We will also consider the technological capabilities of countries (*internal factors*); specifically, the absorption capacities -measured through R&D-, the acquisition and international diffusion of technology and the technology creation -measured through patents-.

4. The empirical analysis

In this section, we analyze the impact of external and internal factors in the competitiveness shift of MIC countries, paying special attention to the relative importance of high-tech exports. For this purpose, the analysis is undertaken for the period 1998-2005, making use of data from the World Bank and the UNCTAD, and it is carried out for 60 countries (29 middle-income countries and 31 high-income ones); we

include the latter to ascertain possible differences in the international competitiveness determinants between the two groups of countries.

4.1 The technological position of MIC countries at the international level

For a description of the international technological position of the MIC, we use those indicators related to the absorption and creation of technology and those connected to the integration in high-tech markets. Although inequality is a persistent element in this field and it can be struggling growth and competitiveness potential of developing economies (Álvarez and Magaña, 2007), particular interest has to observe whether the gap of these economies has remained invariant from 1998 to 2005 or not. Considering the absorption capabilities, Graph 1 shows a huge distance in the R&D effort (R&D as share of the GDP) of the two groups of middle-income economies in comparison to the high-income group. The average for this latter was 2.31% at the end of the 1990s, and it has achieved almost 2.40% in 2005; then, the most advanced countries in average have rather not modified their R&D effort. On the other hand, average R&D effort of the lower-middle subgroup reaches 1.00% in 2005, while upper-middle income countries show values under lower-middle income economies in the two years considered. This latter group has indeed shown the highest cumulative rate of growth between 1998 and 2005 (near 6%) reducing the distance in relation to the most developed countries in terms of R&D effort.

Graph 1 here

Graph 2 shows high-technology exports as percentage of total manufacturing exports and we can see that differences between the MIC and the high-income group are rather short. Particularly, in the more developed countries, the average value of the indicator is over 21%, being exceeded by the lower-middle income group in 2005. Besides, only

this set of middle-income economies has shown a positive rate of growth in the period (around 4%). Nonetheless, the upper-middle economies have kept the average value above 15% in these years. 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 movement has apparently gone in favor of those countries with the lowest income level.

Graph 2 here

Therefore, there are grounded reasons to explore the factors affecting the results of the MIC in high-tech exports. In that direction, some specific contributions based on firm level data confirmed for some countries, such as Thailand and Malaysia, the existence of a close connection between exports and technology (Rasiah, 2003). Then, it is suitable to explore the existing connections between technological indicators and the revealed results in trade of technology intensive manufactures.

Looking at the factors conditioning the adaptation and creation of technology in the MIC, a smooth relationship between the R&D intensity and the exports of high-technology products in foreign markets in 2005 exist (Graph 3). This would address us to underline the role of the national efforts in developing countries to develop their absorptive capabilities and how these could be dynamically translated into competitiveness gains in high-tech markets. Nonetheless, there are notable differences across countries; it is clearer for some of the so-called emerging economies, being noticeable that China adopts one of the best positions. There are also other large economies doing especially well in terms of R&D such as some of the BRIC group (Brazil and Russian Federation) as well as some European transition economies such as Croatia, Ukraine and Lithuania. In this set of countries that are positioned on the right

hand side of the Graph, we found also some of the most competitive economies such as Tunisia and South Africa although they are not so intense in high-tech exports.

Graph 3 here

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 Costa Rica and Thailand and even Mexico. In a slightly better position we find Malaysia that presents a higher ability to export high-tech manufactures but its effort in R&D is only above the median of the group. Nevertheless, some of the more competitive MIC, such as India and Chile, seem to be still in a take-off phase regarding these two indicators. In the bottom-left corner of the Graph 3, we can observe an important number of MIC characterized by a low proportion of high-tech exports and low absorptive capabilities, such as Paraguay and Algeria.

This simple description allows us to relate the absorptive capacities of the MIC with their high-tech performance in foreign markets. Accordingly, it would be plausible to think in two different dynamics: the process of building absorptive capabilities and the process of becoming competitive. From the combination of both, different factors can intervene in their evolution and in the potential definition of strategies, becoming helpful for the analysis of competitiveness and for providing some insights about the next steps to follow by countries to be more competitive.

4.2. The econometric model

The relevance of the technological factors in the competitiveness position of countries in the international scene -shown in previous sections- supports our interest in analyzing the competitiveness gains of countries in high-tech markets as a function of a set of

factors related to those aspects that could contribute to define a country's competitive profile. For this purpose, we specify an econometric model where the dependent variable is the high technology exports as a percentage of the total manufacturing exports. We regress this variable against the set of internal and external factors that were defined in section 3. This relationship can be defined as follows:

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

where HT_{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}^{δ} represents a set of other factors; ηi represents individual time-invariant effects (capturing the unobserved heterogeneity among countries); and γt represents time-variant effects.

Taking natural logarithms from equation (1), it can be rewritten as follows:

$$ht_{it} = \alpha if_{it} + \beta ef_{it} + \delta x_{it} + \eta_i + \gamma_t + \varepsilon_{it} \qquad (2)$$

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

We include as external factors the inward and outward FDI stock in order to capture the relevance of the impact of foreign firms on the competitiveness gains of host countries in the global high-tech markets. Besides, these two variables can be considered as proxies of the commitment and integration of countries in the international scene. As internal factors we take the level of technological skills measured through the absorptive capabilities (R&D intensity) and the creation of technology (patents applications). We also include the openness degree to foreign markets and the acquisition of technology (royalty and license payments) as control variables due to the relevance of trade flows

and the potential technology transfer from the international context. Table 1 shows a summary and description of the variables included in the analysis[2].

Table 1 here

The different evolution followed by the groups of countries in terms of high-tech exports and also in terms of technological indicators shown in section 4.1, justifies to taking into account the income level in order to explore whether the factors explaining competitiveness differ according to the countries' level of development. Then, the model previously described is estimated for the total sample -that includes high and middle income countries- and also for the subsample of both high-income and middle-income countries.

The availability of panel data makes of special relevance 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 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 differences 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). Then, equation (2) can be rewritten as follows:

$$\Delta ht_{it} = \alpha \Delta if_{it} + \beta \Delta ef_{it} + \delta \Delta x_{it} + \gamma_t + \varepsilon_{it} \qquad (3)$$

[2] Some descriptive statistics of the variables included in the analysis can be found in the Appendix (Table A1).

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 results of the estimations are shown in Table 2. Accordingly to the results for the total sample (column 1), the countries' competitiveness improvements are mainly affected by the national R&D effort and by their degree of openness to international trade. Nonetheless, as we postulate in the conceptual approach, other factors intervene positively in the dynamics of high tech exports: these are the acquisition and creation of technology and the internationalization level of countries from both the inward and the outward perspectives. The positive and significant coefficients of these variables would confirm our proposition.

Table 2 here

However, results differ when taking into account the income level of countries. As we can see in column 2 of Table 2, the competitive dynamic of high-income economies shows a different picture. Beyond their commercial openness, the fact that they have became FDI emitters, via outward investments, has a positive and important effect in their competitiveness' results while the stock of inward FDI loses its significance in this

group of economies. Moreover, the acquisition of technology abroad is still significant but neither the patents nor the R&D enhance their market shares in the more dynamic markets. These results would come to be justified by the argument of previous findings regarding the positive effects of reverse knowledge flows in the competitiveness of home countries. The negative relationship between the high-tech exports and the absorptive capabilities in the period analyzed could reflect the evolution of the variables showed in section 4.1 for this group of countries. Particularly, we observed in these countries a small raise in R&D during the period and a reduction of high-tech exports. Moreover, this result could be also revealing the more positive recent evolution of the MIC in their technological indicators and even their more notable improvement as exporters of high-tech regarding the most developed economies.

Looking now at the results for the middle-income countries, it is noticeable the significant largest coefficient corresponding to the national R&D efforts and there is also a positive impact of the inward FDI stock in these economies (column 3). The creation of technology and also the technology acquisition worldwide are significant factors in the explanation of their positive competitive evolution since both patents and payments for licenses and royalties show a positive sign. However, their openness level and their foreign investment capabilities do not seem to be a relevant aspect.

Therefore, from this empirical analysis of the MIC competitiveness evolution of in technology-intensive industries, we find empirical support that highlights the relationship between technology and FDI that integrated our analytical construct (Figure 1). Even though it may hold in general terms, it is important to underline the emergence of important differences by groups of countries. Regarding the MIC, the presence of

foreign companies together with both the efforts to adapt foreign technologies and to create own techniques are suitable combinations to contribute to the generation of external effects from FDI in host productive systems. By contrast, these countries do not yet accomplish a competitive dynamic that would be based on their integration in the international context via FDI. This would be coincident with the argument in favor of the regionalization of the world economy instead of a truly broad globalization, considering the modest role that developing countries are still playing in the activities of the MNC worldwide (Rugman and Doh, 2008). Moreover, our findings would confirm that although this group of countries has began to manifest an active competitive behavior, its building process of absorptive capabilities is more important than their role as technology creators worldwide (Athreye and Cantwell, 2007).

On the other hand, the results for the MIC 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 (Lundvall et al., 2002; Cantwell and Molero, 2003; Álvarez and Marin, 2008; Álvarez et al, 2009). In this direction, actions and strategies at country level could consider the potential effect of inward FDI in terms of spillovers as well as the consolidation of more advanced systems that could take-off as investors abroad. Besides, the positive impact of the inward FDI on the participation of the MIC in the international high-tech markets could reveal the positive role of foreign firms in the upgrading of their technological capabilities. What is more, since the openness level of MIC does not seem to affect their high-tech export capacity, it could be inferred that foreign firms are not only looking at the MIC as mere export platforms. Likewise, the interplay between foreign firms and national technological

capabilities would gain some ground in the improvement of their competitive dynamic behavior. This would derive into a direct implication that could accentuate those actions that would enhance technology creation.

6. Conclusions

There is a set of developing economies integrating the middle-income group that are revealing important opportunities in terms of competitiveness results, ranked in many aspects even better that some of the economies included in the richest and developed club of countries. Nonetheless, there seem to be still some elements of exclusion inside the own MIC group and there is not a clear behavior pattern that could indisputable characterize their position in the more dynamic international markets. Our proposition here has been based on the interplay between national technology capabilities and the impact of the international integration that FDI may generate. The objective has been to adopt this approach to explore the diversity of the MIC in these fields in order to provide some new fresh empirical evidence about the factors explaining their competitive results and the actions than can be derived from.

Our analysis reveals the existence of a close relationship that emerges from those economies that show a good competitive performance and the relative importance that foreign firms achieved in their national systems of innovation. More substantial is the idea that would emerge clearly from the comparative analysis of the MIC and their absorptive capabilities and how the latter become a crucial element for the processes of technology creation and adaptation. With a new conceptual approach we confirm this statement that finds broad support in a large number of contributions in different branches of the literature on innovation, spillover and multinational companies. Our

findings confirm that in the middle-income economies, the stock of inward FDI is an important external factor that combines with both their ability to adapt technology (more typical of less developed countries) as well as with their effort to create it, revealing in any case the importance of their absorptive capabilities. However, the other way round regarding the integration of these countries abroad via FDI has not yet been confirmed, this becoming the most important element of differentiation with regard to the competitive behavior of the most developed economies; this is a process that seems to be at the beginning stage and only in some selected MIC countries.

Finally, among the limitations of this analysis we would say that our results do not allow us to ascertain an active behavior of the MIC economies in terms of outward FDI neither that reverse knowledge effects are easily detected and translated in their competitiveness results, aspect that seems to be more clear for the most developed economies. The multiple specialization patterns of the MIC and how that industrial diversity could derive into different competitive profiles in a given country is another aspect 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 industrial level and even for intra-firm trade could provide a more complete picture in further research.

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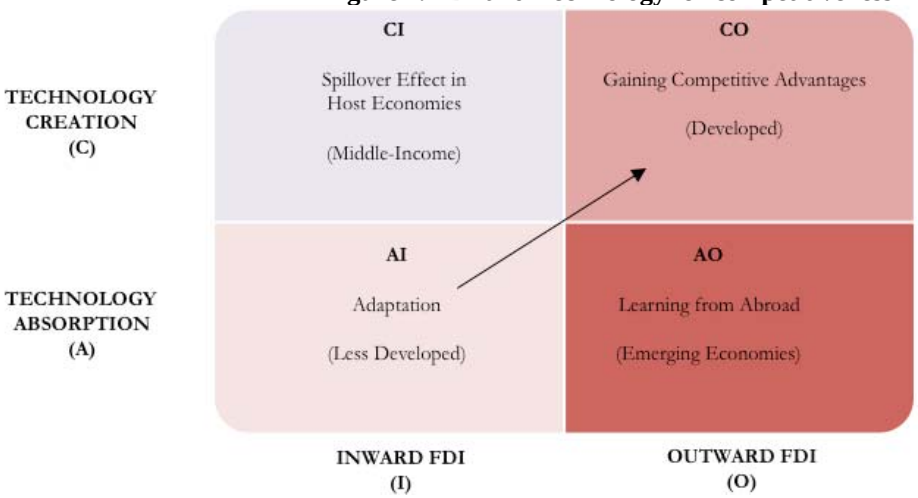
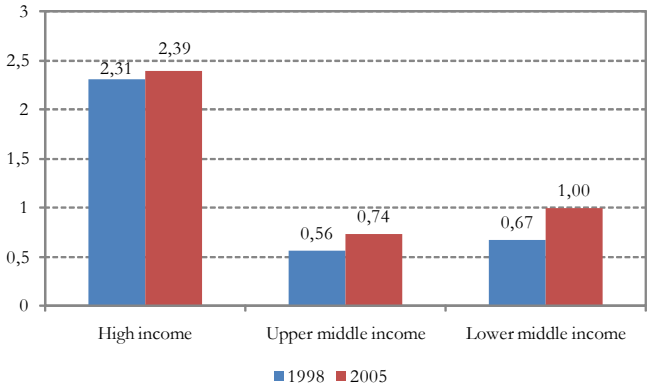
Figure 1. FDI and Technology for competitiveness



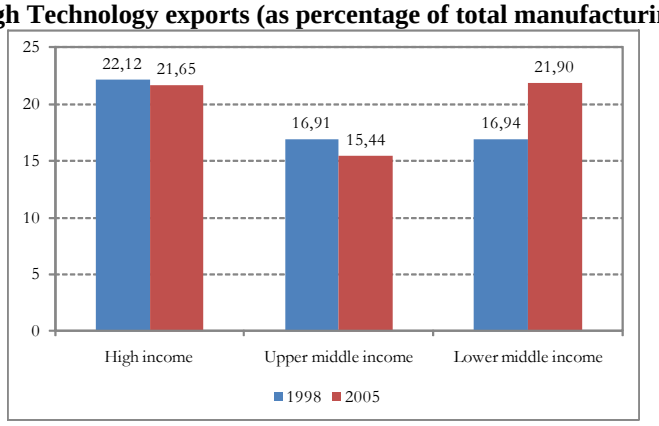
Source: Own elaboration

Graph 1. R&D expenditures (as percentage of the GDP)



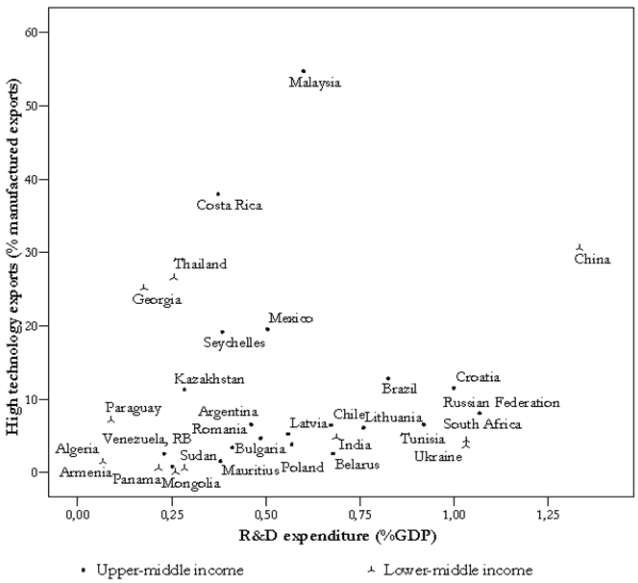
Note: In the upper-middle income group, R&D expenditure in 1998 refers to 1999
Source: Own elaboration, World Development Indicators (World Bank)

Graph 2 High Technology exports (as percentage of total manufacturing exports)



Source: Own elaboration, World Development Indicators (World Bank)

Graph 3. High technology exports and R&D expenditure, 2005



Note: R&D data for Chile, Costa Rica, Malaysia and Thailand refers to 2004

Table 1. Summary of variables

Dependent variable	
ht_{it}	Logarithm of high technology exports (as the percentage of the total manufacturing exports), country *i* year *t*
Independent variables	
$FDInwS_{it}$	Logarithms of FDI inward stock (million current US$), country *i* year *t*
$FDIOutwS_{it}$	Logarithms of FDI outward stock (million current US$), country *i* year *t*
Op_{it}	Logarithm of exports and imports of goods and services (as the percentage of GDP), country *i* year *t*
$RoyP_{it}$	Logarithm of royalty and license fees, payments (current US$ by thousands of inhabitants), country *i* year *t*
RD_{it}	Logarithm of research and development expenditures (as the percentage of GDP), country *i* year *t*
Pat_{it}	Logarithm of total patents applications (by thousands of inhabitants), country *i* year *t*

Table 2. Estimations results

	Total sample	High income countries	Middle income countries
Inward stock	,0607	-,0598	,3803
	(,0112)***	(,0403)	(,0501)***
Outward stock	,0629	,1323	-,0151
	(,0094)***	(,0357)***	(,0291)
Openness	,2151	,3102	,3264
	(,0346)***	(,1567)**	(,3892)
Royalties payments	,0322	,0617	,0355
	(,0032)***	(,0169)***	(,0136)***
R&D	,2982	-,5534	,5537
	(,0126)***	(,1277)***	(,0771)***
Patents	,1765	-,0320	,1619
	(,0076)***	(,0294)	(,0267)***
Constant	-,0302	-,0221	-,0442
	(,0021)***	(,0054)***	(,0087)***
Number obs.	378	201	187
Number of groups	57	29	28
Sargan test (Chi^2)	41,72	18,71	15,76
AR(1)	-1,80**	-1,65*	-2,05**
AR(2)	-1,20	-1,09	-0,94

Robust standard errors in parenthesis
*Significant at 10%; **Significant at 5%; Significant at 1%

APPENDIX

Table A1. Descriptive statistics. Variables included in the model

	High income		Upper middle income		Lower middle income	
	Mean	Std. Dev/Mean	Mean	Std. Dev/Mean	Mean	Std. Dev/Mean
High-technology exports (% of manufactured exports)	17,62097	0,5432	9,4970	1,4278	7,7648	1,7649
FDI inward (Stock, %GDP)	37,02765	0,9200	36,8887	0,8688	34,3973	0,9869
FDI outward (Stock, % of GDP)	28,89107	0,9495	10,0356	2,0404	1,5743	1,8029
Trade (% of GDP)	93,41928	0,5720	91,2971	0,4652	89,2526	0,4413
Royalty and license fees, payments pc (current US$/1000 hab)	201.175,71	3,1201	7.816,43	1,0225	4.985,84	2,2715
Research and development expenditure (% of GDP)	1,81561	0,4742	0,5411	0,4634	2,1482	3,4786
Total patents per capita	0,00073	1,1505	0,0001	0,9131	0,0000	1,3894

Table A2. Correlations between high tech exports (as the percentage of total manufacturing exports) and the variables included in the model

	Total sample	High income countries	Middle income countries
Inward stock	0,0405	0,0974	0,2002***
Outward stock	0,2847***	0,4631***	0,2852*
Openness	0,0286	0,1193*	0,1678
Royalties payments	0,4330***	0,5174**	0,2413**
R&D	0,4390***	0,4929*	0,1436
Patents	0,5457***	0,3328***	0,3101***

*Significant at 10%; **Significant at 5%; Significant at 1%