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Horizontal and Vertical FDI: a comparative analysis of technological determinants

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Abstract

The study analyzes the role played by technological determinants, using the approach of National System of Innovation (NSI), in enhancing or hampering Foreign Direct Investments (FDI) with different motivations, namely horizontal and vertical FDI. The empirical analysis is carried out using data relative to the final destination of sales of US foreign subsidiaries in 42 host countries grouped according to income criteria. A three step empirical strategy is employed: first, we estimate a benchmark model finding that technological determinants exert a greater influence in high income countries especially for vertical FDI. Secondly, applying a dynamic panel data approach we take into account that agglomeration economies may play a role as well as other FDI determinants. Finally, we are able to further disentangle the destination of sales according to whether they are directed towards other foreign affiliates or to unaffiliated persons recognizing that they are affected by different determinants.

Keywords: Horizontal FDI; Vertical FDI; FDI determinants; National System of Innovation

JEL Classification: F20; F23; O30

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1 Introduction

Multinational Enterprises (MNEs) represent one of the most relevant source of foreign knowledge for both developed and developing countries. This fact has induced policymakers to favour Foreign Direct Investments (FDI) inflows because of the supposed beneficial impacts they are going to bring into the host country such as, for example, growth enhancing effects (e.g Barba Navaretti and Venables, 2004). However, the analysis of the motivation for which MNEs decide to invest in a specific host country through FDI is usually disregarded. In particular, scarce attention has been paid to the different types of MNEs that each country is going to attract and, with a few exceptions, (e.g. Beugelsdijk et al., 2008), no empirical investigations have been carried out with respect to the impacts that different FDI motivations may have on host countries. The general approach followed by empirical literature on FDI determinants is that of simply examining the relationship between FDI at an aggregate level (namely the percentage of FDI inflows on GDP) and some country level variables that are most of all related to institutions or to the macroeconomic environment. Some other drawbacks of the literature can be identified: in the first place, it has been investigated the role played by technological capabilities of countries only with respect to R&D intensive FDI, leaving aside to link this concept with theoretical studies on FDI motivations. In the second place,case studies focusing upon single or group of countries have been carried out but mainly diving them according to regional criteria. For example, Asiedu (2002) and Naude and Krugell(2007) focus on African countries; in the same way, Bevan and Estrin (2004) put emphasis on the analysis of FDI determinants in transition countries, while Du et al. (2008) analyze the Chinese case.

The contributions of the paper to the literature are manifold. Firstly, as no studies have been carried out linking the literature of FDI motivations with technological determinants, we try to fill this gap by making use, from an empirical point of view of the concept of National System of Innovation (NSI).Up to now, this concept has been mainly used in theoretical analysis to explain in which way a country is able to generate, exploit and diffuse innovations (Freeman, 1987; Lundvall, 1992), being employed mainly from a descriptive point of view and avoiding quantification. In particular, we consider that some NSI functions may result more relevant with respect to the attraction of FDI with different motivations. Secondly, like Driffield and Love (2007), rather than adopting an ex-post FDI classification we use an ex-ante categorization that allow us to generate research hypotheses. Indeed, through data on US MNEs subsidiaries over the period 1989-2001 we are able to disentangle vertical from horizontal FDI as we have informations on the final destination of sales in 42 host countries. We further employ a FDI disaggregated measure dividing sales to other foreign affiliate from sales to unaffiliated persons. Thirdly, we adopt a comparative approach grouping countries according to income levels rather than following regional criteria.

The paper is organized as follows: in the second section we discuss a framework in which we explain the two different approaches used in the classification of horizontal and vertical FDI motivations; in the third section we briefly review literature dealing with FDI location factors explaining why the NSI approach could result relevant in our study. In the fourth section, we present the data and empirical approach while the fifth section is devoted to illustrate some research hypotheses to be tested in the empirical application. Section 6 comments on results obtained from estimations while section 7 concludes evidencing limitations of the study.

2 A framework to account for FDI motivations

The topic of FDI motivations has been discussed mainly from two theoretical perspectives: the first refers to international trade literature (IT) while the second is grounded in the international business literature (IB). With respect to the first, the early theoretical models dealing with horizontal (HFDI) and vertical FDI (VFDI) are respectively by Markusen (1984) and Helpman (1984). In particular, the aim of HFDI is that of serving the local market by duplicating in foreign plants the same good produced at home. Accordingly, HFDI are predicted essentially by market size and high trade costs because firms try to avoid trade barriers by building a new plant in the host country. Instead, the aim of VFDI is that of taking advantage of lower costs of production of destinations countries by relocating part of the value chain abroad. For this reason, high trade costs hamper rather than favouring flows of this type of FDI.[1]

The approach followed by IB literature is grounded in the OLI paradigm (Dunning, 1977) according to which FDI are attracted to those countries where they are able to combine their own firm specific advantages, the so called Ownership advantages (O) with the Location specific advantages (L) and where they are able to exploit them through Internalization means (I). By using this framework, Dunning (1993) proposes a taxonomy in which he singles out four categories that represent different motivations according to which a MNE chooses a specific foreign country to carry out its investment. The first three categories are relative to market seeking, resource seeking and efficiency seeking FDI. They are all part of the asset exploiting FDI category because they exploit in the host country the ownership advantages that MNEs already own at home. In particular, in the first case the main aim is that of exploiting the local market demand, while resource seeking FDI involve the relocation of parts of the production chain to the host country. This type of FDI is often driven by the lower cost of labour in the manufacturing sector as well as the availability of natural resources such as oil and gas. It is evident that these two motivations partially overlap with those considered by the IT literature. However, according to Dunning (1993), FDI motivations can be driven also by the desire to gain efficiency from the common governance of geographically dispersed activities when economies of scale and scope are present. Bevan and Estrin (2004) find proof for such kind of FDI in the first wave of EU accession countries as the prospects of EU membership have favoured the establishment of regional corporate networks. The last category singled out by Dunning is relative to the asset seeking motivations. Contrary to asset exploiting motivations,the aim is that of acquiring specific technological competence or qualified human capital not available at home. This motive has gained attention in recent years due to the development of a new strand of literature around this topic. It starts from the consideration that MNEs should not be analyzed just from a "vertical" point of view: it means that not only the headquarters transfer technologies to their affiliates, but they are themselves involved in an asset seeking process through the connection with other affiliates or through higher involvement inside the production structure of the host country (Zanfei, 2000). This hypothesis gave origin to two strands of literature: the first is related to the phenomenon of R&D delocalization while the second is relative to the so called MNEs "without advantages" (e.g.Fosfuri and Motta,1999). From a theoretical point of view, the latter underlines how even a laggard firm may engage in FDI by choosing the location on the basis of the possibility of reaping technology spillover due to the proximity to local firms.[2] The former examines the factors that should induce MNEs to delocalize R&D expenditures. These factors may be grouped under

three headings: according to Kumar (2001) who analyzes the location of US and Japanese MNEs abroad, a first motivation is the adaptation of the technological base present in the home country to the needs of local customers. The second factor that favours R&D delocalization is that of taking advantage of the skilled labour force available at a lower cost with respect to the home country. It means that due to the abundance of trained R&D personnel, MNEs may invest in a specific host country in order to reduce their costs. The last motivation is that of taking advantage of possible positive externalities that may be found in specific locations of the host country, such as in the case of agglomeration externalities (Kumar, 2001; Hedge and Hicks, 2008).

A couple of issues deserves some comments: in the first place, unlike the case of FDI motivations, R&D delocalization literature has already been linked to country determinants while it is not case for other aspect of MNEs activities inside the host country. Secondly, we recognize that VFDI can be carried out in developed countries with the aim of exploiting mainly skills rather than low labour costs and natural resources. For this reason, in the case of high income countries resource seeking FDI could be considered to represent to a greater extent asset seeking motivations rather than pure asset exploiting motivations.

3 FDI determinants and location factors

The second theoretical framework we need to discuss is the literature relative to FDI determinants. As suggested in surveys related to this argument (e.g. Blonigen, 2005) some ambiguous findings about this crucial topic of investigation are emerged. One of the main reasons lies in the fact that even though the Duninng's OLI paradigm (1977) furnishes some guidance into the search for location advantages it does not provide a definite list of possible variables to test; as a further flaw it is quite difficult to understand the relative importance of different determinants for different types of FDI. This is due to the fact the paradigm assumes all determinants to affect FDI in an aggregate way.[3]

Many heterogeneous determinants may be identified even though they can be labeled under three headings: institutional factors, market related factors and technological factors.

3.1 FDI and institutional factors

Many authors have put at the center of their analysis the role played by institutions proxing them with several variables such as the security of property rights, effectiveness of the legal system, the lack of corruption, or the easiness to create a company. As Blonigen (2005) argues the quality of institutions is likely to be relevant especially for developing countries for a series of reasons: a lack of legal protection increases the possibility of appropriations of firms assets, in this way reducing the possibility of investing abroad. The study by Wei (2000) points out that FDI are negatively correlated with corruption.[4] Jun and Singh (1996) examining 31 developing countries found that variables measuring political risks were negatively related to FDI. In the same way, Busse and Hefeker (2007) recognize that the role played by government stability, the quality of burocracy, corruption, law and order are particularly relevant in a sample of 83 developing countries. The reason is that poor quality of institutions increases the cost of doing business. However, we need to point out that even though most studies provide evidence of a positive association between

institutions and FDI, some authors also find negative or non significant results: for example, Asiedu (2002), recognizes that political and expropriation risk do not show a significant impact on FDI in Africa.

Inside the broad category of institutions, a specific role is also given to agglomeration economies.Recently, several studies have acknowledged that the presence of foreign investors may act as a catalyst to attract further investors (Dunning, 1998). Several reasons could cause such agglomeration effect: firstly, foreign firms are quite unfamiliar with the host specific context and the presence of other foreign firms may represent a signal of a locational advantage and of high profitability. In addition, new investors may try to benefit from positive externalities, such as knowledge spillovers, specialized labour and intermediate inputs, resulting from locating their activities next to other firms. This aspect has been empirically investigated by Wheeler and Mody (1992) who analyze US investors' location decisions finding a positive relationship with them. In the same way, Head and Ries (2001), point out that industry-level agglomeration economies explain much of the location choices of Japanese manufacturing FDI in the United States.

3.2 Market related factors

In the second place, FDI inflows are driven by market related variables, usually measured by GDP per capita or GDP growth. As theory predicts, a rise in the market dimension should be associated with a rise in FDI inflows. The studies by Brainard (1997) and Markusen and Maskus (2002) confirm this hypothesis. The market effect captures potential economies of scale in production and the fact that larger market dimensions can lead to the recovery of the MNEs investments costs rising FDI inflows. Another variable deemed particularly important for VFDI is the wage differential: it is usually considered to positively influence FDI inflows. However, ambiguous findings are present even for this variable: for example, Hatzius (2000), examining British and German FDI to and from OECD countries, finds that higher unit labour costs may favour intra European FDI. Finally, other market related variables used in the empirical applications about FDI determinants are those that measure the macroeconomic conditions of the country such as the inflation rate and trade effects. The former is usually taken as a measure of macroeconomic instability and it is considered to influence negatively the level of FDI. In the latter case, many strands of literature are emerged on this issue: they are related to the exchange rate policy or the trade liberalization issues. In both cases the effect singled out is not always clear, even though the study by Blomstrm and Kokko (1997) considered that the liberalization variable had different effects according to the motivations for which a firm invests abroad. In particular, if the underlying motivation is the exploitation of the market of the host country the effect in relationship with FDI is negative as far as they are tariff jumping (market seeking FDI)[5]; instead if the motivation is related to resource seeking hypothesis the effect of greater trade liberalization may be positive.[6]

3.3 Technological factors-NSI approach

Even though technological variables are scarcely employed in empirical applications, globalization forces have led to a reconfiguration of the way MNEs pursue their market seeking or resource seeking objectives. Despite the fact that a large domestic market remains a powerful magnet for investors, MNEs are searching for new attributes, such as those related to technological capabilities meaning that a lower value is attached to

costs. For example, as Noorbakhsh et al. (2001) argue, the importance of human capital has become greater. It happens because the need for local skills is growing together with complementary factors of production or business related services such as, for example, the access to local finance. This means that attracting MNEs mobile asset requires host countries to improve the availability of local skills and of those factors that may influence the efficiency and strength of the local firms on which MNEs would like to draw as suppliers and potential customers. Even though the institutional set-up is one of the most studied FDI determinants, the gap in this type of literature is a lack of consideration of other institutions and organizations that may be able to strengthen the innovative capacity at the firm and at the country level. The only exception is made in the analysis of the Intellectual Property Right (IPRs) regime. The strength of IPRs affects not only the location choices of MNEs but also the quality of technological knowledge they decide to transfer. The literature relative to this topic is quite mixed but an important result can be put forward: as Lall (2003) points out, the importance of IPRs for a country in the attraction of FDI is linked to their level of development because as confirmed by Javorcik (2004), the IPRs regime influences the composition of FDI. Up to now, technological determinants have been used to study the attractiveness of FDI activities based on R&D, neglecting the issue of FDI with different motivations. In this paper we will refer to the concept of National System of Innovation (NSI) to single out what is the role of technological determinants in attracting FDI. Let us briefly sketch what we mean by NSI: first of all, NSI concept is a variant of a much larger family of systems of innovation approaches that includes other specifications like, for example, the Sectorial Innovation System (Breschi and Malerba, 1997) and the Technological System (Carlsson, 1995). However, in this paper, the focus is explicitly on NSI because the aim is that of understanding the role played by country specific actors that may be crucial for the building of innovative capacities at the national level. It should be underlined that a lot of different definitions of NSI have been proposed (e.g. Freeman 1987, Lundvall 1992). Although it is not possible to find out a unique general accepted definition, they have in common some features: firstly, these definitions are mainly used to define NSI in a developed context. As a matter of fact, the attention paid to institutions and organizations related more specifically to the R&D system is high. Secondly, on the basis of the evolutionary and institutional foundations, NSI literature adopts a systemic approach towards innovative activities. In particular, the innovation process is not based on a sequential order of steps, but, rather, it is carried out by feedbacks and interactions among several actors. In this way, the research process which results in innovation is characterized by collaborative innovative efforts brought about by the science and the business sector.Finally, they are identified some basic aims (functions) of the NSI that are those relative to production, use and diffusion of innovations and new technologies. According to this theoretical framework, three points are worth noting: in the first place, the role played by the institution endowment of a country is of extreme importance in the NSI approach. Following Edquist (2004), firms do no innovate alone but, rather, they are part of a complex environment where institutions and organizations shape and guide their innovative efforts. In the second place, the process of technological change is not considered as exogenous to the system but of endogenous nature. As a matter of fact, the focus of the analysis is on dynamic instead of steady states. Finally, the analysis reserves particular attention to the development of the historic process because, as Balzat (2002) argues, historically grown structures of a system determine the current economic performance.

4 Dataset and empirical methodology

To test the relevance of technological determinants with respect to FDI motivations we merged data from different sources: the first type of variables are from the Bureau of Economic Analysis (BEA) that provides data relative to sales of US MNEs' subsidiaries in 42 host countries[7], over the period 1989-2001. The division, presented in Table 1, is done according to income criteria following the World Bank classification (2008). The first, second and third group, correspond respectively to lower-middle income countries, upper-middle income countries and high income/OECD countries. We need to point out from the beginning that in this study we consider both developed and developing countries. For this reason, there are various constraints due to the availability of data and the statistical sources that may be used in this respect, because it may happen that some data are not satisfactory with regard to developing countries. To capture the different FDI motivations (dependent variables) we use two proxies:

- the first is horizontal or market seeking FDI ($mseek_{jt}$) measured as a share of local sales over total sales;
- the second is resource seeking or vertical FDI ($rseek_{jt}$)[8], measured as the share of sales back to US over total sales.

where j represents host country and t year.
As far as independent variables are concerned, we divide them in two groups:

- First we add to the model some usual gravity variables such as: population (Pop_{jt})to take into account the size of the country, GDP per capita growth ($GDPgrowth_{jt}$) that accounts for the market development potential and the inflation rate ($Inflation_{jt}$) that stands for the macroeconomic instability of the country. As we are dealing with FDI flows, we add a variable calculated as the ratio of imports and exports of goods and services over GDP ($Open_{jt}$), that measures the openness of the country. In the end we also added the distance from US to the host country ($Dist$) and a dummy variable that accounts for the language commonality ($Comlang$). The first four variables are taken from World Development Indicators (WDI) of the World Bank while the last two are taken from the CEPII database (www.cepii.fr).
- The second group of variables we are interested in, are those that account for technological determinants. The way through which we account for technological variables draws from the NSI framework adopting the view carried out by Lundvall (2007). According to him, one of the most promising way of dealing with NSI quantification is that of clarifying what are the functions that should characterize the NSI framework[9].All components of this framework need to bring their contribution to achieve the final goal at the system level. In order to do this, each component has a specific function to pursue. According to many authors (e.g. Edquist 2004), the term function is mainly related to a specific task that one (or more than one) component of the system needs to fulfill. The specific functions that are singled out and that are part of the framework through which the impact of NSI on different FDI motivations are measured are essentially six:

– Firstly it is considered the role played by IPR (IPR_{jt}): the function of this variable is that of providing the suitable innovation policy: this role is usually played by the implementation of a proper IPR regime. It should favour the propensity to innovate on the part of local firms as well as the attraction of potential sources of knowledge coming from abroad. This aspect is particularly relevant with regard to FDI, because the IPR regime may influence the quality of technology transferred from the headquarters to subsidiaries, and, as a consequence, the possibility of local firms to grasp some possible spillover effect. The way we measure this variable is through the Ginarte and Park index (1997)[10].

– The second crucial function is the learning function: it means that a country should be able to provide the necessary resources needed to create new knowledge. In this regard, the role played by education is crucial: however, due to the fact that many developing countries are present in the dataset it is used the number of the scientific and technical journal articles (Pub_{jt}), instead of the usual indicator of enrollment in tertiary education. Moreover, this variable represents an indicator of output of research activities and it is a way to take into account the role and effectiveness of the academic institutions.

– The ability of a country to produce new knowledge is at the heart of the NSI framework. This aspect is particularly relevant in developed countries while in the case of developing countries most of the technological effort is not formal. For this reason, as a measure of the overall R&D effort, it is used the number of patent application ($Ptapp_{jt}$) by resident, instead of R&D intensity in the host country, as time series for this indicators are not available especially in the case of developing countries.

– Each country needs specific resources to finance its innovative effort: to take into account this determinant, it is used the percentage of domestic credit provided by the banking sector ($Credit_{jt}$).

– A specific function is deserved to technological infrastructure: the creation of a suitable high-tech infrastructure allowing firms to be involved both in simple and more complex innovation activities is relevant both for developed and developing countries. The proxy used to measure the role played by the high-tech infrastructure is the number of Internet user by 100 people ($Internet_{jt}$). We use this indicator instead of telephone main lines, because the aim is that of measuring especially the role played by high-tech infrastructure as well as the computer literacy of the population. All these data are taken from the WDI as they are available in time series from 1989 to 2001.

  Some last comments are needed: the first is that due to missing values our dataset is an unbalanced panel and secondly, all nominal values are deflated using GDP deflators (base year=2000).In the end, some of the dependent variables are expressed in log form: in this way we are able to interpret coefficients in term of elasticities and minimize possible outliers. The exceptions are given by variables that are qualitative or expressed in percentage: IPR index, internet users (per 100 people), percentage of domestic credit provided by the banking sector, percentage of inflation, GDP per capita growth.

4.1 Empirical approach

The purpose of the empirical strategy is threefold and it is reflected in the three step strategy adopted: firstly we simply test what are the most important NSI functions to account for horizontal and vertical FDI. In the second place, we test whether the role played by agglomeration economies may result relevant to account for FDI determinants. Finally, we disaggregate further the final destination of sales disentangling those made to other foreign affiliates and those to unaffiliated persons.

- From an econometric point of view, in the first step, we estimate a benchmark model through the use of a random effect model. We choose to employ this technique as pooled OLS technique may omit unobserved country specific effects leading to a likely problem of aggregation bias which would made inferences wrong. Instead, using fixed or random effects is appropriate as the intercept may vary over the sample of countries; however, due to the presence of time invariant factors we can only use random effects. The specification of the benchmark model is as follows:

  $$FDI_{jt} = \alpha_i + \beta_1 Dist + \beta_2 Comlang + \beta_3 GDPgrowth_{jt} + \beta_4 Inflation_{jt} + \beta_5 Pop_{jt} + \beta_6 Open_{jt} + \beta_7 Pub_{jt} + \beta_8 IPR_{jt} + \beta_9 Ptapp_{jt} + \beta_{10} Internet_{jt} + \beta_{11} Credit_{jt} + \gamma_t + \epsilon_{jt}$$

  We also include time dummies,γ_t,to account for possible business cycle effects.

  When dealing with FDI data one of the possible problems encountered is the endogeneity derived from a reverse causality problem: for example, with regard to technological variables it may happen that FDI can positively influence all technological variables. [11] In the same way, some of the control variables may be endogenous as well: high GDP growth rates may signal high investment returns and, hence, it cause the attraction of further foreign investments; however, at the same time high growth rates may be increased by FDI. In the same way, higher amount of FDI may stimulate the increase in the degree of openness of the economy. To tackle this problem, in this first step of the analysis we lag one period these likely endogenous variables.

- In the second step of the analysis, to test the effect of agglomeration economies, we include lagged FDI in the specification of the model turning it into a dynamic panel-data model.
  Indeed, as Driffield (2002) points outs, as FDI may be persistent in time, we expect that current levels of FDI in a country can be highly correlated to previous FDI levels.
  In this case, by using random or fixed effect models we may produce inconsistent estimations because of the likely correlation of error terms with the lagged dependent variable. To solve this problem we follow the approach by Blundell and Bond (1998),who use the system GMM technique. They acknowledge that, in difference-GMM technique proposed by Arellano and Bond (1991), lagged levels are often poor instruments for first-differenced variables. [12] We use as instruments for the suspected endogenous variables, the second lag of those variables: in particular, earlier instruments dated t-2 for the equations in first differences and instruments dated t-1 for the equations in level.[13] As we are able to control for endogeneity not only of the lagged dependent variable but also of the all suspected independent variables we do not lag them like in the estimations carried out using random effects.

- In the third step of the analysis we propose to further disentangle the dependent variable: in partic-

ular, as far as HFDI are concerned, we differentiate between sales destined to other foreign affiliates ("internal sales") and sales destination towards unaffiliated parties ("external sales"). In the case of vertical FDI we are able to differentiate between sales towards US parents ("internal sales") and sales towards unaffiliated parties ("external sales"). Again, in this case, to account for possible endogeneity we lag one period the suspected variables.

5 Research Hypotheses

According to the theoretical framework outlined above we can single out some research hypotheses that will guide our empirical analysis: as it is divided in three steps, we accordingly divide our research hypotheses into three points. We also link our theoretical hypotheses with the expected signs of coefficient according to the level of income of countries as this may be a relevant factor in influencing the way the same determinants behave in countries characterized by different economic structure.

- The role played by market and institutional factors is greater for HFDI rather than for VFDI. In particular, we expect that distances and common language as well as GDP per capita growth and population positively affect HFDI, while inflation rate and openness should negatively influence them. Our expectations about the importance of these determinants with regard to the level of income of host countries is that they may result in a positive effect for low and middle income countries. Instead, with respect to VFDI, market determinants could result more relevant the higher is the income of countries because they are progressively searching for local skills to be matched with skills possessed at home. With respect to technological determinants, i.e. those related to NSI approach, we expect they all positively affects VFDI especially in high income countries as they need to rely more on local skills than HFDI. Among them, the most important variables could be those related to R&D infrastructure or the efficiency of the education system and the IPR system; instead the role played by high-tech infrastructure or the level of demand could result less relevant because it is supposed that in high income countries the level of infrastructure or the level of demand are already at a significant level.

- The role played by agglomeration economies could be equally relevant for HFDI and VFDI. In particular, the FDI persistence could be more important for high income countries because the greater "stability" of those countries may further attract higher amount of FDI.

- The role played by technological determinants for "internal" and "external" sales is expected to be different in the case of VFDI and HFDI. With respect to VFDI we expect to find that technological determinants are more important for the case of sales directed towards US parent company ("internal sales") as they should enhance the level of the productivity of the firm itself; instead in the case of HFDI, technological determinants should be less important when sales are for other foreign affiliates ("internal sales") as internalization advantages are exploited. This stands for the fact that when selling to other foreign affiliates the aim is that of exploiting a sort of internalization effect according to which we may notice irrelevance of both market and technological determinants. Instead, when selling to unaffiliated persons, the external environments is deemed to be more relevant. We also expect that this effect could be more important for low income countries because, in that case, foreign firms will

be more willing to maintain their assets inside their own boundaries while it could be less relevant for high income countries that are endowed with greater technological capabilities or better market related factors.

6 Econometric results

In Table 2 we present the results of the estimation of the benchmark model. As in all the other regressions, in the first three columns we report the result using as dependent variable HFDI while in the last three columns VFDI; the columns are in progressive order of level of income.[14] We first notice that, as expected, for low income countries the higher is the distance with US and the sharing of a common language the higher the amount of HFDI. These results confirm those found with respect to studies (e.g. Filippaios et al., 2003) in which it is found that the cultural distance positively influences US investment decisions. However, the same variable negatively affects HFDI in middle income countries while it favours them in high income countries showing, a sort of non linear effect with respect to income. The same non linear effect, is found for the size of the country (population) that is strongly negatively correlated with HFDI in low income countries while it is positively correlated in high income countries. A non significant result, even though the sign of the coefficient is positive, is found for middle income countries. It means that bigger countries attract higher amount of HFDI only if their level of income is high: this proves the fact that HFDI are driven mainly by market related factors.

As expected we also found that openness of the country is not significant in the case of low income countries but, it is strongly and negatively correlated in the case of middle income and high income countries proving that the less the country is open to international capital flows the higher is the level of HFDI attracted. This aspect allows us to infer that market seeking FDI are not completely tariff jumping but these barriers are more relevant in the case of high income countries. On the contrary, we find that GDP per capita growth is not significant or even negatively correlated with regard to high income countries: it means that the aim of market seeking FDI is not the growth of the market but rather its size. A final remark about market and institutional variables regards inflation rate, that, as expected, is strongly and negatively correlated with HFDI despite the income level of countries.

With respect to our main variables of interest that are technological determinants, they behave in a different way according to the level of income. In the fist place, we recognize that, contrary to expectations, in the case of higher income countries they all display negative or non significant results. This result may be explained by the fact that the higher embeddness requested for market seeking FDI may also entail a higher degree of likely imitation on the side of the host country. For this reason, if the host country is endowed with higher imitating capabilities, represented by a strong NSI, it is easier for them to capture likely leakage of knowledge. Instead, a strong role is played by education and by R&D technological capabilities especially in low and middle income countries. A negative role is found out with respect to high tech infrastructure in low income countries confirming that FDI are only searching larger markets rather than technological quality. It also means that in this case, US investors are less worried about possible imitating effects.

Passing to consider resource seeking FDI, we first analyze how market related variables behave in comparison with HFDI. We recognize that they show different signs of coefficients when considering low and high income

countries. In line with general expectations, in low and middle income countries the higher is the distance and the language commonality the lower is the amount of vertical FDI. However, this is not true in high income countries: this may prove the fact that the nature of VFDI, and in particular, the aims of US investors in high income countries, are different from those specific to countries of lower income level meaning that they are more turned to asset seeking motivations. Contrary to HFDI, we find that the size of the country is significant and positive both in low and middle income countries while it is not relevant, even though it appears with a positive coefficient, in the case of high income countries. In the same way, we always find that the openness of the country is positive and significant; this is in line with expectations as VFDI are more "trade intensive" than HFDI, being carried out with the purpose of exporting them back to US for further manufacturing. In line with expectations, both inflation and GDP per capita growth are never significant in any of the subsample: the reason is that the aim of VFDI is the exploitation of local skills rather that the local market characteristics. As far as NSI variables are concerned, there is a significant distinction between low and middle income countries in which they are non significant or negatively correlated with FDI being especially true with regard to the education variables; instead, in high income economies, we notice that some technological factors are particularly relevant such as the R&D system and the high-tech infrastructure. This proves the fact that asset seeking motivations are prevalent in those countries and that FDI determinants are changing towards being more directed to exploit technological factors and NSI structure rather than just low cost factors.

In the second step of the analysis, we implement the sys-GMM estimations presented in Table 3. The p-value of the Sargan test validates the choice of the instruments and a lack of second order correlation is correctly found. We notice that in all cases the effect tested is that agglomeration economies are present both for HFDI and VFDI: this effect matters independently of the level of income. This fact confirms what found by other studies about agglomeration economies (e.g. Barrel and Pain, 1999)). However, we have to recognize that NSI determinants and other gravity variables lose significance indicating that lagged FDI variable exerts the predominant effect. Only in the case of VFDI and high income countries the role played by R&D infrastructure is positive and significant, confirming results obtained in the previous step. This strong result proves that agglomeration economies are quite crucial determinants irrespective of the level of income and that FDI persistence is one of the underlying motivations for which a country is chosen instead of another one.

The analysis is completed in the third step, whose results are displayed in Tables 4 and 5. We provide evidence of the fact that when splitting the dependent variables between sales made to other foreign affiliates (so called "internal sales") and to unaffiliated persons (so called "external sales"), different determinants are relevant in each case. Indeed, as far as HFDI are considered (Table 4), we find that, in low income countries, the inflation coefficient is positive and significant: it proves that the higher the rate of inflation the higher the sales that remain internal to the firm. However, this effect is not relevant when we consider higher levels of income. With respect to technological variables there is a quite important difference between internal and external sales. In low income countries all of them are non significant, in contrast with the case of external sales in which the function of effectiveness of education play an important role. Similar insignificant results are found in the case of high income countries while for middle income countries, we recognize that internal sales are positively correlated with R&D infrastructure and high tech infrastructure.

Furthermore, in middle income countries, we find insignificant results for all technological determinants and also for market related variables. A reverse effect is also found in the case of high-income countries in which, similarly as in the case of low income countries, significant effects are played by NSI functions. However, we have to notice a big difference with respect to low income countries, that is the negative signs of most of the NSI variables. This is a sort of robustness check of results found in the first step according to which market seeking FDI are negatively correlated with technological determinants.
Considering the case of VFDI (Table 5), as underlined in research hypotheses, we expect to find that MNEs are more worried about the external environment they will find as they need to rely on skilled people in order to export back products of good quality. Indeed, the external environment becomes more and more critical passing from low income to high income countries. In particular, in the case of high income countries we find that a different effect is evident for R&D structure and the variable that measures the education system of the country. If, in the case of low income countries we find that only the R&D structure is important to explain VFDI, we recognize that in high income countries a great relevance is given also to IPR and to the high tech infrastructure. We also find that the role played by education structure is strongly and negatively correlated with VFDI in middle income and high income countries. This stands for the fact that this type of FDI is sensitive to the conditions of the industrial environment contrary to what find with aggregated data; in particular, this role is important especially for exports back to US parents ("internal sales"). In the case of middle income and high income countries and with regard to external sales variables are most of all not significant proving the fact that when the splitting of the value chain is not for the final purposes of the MNE as a whole, the effect is that the external environment is not deemed to be crucial.

7 Conclusions

The rising openness of countries has several impacts on their possibility to gain benefits from technological knowledge that is outside their own boundaries. Different types of technologies may flow across countries through various means such as trade, FDI and licensing but not all of them are equally able to influence destination countries in the same way. In this paper we considered the specific role played by FDI, arguing that they may be characterized by different motivations, namely HFDI and VFDI. In particular the aim was that of finding out which is the relationship between FDI determinants related, specifically, to technological characteristics of the country and different FDI motivations. From a theoretical point of view, in order to define what are the main technological determinants, we make use of the concept of NSI singling out what are the main functions played inside it and trying to quantify them.
From an empirical point of view, we use a dataset that allows us to disentangle the final destination of sales of US foreign affiliates in 42 destination countries, over the period 1989-2001. The empirical analysis is carried out in three steps and, in each of them, interesting results can be singled out. In the first place, we propose a benchmark model in which we test the importance of different determinant for HFDI and VFDI. The main empirical finding is that for HFDI market determinants are more relevant than technological determinants while the reverse is true for VFDI. In particular, they become more relevant in the case of high income countries. This may be due to the fact, that MNEs when investing in a foreign country are also interested to preserve their internal technological knowledge and, for this reason, a higher level of

technological capacity of the recipient country may also be a signal for higher imitating capacities. In the second step, through the use of the GMM technique we test whether agglomeration economies matters to attract FDI: we find positive and significant results across all countries both for horizontal and vertical FDI. It means that when accounting for the persistence of FDI, this effect predominates on all the other determinants. The third step of the analysis entails the disentanglement of HFDI and VFDI according to whether sales are directed to other foreign affiliates rather than to unaffiliated parties. We find confirmation of the fact that when sales are directed to other foreign affiliate the role played by industrial environment is particularly relevant in the case of HFDI while the opposite is true for VFDI.

Some limitations of the study are worth underlining: in the first place, we decided to focus just on two FDI motivations in order to make them comparable across the two theoretical frameworks dealing with this topic (International trade models and International Business approach) but, a more comprehensive view of the FDI motivations, would entail considering also export platform FDI as well as a more precise definition and measurement of asset seeking FDI. In the second place, even though we drawn on the NSI framework we are not able to consider the interactions between the different component of the NSI; the consideration of this effect could alter the results and it proves to be an avenue for further research. Finally, we considered just FDI coming from one home country, namely US: this could result quite limiting as inside a host country FDI with different origins may be present.

Tab.1 List of countries

1	2	3
Low income	Middle Income	High Income
China	Argentina	Austria
Colombia	Brazil	Belgium
Dominican Republic	Chile	Denmark
Ecuador	Costa Rica	Finland
Guatemala	Jamaica	France
Honduras	Malaysia	Germany
India	Mexico	Greece
Indonesia	Panama	Hong Kong
Peru	Turkey	Ireland
Philippines	Venezuela	Italy
Thailand		Japan
		Korea, Republic of
		Luxembourg
		Netherlands
		Norway
		Portugal
		Singapore
		Spain
		Sweden
		Switzerland
		United Kingdom

Tab.2 Benchmark model

Independent variables	mseek	mseek	mseek	rseek	rseek	rseek
dist	-0.00003***	0.00002***	0.00003***	-0.00002**	-0.00002***	0.00001***
	(0.00001)	(0.00001)	(0.00000)	(0.00001)	(0.00000)	(0.00000)
comlang	0.16713***	0.28266***	-0.08804***	-0.00691	-0.13294***	0.04646***
	(0.05085)	(0.04840)	(0.02651)	(0.03277)	(0.03517)	(0.00622)
lnopen (-1)	0.08589	-0.12445*	-0.29639***	0.14434***	0.15256***	0.02872***
	(0.07491)	(0.06525)	(0.02457)	(0.04968)	(0.04741)	(0.00583)
lnpop	-0.10417***	-0.06457	0.05219***	0.08506***	0.13231***	-0.00139
	(0.03973)	(0.04362)	(0.02002)	(0.02719)	(0.03170)	(0.00474)
GDPgrowth(-1)	-0.00133	0.00283	-0.01069**	-0.00366	-0.00259	0.00102
	(0.00406)	(0.00435)	(0.00437)	(0.00254)	(0.00316)	(0.00105)
inflation	-0.00101***	0.00003	-0.00506	-0.00115	-0.00004	-0.00065
	(0.00024)	(0.00006)	(0.00445)	(0.00149)	(0.00004)	(0.00105)
ipr	-0.05031**	-0.04978	0.04058	0.00472	0.08033***	0.00964
	(0.02475)	(0.03063)	(0.02760)	(0.01630)	(0.02226)	(0.00648)
lnpub(-1)	0.13575***	0.12931**	-0.02163	-0.04821**	-0.12376***	-0.00889
	(0.03474)	(0.05471)	(0.02439)	(0.02300)	(0.03975)	(0.00574)
lnptapp(-1)	-0.01709	-0.02312	-0.02108**	0.01415	0.05119**	0.00382
	(0.01826)	(0.03502)	(0.01015)	(0.01217)	(0.02544)	(0.00240)
credit(-1)	0.00008	-0.00041	-0.00169***	-0.00043	-0.00001	0.00004
	(0.00103)	(0.00076)	(0.00021)	(0.00062)	(0.00055)	(0.00005)
internet(-1)	-0.04426*	0.01150	0.00166	0.00667	0.00229	0.00106***
	(0.02610)	(0.00840)	(0.00170)	(0.01612)	(0.00610)	(0.00040)
Observations	53	63	182	53	63	178
R^2	0.884	0.796	0.760	0.695	0.799	0.729

Standard errors in parentheses
***,**,* denote significance at the 1%, 5%, 10% level, respectively
A full set of time dummies is included in all regressions

Tab.3 Benchmark model: sys-GMM estimations

Independent variables	mseek	mseek	mseek	rseek	rseek	rseek
mseek(-1)	0.72132***	0.42066**	0.90499***			
	(0.12855)	(0.20668)	(0.15049)			
rseek(-1)				0.47140**	0.73775***	0.67423***
				(0.24006)	(0.17891)	(0.17686)
lnopen	-0.01369	0.03477	0.00782	-0.07392	-0.01094	0.02377
	(0.04113)	(0.10000)	(0.04657)	(0.06570)	(0.04075)	(0.02491)
lnpop	-0.04243	-0.20244	0.00703	0.11339	0.09563	-0.01771
	(0.04976)	(0.13699)	(0.02483)	(0.07242)	(0.08531)	(0.01349)
GDPgrowth	0.00271	0.00325	0.00509	-0.00199	-0.00163	0.00287
	(0.00368)	(0.00695)	(0.00460)	(0.00495)	(0.00357)	(0.00244)
inflation	-0.00001	0.00006	0.00267	0.00026	-0.00002	0.00231
	(0.00001)	(0.00005)	(0.00349)	(0.00153)	(0.00002)	(0.00167)
ipr	-0.03369**	-0.11488*	-0.01339	0.00780	0.03207	-0.01087
	(0.01482)	(0.06557)	(0.02395)	(0.02241)	(0.04053)	(0.01179)
lnpub	0.01863	0.18822	0.01521	-0.10769	-0.07452	0.00139
	(0.04644)	(0.14941)	(0.02906)	(0.06608)	(0.08233)	(0.01183)
lnptapp	0.01409	0.03049	-0.00042	0.00403	-0.01820	0.01382*
	(0.01968)	(0.04534)	(0.01706)	(0.01699)	(0.02155)	(0.00745)
credit	-0.00056	-0.00038	-0.00019	0.00122	0.00021	0.00013
	(0.00077)	(0.00092)	(0.00031)	(0.00098)	(0.00049)	(0.00021)
internet	-0.00150	-0.00080	-0.00120	-0.00177	0.00183	-0.00031
	(0.01084)	(0.00674)	(0.00108)	(0.00860)	(0.00383)	(0.00052)
Observations	49	67	191	51	67	182
Sargan p-value	0.200	0.866	0.984	0.104	0.588	0.887
AR1 p-value	0.0145	0.360	0.000	0.00245	0.0815	0.0169
AR2 p-value	0.391	0.450	0.275	0.619	0.993	0.480

Standard errors in parentheses
***,**,* denote significance at the 1%, 5%, 10% level, respectively
A full set of time dummies is included in all regressions

Tab.4 Dependent variable divided into into internal sales (i) and external sales (e): Market seeking FDI

Independent variables	mseeki	mseeki	mseeki	mseeke	mseeke	mseeke
dist	0.00003***	0.00002**	0.00002***	-0.00005***	0.00000	0.00002***
	(0.00001)	(0.00001)	(0.00000)	(0.00001)	(0.00000)	(0.00000)
comlang	0.11221	0.03296	0.06093**	0.23472***	0.13032***	-0.06101**
	(0.08095)	(0.08104)	(0.02679)	(0.04915)	(0.04145)	(0.02543)
lnopen(-1)	-0.50181***	-0.26485**	-0.12955***	0.34166***	0.01553	- 0.18947***
	(0.11986)	(0.10925)	(0.02475)	(0.07241)	(0.05588)	(0.02358)
lnpop	-0.05884	0.06457	-0.05181**	-0.02358	0.06984*	0.11982***
	(0.06245)	(0.07304)	(0.02020)	(0.03841)	(0.03736)	(0.01920)
GDPgrowth(-1)	0.01167*	0.00484	-0.00157	-0.00550	-0.00040	-0.00792**
	(0.00625)	(0.00729)	(0.00442)	(0.00392)	(0.00373)	(0.00420)
inflation	0.00108***	-0.00001	0.00489	-0.00120***	-0.00000	0.00891**
	(0.00037)	(0.00009)	(0.00449)	(0.00023)	(0.00005)	(0.00427)
ipr	-0.02415	0.01861	0.01169	-0.05677**	-0.00764	0.02888
	(0.03907)	(0.05129)	(0.02787)	(0.02393)	(0.02624)	(0.02661)
lnpub(-1)	-0.03698	0.07482	0.03851	0.09399***	0.01294	-0.04603**
	(0.05271)	(0.09160)	(0.02468)	(0.03358)	(0.04685)	(0.02351)
lnptapp(-1)	-0.03509	-0.22827***	-0.00516	0.00100	0.01694	-0.02724***
	(0.02803)	(0.05863)	(0.01024)	(0.01765)	(0.02999)	(0.00973)
credit(-1)	0.00264	0.00114	0.00010	0.00083	-0.00065	-0.00148***
	(0.00165)	(0.00127)	(0.00021)	(0.00100)	(0.00065)	(0.00020)
internet(-1)	-0.02641	0.03332**	0.00248	-0.02462	0.01070	0.00381**
	(0.04104)	(0.01406)	(0.00173)	(0.02523)	(0.00719)	(0.00165)
Observations	52	63	183	53	63	181
R^2	0.763	0.515	0.349	0.901	0.719	0.705

Standard errors in parentheses
***,**,* denote significance at the 1%, 5%, 10% level, respectively
A full set of time dummies is included in all regressions

Tab.5 Dependent variable divided into internal sales (i) and external sales (e): Resource seeking FDI

Independent variables	rseeki	rseeki	rseeki	rseeke	rseeke	rseeke
dist	-0.00002	-0.00006***	0.00002***	-0.00000*	-0.00000	0.00000***
	(0.00003)	(0.00001)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
comlang	0.11427	-0.15368**	0.04563**	0.00342	-0.02041*	0.01004***
	(0.13883)	(0.07313)	(0.01896)	(0.01507)	(0.01221)	(0.00366)
lnopen(-1)	-0.01822	0.29585***	-0.03861**	-0.02316	0.04074**	0.00934***
	(0.21128)	(0.09859)	(0.01777)	(0.02099)	(0.01647)	(0.00343)
lnpop	0.03353	0.18202***	0.01097	0.02317*	-0.00182	-0.00687**
	(0.11384)	(0.06591)	(0.01443)	(0.01231)	(0.01101)	(0.00279)
GDPgrowth(-1)	-0.00351	-0.00717	-0.00094	0.00013	-0.00067	-0.00041
	(0.01065)	(0.00658)	(0.00319)	(0.00116)	(0.00110)	(0.00062)
inflation	-0.01140*	-0.00009	-0.00895***	-0.00210***	0.00002	0.00113*
	(0.00629)	(0.00009)	(0.00320)	(0.00069)	(0.00001)	(0.00062)
ipr	0.03481	0.17332***	0.08808***	0.00302	0.00532	-0.00196
	(0.06875)	(0.04629)	(0.01983)	(0.00752)	(0.00773)	(0.00383)
lnpub(-1)	-0.10434	-0.19133**	-0.10568***	-0.02783**	-0.00434	0.00704**
	(0.09914)	(0.08266)	(0.01756)	(0.01101)	(0.01381)	(0.00340)
lnptapp(-1)	0.08898*	0.18331***	0.05101***	0.00748	0.00978	-0.00043
	(0.05271)	(0.05291)	(0.00730)	(0.00555)	(0.00884)	(0.00141)
credit(-1)	-0.00111	0.00098	-0.00063***	0.00023	-0.00023	0.00006**
	(0.00263)	(0.00114)	(0.00015)	(0.00029)	(0.00019)	(0.00003)
internet(-1)	-0.00090	0.00020	0.00400***	0.01182	-0.00019	0.00032
	(0.06803)	(0.01269)	(0.00123)	(0.00746)	(0.00212)	(0.00024)
Observations	52	63	177	50	63	176
R^2	0.493	0.805	0.703	0.685	0.557	0.348

Standard errors in parentheses
***,**,* denote significance at the 1%, 5%, 10% level, respectively
A full set of time dummies is included in all regressions

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Notes

[1]A framework to integrate both HFDI and VFDI is empirically tested by Carr et al.(2001) and it is known as the "knowledge capital model".

[2]On the empirical side, technology seeking behaviour is considered to occur when the R&D intensity of the host country is greater than the R&D intensity of the home country.

[3]It is not considered that for example, market seeking FDI are more influenced that resource seeking FDI by market size.

[4]However, quite surprisingly, Egger and Winner (2005) find a positive relationship between FDI and corruption, especially in countries with high level of regulation and administrative burden.

[5]Instead, if the main motivation is the exploitation of intangible assets, the tariff jumping hypothesis is considered as positively correlated with vertical FDI rather than with horizontal FDI.

[6]The effect of the exchange rate was investigated in an early study by Froot and Stein (1991) who found a negative relationship with FDI inflows. Other dimensions of this variable were taken into consideration such as the volatility (Goldberg and Kolsad, 1995) or the effects of the real exchange rate.

[7]For some years (1999,2000 and 2001) Jamaica and Guatemala are not part of the sample.

[8]From now on market seeking and resource seeking FDI will be used as synonyms respectively for horizontal and vertical FDI.

[9]One of the first attempts to specifically deal with the concept of functions inside the NSI framework is by Liu and White (2001) with regard to the case of China. After having grounded their framework into the innovation literature they single out five distinct functions: (1) to provide research capacities (basic, developmental, engineering), (2) to turn ideas into effective implementation (manufacturing); (3) to favour the relationship users-producers; (4) to bring together complementary knowledge fostering linkages and (5) to provide an effective education system. Rather than simply describing the role and performance of particular actors, institutions and policies, this approach focuses on the description of system level characteristics that include issues such as the distribution of these activities within the system, the organizational boundaries around them, coordination mechanisms or the effectiveness of the system in generating and diffusing innovations.

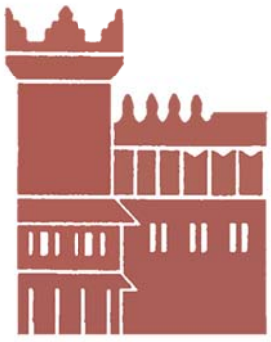
[10] This index is measured on a scale ranging from 0 to 5, where the value of 0 indicates very weak IPR system and 5 indicates, instead, very strong IPR system. As it is available only every five years we consider it remains equal for the missing values.

[11]An exception can be made for IPR as it is less likely that higher amount of FDI cause a rise in IPR regime.

[12]As distance and common language variables are time-unvarying we do not include them in the specification of this model.

[13]Due to problems related to the fact that the Sargan test may not be reliable when the number of instruments exceeds the number of regressors, instruments are collapsed and it is limited the use of lags (until the third) for variables used as instruments (Roodman, 2006).

[14]We report the results of random effects model, even though by using a Lagrangian Multiplier test we found that especially with respect to low and middle income countries we cannot reject the hypothesis of consistence of pooled OLS estimates. We also conducted a VIF test based on a regression with all countries finding that all coefficients are all below the threshold value of 10 evidencing no problem of multicollinearity.



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