10. THE ROLE OF MULTINATIONAL CORPORATIONS IN NATIONAL INNOVATION SYSTEMS IN DEVELOPING COUNTRIES

From technology diffusion to international involvement

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10.1. Introduction

National Innovation Systems (NIS) in developing countries are typically inefficient and/or ineffective in their task of producing and exploiting knowledge (Intarakumnerd et al, 2002, Alcorta and Perez, 1998, Arocena and Sutz, 2000, Radosevic, 1999, Viotti, 2002)[1]. Development and innovation studies have therefore acknowledged the importance for developing countries to remain open and receptive to knowledge and technologies created abroad (see for instance Lundvall, 1992; Wong, 2001; Hobday, 1997; Keller, 2004). The literature has been less willing however to highlight the importance of promoting mechanisms to improve and sustain the *international involvement* of the system. The *international involvement* of the system relates to the capacity of the system of having in place mechanisms to assure not only *access to a*

given piece of technology or knowledge but also involvement in international processes of knowledge creation and diffusion.

Mechanisms of *international involvement* are becoming increasingly important for developing countries given two undeniable facts of technological change. Firstly, technologies are ever becoming more complex, which implies that technological change tends to increasingly involve sectoral and inter firm interdependences. Industrialising countries, therefore, which typically produce with sectoral structures which are seldom diversified increasingly need to have mechanisms that allow them to get involved in international processes of knowledge creation in order to gain access to the complementary assets that are needed to increase the likelihood of becoming themselves worldwide knowledge producers. Secondly, the worldwide rate of technological change is becoming faster and faster. Therefore, developing countries, which often produce using technologies far behind the technological frontier, increasingly need to be internationally involved to keep the path of worldwide technological change.

There are various potential mechanisms to facilitate *international involvement* of NISs. These include the movement of qualified workers and/or researchers, the promotion of knowledge interactions with expatriates (*diaspora*), the promotion of international technological joint ventures or joint research projects, scholarships for graduate students to study abroad, international programmes of inter-governmental co-operation, etc.

Among those various possible mechanisms in this chapter we focus on the potential role of multinational corporation (MNCs) *subsidiaries.* We see the installation of MNCs

subsidiaries in a particular country as “offering” a potential mechanism or dynamic of international involvement that would enable the host countries not only to have more direct or smoother access to existing `technological (and managerial) competences originated outside the national systems *but also to be part of international processes of knowledge creation and diffusion*. Our view is that MNCs subsidiaries are in a privileged situation to do so, given their position at the interface of two systems of knowledge: the global – via their links with their MNCs and other international agents – and the national. We recognise however that they do not always do so. In this chapter we then explore the different dimensions that must be considered when analysing this potential bridging role of MNCs subsidiaries, and what we know and do not know about this role. Figure 10.1 illustrates our conceptual framework and organises the discussion presented in the chapter.

[Figure 10.1 about here]

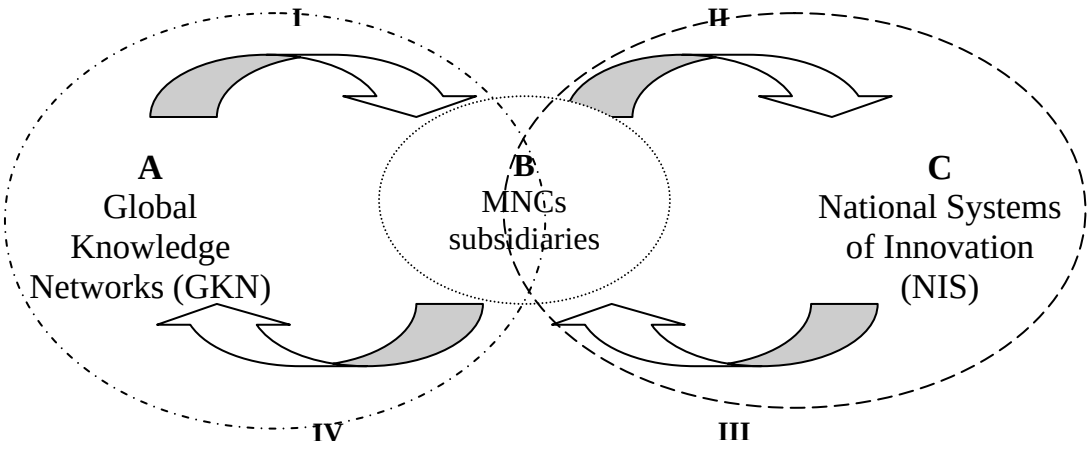


Figure 10.1 Conceptual framework to analyse the bridging role of MNCs subsidiaries

The first distinctive feature of our framework is that it puts MNCs subsidiaries at the core of the analysis. This contrasts with conventional views which focus on the MNC as a whole, and explore issues about how the whole MNC strategy might affect specific components of the host country NIS. It also helps to highlight the importance of considering multiple and multidirectional flows of knowledge for understanding the relationship between MNCs and NISs, i.e. not only from MNCs to domestic components of the systems, but also from the MNCs to their subsidiaries, from the NISs to MNCs subsidiaries, and from the subsidiaries to their MNC' parents and domestic firms. The second distinctive feature of our framework is our emphasis on the potential bridging role of subsidiaries. We see subsidiaries as being, in principle, part of two knowledge systems: the local (e.g. national) and the global (e.g. corporative). We think therefore, that they can serve as a mechanism to connect these two systems of knowledge. Nevertheless, as we will discuss in the rest of this paper they do not always do so. In consequence one of the main challenges for research about the interaction between MNCs and NISs is to understand the circumstances under which they can play this bridging role. In the rest of the paper, using this framework as a guide, we discuss what we know about this potential bridging role of MNCs subsidiaries in developing countries and we illustrate empirically some of the topics. The chapter is organized as follow.

Section 10.2 discusses the NIS literature concerned with the role of MNCs (Block C in Figure 10.1). We will argue that this literature has mostly been concerned with the role of MNCs in technology transfer, but less so with the role of MNCs in opening the system or helping the systems to get internationally involved.

Section 10.3 discusses the literature that has covered issues represented by arrow I and II in Figure 10.1, i.e. knowledge flows from MNCs to NIS in developing countries. Our main argument will be that this literature assumes somehow that arrows I and II are univocally defined in a direct flow from GKN to NISs ignoring the role of subsidiaries. We will discuss however recent evidence suggesting that subsidiaries play a key role in the explanation of any significant positive effect in association with MNCs operations in host countries.

Section 10.4 concentrates on what we know about innovativeness of MNCs subsidiaries in host developing countries (Block B). The discussion will include issues related to Arrows I and IV in Figure 10.1, which represent the bi-direction knowledge flows between subsidiaries and the GKN. Indeed, we will show that these flows of knowledge are key factors in the explanation of diverse degrees of technological activity in subsidiaries in host developing countries.

Section 10.5 discusses issues related to arrow III in Figure 10.1. In other words, the knowledge flows from NISs in developing countries to subsidiaries. These are not just important for better understanding knowledge creation activities in MNCs, as the international business literature has suggested. Also and more relevantly perhaps, they are important to assess the overall effect of MNCs in NISs in developing countries. This literature is much scarcer; but, nevertheless, some questions and topics will be discussed in Section 10.5. Finally, Section 10.6 concludes.

Box 10.1 MNCs in innovation systems in developing countries: main terms used in this chapter

FDI = Foreign direct investment = it is a component of any country balance of payment. It represents investment in an organisation resident in such country which is different of that of the investor. FDI implies a long-term relation between the organisation and the foreign investor who has a significant control of the organisation.

MNC = Multinational Corporations = it is a corporation with value-added activities in more than one country.

Headquarter = it is the location of the most important entity of the corporation, where most important business decisions are taken. It is usually the place were the corporation was first founded.

Subsidiaries = all the other entities of the multinational corporation.

GKN = Global knowledge networks = it includes the MNCs and other international networks of knowledge, such as networks of universities or research centers (e.g. Globelics, Prime, etc.) or multilateral organizations such as the World Bank.

NISs = National Innovation Systems = set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies. (Metcalfe, 1995)

International involvement = it implies to put in place mechanisms for being part of the international processes of knowledge creation and diffusion, which would ensure a continuous access to updated technology and knowledge.

Technological spillovers = they occur when some firms benefit from original knowledge generated by other firms, without incurring any costs. Spillovers from FDI include all unintentional technological benefits generated by an MNC in the host country. For example, information technology MNCs in India, such as Texas Instruments and Oracle, send their employees to the United States for training in research and development. Local firms then use these skills when those workers change jobs.

Spillovers literature = the literature that attempts to measure empirically the existence of spillover using production function models and econometric techniques. In most cases the mechanisms for technological diffusion between MNCs and domestic firms are not explicitly assessed.

Case study literature = the literature that attempts to explain spillovers using in-depth examination of a single event (case), which is believed to be analytically representative of general principle (on how spillovers occur).

International Business literature = literature concerned with the understanding of MNCs.

10.2. MNCs' role in the NIS literature

The NIS literature recognises that NISs, in particular the less advanced ones, should remain open to incorporate technology generated outside their system. In effect, in this literature one finds very often statements such as: *"It is a fact that successful developing countries are good in linking up to the national systems of innovation in more developed countries (Lundvall et all, 2002, p226)"*or *"the ability of a country to acquire new technology from whatever geographical source should be considered a part of its national innovation system" (Liu and White, 2001, p 1103)*

MNCs are typically listed together with the imports of capital goods, licensing and international joint ventures, as one of the main ways in which technologies created outside the system can be introduced into the system (see for instance Mowery and Oxley, 1995). Less attention has been paid however to the different ways in which MNCs can link the national to the global system of knowledge. Or, in other words the literature has focused less so on the potential role of MNCs in actually opening the system or helping the system to get internationally involved.

Indeed, very few papers within the NIS literature have focused on the issue of openness at the system level, or openness as one of the characteristics of the NIS^2. National Innovation Systems are often characterised in terms of specialisation of production, resources spent on R&D, public/private R&D, characteristics of dominant firms, number and type of the main organisations supporting R&D, knowledge interactions within the system, etc. (Nelson and Rosenberg, 1993; Viotti, 2002; Katz and Bercovich,

1993, Niosi, 2002). Less attention has been paid however to the issue of openness, i.e. how many mechanisms of linking to the external environment are available in a system, how they are administrated, how they might complement each other, etc.

Few exceptions are the papers by Niosi and Bellon (1994, 1996), Fransman, (1999), Carlsson (2006), Fromhold-Eisebith (2007), or Chapter 8 by Pietrobelli and Rabellotti in this handbook. All these papers explicitly examine internationalisation at the national system level – which would be similar to openness, in the sense we use the term here[3]. None of these papers however include MNCs together with other mechanisms of openness to explore the association between the system's openness and its performance. Even less so they have explored the way in which the MNCs could contribute to the system´s openness.

A similar lack of attention to the issue of openness at the system level is present in the NIS literature on developing countries. Indeed this literature, very much concerned with the inefficiencies of the innovation systems in developing countries, has focused most of its attention on the internal failures of the system – such as the existence in developing countries of cultural patterns that under valuate scientific knowledge and technologic[4]al innovation, the lack of relevant institutions and markets, the existence of sporadic and informal R&D activities, the lack of coherent and explicit national innovation policy, the low involvement of the private sector in technological activities, the lack of investments in intangible and human capital, the weak knowledge interactions within the NIS, etc.. (see for instance Intarakumnerd et al, 2002, Alcorta and Perez, 1998, Arocena and Sutz, 2000, Radosevic, 1999, Viotti, 2002, Katz and

Bercovich, 1993). However, we know much less about openness at the system level. For instance the following important questions remain unexplored: how many mechanisms of linking to the external environment are available in a particular system, how do they link/complement to each other, which are the better suited given the characteristics of particular systems and/or times, how should they change as the system evolve, how can they be administrated, etc.

In sum, within NIS literature very few papers have discussed systematically the role of different degrees of openness and different mechanisms to intensify openness (included different type of policies to deal with MNCs) in explaining the success of different national innovation systems to catch up (some papers about East Asia are exceptions; see for instance Wong 1999, 2001). Moreover, when openness is considered, liberalisation of trade and FDI flows are the main mechanism to be mentioned. Very rarely, if ever, the literature has focused on the role of MNCs subsidiaries activities in enabling the system's openness.

10.3. Knowledge flows from MNCs to NIS (arrow I and II)

10.3.1 Predominant approach

A substantial part of the empirical literature that has dealt with the association between MNC and NISs in developing countries has focused on the effects of MNCs superior technological knowledge on specific components of NISs in developing countries. In particular, the literature has been mostly concerned with the unidirectional flows of

knowledge from MNCs to related domestic firms, and associated effects on productivity growth or technological upgrading.

Within this literature MNCs are by definition supposed to be technologically superior to domestic firms because its very existence is explained by their being able to develop, accumulate and take advantage of a unique set of technological assets, such as particular product innovations and superior management or marketing techniques. Thus, this technological superiority is supposed to affect positively domestic firms, competitors or suppliers. One reflection of this conceptualisation is noticeable within the influential body of econometric analysis of spillovers in host economies[5]. For more than thirty years this has modelled spillovers as arising from the superior, centrally created technological assets of the MNC. These assets are supposed to be automatically available in subsidiaries in association with MNC' decisions and then to leak out into domestic firms generating "spillover" effects. A pipeline is supposed to link the superior technological resources of MNCs to domestic firms in the host economy (Blomstrom and Kokko, 2003; Markusen, 1995; Haskel, Pereira and Slaughter, 2002; Kokko, 1994; Jarovick 2004). In other words, Arrows I and II in Figure 10.1 are supposed to be only one arrow, running from the parent to domestic firms in the host economy (for an in-depth discussion on this, see also Marin and Bell 2006).

The same model, though usually more implicit, has underpinned case-studies and survey research about knowledge links between MNC subsidiaries and actors in host economies – the objects of study have been one-way flows running via FDI from

technological superiority in the advanced economies to domestic firms in the host economy (e.g. Ivarsson and Alvstam, 2005; Zhou and Xin, 2003).

There are four main mechanisms in which the superior technology of MNCs might diffuse from MNCs to domestic firms according to these studies:

i. via the movement of highly skilled staff from subsidiaries to domestic firms: it is argued that on-the-job learning might spread the superior technology knowledge owned by the MNCs' subsidiaries to the rest of the economy if workers previously employed in subsidiaries move towards other domestic firms or create their own enterprises carrying the knowledge with them;
ii. via demonstration effects involving the domestic firms' observation and imitation of the superior technology in subsidiaries: MNCs might accelerate the use of novel technologies in the host country by demonstrating how to use them. Domestic firms that were previously not aware of some specific technology, or felt it was not profitable to use, might observe how it is used by subsidiaries and therefore be tempted to introduce it (Blomstrom and Person, 1983);
iii. via purposeful (but not market-mediated) transfers of knowledge from subsidiaries to local firms: domestic suppliers might benefit from the presence of MNCs if the latter help them to satisfy high standards of quality control, delivery dates, prices, etc;
iv. via 'competition effects'. It is argued that subsidiary's superior performance, derived from its transfer delivered technology, may bring greater competitive

pressure to bear on domestic firms which are induced to respond by generating their own technological change.

10.3.2 The empirical evidence

Two types of empirical literature have looked for evidence related to arrows I and II. First, there is the evidence emerging from case studies which often is very informative and includes very detailed information about how those mechanisms take place[6]. This literature has focused mostly on the purposeful (but not market-mediated) transfer of knowledge from subsidiaries to domestic suppliers, via backward linkages (Wong, 1992, Ivarsson and Alvstam, 2005; Zhou and Xin, 2003, Miozzo and Grimshaw, 2008). In general they have found positive technological effects of MNCs operations, however, because it pertains to particular FDI projects or specific regions, it can not be easily generalised. Second, there is the evidence coming from econometric studies, hereafter the *spillover literature*. This literature, having generated most of the empirical evidence on the issue of FDI-related effects in industrialising countries, has intended to capture all the mechanisms mentioned above, and has been the most influential on this topic.

The spillover literature models technological spillovers from MNCs within the context of production functions. The presence of MNCs (or FDI participation) in the same or related industries is treated as an additional explanatory variable for productivity growth of domestic firms. Thus, a positive and significant coefficient of FDI is understood as evidence of spillover effects[7].

A major problem about the spillover literature is that it has failed to provide convincing evidence that spillover effects exist. Early studies using industry level and cross

sectional designs (e.g. Caves 1974 or Globerman, 1979) found positive results but were unable to identify the relevant causality (see Aitken and Harrison, 1990). More recent studies using panel data analysis, however, have not been able to replicate the generally positive results in the earlier research in a wide range of countries (see Jarovick, 2004 for a discussion of the empirical literature and Smeets 2008, for a recent survey).

Yet, the response to such inconclusive evidence has been limited insofar as researchers have not tended to question the main assumptions underlying the model but have instead turned their attention to two other types of explanations: the absorptive capabilities of domestic firms (Cohen and Levinthal; 1990, Kokko, 1994; Konings, 2001) and the strategy of the MNC (or their industry) (Narula and Dunning, 2000; Chung, 2001). The former is expected to constrain the ability of domestic firms to fully realise the potential productivity gains from implementing the new technologies introduced by subsidiaries. The second is expected to influence the types of technology that MNCs transfer to subsidiaries, and hence the scale and significance of the knowledge resources that may subsequently leak to domestic firms.

Unfortunately, however, these initiatives have not solved the empirical problem. In the first case, many studies have not found the effect of absorptive capability of domestic firms to be significant (e.g. Haskel, Pereira and Slaughter, 2002, Damijan et al., 2001, and Sjoholm, 1999) whilst the second type of argument has not, for the most part, been empirically evaluated.

10.3.3. The importance of including subsidiaries: Ideas coming from the international business literature

Beyond these empirical drawbacks, there are conceptual problems associated to the literature dealing with arrows I and II in Figure 10.1. Implicit in this literature – both in the spillovers and case study type literature - is the assumption that knowledge is a kind of 'public good' within MNCs[8]. It is assumed that the superior technology created by MNCs - which as discussed before is supposed to explain the existence of MNCs - is easily transferable across different subsidiaries of the MNC. These subsidiaries are presumed to be passive recipients of this technology, with no role at all in either the transfer or creation of this superior technology. Indeed, the typical study concerned with the effects of MNC operations in developing countries expects the benefits of superior technology in association with MNCs operations to be delivered directly from MNC parents to domestic firms, without the active intervention of local MNC subsidiaries. The role of the subsidiaries' own technological activities is often not analysed. Indeed the common perspective is that there is, in effect, no role to be analysed because the subsidiary is presumed to be entirely passive, merely acting as a knowledge-conduit at the end of the 'pipeline' running from the parent via international technology transfer to the subsidiary.

Numerous studies within the international business literature, however, have demonstrated that this assumption is unrealistic (Teece, 1977; Szulansky, 1996; Gupta and Govindarajan, 2001; Cantwell and Jeanne, 1999; Nobel and Birkinshaw, 1998; or Birkinshaw et al., 1998). On the one hand studies concerned with technology transfer

within MNCs have shown that this transfer, even when is done within the same firm, it is complex and difficult, and that its success depends heavily on the technological capacity of the recipient unit; i.e. the subsidiaries. They emphasize therefore the important role of subsidiaries own technological activities for assuring the success of technology *transfer* within MNCs (see for instance Teece, 1977; Szulansky 1996 and; Lim, 1991).

On the other hand, studies concerned with technology creation within MNCs have recently emphasised the increasingly important role of subsidiaries' own technological activities for *knowledge creation* within MNCs (Cantwell, 1995; Kummermele, 1999). Early studies within the international business literature suggested that knowledge activities in subsidiaries were typically adaptive adjuncts to the transfer of technology from parents, especially so in the case of MNC affiliates in developing countries (Lall, 1979). Recent studies, however, reflecting the idea that innovation by multinationals involves more distributed processes of knowledge creation and diffusion, have shown a wider role for subsidiaries' technological activities. These studies recognise that subsidiaries can develop a unique stock of assets — a collection of skills, capabilities, products and know-how on which the rest of the corporation starts to depend – and that in many cases the development of those unique resources in subsidiaries may not always depend exclusively on headquarters decisions (Birkinshaw and Hood, 1998). Instead, subsidiaries may themselves actively engage in the attraction of capacities and resources from the rest of the corporation, as well as in the development of their own technological capabilities. The early centrally driven models of the MNC, with their technologically passive subsidiaries, which have underpinned most studies concerned

with the effects of MNCs in NISs in developing countries, have therefore lost relevance within the international business literature.

10.3.4. The importance of including subsidiaries: New empirical evidence from the spillovers literature

In line with these ideas, a more recent line of research within the spillover literature has started to question the use of the centrally driven model of the MNC (or pipeline model) in spillover studies by emphasising the role of subsidiaries vis-à-vis spillovers . Studies conducted in Argentina, India, Indonesia and Italy have all found the same pattern: spillovers from MNCs operations were strongly associated with the intensity and kind of technological activity of subsidiaries in the host country.

Todo and Miyamoto (2002), for instance, using two indicators of technological activity in MNC subsidiaries to estimate spillovers in Indonesia - the commonly used R&D-based indicator and what they called a human resources development indicator (measured by the subsidiaries' expenditures on training) - : found that only subsidiaries engaged in R&D and training activities had a positive impact on the productivity of domestic firms.

Castellani and Zanffei (2005), using data for Italy (1996-2000), found that positive spillovers arose only when foreign affiliates were R&D intensive, co-operated with local counterparts, and had long been established in Italy.

In Argentina, Marin (2006) found that FDI –related technological spillovers emerged only in association with the existence of specific types of knowledge-creation activities undertaken by local subsidiaries in the host economy[9]. In particular, she found that positive and significant effects emerged only in association with high investments in disembodied knowledge and human capital by subsidiaries in the host economy, such as local training and R&D activities, skills intensity of the local workers, and other investments disembodied technologies. On the contrary effects were less significant in association with investments in capital goods and imports, confirming the presumption that the knowledge actually embodied in those assets is probably very 'sticky'.

Finally, in a comparative study about spillover in Argentina and India, Marin and Sasidharan (2006) found similar patterns in India: a) FDI related spillovers only occurred in India when subsidiaries were technologically active[10] and b) associated with relatively larger investments in disembodied knowledge and human capital by MNC' subsidiaries in host countries.

This evidence points to the importance of focusing on subsidiaries' own technological activities[11] as the main drivers of technological effects in association with MNC operations in host countries, which justifies the central role of subsidiaries in Figure 10.1. It also points to the importance of understanding possible reasons for variability in the innovativeness of subsidiaries. This is the subject of the next section.

10.4. Innovativeness of subsidiaries: the importance of being involved into global networks (arrows I y IV)

10.4.1. Existing research

Numerous strands of research have contributed to understanding the innovative activity of subsidiaries in 'modern' forms of MNC. Some have focused on forces in the global context that shape corporate strategies in ways that in turn influence the positions of subsidiaries – for example, Porter (1986) and Bartlett (1986). Others have centred attention on those corporate strategies themselves and the associated corporate structures that shape subsidiaries' behaviour – for example Doz and Prahalad (1984) and Prahalad and Doz (1987). There is also a well-established body of literature that focuses more directly on how MNC strategies have influenced both the international location of their innovative activities and the nature of those activities in subsidiaries – for example, Ghoshal and Bartlett (1988); Pearce (1999), Kuemmerle (1999), Papanastassiou and Pearce (1999), Zander (1999), Kumar (2001), and von Zedwitz and Gassman (2002). Others give greater attention to more 'local' influences. These include aspects of host country environments, in particular their knowledge resources – for example Cantwell and Jeanne (1999), Cantwell and Iammarino (2003), Florida (1997), Thursby and Thursby, (2007). Finally, others also include characteristics and initiatives of subsidiaries themselves- for example, Nobel and Birkinshaw (1998) or Birkinshaw et al. (1998).

One of the problems of this research, however, is that almost everyone relates to the particular experience of subsidiaries in developed host-countries. Notwithstanding the emerging empirical evidence suggesting the increasingly strategic importance of subsidiaries´ activities in industrialising countries (see UNCTAD 2005 and Table 10.2 below)[12], so far, our knowledge is limited with respect to the different circumstances that might shape innovative activity in subsidiaries across diverse industries and locations in developing economies.

There are, nevertheless, a few papers that do explore innovative activity of subsidiaries in developing countries, and the evidence emerging from these papers all point to the same direction. MNCs subsidiaries can be very innovative in developing countries, however, not all of them are. Two aspects appear to be relevant in explaining diverse degrees of innovativeness in subsidiaries in developing countries: 1) their international integration or interconnectedness - to their MNC or other international sources of knowledge – and, 2) their entrepreneurial attitude or initiative.

Ariffin and Bell (1999), for instance, explored technological upgrading in a sample of twenty five subsidiaries in the electronic sector in Malaysia and found that most of the subsidiaries, even though started simply doing assembly operations and with very low innovative activity evolved with the time towards more advanced complex production process and products and, to substantially higher levels of innovative activity. However, this evolution was not automatic according to their study. It was affected by the type of relationship the subsidiaries maintained with their parents. The subsidiaries that

succeeded moving into intensive innovative activities were those that draw heavily on learning links with their parents[13].

The results of a more recent study conducted by Marin and Bell (2006) in Argentina suggest a similar pattern. They distinguish subsidiaries according to how well integrated were to: a) their corporation, and b) the local economy. Thus, they explored how the degree of integration of subsidiaries to these two systems of knowledge related with their technological behaviour in Argentina. Two of their results are worth mentioning. Firstly, a significant number of subsidiaries were either completely disconnected to these two systems of knowledge or connected to both. This illustrates the high level of heterogeneity in the way in which subsidiaries relate to the NIS and the GKN. Secondly, only subsidiaries connected with their corporation showed relatively higher levels of localised innovative activities.

Pointing to the same direction, Giuliani and Marin (2007) and Marin and Giuliani (2008) identified that the degree and type of global integration of subsidiaries was highly correlated with their innovativeness in Argentina. Their results can be summarised in the following points: 1) Only the subsidiaries that were highly interconnected with external sources of knowledge were innovative. On the contrary, isolated or disconnected subsidiaries were characterised by weak internal technological capabilities, 2) Only subsidiaries connected with non-corporative external sources of knowledge developed local linkages intensively, and 3) Only the subsidiaries that being well connected with their corporation were also entrepreneurial enough to look for non-corporative external partners, deploy positive spillovers. This type of subsidiary was also the most innovative

of all types. The last two results were interpreted by the authors as suggesting that, to benefit the host economy, subsidiaries need not only to be internationally connected, which gives them access to superior sources of knowledge, but also they need to have initiative, which is necessary for both to develop new technological assets and promote local linkages.

The importance of certain degree of autonomy and initiative was identified as well as important by Hobday and Rush (2007) in an analysis of technological upgrading of subsidiaries in the electronic sector in Thailand. They identified four possible outcomes in terms of technological upgrading: 1) Weak, corresponding to assembly operations, 2) Moderate, corresponding to process engineering, 3) Strong, corresponding to product development, and 4) Very strong, corresponding to R&D capabilities. Thus, they analysed the influence of four factors in explaining differences in the intensity of technological upgrading: a) the type of product produced in the subsidiary, b) the stage of development of the firm, c) the size of the firm and plant, and d) the corporate and technology strategy of the HQ. They found that only one of these dimensions was important to explain differences in the innovative activity of subsidiaries. The dimension referred by them as "corporate strategy of the HQ". More specifically, they found that only those subsidiaries *integrated* into corporate strategies fairly decentralised, which provide subsidiaries with both support and certain discretion to "invest" in technology showed consistently better performance.

Finally, similar conclusions were found by Sargent and Matthews (2006) in a study of 50 Mexican Maquiladoras. Higher and faster technological and industrial upgrading

happened only in a group of subsidiaries that have initiated to start new projects or ventures. On the contrary subsidiaries that were driven mainly by the decision of their parents were slower and less effective in their technological upgrading.

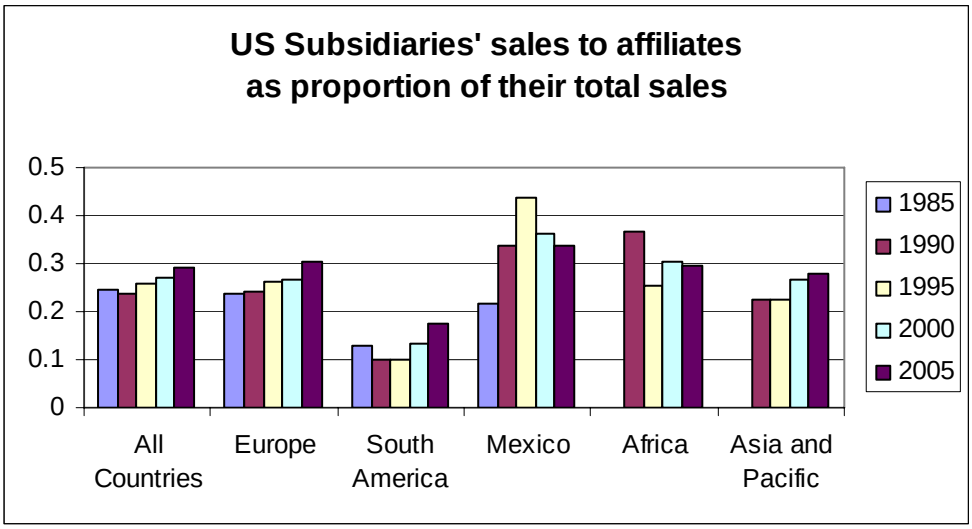
In sum, the six studies reviewed here about factors affecting the innovative activity (or upgrading) of subsidiaries in industrialising countries all indicate that subsidiaries can be highly innovative or evolve towards more sophisticated technological activities even in industrialising countries. They also point however that an important number of subsidiaries are not innovative or not evolve towards position of higher technological complexity with time. Two factors seem crucial in favouring innovativeness or a positive evolution: 1) the degree with which subsidiaries are integrated or connected to their international network, and 2) their local initiative or entrepreneurial attitude.

10.4.2 An empirical illustration

In Figure 10.2, using data on US MNCs' subsidiaries located in different economies, we drew one dimension of international involvement: the percentage of sales by subsidiaries in different regions to other affiliates. As it can be seen in the Figure, Asia is more connected worldwide than South America, which could be indicative of this region being strategically more important for global production and diffusion of knowledge. However, the same indicator for Africa cast doubts that this interpretation could be applied without warnings, since it is unlikely that this region's large share of sales to affiliates is related to its international involvement. Rather, it seems that in the African case the high proportion of exports in general (around 50%) and to other

affiliates in particular (around 30%) is related to the size and purchasing power of the African market, as well as to the type of activities in which US MNCs are involved in this continent, mostly extractive. This highlights the need to control for other factors that may affect the relationship[14].

[Figure 10.2 about here]



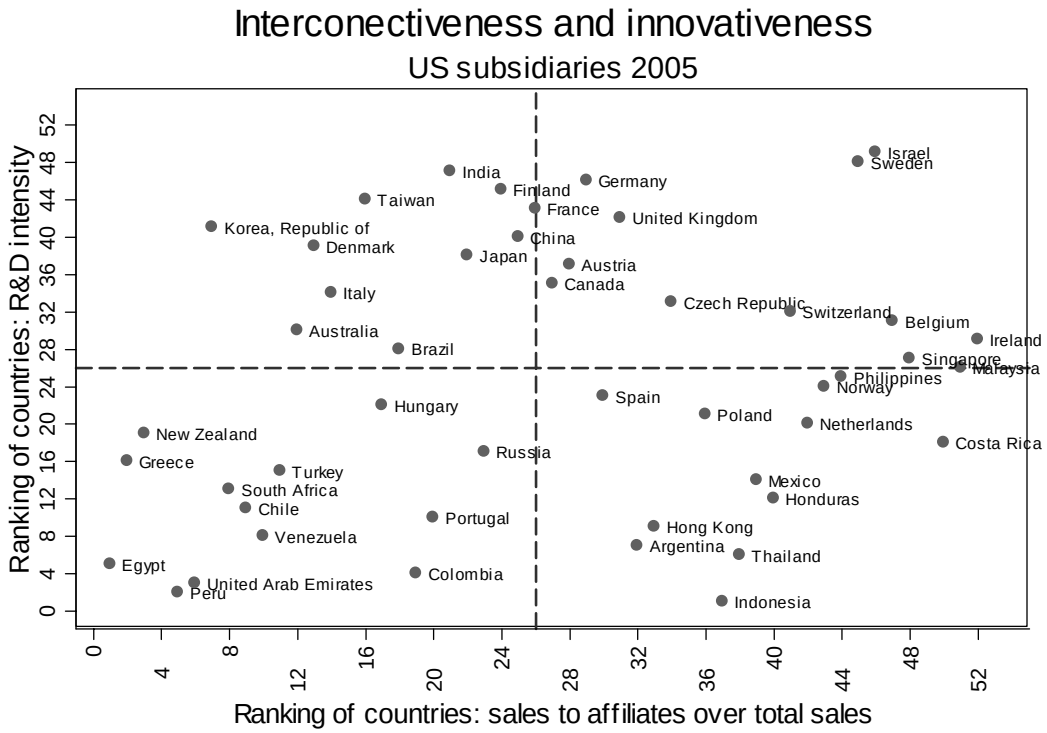
Source: Bureau of Economic Analysis - US Department of Commerce

Figure 10.2 US Subsidiaries sales to affiliates over total sales, by region 1985-2005

Figure 10.3 shows the relation between the intensity of subsidiaries investment in R&D and their connections to other affiliates in the year 2005. According to our discussion in the previous sub-section we would expect, that those countries that have subsidiaries that are more internationally involved, to have subsidiaries that are more actively involved in local innovation (proxied by percentage of R&D expenditures). In other words we would expect most countries to be placed in quadrant SW and NE. However, countries are scattered all over the figure.

The reason for this is that although R&D over sales seem to be a good proxy of innovativeness, the indicator of international involvement needs to be corrected by market size and development in order to truly account for the degree of connection that the subsidiary has with the GKN. Countries with important markets are pulled to the left of the figure since their internal markets capture an important proportion of their sales (eg. India, Brazil, China) while small / poor and close-to-US markets are pulled to the right (eg. Costa Rica, Honduras, Mexico).

[Figure 10.3 about here]



Source: Bureau of Economic Analysis - US Department of Commerce

Figure 10.3 The relation between interconnectiveness and Innovativeness of US subsidiaries, by country in 2005

In Table 10.1 we run regression analysis that enable to evaluate the relation between intensity of R&D carried out by affiliates and their worldwide interconnectiveness, controlling for size, income-level and location of host markets. Information was collected for 1990, 1995, 2000 and 2005. GDP and Poverty are proxies of market-size and income-level respectively, and were measured in average for the previous five years to make to most of data available[15]. Three econometric models were estimated: Pool, Random and Fixed Effects[16]. As expected, the host country size and poverty are important variables that mediate the relation between international involvement and innovativeness. These variables significantly affect R&D intensity carried out by US subsidiaries[17]. Once they are controlled for, we find that countries that have subsidiaries that are more internationally involved are also those that have subsidiaries that commit more resources to R&D.

Table 10.1 Regression analysis on of R&D over sales done by US affiliates[18]

Dep. Var. **R&D over sales in %**	**Pool Ordinary Least Square**			**Random Effects Model**			**Fixed Effects Model**		
	Coefficient	**p-value**	**Sig**	**Coefficient**	**p-value**	**Sig**	**Coefficient**	**p-value**	**Sig**
Host country poverty	-0.004	0.038	**	-0.004	0.087	*	-0.012	0.173	
Host country GDP	3.E-07	0.000	***	2.E-07	0.000	***	5.E-08	0.675	
Sales to affiliates (over sales)	0.005	0.019	**	0.006	0.028	**	0.021	0.002	***
Asia & Pacific	-0.214	0.021	**	-0.183	0.140		(dropped)		
South & Central America	-0.278	0.006	***	-0.267	0.043	**	(dropped)		
Africa	-0.247	0.210		-0.265	0.279		(dropped)		
Constant	0.362	0.000	***	0.343	0.001	***	(dropped)		
R^2	0.35			Overall R^2	0.3528		Overall R^2	0.07	
Number of countries	46			Breusch-Pagan	11.87	***			
Number of observations	157			Hausman	8.01	**			

Source: World Development Indicators and Bureau of Economic Analysis - US Department of Commerce

In sum, to our conclusion of Section 10.2, which have highlighted the importance of innovative activities of subsidiaries for the creation of FDI related technological spillovers, we can now add the importance of *international involvement* to explain the local innovativeness. The more the subsidiaries are connected with the GKN the more they seem to be devoted to innovate locally. However, data presented here is just

illustrative. More research in these lines needs to be done in developing countries. In particular, it is necessary to identify factors that explain heterogeneity in levels and evolution of these dimensions in developing countries with the policy aim of defining policy actions that could enable these countries to improve the international involvement and local attitude towards innovation.

10.5. Knowledge flows from NIS to subsidiaries (arrow III)

The international business literature has long ago recognised that technological activities in MNC subsidiaries in advanced contexts are not only motivated by the need of supporting off-shore markets and manufacturing, adopt and tailor products for local markets and provide technical support as classical studies suggested (Vernon 1966, 1977), but also by technological oriented factors, such as gaining access to science and technology and developing links to science community, attracting high quality scientific and technical talent from the host economy, etc. (Florida, 1997; Cantwell, 1995; Cantwell and Piscitello, 2003). However, it is only recently that the literature has started to emphasise the importance of technological motivations for MNCs' subsidiaries investments in technology in industrialising countries (UNCTAD 2005). In other words, it is only recently that the literature has started to pay attention to the possibility of reverse flows of knowledge from NIS to MNCs in industrialising countries.

The importance of these reverse flows of knowledge in both, advanced and less advanced countries, has been demonstrated in a very recent study by Singh (2008). He examined knowledge flows between foreign MNCs and host country organisations in 30

countries using patent citations, and found that in advanced countries, knowledge outflows to foreign MNCs greatly outweigh knowledge inflows, i.e. from MNCs to domestic organisations. This result is not that surprising taking into account the ideas discussed in the introductory paragraph of this section which have emphasised the potential for reverse flows of knowledge as a motivation for MNCs' investments in technology in advanced host countries. On the light of the enormous amount of literature that emphasise the potential importance of knowledge inflows from MNCs to host country organisations in developing countries, more striking is the fact reported in his study that in technologically less advanced countries, knowledge outflows are only slightly weaker than knowledge inflows.

Investments in R&D by MNCs in host countries are also often interpreted as one of the signals of the increasing importance of knowledge sourcing by MNCs. UNCTAD indicates that MNC spending in R&D abroad has increased from 15% in 1995 to 21% in 2001, and the trend is growing. Table 10.2, bellow shows the increases in R&D investments by USA' MNCs abroad in a group of selected countries. It strikes from this table again the pattern observed in developing countries. In these type of countries, R&D investment by subsidiaries of USA' MNCs increased by 102.7% between 1990 and 2005, while R&D investments in the selected developed countries dropped by 0.7%.

Table 10.2 Investment in R&D by US subsidiaries as a proportion of sales, selected countries 1990-2005

	R&D over Sales				Change
Region / Type of country	**1990**	**1995**	**2000**	**2005**	**1990/2005**
All Countries	0.843	0.743	0.816	0.767	-9.1
Europe	1.116	0.947	0.990	0.952	-14.7
South America	0.270	0.415	0.264	0.306	13.6
Central America	0.232	0.141	0.292		
Africa	0.094	0.110	0.073	0.057	-39.9
Asia and Pacific	0.450	0.560	0.753	0.642	42.6
Developed Countries	**1.033**	**0.951**	**1.021**	**1.026**	**-0.7**
Australia	0.484	0.632	0.575	0.545	12.6
Canada	0.649	0.501	0.690	0.606	-6.5
France	0.982	1.092	1.175	1.144	16.5
Germany	1.931	1.607	1.577	1.714	-11.2
Greece	0.125	0.112	0.294	0.192	53.8
Israel	1.017	3.417	9.028	11.950	1075.4
Japan	0.827	1.156	1.009	0.862	4.2
New Zealand	0.128	0.155	0.106	0.261	103.4
Russia			0.032	0.213	
Spain	0.363	0.747	0.463	0.324	-10.7
United Kingdom	1.100	0.770	1.008	1.129	2.7
All Developing Countries	**0.205**	**0.225**	**0.480**	**0.417**	**102.7**
Lead Developing Countries	**0.231**	**0.269**	**0.695**	**0.616**	**166.2**
Brazil	0.308	0.624	0.403	0.522	69.1
China		0.241	1.920	0.980	
Czech Republic			0.385	0.562	
Hong Kong	0.061	0.151		0.092	50.0
Hungary			0.480	0.305	
India	0.909	0.300		2.001	120.1
Korea, Republic of	0.295	0.385	0.871	1.048	254.8
Malaysia	0.089	0.150	0.837	0.460	417.6
Singapore	0.200	0.105	0.578	0.492	146.5
Taiwan	0.484	0.380	0.590	1.225	153.2
Turkey	0.115	0.080	0.131	0.191	65.8
Laggard Developing Countries	**0.193**	**0.170**	**0.214**	**0.137**	**-28.8**
Argentina	0.305	0.178	0.152	0.083	-72.7
Chile	0.136	0.206	0.122	0.107	-21.2
Colombia	0.095	0.121	0.111	0.051	-46.8
Ecuador		0.086			
Peru		0.251	0.048	0.026	
Venezuela	0.412	0.352	0.201	0.087	-78.9
Costa Rica	0.175	0.103		0.249	42.6
Honduras		0.000	0.000	0.108	
Mexico	0.275	0.160	0.305	0.179	-34.8
Panama		0.050			
Egypt		0.040	0.067	0.067	
Nigeria	0.032		0.016		
South Africa	0.328	0.332	0.189	0.126	-61.6
Indonesia	0.040	0.103	0.020	0.023	-43.9
Philippines	0.182	0.367	0.392	0.393	115.8
Thailand	0.060	0.040	0.078	0.074	23.1

Source: Own elaboration based on the US Bureau of Economic Analysis – US Department of Commerce

It is also remarkably however the difference observed between different types of developing countries, as Chapter 4 by Fagerberg and Srholec illustrates. There is a group of *leading industrialising countries* that explain most of the increase in R&D investment by MNC' subsidiaries of USA, which include Brazil, China, India, Korea, Malaysia, Singapore and Taiwan. However, there is a second group, called here *laggard developing countries*, which includes most of Latin American countries such as Argentina, Venezuela, Mexico, but also Indonesia, Philiphines, Thailand, and some African countries, which show a reverse pattern; R&D investments by MNCs subsidiaries from USA actually decreased almost 30% between 1990 and 2005.

Several studies have focused on trying to understand the reasons that explain diverse types and intensities of international R&D by MNCs in different locations or countries. In general, these studies have identified three types of determinants of different intensities (and types) of international R&D by MNCs. These are related to differences across firm, industry and country. The studies exploring differences across MNCs have emphasised the positive effect of four factors on the degree of internationalisation of the firm R&D. These are the R&D intensity of the parent company, its degree of internationalisation, the richness of its international technological portfolio and the compatibility between the technological specialisation of the MNC and the technological specialisation in the host country (Cantwell and Janne, 1999; Zejan, 1990; Almeida and Phene, 2004; Hakanson, 1992).

With regard to the influence of inter-industry differences the conclusions are not so clear. Although traditionally, the more technologically intensive industries, such as electronics or aerospace, are supposed to have higher ratios of R&D to total sales, in both home and host countries, Kumar (2001) did not find a consistent relationship between these two variables. He compared MNCs from the US and Japan and found that, US MNCs' overseas R&D followed a normal sectoral pattern in that affiliates in more R&D intensive industries also did more R&D abroad. However in the case of Japanese MNCs the pattern was the opposite; R&D in technologically intensive industries remained in Japan, while R&D in relatively simpler technology sectors was moved abroad[19].

Finally, the studies exploring differences across countries have found that the level of development of the host county, the size and growth of the domestic market, and the local amount of R&D has a positive effect on the amount of R&D conducted by subsidiaries in a particular location (Hakanson, 1992; Kumar, 2001). The same arises with respect to some indicators of human capital development and of cost of labour, which are supposed to reflect the local availability of 'cheap' domestic resources useful for conducting R&D (Kumar 2001). Nevertheless, the local openness and the strength of the IPR regime in a particular country were not found to consistently affect the amount the R&D conducted by MNCs in this particular country (Kumar, 2001)[20].

In Chapter 4, Fagerberg and Srholec analyse the relationship between technological, economic and social aspects of different countries and found that most of them were interrelated. Below, we explore the association between similar aspects of the NSI but

not among themselves but with variables that characterise subsidiaries innovative behaviour and their international involvement. The aim is to understand the extent to which the MNCs subsidiaries innovativeness and international involvements were related to the characteristics of the NISs. We calculated rank-correlation (Spearman coefficient)[21] to analyse these associations. Variables characterising NIS were classified in two groups. A first group of variables measures socioeconomic aspects of the NIS. For example GDP and population will account for country size, HDI for the degree of human development and trade openness and FDI for the intensity of international connections. A second group of variables attempt to proxy technological accumulation by the NIS. In here we include: gross fixed capital formation over GDP, to account for the country commitment to embodied technology; high technological exports as a proportion of manufacturing exports, to account for specialisation in high-tech products; and royalty and licence fees payments to account for the incorporation of disembodied technology, and R&D over GDP to account for the country attitude towards innovation.

Table 10.3 Spearman correlation coefficients data related to US subsidiary behaviour and the characteristics of the NIS, selection of 40 countries[22] for years 1985, 1990, 1995, 2000 and 2005 according to data availability

US Subsidiaries behaviour	R&D over sales			Sales to affiliates over sales		
Characteristics of the NSI	Spearman	Obs	Sig	Spearman	Obs	Sig
Socioeconomic characteristics of NSI						
GDP (constant million of USD 2000)	0.55	96	***	-0.29	108	***
Population in millions	0.06	96		-0.20	108	**
GDP per capita (PPP)	0.63	96	***	-0.08	108	
Ranking of Human Development (1st in ranking, the most developed)	-0.57	128	***	0.08	174	
Poverty (% of people that live with less than 2 USD a day)	-0.53	165	***	-0.08	182	
Openness: Merchandise imports plus merchandise exports over GDP	-0.10	96		0.61	108	***
Foreign direct investment (net inflows) over GDP	-0.03	93		0.26	104	***
Technological knowledge accumulation in the NSI						
Gross fixed capital formation over GDP	-0.08	89		0.15	101	
High technology exports over of manufacturing exports	0.42	84	***	0.41	87	***
R&D over GDP	0.77	32	***	-0.06	37	
Royalty and licence fees, payments (constant million of USD 2000)	0.68	80	***	-0.03	90	

Source: World Development Indicators and Bureau of Economic Analysis - US Department of Commerce

As can be expected, the intensity of investment in R&D carried out by the subsidiary is strongly related to the innovative attitude of the host country and also to its degree of development. Since these variables are inter-related, we also run partial correlation, and we confirm that the innovative attitude of the host country is still related to the subsidiary innovative behaviour even when the degree of economic development is controlled for.

Two expected and still interesting results emerge in the relation between subsidiary international involvement and the NIS. Firstly, the bigger the country the less likely the subsidiary would trade intensively with other affiliates, presumably because there would

be a bigger market to serve within the host economy. Secondly, the more open to the trade the country is, the more likely the subsidiary would sell a higher proportion of its sales to other affiliates. However, this result vanishes when the intensity of subsidiary exports is being controlled for in partial correlation analysis. Therefore, trade openness matters in general for the intensity of international sales and not necessarily for the intensity of sales among affiliates.

Positive or negative effects?

In general the literature presumes that the effects of higher investments in R&D by MNCs in host countries have always positive effects. However, this is not necessarily always the case. Indeed, technological facilities of MNCs subsidiaries might be a channel through which technology produced at high cost in a country ends up being "privately appropriated" by the subsidiary (on behalf of the MNC) leaving low or null return for the country. It could also be the case that technology produced domestically falls into the hands of foreign competitors, and to the extent that unique access to such technology is crucial for the competitive advantage of domestic firms, it would also represent a cost for the host country (Singh, 2007)

Pearce and Papanastassiou (2006) point to other two possible negative effects of MNCs' subsidiaries R&D or other technological activities in host countries:(1) they see a potential crowding out effect, if MNCs' subsidiaries doing research in a country employ highly skilled and unique scientific personnel which would not be available to indigenous enterprises – although they recognise that in a lot of situations this kind of

personnel might not find employment in the host country and therefore migrate, which would be worse, and (2) a diversion in the technological path/specialisation of the host NIS (they argue that in association with MNCs' R&D activities NISs can follow paths different to the ones it would have followed otherwise).

In sum, there could be negative effects in association with technological activities by MNCs subsidiaries in industrialising countries. However, up to now the literature has only speculated about these potential negative effects. We do not have yet empirical studies that have evaluated whether or not these possible negative effects actually exist.

10.6. Conclusions

Our main argument in this paper is that research about the relationship between MNCs and NIS in industrialising countries should change its focus in three dimensions; (a) from focussing on the MNC as whole unit to focusing on its subsidiaries located in industrialising countries, (b) from focusing on technology transfer as the main role potentially played by MNCs subsidiaries to focus on their role in helping host industrialising countries to get internationally involved , and (c) from focusing only on the possibility of one directional flows of knowledge (or effects) to focus on the possibility of multiple and multi directional flows of knowledge .

The strategy to support these arguments was two-fold.

Firstly, our claim for further research in these lines is justified from a policy viewpoint. In a world of rapidly evolution of technologies, which in turn are becoming ever more complex, internal sources of knowledge are not enough for catching-up. Developing countries need to create the mechanisms *to be involved* in the international process of knowledge creation and diffusion, as other chapters in this Handbook also point out (for example, Padilla et al (Chapter 6), Pietrobelli and Rabellotti (Chapter 8), Barnard et al (Chapter 9) or Chaminade et al (Chapter 13). Among other institutional channels, we see MNC subsidiaries as key nodes in the intersection of local and global systems of knowledge. Our revision of the NIS literature of Section 10.2, suggests that although this literature has been traditionally committed to highlighting the relevance of linkages in general, it very rarely emphasised the need of local systems to create permanent mechanisms of international involvement. Even less, the literature has emphasised the potential bridging that MNC subsidiaries might play. Our claim is that although this potentiality exists, MNC subsidiaries do not always exploit it. We believe policy makers should be more aware -and therefore informed- about the factors that influence the likelihood and efficacy of exploiting this potential. Therefore, more research that places MNC subsidiaries at the core of the analysis, accounting for factors affecting the likelihood and effectiveness of their local and global connections, is necessary. As we claimed in Section 10.2, neither the literature on NIS nor the literature on FDI policy for developing countries, has emphasised the importance of this potential role. Rather, MNC are considered together with imports of capital goods or licensing as options of technology transfer from other locations.

Secondly, we discuss recent evidence from the MNC and spillovers literature which has demonstrated the crucial role played by knowledge activities carried out by MNCs *subsidiaries* in knowledge creation and spillovers (Section 10.3). We also brought up the literature that discuss the importance of international involvement of MNCs subsidiaries as a mediating factor in explaining knowledge activities in MNCs subsidiaries (Section 10.4). Finally, we discuss evidence which called the attention to the increasingly importance of the reverse knowledge flows of knowledge (i.e. from NISs to MNCs' subsidiaries and from MNCs' subsidiaries to their parents) both in developing countries and in advanced contexts (Section 10.5).

Some of these issues were illustrated using empirical information about the behaviour in different host economies of US MNCs' subsidiaries. We did not intend however to provide definitive answers to all the issues raised in this chapter. As a matter of fact, the empirical evidence we provided is just evocative. We explicitly voice the need to collect more data so as to further analyse these issues.

In sum, we believe that changing the focus of research about the relation of MNC and NIS towards the bridging role between local and global knowledge system that MNC subsidiaries might play, would be useful to a) disentangle academic controversies on the actual role that MNC could play for the technological dynamisms of developing countries and b) point out to specific policy measures to trigger a deeper and wider exploitation of the bridging role.

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NOTES

[1] The literature of innovation systems is broader than the NIS literature we refer to in this chapter. It includes clusters studies, regional studies, industrial districts, industrial geography, etc. However, we chose to focus on NIS literature since it has been the one more openly concerned about development issues.

[2] Or the interaction with external sources of knowledge production as one of the function, see Bergek et al (2008) for a discussion on the different functions of a NIS.

[3] Carlsson (2006) reviewed about 750 papers on NIS, and he claims that only 250 have terms such as global or international in their title, keywords, abstract (or table of contents in the case of books); and only **5** explicitly examine internationalisation at the system level. These include two papers by Niosi and Bellon (1994 and 1996), a paper by Fransman (1999) about Japan, and a paper by Bartholomeow (1997), about interdependencies between several innovation systems in the biotechnology sector.

[5] Technological spillovers in a strict sense are externalities that occur when some firms benefit from the original and valuable knowledge generated by other firms without incurring costs. Their existence relies on the public good attributes of knowledge (Griliches, 1992). However, in the literature on FDI and development it is used in a broader way. It is used to reflect all unintentional (and sometimes intentional) benefits generated by an MNC in the host country, which are not fully appropriated by the MNC (or the factors employed by the company). We adopt this more flexible definition in this chapter.

[6] See for instance Patibandla and Petersen (2002) or Wong (1992).

[7] The formulation assumes three things: (a) that output differences that cannot be attributed to the accumulation of any input – the Solow residual – can be conceived as technological progress, (b) that the level of productivity achieved by firms depends not only on its own "research" efforts, but also on the pool of general knowledge accessible to it, and (3) that FDI – similar to R&D – directly augments the domestically available stock of knowledge in its economic space. On this basis, if the rate of productivity growth of domestic firms increases when FDI participation increases, it could be claimed that the presence of MNC in related industries must be *upgrading* the technology of domestic plants -provided that all other possible factors that affect productivity growth of domestic firms have been controlled for in

the estimation. This is the same as saying that there are technological externalities associated to the mere presence of MNC.

[8] A view that reflects neo-classical theoretical perspectives on the MNC, such as the knowledge capital model, which assumes that technological knowledge is mobile and has a joint character within firms. This perspective has been formally developed by Markusen (1995) who argues that technological knowledge within firms can "*be transferred easily back and forth across space at low cost between units, and has a joint character, like a public good, in that it can be supplied to additional production facilities at very low cost*" (Markusen, 1995, p174). On this basis, studies of spillover effects expect that affiliates have easy and virtually costless access to the technological assets developed by the MNC's parents at the centre

[9] These results contrasted with her estimations of spillovers under the other three commonly discussed "models" of spillover effects, which provided non significant results. We refer to the 1) the 'Pipeline Model' (where spillover effects are supposed to arise from FDI in general independently of any other circumstance of mediating effect), 2) the '*Absorptive Capability*' model: (where spillover effects are expected to be dependent on the capabilities of domestic firms) and, 3) the '*Industry Model*' (where spillovers are expected to arise only in the more 'advanced' industries, such as the electronics or capital goods industries).

[10] These results are striking because the whole sample of Indian firms showed a negative externality from FDI, even after taking into account the effects of absorptive capacity on the part of domestic firms.

[11] The term 'technological activity' is used here in a broad sense to relate to any activities concerned with acquiring, accumulating or creating knowledge in subsidiaries.

[12] One example of this is the Brazilian subsidiary of General Motors, which over a period of 80 years moved from performing simple assembly tasks to becoming the fifth most important R&D centre within the corporation. Another example is the case of Seagate Technology Thailand, which between 1982 and nowadays successfully upgrade from merely assembly activities to product development (the process of upgrading of this subsidiary is very well described in Hobday and Rush, 2007).

[13] Evidence from Singapore indicates also that part of the success the country achieved in taking advantage from MNCs operations in the country can be associated with active policies oriented to

promote integration and knowledge flows between the MNCs subsidiaries in the country and their global networks (Wong, 2001).

[14] Nevertheless, total sales by US subsidiaries located in Africa represents only 1.6% of sales by US subsidiaries worldwide.

[15] Measures of poverty are only available for some years in each country.

[16] The diagnostic tests point out to select Fixed Effects model, since the Breusch-Pagan test indicates we must reject the Pool Model in favor of the Random Effect Model and the Hausman test in turn indicates we must choose the Fixed Effect Model. In this latter model, the region variables drop because they are time-invariant.

[17] Different to the previous two models, in the fixed effect model host country poverty and size stop being significant since they do not account for difference across sections (which are controlled for fixed effects) but for the evolution of these variables over four points in time.

[18] R&D of over sales and Sales to affiliates over sales is measured in percentages for years 1990, 1995, 2000 and 2005, using information of the Bureau of Economic Analysis-US Department of Commerce. Host country poverty is the percentage of people that live with less than 2 USD a day over in average for previous five years. Host country GDP is measured in million of 2000 constant PPP in average for previous five years. Information from these two variables come from the World Bank Development Indicators. The base regions are countries in Europe + Canada + Israel.

[19] See Chapter 8 by Pietrobelli and Rabellotti in this volume for a more detailed discussion on sectoral differences in globalization patterns.

[20] It is interesting to note that Kumar (2001) found the variable openness of domestic trade regimes to have a negative and significant effect only for the sub-sample of industrialising counties, while the same did not happen for the whole sample or the sub-sample of industrialised countries. This was interpreted by the author as an indication of the prevalence of R&D for local adaptations in industrialising countries.

[21] We use Spearman (non-parametric) rather than Pearson because data in our sample is not normally distributed and because we want to allow for association between the variables that are not necessarily linear.

[22] We considered most countries with data informed by the Bureau of Economic Analysis - US Department of Commerce: Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Ecuador, Egypt, France, Germany, Greece, Honduras, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Japan, Korea, Republic of, Malaysia, Mexico, New Zealand, Nigeria, Panama, Peru, Philippines, Russia, Singapore, South Africa, Spain, Taiwan, Thailand, Turkey, United Kingdom, and Venezuela.