Foreign Direct Investment and Technology Spillovers:

A Review

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Abstract

This paper reviews the theory and the empirical studies on the hypothesis that FDI may generate technology spillovers to the host countries. There are five sources affecting the scope and significance of the technology spillovers from FDI: (1) linkages between foreign affiliates and local firms, (2) R&D efforts undertaken by MNC affiliates, (3) training of local firms in the foreign affiliates, (4) demonstration effects, and (5) ownership sharing of foreign affiliates.

The study concludes that: (1) The literature and empirical evidence show mixed support for the hypothesis that FDI yields positive spillovers to the host countries. (2) Backward linkages are the strongest channel for diffusing technology from foreign affiliates; governments in host countries can play a significant role in creating and deepening these linkages. (3) Spillovers from FDI may decrease national welfare in most developing countries because the local firms are often not able to compete with MNC, and this may lead to a loss in profits due to the crowding out of these local firms. Henceforth, strong local firms could be the key challenge for developing countries to receive positive spillovers from FDI.

Key words: Foreign investment, Multinational companies, Technology, Developing countries.

1. Introduction

In 2000, Foreign direct investment[1] (FDI) grew faster than world production, capital formation, and trade; its growth rate was 18.2% in 2000 (UNCTAD, 2001). There are 135 countries that reduced barriers to FDI during the period 1990-1998 (UNCTAD, 1999).

There exist two approaches in economic theory to the study of the effects of foreign direct investment. The first approach, whose founder is Macdougall (1960), comes from the theory of international trade. This approach examines the host country's gains from foreign investment. In general, the trade theory approach focuses on the direct effects of foreign investment (direct and portfolio) on factor rewards, employment, and capital flows.

The second approach, whose founder is Hymer (1960), follows from the theory of industrial organization. There are also important contributions made by Buckley and Casson (1976), Caves (1971), Dunning (1973), Kindleberger (1969), and Vernon (1966). This approach addresses the question of why firms undertake investments abroad to produce goods. The answer is that firms undertake investment abroad due

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[1] Throught this paper foreign direct investment refers to inwards foreign direct investment which is defined as "*the category of international investment that reflects the objective of obtaining a lasting interest by a resident entity in one economy in an enterprise resident in another economy*" IMF (1993, p.85). Note that the lasting interest implies the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence by the investor on the management of the enterprise. A resident entity is the direct foreign investor who owns 10 percents (OECD criteria) or more of the ordinary shares or voting power for an incorporated enterprise or the equivalent for an unincorporated enterprise.

to some imperfection in the goods' or factors' (including technology) markets, or due to some interference with competition by governments or by firms. In general, the industrial organization approach focuses on the indirect effects or externalities.

In this study, I shall review the literature and empirical evidence on the impact of technological spillovers from FDI on the host countries. In section 2 I discuss the international diffusion of technology and the role of FDI companies. Section 3 will review the literature on the technology spillovers from FDI. Section 4 will examine the empirical evidence on the sources of the FDI related technology spillovers. Section 5 summarizes and concludes the paper.

2. The international diffusion of technology and the role of MNCs

Fransman (1985) indicates that technology is diffused through many different types of transactions. The first one is called formal market transactions –transfers– which include joint ventures, licensing, and goods trade. The second one is called informal or involuntary technology dissemination, which includes the linkages of Multinational Corporations (MNCs) with the domestic suppliers and customers, trade journals, scientific exchange, et cetera. In both modes the MNCs is the main source of diffusion and generation of technology.

Regarding the formal mode, it is well known that MNCs are the main source of joint ventures, licensing, and goods trade. For example, over 90% of technology payments from developing countries to Germany and more than 60% of the payments to Japan, came from their own foreign affiliates in the early 1980s (UNCTC, 1988, p.177). Also, more than 70% of the goods exports of both the US and the UK are generated by MNCs (UNCTC, 1988, p.90).

For the informal modes of technology diffusion, the MNCs play an important role. We will discuss the linkages with domestic firms in section 3.3. Finally, the other informal transfers (e.g. academic contacts, technical publications, and education abroad) can occur regardless of the presence of foreign affiliates.

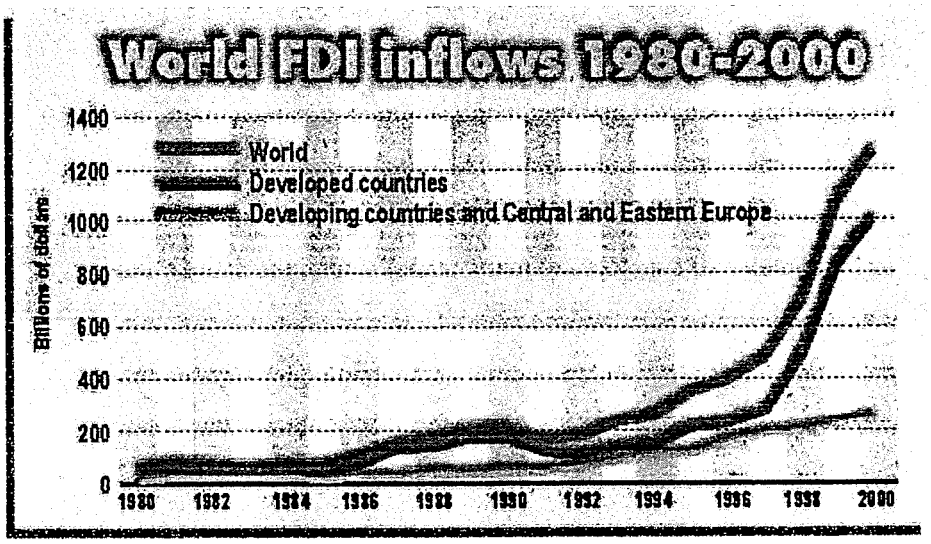
The share of developing countries in world FDI flows declined in the year 2000 for the second time, to 19% compared to the peak of 41% attained in 1994 (see figure 1). FDI is highly concentrated: 95% of FDI inflows to developing countries in 2000 went to two regions only: Latin America and the Caribbean, and Asia and the Pacific (UNCTAD, 2001).

However, the clustering of technology production is more concentrated than FDI flows, where the US, the UK, Japan, Germany, Switzerland, and the Netherlands dominate more than four fifths of the world's research and technology. At the same time, less than 10% of the

R&D expenditures of US manufacturing MNCs come from their majority-owned foreign affiliates (Blomstrom and Kokko, 1997).

Figure 1

The distribution and the trend of World FDI inflows 1980-2000:



Source: UNCTAD, World Investment Report 2001, p.291

3. The literature of the technology spillovers from FDI

Blomstrom and Sjoholm (1998) mention that external effects or spillovers from FDI can be due to two factors. First, the MNCs have new advanced technology that allows them to compete successfully with local firms. Second, the entry of MNCs affects the existing equilibrium in the market by forcing local firms to take action to maintain their market shares and profits. These two factors can affect the productivity and growth of local firms by changing their financing methods, their marketing and production techniques, and their managerial skills.

This paper will focus on the first factor, technological spillovers. The significance of spillovers from FDI may rely on the host industry characteristics and on the policy environment in which the multinationals operate. These characteristics are discussed in detail in the two following sections.

3.1 MacDougall (1960) Model

MacDougall (1960) is the first author to point to spillovers as a byproduct of FDI. In his static model, he assumed that the technology has two inputs, labor and capital, producing output F(K,L) with constant return to scale. He found that when all countries can access an identical technology, countries that have highest K/L ratio will export capital and countries with the lowest K/L ratio will be the recipients of foreign capital; this international relocation of capital is welfare improving for both countries. The MacDougall model predicted that foreign capital inflows (FDI or portfolio capital) will increase the marginal product of labor (MPL) and decrease the marginal product of capital (MPK) in the host country. MacDougall mentioned also that the most important direct gains come through higher tax revenues from foreign investment profits, especially if the higher investment is not induced by lower tax rates. Also, the gains can come through external economies especially when domestic

firms acquire "know how" or when they adopt more efficient methods to face foreign competition.

However, this simple version of the standard neoclassical approach to international capital movements does not lead to significant predictions of international capital movements, unless capital market imperfections are added (Barro et al., 1995). Also, when technologies differ between countries, factor and trade movements become complements, not substitutes. Hence, the main source of international capital movements can be the difference in technology (Harm Zebregs, 1999).

3.2 The Blomstrom model

The early literature suggests that the effect of FDI on host country productivity is positive. Caves (1974) shows that there is a positive relationship between industry average value-added per worker and the share of industry employment in foreign firms for Australian manufacturing in 1966. Similar results can be found in Globerman (1979), Blomstrom and Persson (1983), and Blomstrom (1986).

However, the only study to focus on the nature of spillovers' efficiency in depth is Blomstrom (1986). Blomstrom (1986) focuses on determining what mechanisms (channels) originating from MNCs can improve the efficiency or the technological structure of an industry.

He examines the hypothesis that the technological structure of an industry may be affected by four factors. The first factor is the rate of technical progress: since the increase in technical progress through the new technology may increase the dispersion between the best-practice firm and the industry average. The other factors are competitive pressure, market growth, and ownership structure.

Blomstrom first estimates a model using cross-section data for the year 1975 to test whether the presence of foreign affiliates in an industry has any independent influence on the technological structure. The second step is to examine the different factors of structural change between 1970 and 1975 to see if they are correlated with the foreign ownership structure during this five-year period.

Blomstrom used Mexican Census of Manufacturers data from 1970-1975, as well as unpublished data broken down by ownership in 145 different industries. The equation tested is:

$$e = f(\Delta y+, H, MG, FS)$$

where: e is the productive efficiency for each industry;

$\Delta y+$ is the change in the highest value-added per employee;

H is the Herfindahl index;

MG is the market growth of each industry; and

FS is foreign participation.

The change in the highest value-added per employee ($\Delta y+$) measures the change in the labor productivity in the best-practice plants (frontier) within each industry, i.e. the change in the rate of technical progress in an industry. The Herfindahl index captures the determinants of competition, i.e. the number of firms in an industry, market shares inequality and the potential for coalition formation. The market growth variable (MG) is the employment growth of an industry in the period 1970-1975. Finally, the plant is "foreign" if 15% of its shares are foreign held, which is consistent with the OECD definition of FDI.

Blomstrom's (1986) results indicate that foreign share (FS) has a positive and statistically significant coefficient at the 0.01 level. This means that FDI has a significant positive independent impact on productivity changes in the industry on average. In particular, the average firm in the industries dominated by foreign firms tends to be closer to the frontier. The second result is that FDI can lead to positive technological effects in an industry that has barriers to entry by increasing competition in this industry.

3.3 Other theoretical approaches and empirical difficulties in testing the relation between FDI and Technology

One shortcoming of the Blomstrom (1986) model is that it does not take into account other technological spillovers channels from FDI

such as the training of local labor. Another shortcoming, which is shared by the early literature, is that the optimistic results about the productivity spillover from FDI are derived from cross-section data on average industry characteristics. These optimistic results could mean that FDI flows into high-productivity industries rather than that FDI raises host-country productivity (Hanson, 2001).

Recent studies overcome this shortcoming by using micro-level time-series data on individual manufacturing plants. They can examine how the presence of foreign ownership affects the productivity of domestic plants overtime. Aitken and Harrison (1999) show that the relationship between the productivity growth of domestic plants and the presence of foreign affiliates is negative in Venezuelan manufacturing during the period 1976-1989. Similar results are obtained by Haddad and Harrison (1993). They use data on Moroccan manufacturing plants during the period 1985-1989. Therefore, this second approach, relying on micro-level data, yields results contradicting those derived from the early literature, which relied on industry-level analysis (Hanson, 2001).

Xu (2000) suggests a third approach to test for the presence of spillovers from FDI. He argues that both multi-country studies and single-country studies that examine the relation between technology and FDI are not reliable. The single-country studies are difficult to generalize, while the multi-country studies rely only on FDI data, which do not

reflect the limits of FDI as a proxy for the behavior and policies of MNCs.

Xu constructs a multi-country model using data on the technology transfer intensity of US MNCs' affiliates in 20 developed countries and 20 developing countries from 1966 to 1994. The technology transfer intensity is captured by the affiliates' spending on royalties and license fees that arise from licensing agreements as a share of their value-added. The results indicate that the scope and the significance of spillovers from FDI depend on the host country human capital threshold level. This important model will be analyzed in detail in section 4.6, which discusses the technology spillovers from FDI in least developed countries (LDCs). But it should be mentioned here that this result is consistent with several single-country studies such as Haddad and Harrison (1993), Aitken and Harrison (1999), and Feinberg and Sumit (2001). These studies found that technology spillovers from FDI are insignificant in LDCs.

The third approach seems more accurate than the two other approaches since it uses more reliable data. However, it seems that this methodology does not capture important technology spillover channels from FDI, such as the training of local employees, and demonstration effects. These channels are taken up in the next section.

4. Empirical evidences on the technology spillovers from FDI

There have been no detailed theoretical models discussing spillovers until the late 1970s. The empirical evidence until the late 1970s came from case studies, not from comprehensive theoretical arguments (Blomstrom and Kokko, 1997). These case studies showed that MNCs may lead to improvements in the market efficiency in the host countries through many effects. First, when MNCs enter the market in the host country, they force local firms to use more efficient methods to be able to keep their market shares. Second, the MNCs can introduce new know-how and new superior technologies, as well as train workers who may find a job at local firms in the future. Third, through their new technology the MNCs can overcome the entry barriers and reduce the monopolistic distortions existing in the market. However, recent studies show that these effects are neither guaranteed, nor automatic (Blomstrom and Sjoholm, 1998). The significance of these effects depends on the host country conditions and on the industry characteristics.

Recent studies examine sources or factors that affect the scope and significance of the technology spillovers from FDI. The first channel is constituted of the linkages between foreign affiliates and domestic firms; however, the efficiency of this channel may be limited if the technology gap between MNCs and local firms is too big. The other factors are the R&D efforts undertaken by the MNCs' affiliates, training of local

employees in the foreign affiliates, demonstration effects of FDI on local firms, and the ownership sharing of foreign affiliates. We will discuss all of these sources in detail in the remainder of this study.

4.2 The ownership sharing of foreign affiliates

The empirical results regarding the ownership sharing of foreign affiliates yield contradictory results. Some governments in host countries may impose restrictions on foreign ownership. This forces MNCs into a joint venture, which gives the local firm a chance to be closer to foreign technology and facilitates the transmission of spillovers.

Ramachandran (1993) uses Reserve Bank of India data that describe the transfer of technology from MNCs to firms in India from 1971 to 1981. The study indicates that some MNCs refuse to invest or do not use advanced technologies, especially when the joint venture scheme involves a risk for them of losing their controls over profits and over their advanced technology or intangible assets. The higher the share of foreign ownership and control, the more advanced technologies can spill over from foreign to local firms, and the larger is the scope for spillovers.

On the other hand, Blomstrom and Zejan (1991) found that MNCs may prefer a joint venture even without host country restrictions. The reason is that the local firms have a better understanding of local market conditions such as factor endowment and workers' skills. They found that

most Swedish firms preferred to form joint ventures when investing abroad in 1980s and 1970s.

Bolomstrom and Sjoholm (1998) contribute to the literature by examining the hypothesis that the type of foreign ownership has a significant effect on the level of productivity and the degree of spillovers. They used unpublished Indonesian micro data. They found that labor productivity is higher in foreign firms than in local firms. Their results do not support the hypothesis that the joint venture facilitates technology spillovers to local firms. Also, the degree of foreign ownership does not affect the degree of spillovers to domestic firms. They suggest that the increased competition that follows FDI has more effects on the degree of technology spillovers than the local ownership sharing of the multinational affiliates. This last result is consistent with Blomstrom (1986). Both models use cross-section data on average industry characteristics and we have already discussed the shortcomings of the analysis based on industry-level data.

4.3 Linkages between foreign affiliates and domestic firms

There are three generations of foreign direct investment promotion policies (UNCTAD, 2001). In the first generation policies, the government of the host country sets market friendly policies by reducing

the barriers to inward FDI. Most countries now have these friendly policies.

In the second generation policies, the host country government attracts FDI by "marketing" the country through national investment promotion agencies. The success of both the first and second generations depends on the economic determinants of FDI in the host country.

The third generation policies aimed at attracting foreign direct investors by meeting their specific location needs at the level of firms. The host countries may build industrial clusters that depend on the country's competitive advantages and lead them to acquire "brand names". However, this type of policy is very difficult and takes a long time to implement, especially for developing countries. But this approach brings up the importance of local firms' capabilities in attracting FDI.

In the following subsections I shall review the empirical studies on the linkages between foreign affiliates and the local firms as the strongest channel for technology diffusion from foreign affiliates. There are two linkages. The first are "backward linkages"; they arise from the relationship between foreign affiliates and local suppliers. The second are "forward linkages"; they stem from the relationship between foreign affiliates and local customers.

4.3.1 Backward linkages

Empirical evidence suggests that the *local content* in the foreign affiliate production is one of the key determinants of the linkages' strength. Reuber et al. (1973) found that a third of the purchases of foreign affiliates in all developing countries came from local firms in 1970. Also, they found that the affiliates in Latin America and India purchased more from local suppliers than affiliates in the Far East as a result of the differences in local content ratio imposed by governments. The second determinant is the affiliates' market orientation; they found that local-market oriented affiliates have more backward linkages than the export-oriented affiliates. However, this study says nothing about the basic determinant which is the technical capability of local suppliers.

Lall (1980) found significant linkages between foreign affiliates and local suppliers in two Indian truck manufacturers, one of which is a MNCs and the other is a joint venture. He showed also that the foreign affiliates provide technical assistance and training to increase the quality of local suppliers in India in the 1970s. Another illustration of the importance of backward linkages is McAleese and McDonald (1978), who show that the share of local inputs in Irish manufacturing increased during the period 1952-1974.

In developed countries technology and knowledge flows move in both directions, from foreign affiliates to local suppliers and vice verse.

Branstetter (2000), using Japanese FDI firms' data, shows that FDI increases the knowledge-spillovers from and to the investing Japanese firms. This is in contrast to most developing countries, where the flows move only from foreign affiliates to local suppliers. The well-known reason for this contrast is that local suppliers are very weak in most developing countries compared with developed countries. Similar results can be found in Liu et al. (2000) who use panel data for 48 UK industries from 1991-1995. They found that the benefits of local firms from the foreign affiliate's advanced technology depend mainly on their technological capabilities.

Backward linkages provide important benefits to the foreign affiliates. They can lower the cost of production of the foreign affiliates through the purchase from local suppliers, and they provide the foreign affiliates with access to the external technological and skill resources of the technologically advanced local suppliers. Henceforth, many MNCs have local supplier development programs that try to help current suppliers to improve their capabilities through training, financing, and sharing information, as well as other programs described in table 1.

Table 1. Measures by foreign affiliates to create and deepen linkages

Creation of new linkages	• Making public announcements about the need for suppliers • Making public announcements about requirement those firms must meet on cost and quality audits. • Supplier visits and quality audits.
Transferring of technology	• Product technology: e.g. collaboration in R&D. • Process technology: e.g. technical support on inspection and testing. • Managerial know-how assistance: e.g. assistance to implementing quality assurance systems.
Providing training	• Training courses in affiliates for suppliers personnel. • Sending team of experts to suppliers. • Promotion of cooperative learning among suppliers. • Offering access to internal training program abroad.
Sharing information	• Exchanges information on future requirement • Provision of market information. • Provision of annual purchase orders. • Encourage suppliers to join business associations.
Financial support	• Long-term financial assistance and guarantees for bank loans. • Providing special pricing for suppliers' products. • Helping suppliers' cash flow through advance purchases and payments, promote settlements and provision of foreign exchange.

Source: UNCTAD, World Investment Report 2001, p.214.

Of course, domestic suppliers and the host economy as a whole also benefit from linkages. Backward linkages likely increase the output, employment, workers' skills, and managerial capabilities of the domestic suppliers. The strong and efficient suppliers can lead to the substitution of local inputs for imported ones. In consequence, the governments in host countries have a duty to create and strengthen backward linkages by solving the different market failures at different levels in the linkage process (UNCTAD, 2001). Table 2 provides examples of such policies.

Table 2. Government specific measures to create and deepen linkages

Information and matching	- Provision of information: • Constantly updated electronic databases, and Handouts. - Matchmaking: • Organizing meetings, visits to plants • Acting as honest broker in negotiations. • Supporting advice on subcontracting deals. • Sponsoring fairs, exhibitions, mission, and conference.
Technology upgrading	• Incentives for R&D Cooperation. • Partnership with foreign affiliates. • Home-country incentives. • Technology transfer as a performance requirement.
Training	• Support to private sector training program • Collaboration with international agencies. • Promoting suppliers associations
Financial assistance	• Legal protection against unfair contractual arrangements and other unfair business practices. • Direct role in providing finance to local firms • Co-financing development programs with private sector. • Mandatory transfer of funds from foreign affiliates to local suppliers. • Encouraging of Payment delays through legislations. • Tax credit or tax reductions and other fiscal benefits to providing long-term funds to suppliers.

Source: UNCTAD, World Investment Report 2001, p.210.

The importance of the government's role in creating and deepening the linkages is increasing over time, especially when we know that the technological specialization of foreign affiliates mainly depends on the regional system and its technological system (Cantwell and Iammarino, 2000). As table 2 indicates, the first task is to reduce the "information gap" between buyers and suppliers by building the accurate and updated electronic databases to allow both buyers and suppliers to know the linkage opportunities. The second task is to solve the "capability gap"

between the requirements of buyers and the capabilities of suppliers by helping local suppliers to upgrade their technology, setting the incentives for R&D cooperation, supporting the private sector training programs, and providing long-term loans to suppliers. Also, the government should take into account that the linkage formation process is affected by economic and political stability, the institutional framework, the quality and availability of human resources and the infrastructure in host countries.

Sadik and Bolbol (2001) use data from five Arab countries: Oman, Morocco, Saudi Arabia, Tunisia, and Egypt from 1978 to 1998. They suggest that the government's incentives can be justified on economic grounds in two cases. The first case arises when the foreign affiliate is export-oriented. In this case, competition in international markets makes the foreign affiliates more innovative. The second case is when the technology gap between foreign affiliates and local firms is large – which is the case for high-technology goods in most developing countries. In both cases the government's incentives can lead to stronger technology spillovers from FDI.

A related important result shown by Xu (2000) is that a country must reach a minimum human capital threshold level to get positive technology spillovers from US affiliates in DC and LDCs during 1966 to 1994. This model will be discussed in detail in section 4.7.

Recently, Malaysia, Thailand and Mexico have been success stories (UNCTAD, 2001). These countries relatively succeeded in supplying advanced technological inputs to foreign affiliates. This could be a main factor explaining why the FDI in these countries increase relatively overtime during the 1990s.

The analysis of backward linkages reveals that: (1) backward linkages are the most powerful channel for the host countries to get the skills, knowledge, and technology that spill over from foreign affiliates; and (2) strong domestic suppliers attract foreign direct investment. The challenge for the host countries, especially developing countries, is to create and deepen these backward linkages (UNCTAD, 2001).

4.3.2 Forward linkages

There is an important role for MNC-customer linkages stemming from the fact that MNCs are the main source of R&D in many industries, especially the most technically advanced ones. Also, it is a major source of expertise, especially in computer-based automation and information technologies.

There are fewer empirical studies on forward linkages than ~~there are~~ on backward linkages. McAleese and McDonald (1978) mention that forward linkages in the Irish economy increased in the same way as backward linkages did in the 1970s. Aitken and Harrison (1991) show

also that the downstream effects of foreign affiliates are more than the upstream effects in Venezuelan manufacturing between 1976 and 1989.

Blomstrom and Kokko (1997) conclude that linkages are increasing over time with the growing managerial and technological skills of local firms, new information about new suppliers, and the increase in local content.

4.4 R&D efforts undertaken by the foreign affiliates

The best starting point of this subsection is to overview the data on the distribution of the world R&D among countries and the role of FDI in that distribution. OECD countries were responsible for 96% of the world's R&D expenditure in 1990 (Helpman, and Hoffmaisr, 1997). The United States, Japan, Germany, the United Kingdom, and France had over 80% of the OECD's research scientists and engineers in the late 1980s (Eaton and Kortum, 1999).

The importance of the R&D undertaken by foreign firms becomes obvious if we know that the R&D performed in the US by foreign firms in 1992 is $14 billion, which represents 13% of the R&D performed by all US based businesses (Catherin, 2000). UNCTAD (1999) found more significant contributions of MNCs in improving and developing Indian research centers in the early 1990s; see table 3.

Table 3. Collaboration of Indian research centers with MNCs: R&D contracts awarded by MNCs to Indian publicly funded R&D institutes in the early 1990s

Institution	MNC involved	R&D area
IICT, Hyderabad	Du Pont, United States	Pesticide chemistry (by screening agrochemical molecules).
IICT, Hyderabad	Abbot Laboratories, United States	Synthesis of organic molecules and advisory consultancy.
IICT, Hyderabad	Parke Davis, United States	Supply of medical Plants
IICT, Hyderabad	Smith Kine and Beecham, United states	Agrochemical and pharmaceutical R&D.
NCL, Pune	Du Pont, United States	Reaction engineering, process modeling for new polymers, nylon research, catalysis, and scouting program.
NCL, Pune	Akzo, Netherlands	Zeolite based catalyst development
NCL, Pune	GeneralElectric, United States	Processes for intermediates of Ploycarbonates.

Source: UNCTAD, World Investment Report 1999, p. 213.

However, empirical studies contradict the claims of the significance of R&D spillovers from foreign direct investment. Catherin (2000) examines the significance of the effects of FDI on R&D intensity using US panel data from 1981-1991. Catherin found that the industry R&D intensity is significantly affected only by non-greenfield (e.g., mergers and acquisitions) FDI firms. There are three possible explanations for this result. First, the acquired firm's technology could be more advanced than the technology of the foreign (acquiree) firm. In this case this foreign firm would like to justify the technology it has acquired. So, it increases its R&D spending, which can lead to an increase in the R&D intensity of the industry as a whole. Second, the foreign affiliates may want to adapt their technology to US (host country) conditions.

Finally, domestic firms may increase their R&D spending to remain competitive.

The second important result of Catherin (2000) is that there is a fluctuation in the significance of non-greenfield foreign direct investment due to the home countries of foreign direct investment. Catherin found that US domestic firms feel more threatened by foreign affiliates from Japan. At the same time, she found that Japanese firms have more motivations to know more about the technology they have acquired than other foreign affiliates in the US. So, she concludes that there are larger R&D effects in those industries that have more non-greenfield Japanese FDI.

Hejazi and Safarian (1999) also found significant R&D spillovers from United States foreign affiliates in the other OECD countries and from the six largest industrial countries to smaller OECD countries during the period 1971-1990. A similar result is obtained by Mohnen (1996).

However, some studies contradict Catherin (2000). Lichtenberg and van Pottelsberghe del la Potterie (1998) did not find any impact of inwards FDI flows on the knowledge spillovers in OECD countries from 1971 to 1990. Lichtenberg and Van Pottelsberghe del la Pottrie (2001) use FDI data of 22 industrialized countries over the period 1971-1990. They found that FDI transfers technology only when the country invests in R&D-intensive foreign countries.

Xu and Wang (2000) investigated the role of FDI in international technology diffusion using a sample of 13 OECD countries over the period 1983-90. They found R&D spillovers for both inward and outward FDI statistically insignificant. However, their results should be interpreted with caution because of the low quality of FDI data that they used.

4.5 Training of local employees in the foreign affiliates

The studies of the MNCs' affiliates training to local employees come mainly from developing countries. The reason is that the education system and skills of workers in these countries are usually relatively weaker than in developed countries. The training includes all levels of employees from machine operators to supervisors and top-level managers. The type of training depends on the skills needed; it varies from seminars to overseas education to on-the-job training.

Empirical studies show that spillovers include both technical and management skills in developing countries. Gerschenberg (1987) shows that the foreign affiliate generally provides more local employees training than do private local firms in Kenya. Gerschenberg uses data for 72 top and middle managers in 41 manufacturing firms. He found that Managers sometimes move from foreign affiliates to other local firms and this leads

to more know-how spillovers. As a result, the MNCs gives its employees higher wages as an incentive for them to stay with the company.

Gangti and Ding (1998) use panel data on 50 Chinese cities and find that the main benefit of FDI inflows in China is the improvement in human resources rather than any improvement in overall technological progress in the early 1990s. A similar result can be found in Caves (1996) and Chen (1983).

4.6 Demonstration effects

The empirical evidence regarding the demonstration effects of foreign affiliates on domestic firms is very scant, for two reasons. It is difficult to know how and where a local firm learns about the new technology it is using, and the demonstration effect is often related to competition.

Mansfield and Romeo (1980) use a sample of US-based multinationals from 1960 to 1978. They show that domestic firms imitate the behavior of foreign affiliates in order to remain competitive in the market. A similar result can be found in Junkins (1990). From the previous discussion, we know that the entry of MNCs may increase the level of competition and force local firms to use more technological techniques to be more efficient.

On the other hand, foreign entry may force local firms out of the market. This could lead to a monopoly in the local market; this means that there is no positive spillover through competition or demonstration effects. UNCTAD (1999) examines the hypothesis that FDI leads to the crowding out of local firms in 39 countries from 1970 to 1996. The study concludes that this situation is more likely to happen in developing countries than in developed countries: local firms in developing countries often have weak technological, financial and managerial capabilities that do not allow them to compete strongly with the foreign affiliates. LDCs have some peculiarities which are taken up in the next subsection.

4.7 Technology spillovers from FDI in the least developed countries

As discussed in section 3.3, recent work does not support the hypothesis that FDI spillovers have positive effects on productivity in LDCs ~~countries~~. Aitken and Harrison (1999), Haddad and Harrison (1993), Xu (2000), as well as Zukowska (2000) obtain similar results that do not support the optimistic results found in the early literature, as discussed in section 3.

Blomstrom and Kokko (1997) provide a good explanation. They indicate that MNCs often enter industries that have relatively high barriers to entry, and concentration may improve the efficiency through increasing competition; this result is in agreement with the Blomstrom

(1986) model discussed above. However, they suggest that, in the long run, these MNCs may lead to more concentrated markets and may crowd out local firms. Also, they mention that when MNCs make markets more concentrated, this could give the MNCs a chance to make more profits, which can be used for increasing their R&D expenditures. But again, this is more likely to happen in developed countries than in developing countries. In developed countries, local firms can compete intensively with the foreign affiliates and both of them have an incentive to increase their R&D expenditures to increase or at least keep their market shares (see section 4.4).

Xu (2000) found that the technology transfer of U.S affiliates is less in the host developing countries than in the host developed countries. As discussed briefly in section 3.3, Xu uses a multi-country model using data on the technology transfer intensity of US MNCs affiliates in 20 developed countries and 20 developing countries from 1966 to 1994. The technology transfer intensity is captured by the affiliates' spending on royalties and license fees that arise from licensing agreements as a share of their value-added. These licensing agreements may include trademarks, copyright, patents, and know-how such as industrial processes.

Xu (2000) constructs three measures to determine technology spillovers from US MNCs' affiliates. The first measure, the value-added

of MNCs' affiliates / GDP, reflects the effect of the presence of MNCs on total factor productivity growth in the host country. The second measure, technology transfer spending of MNCs' affiliates / value-added of MNCs' affiliates, can reflect the effect of technology transfer by MNCs on total productivity growth in the host countries. The third one is technology transfer spending of MNCs' affiliates / GDP in the host country; this can measure the technology diffusion effect of MNCs in the host country.

Xu's results indicate that technology transfer of US MNCs can have positive spillovers on the productivity growth in the host country only if this country has a minimum threshold level of human capital (more than 1.4 years in terms of male secondary school attainment). He found that the average male secondary school attainment is 2.7 years in developed countries but only 1.4 years in LDCs. Xu's argues that this result could partially explain why the technology spillovers from FDI are very weak in the LDCs.

This minimum level is much higher than the 0.52 year threshold obtained by Borensztein et al. (1998). The reason is that the latter study estimates the minimum level of human capital that allows the host country to benefit from the presence of MNCs, i.e., only the first measure that Xu (2000) constructs to capture the technology spillovers from US MNCs' affiliates. Moreover, Xu found that some developing countries

such as Mexico, Peru, Venezuela, and Argentina have human capital levels above 0.52 and the technology spillover from FDI in these countries is insignificant. As mentioned in section 3, this model seems to be more accurate than the previous models, in part because it uses more reliable data. However, a shortcoming of this methodology is that it does not capture the other technology spillover channels from FDI discussed in this study.

To summarize, we have just showed that empirical studies find that the technology spillovers from FDI in developing countries are generally not significant, and less than those found in developed countries. This deficiency is due to the weak capabilities of local firms and the weak level of human capital in the developing countries.

5. Summary and conclusions

This paper reviewed the theory and the empirical studies on the hypothesis that foreign direct investment may generate positive technology spillovers to the host countries. The early literature had shown optimistic results about the productivity spillovers from FDI. This result comes, however, from their use of cross-section data on average industry characteristics. So, this positive and significant relationship between industry productivity and foreign ownership means that those foreign direct investments likely flow into high-productivity industries, rather

than that FDI raises host-country productivity. Recent studies sort out this confusion by using micro-level, time-series data on individual manufacturing plants. Recent results seem to be quite different from those generated in early literature in the case of developing countries.

The paper indicates that the empirical studies found five sources affecting the scope and significance of the technology spillovers from FDI: (1) the linkages between foreign affiliates and local firms; (2) R&D efforts undertaken by MNCs' affiliates; (3) training of local firms in the foreign affiliates; (4) Demonstration effects of FDI on local firms; and (5) ownership sharing of foreign affiliates.

Empirical studies on the linkages between foreign affiliates and local firms show that forward linkages grew in the same way as backward linkages. However, backward linkages are the most powerful channel to spill over technology from MNCs to the host countries. The capabilities of local suppliers, local content, and foreign affiliates' market orientation are the key determinants to create and strengthen backward linkages. Governments and MNCs have incentives and duties to promote and deepen those linkages.

Empirical studies suggest that the significance of R&D spillovers from FDI depends on the home country of FDI, the level of competition in the local market, and sometimes the quality of the FDI data. However,

R&D spillovers from outward FDI are likely to be more significant than inward FDI.

The empirical studies on the ownership sharing of foreign affiliates and on the demonstration effects are relatively few and show mixed support for the positive spillovers from FDI. However, the empirical studies on the training of local employees in the foreign affiliates suggest the presence of positive spillovers from FDI through training local employees who can move to local firms. Also, the training expenditures seem to be higher in foreign affiliates than in local firms.

The literature and empirical studies indicate that technology spillovers from FDI in developing countries are generally not significant, and are less than in the developed countries. This is due to the lack of competition, the weak capabilities of local firms, as well as the weakness of human capital in the developing countries. MNCs in most developing countries may crowd domestic firms out of the market and this may lower national welfare.

I can conclude here that the technology spillovers from FDI may increase or decrease national welfare, depending on whether the positive FDI spillovers due to competition and strong local firms matter more than the loss in profits due to the crowding out of local firms.

Although recent work seems to have succeeded in explaining why the early literature had obtained optimistic results, some issues are still

looming and need more research. The first issue comes from the fact that there is no agreement among researchers on the significance of the multiantionals' R&D, demonstartion effects (which have not been studied very extensively), and the ownership sharing of foreign affiliates as channels of technology spillovers from FDI. One explanation may be the poor quality of FDI data. An alternative explanation lies in the countries being studied, for example the small sized countries and the LDCs generally have weak spillovers from FDI.

The second issue in need of clarification is whether there are other factors (such as the weakness of government expenditure on the R&D) which are more significant than the weakness of local firms and human capital levels in LDCs, and which can lead to the weakening of technological spillovers. Finally, to what extent does the entry of a MNCs differ from the entry of a domestic firm of comparable size? Should the study of FDI be more integrated with the study of entry and its effects on innovation more generally?

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