Entry for Encyclopedia of Financial Globalization:

Foreign Direct Investment and International Technology Transfer

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I. Introduction

This paper reviews the evidence on international technology transfer taking place through flows of foreign direct investment (FDI). It starts by looking at arguments for why one would expect FDI to serve as a channel of knowledge transfer across international borders. It then presents evidence on knowledge transfer from headquarters to foreign affiliates of multinational companies. Establishing that such transfer takes place suggests that foreign affiliates can be a potential source of knowledge externalities for host countries. Further, the literature on intra-industry, inter-industry and exporting spillovers is discussed.[1]

The paper draws on the case study literature, enterprise surveys and econometric studies and concludes that FDI is indeed an important channel of transmitting technologies and know-how across countries. The article concludes with some policy recommendations.

II. Why should we expect FDI to be a source of knowledge transfer across international borders?

A basic tenet of the theory of the multinational firm is that such firms rely heavily on intangible assets in order to successfully compete with indigenous producers that are more familiar with the host country environment. These assets, named ownership advantages by Dunning (1988), can take the form of new technologies and well-established brand names, know-how or management techniques. Intangible assets, developed in headquarters, can be easily transferred to foreign subsidiaries and their productivity is independent of the number of facilities in which they are employed. Multinationals therefore offer the world increased technical efficiency by eliminating the duplication of the joint input that would

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[1] This chapter focuses on micro-level evidence. For a review of the macro literature on FDI and growth see the chapter by Kalemli-Ozcan and Villegas-Sanchez in this volume. For a review of both the macro and the micro literature with an emphasis on the role of complementary local conditions see the chapter by Alfaro and Johnson in this volume.

occur with independent national firms (Markusen 2002). The existence of ownership advantages is echoed in the recent theoretical work focusing on heterogenous firms which suggests that only the most productive establishments can afford the extra cost of setting up production facilities in a foreign country and predicts that multinationals come from the upper part of the productivity distribution of firms in their country of origin (Helpman et al. 2004).

The data confirm that multinationals are responsible for a vast majority of the world's research and development (R&D) activities. In 2002, 700 firms, 98 percent of which are multinational corporations, accounted for 46 percent of the world's total R&D expenditure and 69 percent of the world's business R&D. Considering that there are about 70,000 multinational corporations in the world, this is a conservative estimate. In 2003, the gross domestic expenditure on R&D of 3.84 billion dollars by the eight new members of the EU[2] was equal to about half of the R&D expenditure of the Ford Motor (6.84 billion), Pfizer (6.5 billion), DaimlerChrysler (6.4 billion) and Siemens (6.3 billion) during the same year. It was comparable to the R&D budget of Intel (3.98 billion), Sony (3.77 billion), Honda and Ericsson (3.72 billion each) (see UNCTAD 2005). More than 80 percent of global royalty payments for international transfers of technology in 1995 were made from foreign subsidiaries to their parent firms (UNCTAD 1997).

Even though most of the R&D activities undertaken by multinational corporations remain in their home country, recent years have witnessed a growing internationalization of R&D efforts. According to data collected by UNCTAD (2005) in their 2004-5 survey of the world's largest R&D investors, the average respondent spent 28 percent of its 2003 R&D budget abroad, including in-house expenditure by foreign affiliates and extramural spending on R&D contracted to other countries.

III. Evidence on knowledge transfer to foreign affiliates

The arguments presented in the previous section suggesting that multinationals have the potential to serve as a channel of technology and know-how transfer across international borders do not immediately imply that such transfer actually takes place. Although many studies document superior performance of foreign affiliates relative to domestic firms in a host country (e.g., Aitken and Harrison 1999, Javorcik 2004a), their findings do not provide evidence of a *causal* relationship between foreign ownership and firm performance. This is because a significant share of foreign affiliates are established through foreign acquisitions of indigenous plants and thus the superior performance of foreign affiliates found in these studies may result from multinationals acquiring the best performing indigenous plants in a host country rather than from characteristics of the foreign parents. Focusing on foreign affiliates established as greenfield projects would avoid the selection bias, but unfortunately empirical studies, constrained by data availability, usually do not distinguishes between greenfield and other types of FDI.

[2] The group includes the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. As the 2003 figures were not available for Lithuania and Slovenia, the 2002 data were used for these countries.

Assessing a causal effect of foreign ownership on productivity poses a number of challenges. Firms acquired by foreign investors are unlikely to be a random sample from the population. To the extent that the acquisition targets differ systematically from other firms, a problem of simultaneity between ownership status and other performance-relevant variables will arise and bias the estimate of the productivity advantage. Addressing the simultaneity issue imposes strong requirements on the data, as one needs to observe firms changing ownership both before and after the change takes place. Typically, in a short plant-level panel only a handful of such cases can be found.

The few studies examining the causal relationship between foreign ownership and firm performance have produced mixed conclusions. Harris and Robinson (2003), using data from the UK, find that foreigners tend to acquire the best performing local firms and that foreign ownership does not lead in general to an improved performance of the acquired firm. In contrast, Conyon et al. (2002) conclude that acquisitions have a positive effect on the labor productivity of the acquisition targets in the UK. A similar conclusion is reached by Girma and Görg (2007), who focus on food and electronics sectors in the UK and Griffith (1999) who considers the British car industry.

A possible explanation for the lack of consistent findings is that all of the above mentioned studies focus on an industrialized country where the technological gap between multinationals and their acquisition targets is unlikely to be large. One would expect that the positive effect of foreign acquisitions, if it exists, is more likely to manifest itself in developing economies. Indeed Arnold and Javorcik (2009), using Indonesian plant-level data, confirm that changes from domestic to foreign ownership lead to improved performance. They find that the increase in plant productivity is quite significant, reaching about 13.5 percent in the third year of foreign ownership.

Although, the work of Arnold and Javorcik does not explicitly measure technology transfer, it documents the fact that productivity improvements take place simultaneously with increases in investment in machinery and equipment, employment, wages and output, suggesting an on-going restructuring process. Plants receiving foreign investment also become more integrated into the global economy by exporting a larger share of their output and sourcing a larger share of their inputs from abroad. Thus, it is likely that acquired plants receive transfer of technologies embodied in machinery and equipment as well as in imported inputs.

Proprietary technologies form only part of multinationals' ownership advantages. Tacit knowledge, know-how, management techniques and marketing strategies may be equally important factors behind the success of multinationals and transfer of such knowledge can be invaluable to FDI recipients in foreign countries. Arnold and Javorcik's study provides some hints that such transfer does take place. In their data, FDI does not appear to induce increases in the skill intensity of the labor force (defined as the share of white collar workers in total employment) or the capital-labor ratio, which begs the question what factors explain the increase in total factor productivity, labor productivity and wages?

There are several potential explanations. The first one is that new foreign owners introduce organizational and managerial changes that make the production process more efficient by reducing waste, lowering the percentage of faulty product and using labor more effectively.[3] Another possibility is that while foreign owners do not alter the skill composition of labor, they are able to attract more experienced and motivated workers.[4] They may also substitute expatriate staff for local managers and introduce pay scales linked to performance in order to motivate their staff.[5] This possibility is in line with the earlier observation that acquired plants hire a large number of new employees and raise the average wage. Further, foreign owners may invest more in staff training, which is consistent with international experience.[6] Yet another possibility is that the use of higher quality inputs or more suitable parts and components translates into higher productivity.[7] This possibility is supported by the observation of FDI leading to a greater reliance on imported inputs.

The positive effects of foreign acquisitions are not restricted to manufacturing sectors. Arnold et al. (2009) find that foreign acquisitions of Czech services providers result in large changes in the labor productivity and sales of the acquired firms. These findings are consistent with foreign services providers bringing new technologies and know-how to the Czech Republic and providing services with greater appeal to Czech consumers.

The findings of econometric studies are in line with the conclusions of the case study literature. In a survey of case studies from around the world, Moran (2007) gives many examples of knowledge, know-how and technology transfer from parent companies to foreign affiliates. However, he also argues that in distorted environments, where host governments impose local content, joint venture or technology transfer requirements, foreign affiliates are less likely to receive such transfers.

Protection of intellectual property rights (IPRs) in the host country appears to be an important determinant of the composition and the knowledge content of FDI inflows. Branstetter, Fisman and Foley (2006) examine whether technology transfer within U. S. multinational firms responds to IPR reforms undertaken by 16 countries over the 1982–1999 period. Their analysis of firm-level data reveals that royalty payments for technology

[3] A relevant example of organizational changes introduced by a foreign investor in its Chinese affiliate is presented in Sutton (2005). According to the interviewed engineer, what mattered was not the obvious alternation to the physical plant, but rather inducing a shift in work practices. This shift involved a move away from traditional notions of inspection at the end of the production line to a system in which each operator along the line searched for defects in each item as it arrived and as it departed. The idea of such constant monitoring was in part to avoid adding value to defective units. More importantly, this system allowed for a quick identification and rectification of sources of defects.

[4] About 10 percent of Czech firms surveyed by the World Bank in 2003 reported that they lost employees as a result of FDI entry into their sector (Javorcik and Spatareanu 2005).

[5] Lipsey and Sjöholm (2004) find that foreign affiliates in Indonesia pay higher wages to workers with a given educational level than domestic producers.

[6] Filer et al. (1995) found that in foreign-owned firms in the Czech Republic spent 4.6 times more than domestic firms on hiring and training. A study focusing on Malaysia also showed that foreign-owned firms provide more training to their workers than domestic enterprises (World Bank 1997).

[7] For instance, a lower percentage of faulty inputs translates into fewer final products that must be rejected at the quality control stage.

transferred to foreign affiliates increase at the time of reforms, as do affiliates' R&D expenditures and total levels of foreign patent applications. Increases in royalty payments and R&D expenditures are concentrated among affiliates of parent companies that use US patents extensively prior to reform and are therefore expected to rely heavily on IPR protection. For these affiliates, increases in royalty payments exceed 30 percent. Evidence from Eastern Europe and the former Soviet Union, presented by Javorcik (2004b) suggests that that weak IPR protection deters foreign investors in technology-intensive sectors that use patents extensively. The results also indicate that a weak intellectual property regime encourages investors to undertake projects focusing on distribution rather than local production.

The level of governance in the host country may also matter for the knowledge content of FDI inflows. Weak governance is likely to decrease the effective protection of investor's intangible assets and lower the probability that disputes between foreign and domestic partners will be adjudicated fairly. At the same time, a local partner may be more valuable in a difficult operating environment. The empirical evidence suggests that the latter effect dominates, as it indicates that a high level of corruption shifts the ownership structure away from wholly owned subsidiaries and towards joint ventures (Javorcik and Wei 2009). This finding matters because survey evidence indicates that technologies transferred to wholly owned subsidiaries are of a newer vintage than licensed technologies or those transferred to joint ventures (Mansfield and Romeo 1980). Foreign investors also tend to devote more resources to technology transfer to their wholly owned subsidiaries than to partially owned affiliates (Ramacharandran 1993). Moreover, econometric studies show that multinational enterprises with the most advanced technologies tend to enter a host country through wholly owned subsidiaries rather than joint ventures (Asiedu and Esfahani 1998, Javorcik and Saggi 2010).

IV. Knowledge externalities

The key question of interest to policy makers is whether the knowledge transferred to foreign affiliates of multinational companies is confined to the affiliates or whether it spills over to indigenous enterprises. The knowledge in question may involve information about proprietary technologies or new products, but it may also relate to quality control procedures, management strategies or inventory planning systems. Multinationals take a great care to protect their proprietary technologies or product innovations, but they may be open to sharing their know-how related to quality control or inventory planning, particularly if this knowledge is scarce in the host country but commonly available in the home economy. In general, while it not in the interest of multinationals to facilitate knowledge flows to their local competitors, they may have an incentive to transfer information to their local suppliers.

The literature on knowledge externalities from FDI can be divided into three strands: studies on spillovers taking place within industries, studies focusing on spillovers to the supplying sectors and studies examining whether multinational presence generates information about opportunities in the export markets.

A. Spillovers within industries

The existing surveys of the extensive literature on intra-industry spillovers from FDI conclude that the evidence on such spillovers is ambiguous (Görg and Strobl 2001, Saggi 2002, and Görg and Greenaway 2004). The surveys point out that while industry-level studies tend to produce evidence in support of FDI spillovers, these findings are rare in firm-level panel studies. Similarly, cross-sectional firm-level studies are more likely to find evidence than firm-level panel studies. Cross-sectional evidence is unlikely to be reliable due to reverse causality problems. A finding of a positive correlation between presence of FDI and productivity of firms operating in the same industry may simply be a reflection of multinationals being attracted to more productive industries. However, even firm-level panel studies produce mixed conclusions.

The ambiguous results emerging from the literature are not surprising given that the presence of multinationals affects domestic firms operating in the same industry through several channels. While isolating these channels in an econometric study is challenging, if not impossible, the plethora of effects is clearly reflected in the results of enterprise surveys.

The first channel relies on real externalities, such as the diffusion of knowledge through the demonstration effect. As local firms observe their foreign competitors, they learn about new technologies (some of which can be embodied in machinery or inputs which are relatively easily available for purchase), new marketing techniques and new types of products. Local firms hire workers trained by multinationals and in this way find out about new management strategies and benefit from the training multinationals provided to their former employees. The diffusion of knowledge should have an unambiguously positive effect on local firms. The results of surveys from the Czech Republic (2003) and Latvia (2003) indicate that local firms in both countries learn from multinationals about new technologies, marketing techniques and benefit from the knowledge of workers who had been previously employed by multinationals.[8]

The second channel takes the form of pecuniary externalities and can be referred to as a competition effect. Entry of multinationals increases the level of competition within the industry as long as some share of their output is sold on the host country market. Even host countries with liberal trade regimes may experience an increase in the level of competition. By producing locally multinationals save on transportation costs and, in the case of emerging markets, also on labor costs and thus can offer their products at lower prices relative to the prices charged before entering the host country. In the long run, increased competition provides incentives for indigenous producers to improve their performance and leads to exit of the worst performers and an increase in the average productivity level in the industry. But in the short- to medium-run weaker firms may experience a decline in the observed performance as their market share shrinks.[9] This mechanism was first pointed out

[8] For a description of the surveys see Javorcik (2008).

[9] It is worth noting that while pecuniary externalities have a negative impact on the affected firms, they lead to more efficient outcomes for the economy as a whole. As a result of increased competition in product, labor and credit markets resources are reallocated

by Aitken and Harrison (1999) who documented negative intra-industry spillovers from FDI in Venezuela. This channel is clearly at work in both the Czech Republic and Latvia where between 48 and 41 percent of indigenous producers, respectively, said that foreign entry increased the level of competition in their industry, and a smaller, though significant percentage (29%), reported losing market share to the foreign entrants (see Chart 1).

It is interesting to note that both of the above mentioned channels can be at work at the same time. For instance, local firms in the Czech Republic seemed to benefit equally from the knowledge flows from their direct competitors as well as from multinationals operating in their sector with whom they were not competing (Javorcik 2008). Crespi et al. (2007), who combined self-reported data on sources of new knowledge from U.K. innovation surveys with information on firm-level total factor productivity, found that competitors are one of the key sources of knowledge that contributes to firm performance. They also showed that the reported knowledge flows from competitors are positively correlated with the presence of multinationals in the same industry.

Finding direct evidence on the channels through which spillovers take place has proven to be difficult, but some progress has already been made. Görg and Strobl (2005) use Ghanaian data on whether or not the owner of a domestic firm has previous experience working for a multinational, and relate this information to firm-level productivity. Their results suggest that firms which are run by owners who worked for multinationals in the same industry immediately prior to opening their own firm are more productive than other domestic firms. Balsvik (2010) documents extensive labor mobility flows from multinationals to non-multinationals in Norwegian manufacturing during the 1990s. During this period 14,400 workers moved from multinationals to non-multinationals. By the year 2000, 28 percent of workers employed in non-multinationals had previously been employed in multinationals. Balsvik finds a robust and significant positive correlation between the share of workers with multinational experience and the productivity of non-multinationals. This finding is consistent with spillovers through labor mobility. Workers with multinational experience contribute 20 percent more to the productivity of their plant than workers without such experience, even after controlling for differences in unobservable worker characteristics. The difference between the private returns to mobility and the productivity effect at the plant level suggests that this type of labor mobility represents a knowledge externality. The same issue is examined by Poole (2009) in a somewhat different manner. Poole also uses matched employer-employee data but she focuses on Brazil and studies wage spillovers. She estimates wage equations for incumbent workers in domestic firms and finds that their wages are positively affected by the share of workers with prior work experience from multinationals.

An alternative approach to examining spillovers from FDI is proposed by Branstetter (2006). Using patent citations data, he examines how US investments of a group of Japanese manufacturing firms affect knowledge flows from American firms to the Japanese firms and vice versa. He finds evidence that FDI enhances knowledge flows in both

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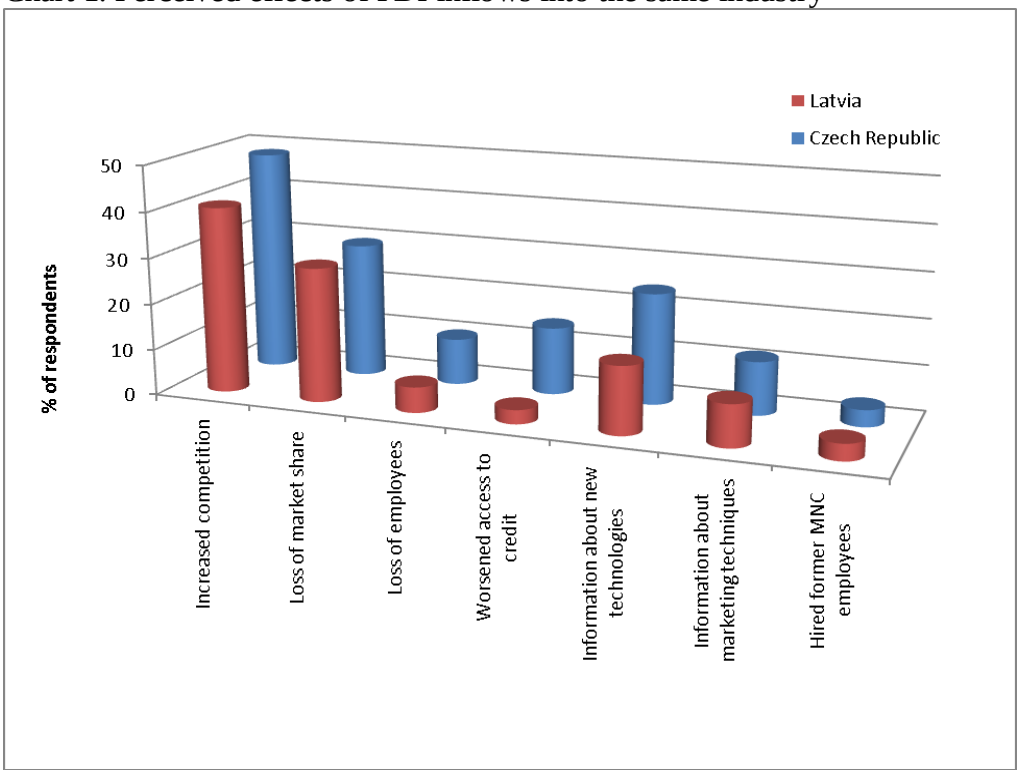
from less efficient firms to firms that are better positioned to benefit from them. This in turn may benefit consumers through lower prices.

directions. Knowledge spillovers received by the investing Japanese firms tend to be strongest via R&D and product development facilities. Spillovers from the investing Japanese firms to indigenous American inventors appear to flow most strongly through Japanese firms' greenfield affiliates. The latter finding is consistent with the observation that wholly owned FDI projects enjoy the largest technology transfer.

Chart 1. Perceived effects of FDI inflows into the same industry



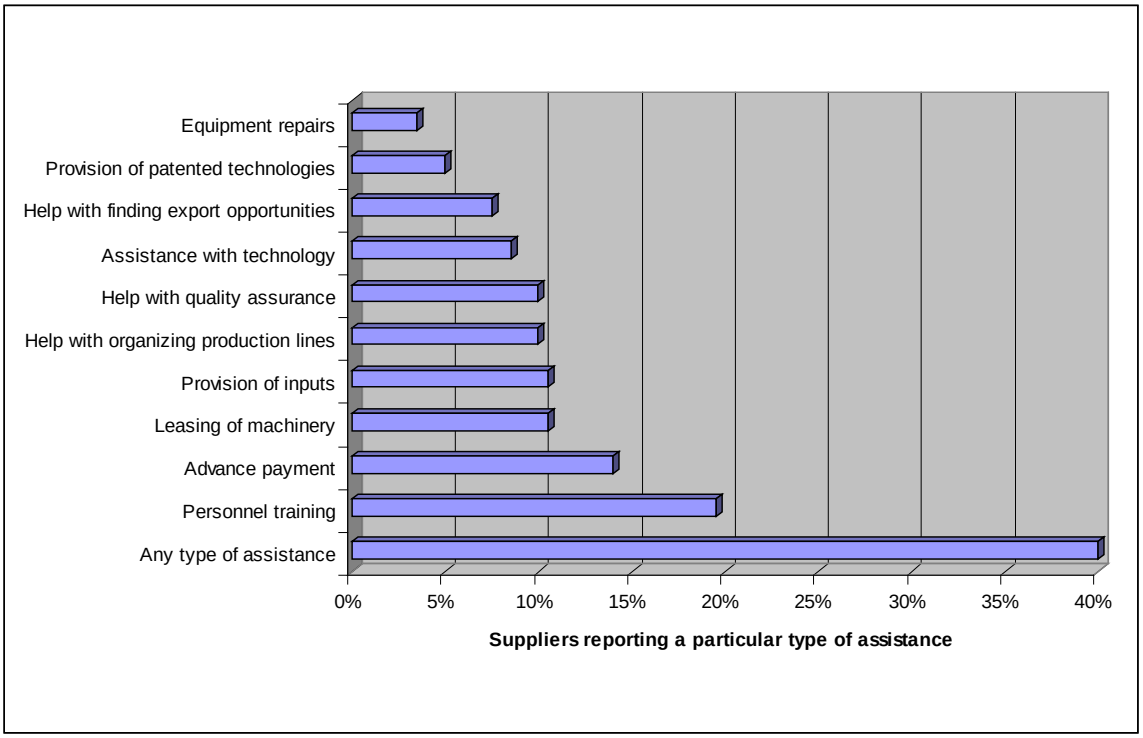
B. Spillovers to upstream sectors

While multinationals may have an incentive to prevent knowledge leakage to their competitors, they may want to transfer knowledge to their suppliers, thus making inter-industry spillovers more likely to happen relative to intra-industry effects. To the extent that the cost of this assistance is not reflected in lower prices which multinationals pay for inputs, this assistance constitutes a knowledge externality. The evidence on vertical spillovers has clearly emerged from a review of the case study literature (Moran 2001). It has also been confirmed by the survey evidence. For instance, 40 percent of Czech suppliers surveyed in 2005 reported receiving some type of assistance from their multinational customer. The most common type of assistance extended was personnel training, advance payment, leasing of machinery, provision of inputs and help with quality assurance and organizing production lines (see Chart 2).[10] The survey also indicated that multinationals offer assistance throughout their relationship with suppliers. Assistance is

[10] Of course, not all the types of assistance listed are associated with knowledge flows.

often offered even before the contract is signed, but it may also provided both before and after completion of the first delivery (Javorcik 2008).

Chart 2. Types of assistance received by Czech suppliers from multinational customers



Source: Javorcik (2008).

Evidence consistent with inter-industry spillovers also emerges from recent econometric studies focusing on a variety of countries (Javorcik 2004a on Lithuania; Blalock and Gertler 2007 on Indonesia; Kugler 2006 on Colombia; Javorcik and Spatareanu 2008 on Romania). These studies find a positive correlation between the presence of multinationals in downstream industries and the performances of domestic firms in the supplying sectors.[11] The evidence provided by these studies is somewhat indirect as the data available do not contain information identifying firms supplying multinationals. Instead the studies proxy for inter-industry linkages using information from the national input-output matrix.

There exist only two studies able to identify suppliers of multinationals operating in their country and thus able to test *directly* whether suppliers are more productive than non-suppliers. Chung, Mitchell and Yeung (2003) examine this question in the context of US automotive component industry in the 1980s. They find that Japanese FDI into automotive assembly was associated with overall productivity improvements in the US auto component industry. However, their results also indicate that Japanese assemblers tended to purchase

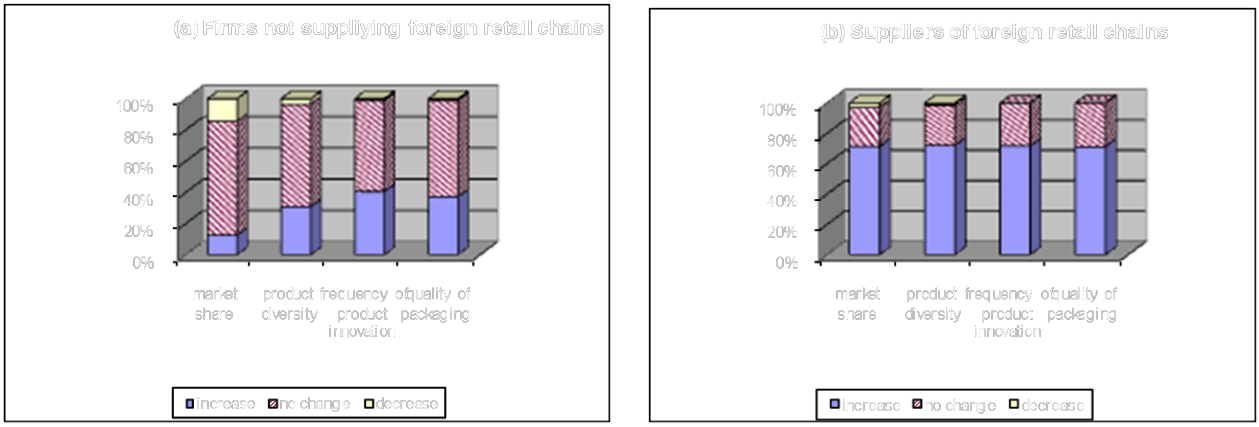
[11] Kugler's study considers inter-industry patterns but does not distinguish between upstream and downstream sectors.

components from *less productive* US suppliers and that the productivity growth of US suppliers affiliated with Japanese assemblers was not greater than that of other non-affiliated US suppliers. Javorcik and Spatareanu (2009) use data from the Czech Republic to make a distinction between the *self-selection* issue (i.e., the possibility that more productive firms become suppliers to multinationals) and the *learning* effect (i.e., the productivity benefits accruing to suppliers from their interactions with multinationals). They find evidence consistent with both high productivity firms having a higher probability of supplying multinationals as well as suppliers learning from their relationships with multinationals.

The studies mentioned so far focused primarily on manufacturing sectors, yet FDI inflows into the retail sector can potentially generate similar effects. A case study by Javorcik, Keller, and Tybout (2008) documents how the entry of Wal-Mart into Mexico facilitated the modernization of the retail sector and stimulated fundamental changes in the relationship between retailers and suppliers of soaps, detergents, and surfactants. Wal-Mart's entry has driven high-cost suppliers out of business, benefited surviving producers by providing access to a larger market and prompted suppliers to introduce more innovations. Survey evidence from Romania confirms that firms supplying foreign supermarket chains were more likely to innovate, diversify their production and improve the quality of packaging than firms not serving foreign retailers (see Chart 3).

Using firm-level data from Romania, Javorcik and Li (2009) examine how the presence of global retail chains affects firms in the supplying industries. Their results suggest that the expansion of global retail chains leads to a significant increase in the total factor productivity in the supplying industries. Their presence in a region increases the total factor productivity of firms in the supplying industries by 3.8 to 4.7 percent, while doubling the number of chains leads to an increase of 3.3 to 3.7 percent. The expansion of global retail chains benefits larger firms more than small enterprises. The conclusions are robust to using the instrumental variable approach.

Chart 3. Impact of entry of foreign retailers on Romanian firms



66-70 responses 97-111 responses

Source: Javorcik and Li (2009).

C. Spillovers of knowledge about export markets

Presence of foreign affiliates may also lead to spillovers of knowledge about export markets. In a widely-cited paper, Aitken, Hanson and Harrison (1997) use panel data on 2,104 Mexican manufacturing plants from the period 1986-1990 to demonstrate that the presence of exporting multinationals in the same region reduces the costs of exporting for Mexican firms. No such externalities are found for exporting firms in general. Based on detailed Chinese trade statistics identifying the type of exporters and their location, Chen and Swenson (2008) find that the presence of multinationals in the same industry is associated with more and higher quality trade transactions by Chinese firms. Using the same data set, Swenson (2007) shows that the positive association between the presence of multinationals and new export connections by private Chinese exporters may be driven by information spillovers.[12]

V. Conclusions and policy implications

Many countries offer foreign investors more favorable treatment than that awarded to domestic producers. Are such policies justified? The argument for special treatment for FDI is usually based on market failure. The presence of positive externalities associated with FDI would lead to underprovision of FDI and thus constitute an example of a market failure and serve as a justification for subsidizing FDI. However, given the difficulties in assessing the benefits of such spillovers, it might be easy to extend subsidies beyond levels that can be justified based on spillovers. According to Haskel et al. (2007), this was the case in the U.K. which extended to foreign investors incentives which exceeded the value of spillovers on a per-job basis. Overpaying is even more likely if countries compete with one another in offering FDI incentives.

Another justification for subsidizing FDI is based on information asymmetries. Domestic investors, who are better informed about investment opportunities in their country, have no incentive to share this information with potential foreign entrants. In such a situation, a capital-importing country would raise welfare by subsidizing foreign capital inflows (Gordon and Bovenberg 1996). However, if the first handful of FDI project or entry of a prominent multinational serves as a signal to other investors that a particular country is a good location for FDI, then the justification based on the information asymmetries may apply only to the initial period after opening to FDI.

[12] Harding and Javorcik (2009a) present evidence suggesting that attracting inflows of FDI offers potential for upgrading a country's export basket. Their empirical analysis relates unit values of exports measured at the 4-digit SITC level to data on sectors treated by investment promotion agencies as priority in their efforts to attract FDI. The sample covers 116 countries over the period 1984-2000. Their findings are consistent with a positive effect of FDI on unit values of exports in developing countries, though they are unable to separate the direct effect of FDI (exports by foreign affiliates) from the spillover effect.

In sum, the findings of the existing literature point to the existence of spillovers from FDI, but also show that such spillovers are by no means automatic. This suggests that while subsidizing information provision by investment promotion agencies may be warranted, the case for general FDI subsidies is much weaker.

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