Collecting the Pieces of the FDI Knowledge Spillovers Puzzle

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Recent surveys of the empirical literature have concluded that the evidence is mixed on the magnitude, direction, and even existence of knowledge spillovers from foreign direct investment (FDI). This article reviews the recent theoretical and empirical literature that responds to these inconclusive results and considers three main issues: spillover channels, mediating factors, and FDI heterogeneity. Studies that take into account individual spillover channels find robust evidence of knowledge spillovers from FDI. Studies on the importance of mediating factors and FDI heterogeneity are less conclusive and could benefit from greater convergence in methodologies and greater specificity in the spillover channels of interest. More generally, many studies do not properly distinguish between knowledge spillovers and knowledge transfers, and empirical studies seem to greatly outnumber theoretical studies. JEL codes: F23, O33

> In the face of difficulties associated with capturing spillover effects and the multitude of factors that can influence the extent of spillovers in each economy, we caution researchers about drawing generalized conclusions about the existence of externalities associated with [foreign direct investment] . . . . (Javorcik and Spatareanu 2005, 47)

Over the past decade or so a large body of research has examined knowledge spillovers from foreign direct investment (FDI). At several points along the way scholars have paused to take stock of the evidence (Blomström and Kokko 1998; Saggi 2002; Görg and Greenaway 2004). The verdict has largely been inconclusive. Indeed, the empirical inconclusiveness has become so infamous that virtually every study reviewed here begins with this observation as its main motivation. Explanations for the lack of conclusive results have focused on methodological and measurement issues (Görg and Strobl 2001), but this sort of approach has recently been disputed (Lipsey and Sjöholm 2005).

The literature has developed in several directions to account for the ambiguity in earlier work. This study reviews these contributions, both theoretical and empirical. To provide some structure in a rapidly expanding field and to identify which approach or combination of approaches is likely to yield the most promising results, the study is structured around three themes.[1]

More insight into the conditions under which knowledge spillovers from FDI are most likely to arise is especially important for developing countries. The highly ambiguous evidence to date on the existence of knowledge spillovers from FDI does not seem to warrant the large sums of money spent by governments to attract FDI.[2]

After setting the stage in the following section, the article is then structured around figure 1, a representation of the FDI knowledge spillover process and the pieces of the puzzle that may affect it.[3] The section on opening the black box of FDI knowledge spillovers discusses the research on vertical linkages, worker mobility, and demonstration effects. This is followed by a review of the evidence on the influence of mediating factors, focusing on the role of absorptive capacity and spatial proximity. The next section analyzes the effect of FDI heterogeneity, examining studies on the role of ownership structure, parent-firm nationality, and motives for FDI as factors influencing the extent of knowledge spillovers. The last section points to some directions for future empirical and theoretical research.

Setting the Stage

> Much econometric work has been done in this area [on knowledge spillovers from FDI], but the results on the importance of spillovers are mixed at best (Görg and Greenaway, 2004, 172).

Inward FDI stocks increased in all regions of the world between 1980 and 2006, especially during the early 2000s (figure 2). Developed countries were the most

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Figure 1. FDI Knowledge Spillovers Framework
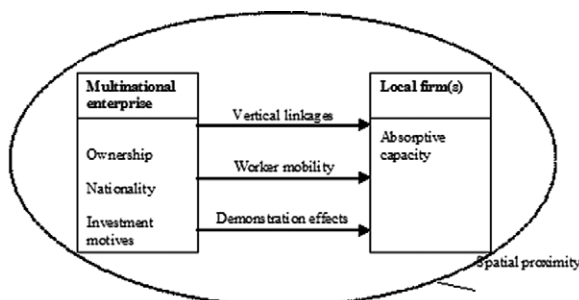
*Source*: Author's schematization.

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important benefactors. Developing countries, especially in Africa, lagged far behind. The picture is similar for FDI as a share of GDP (figure 3). On this measure countries in Latin America were catching up somewhat during the early 2000s, but Africa is still far behind.

The overall increase in inward FDI may partly explain the rising interest scholars have shown in knowledge spillover effects. However, as the countries that stand to gain most from such spillovers are also those for which inward FDI is still a small part of their economic activity, one could wonder whether the attention devoted to knowledge spillovers from FDI as a (crucial) factor for economic development has not been disproportionate.

Following Javorcik (2004b), this survey defines knowledge spillovers at the firm level as knowledge created by one firm (a multinational enterprise) that is used by a second firm (a host-country firm) for which the host-country firm does not (fully) compensate the multinational enterprise. This definition does not include pecuniary spillovers (nominal gains resulting from quality increases that are not fully reflected in prices) or competition effects (changes in market structure caused by the entry of a multinational enterprise). It does distinguish between knowledge spillover and knowledge transfer (the purposeful or intended diffusion of knowledge from one firm to the other, which creates no externality).

The literature has identified three main channels along which knowledge may spill over from a multinational enterprise to a local firm (Saggi 2006) (see figure 1). Demonstration effects involve the imitation, or reverse-engineering, by host-country firms of the products or practices of multinational enterprises.

Figure 2. Total Inward FDI Stocks, by Region, 1980–2006
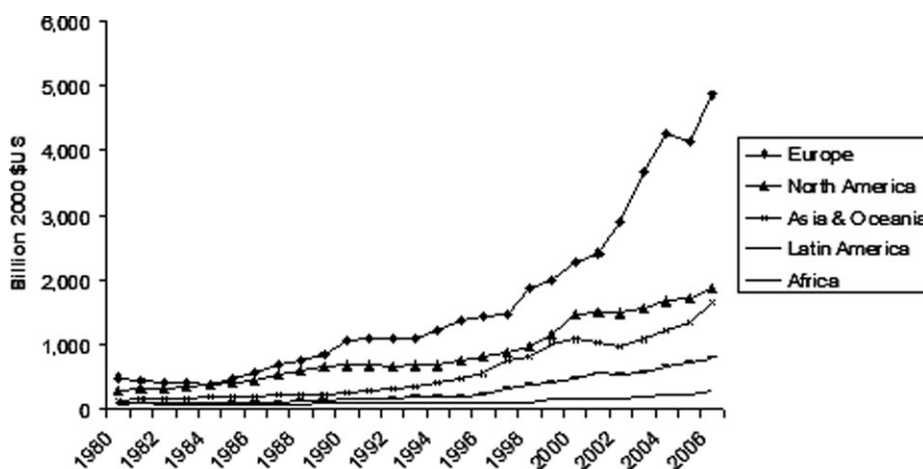
Source: UNCTAD 2007.

Figure 3. Inward FDI Stocks as Percent of GDP, by Region, 1980–2004
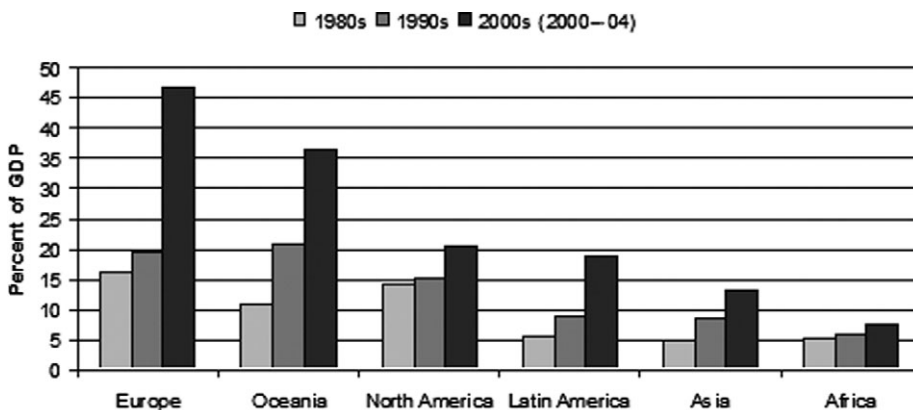
Source: UNCTAD 2007; Heston, Summers, and Aten 2006.

Worker mobility allows employees trained by the multinational enterprise to apply their knowledge in the local firm. Upstream and downstream vertical (interindustry) linkages involve the spillover of knowledge from the multinational enterprise to its suppliers and customers.

Much empirical research has tried to identify the direction, size, and scope of knowledge spillovers from multinational enterprises to local firms. One of the major challenges these studies face is measuring knowledge spillovers. The usual approach has been to assume that the major knowledge spillover effect is on the receiving firm's productivity, often measured by changes in the receiving firm's productivity following entry of the multinational enterprise, controlling for other observable determinants of productivity. (This survey does not address issues of measurement.)

The first major review of this empirical literature appeared in 1998 (Blomström and Kokko 1998). It shows that most studies (many of them multiple case studies) consider the effects of knowledge spillovers from multinational enterprises through backward linkages (linkages to supplier industries).

Multiple case studies tend to find evidence of the existence of knowledge spillovers more often than econometric studies do. Görg and Strobl (2001) conduct a meta-analysis of 21 econometric studies of the knowledge spillover effects of FDI to determine whether differences in research design, methodology, and data can at least partially explain the ambiguity of the results. The econometric studies included in the analysis estimate models of the following form:

$$y_{ijt} = \beta_0 + \beta_1 \text{FDI}_{ijt} + \beta_2 \mathbf{X}_{it} + \beta_3 \mathbf{Z}_{jt} + \varepsilon_{ijt} \qquad (1)$$

where y_{ijt} is some measure of productivity of firm i active in sector j at time t; FDI is a measure of the presence of FDI; $\mathbf{X}$ is a vector of firm-level control variables that are known

to affect productivity (such as own investments in R&D and human capital); $\mathbf{Z}$ is a vector of industry-level control variables (for example, market concentration); and ε is an error term. The β's are the parameters to be estimated, and β_1 is the parameter of interest.

Two problems affect models of this type. First, the measures of productivity vary across studies, making comparisons difficult. Some look at total factor productivity (TFP), while others consider labor productivity. Second, the endogeneity of FDI (the fact that FDI may be attracted to more-productive countries, regions, or sectors, reversing the causal mechanism) is not always properly accounted for, which could bias the estimation results.

Görg and Strobl (2001) find that cross-section studies find more significant evidence of positive knowledge spillovers than panel studies do. This suggests that unobserved firm heterogeneity may be present. Their results also indicate that the way FDI is measured may influence the results and that there may be publication bias in favor of studies that find evidence of significant positive knowledge spillovers. Yet Lipsey and Sjöholm (2005) show that results for different countries tend to diverge even when similar estimation techniques are used on similar data over similar time periods. They conclude that heterogeneity in host-country factors are the most likely source of the inconclusiveness of empirical research.

Görg and Greenaway (2004) survey more than 40 econometric studies, mainly at the microeconomic level. Their review indicates that the empirical evidence is at best ambiguous, with 20 cases finding evidence of positive spillovers, 17 cases finding insignificant results, and 8 cases finding evidence of significant negative knowledge spillovers. The studies they review cover different periods and countries and use both cross-sectional and panel designs.[4]

Opening the Black Box of FDI Knowledge Spillover Mechanisms

> One of the drawbacks of these [empirical FDI spillover] studies is that they treat the specific mechanisms by which the spillovers are supposed to occur as a "black box" (Görg and Strobl 2005, 695).

The empirical literature for a long time has not explicitly considered spillover channels other than knowledge spillovers from FDI through backward linkages. Indeed, the general empirical model specified in model 1 is the most frequently encountered in econometric tests of knowledge spillovers from FDI. As Görg and Strobl (2005) argue, such an empirical specification disregards the existence and importance of knowledge spillover channels. It could very well be that β_1 picks up the net effect of FDI (including adverse competition effects, for example) (Aitken

and Harrison 1999).[5] Empirical research has increasingly been trying to explicitly take into account the different spillover channels.

Vertical Linkages

Many of the studies opening the black box of knowledge spillovers from FDI have focused on knowledge spillovers through vertical linkages (Hoekman and Javorcik 2006; for brief reviews see Lin and Saggi 2005; Saggi 2006). Two early theoretical contributions in this field are Rodríguez-Clare (1996) and Markusen and Venables (1999).

Rodríguez-Clare focuses on the input–demand effects of multinational enterprises. He constructs a model with monopolistic competition in the intermediate goods sector, which national firms and multinational enterprises use as inputs in the production of final goods. He assumes that multinational enterprises' final goods are more complex (that is, require a larger variety of inputs) than those of national firms, and that all firms have a "love of variety" for intermediate inputs. Accordingly, the entry of a multinational enterprise increases demand for intermediate inputs, which establishes the backward linkage. Because of monopolistic competition in the intermediates sector, the arrival of the multinational enterprise leads to an increase in the variety of available inputs. Final goods producers benefit because of the love of variety for inputs, which establishes the forward linkage effect.

The Markusen and Venables (1999) model has a similar setup. However, they explicitly consider the intraindustry competition effect a multinational enterprise induces upon entry. Rodríguez-Clare (1996) effectively ignores this effect, considering situations in which multinational enterprises are the only firms producing in one of the two countries. These two studies thus look only at pecuniary spillovers and competition effects of FDI, not at knowledge spillover effects.

Lin and Saggi (2007) explicitly consider vertical technology transfer through backward linkages (from multinational enterprises to their local suppliers). They assume that upon entry a multinational enterprise can negotiate an exclusivity contract with a number of local suppliers. Only then will the multinational enterprise engage in vertical technology transfer. This model does not consider knowledge spillovers as in the definition of being an externality considered here.

A number of empirical studies have been conducted in this area (table 1), all of them estimating a modified version of model 1:

$$y_{ijt} = \beta_0 + \beta_1 \text{FDI}_{jt} + \beta_2 \sum_{k \neq j} (\alpha_{jkt}^O \cdot FDI_{kt}) + \beta_3 \sum_{k \neq j} (\alpha_{jkt}^I \cdot FDI_{kt})$$
$$+ \beta_2 \mathbf{X}_{it} + \beta_3 \mathbf{Z}_{jt} + \varepsilon_{ijt}$$

(2)

where α_{jk}^O is the output share flowing from industry j to industry k; α_{jk}^I is the share of inputs used by industry j from industry k; i indexes the firm; j and k index the industry; t

Table 1. Empirical Results on Effects of Vertical Linkages, Worker Mobility, and Demonstration Effects on FDI Knowledge Spillovers

Channel	Study	Sample	Effect
Vertical linkages	Javorcik (2004b)	4,000 firms in Lithuania, 1996−2000	Positive effects through backward linkages; no effects through forward linkages
	Javorcik and Spatareanu (2008)	13,129 firms in Romania, 1998−2003	Positive effects through backward linkages
	Kugler (2006)	All manufacturing plants in Colombia, 1974-1998	Positive effects through backward linkages; no effects through forward linkages
	Bwalya (2006)	125 Zambian manufacturing firms, 1993-1995	Positive effects through backward linkages; no effects through forward linkages
	Schoors and van der Tol (2001)	1,084 firms in Hungary, 1997−98	Positive effects through backward linkages; negative effects through forward linkages
Worker mobility	Markusen and Trofimenko (2007)	304 manufacturing establishments in Colombia, 1977−91	Positive
	Görg and Strobl (2005)	228 manufacturing firms in Ghana, 1991−97	Positive
	Poole (2007)	Formal sector workers in Brazil, 1996−2001	Positive
	Hale and Long (2006)	1,500 firms in China, 2000	Positive
Demonstration effects	Cheung and Lin (2004)	26 provinces in China,1995−2000	Positive
	Hale and Long (2006)	1,500 firms in China, 2000	Positive

Source: Author's compilation.

indexes time; and y, $\mathbf{X}$, $\mathbf{Z}$, and ε are defined as in model 1. In this model β_1 measures the effect of FDI in firm i's own sector, which can be interpreted as a demonstration effect; β_2 captures the effect of FDI in sector k on the productivity of firm i in sector j, weighted by the share of output flowing from sector j to k (that is, backward linkages); and β_3 captures forward linkages.

Javorcik (2004b) analyzes knowledge spillovers from multinational enterprises through backward and forward linkages in a panel of about 4,000 Lithuanian firms. She finds evidence of positive knowledge spillovers through backward but

not forward linkages. Javorcik and Spatareanu (2008) also find evidence of positive knowledge spillovers through backward linkages, although only from multinational enterprises that share ownership with local firms. Kugler (2006) analyzes interindustry spillovers from FDI in eight Colombian manufacturing sectors. He finds strong and robust evidence of backward linkages and no evidence of forward linkages. Bwalya (2006) obtains a similar result for a sample of 125 Zambian manufacturing firms. Schoors and van der Tol (2002) find evidence of positive knowledge spillovers through backward linkages in Hungary but negative spillovers through forward linkages. Moreover, they find that these intersectoral effects are statistically more important than the intrasectoral effect (β_1).

It is questionable whether these empirical studies actually measure knowledge spillovers and not knowledge transfer. Indeed, in a study of more than 100,000 Indonesian manufacturing establishments, Blalock and Gertler (2008) refer to the evidence they find of local firm productivity increases through vertical linkages with multinational enterprises as knowledge transfers rather than spillovers. Javorcik and Spatareanu (2005) use survey data on the perceptions of managers in local Latvian and Czech firms. They find that intentional multinational enterprise assistance is an important factor influencing local firms' productivity. Pack and Saggi (2001) provide a theoretical treatment of vertical technology transfer. These studies clearly demonstrate the importance of knowledge transfer instead of knowledge spillovers.

Worker Mobility

A second channel through which knowledge spillovers can flow is worker turnover. The multinational enterprise is likely to provide some host-country workers with better training, education, and work experience than the average local firm does. If its workers eventually move to a local firm or start their own companies, they can apply the knowledge acquired from the multinational to the local firm's benefit. As the multinational enterprise is not compensated for this, this knowledge constitutes a knowledge spillover.

Fosfuri, Motta, and Ronde (2001) were among the first researchers to formally model this channel of multinational enterprise knowledge spillovers. In their model a firm must choose between FDI and exports to serve a foreign market. If it chooses FDI it must train host-country workers. When training is completed, both the multinational enterprise and local firms can bid to acquire the services of the trained local workers. Knowledge spillovers occur if the local firm wins the bid. Such a situation is most likely to occur if market competition is low and knowledge easily transferable, because in this case the local firm has much to gain by obtaining the knowledge, and the cost of training an additional worker for the multinational enterprise is relatively low. Markusen and Trofimenko (2007)

model worker mobility as a channel for knowledge spillovers in a general equilibrium setting in which changes in the wages paid by firms attract experts from multinational enterprises.

Two models are used in empirical research on knowledge spillovers through worker mobility. The first is a straightforward extension of model 1:

$$y_{ijt} = \beta_0 + \beta_1 S_{it}^M + \beta_2 \mathbf{X}_{it} + \beta_3 \mathbf{Z}_{jt} + \varepsilon_{ijt} \tag{3}$$

where S^M denotes some measure of the presence of foreign workers (workers previously employed by a multinational enterprise's subsidiary). If knowledge spillovers diffuse through worker mobility, β_1 should be positive.

A second empirical specification analyzes knowledge spillovers through worker mobility at the individual level, by looking at wages:

$$w_{ijt} = \beta_0 + \beta_1 S_{jt}^M + \beta_2 \mathbf{X}_{it} + \beta_3 \mathbf{Z}_j t + \varepsilon_{ijt} \tag{4}$$

where w denotes the (log of the) individual wage level, i in this case subscripts individuals and j subscripts firms. The underlying assumption is that wages are strongly correlated with marginal labor productivity. Hence positive knowledge spillovers through worker mobility again imply that β_1 is positive.

Markusen and Trofimenko (2007) test their model using plant-level data on a sample of 304 Colombian manufacturing establishments, employing at least 10 workers. Their results show that hiring foreign experts increases real wages at the hiring plant. This effect is both instantaneous (it occurs during hiring) and persistent (it remains even after the foreign expert has left the plant).

Görg and Strobl (2005) estimate a model similar to model 3 in a panel of 228 Ghanaian manufacturing firms. Their results indicate that a local firm's owner's previous experience in a multinational enterprise increases the local firm's productivity but only if the multinational enterprise is operating in the same sector as the local firm. Having an owner that received explicit training in the multinational enterprise does not contribute significantly to firm-level productivity. (The extent to which this result reflects the more general situation in which any foreign employee, not just the owner, hired by a local firm can spill over knowledge remains unclear.)

Poole (2007) analyzes knowledge spillovers through worker mobility at the worker level, using data on formal sector workers in Brazil in a model similar to model 4. She finds that an increase in the presence of foreign workers (S^M) increases wages, indicating that knowledge is spilling over from former multinational enterprises' employees to national firms. Hale and Long (2006) investigate spillovers from FDI in a sample of 1,500 firms in five Chinese cities. They find evidence that an increase in S^M (as defined by Poole) increases firm productivity.

Demonstration Effects

Various definitions of demonstration effects can be found in the literature (Cheung and Lin 2004; Moran, Graham, and Blomström 2005). Saggi (2002) defines demonstration effects as occurring through the imitation and reverse engineering of a multinational enterprise's products and practices by local (host country) firms. This definition largely fits the definition here of knowledge spillovers.

Many of the studies reviewed by Görg and Strobl (2001) and Görg and Greenaway (2004) implicitly deal with knowledge spillovers through demonstration effects, as the majority look for horizontal (intraindustry) knowledge spillovers. By (Saggi's) definition demonstration effects occur mainly through these horizontal spillovers. Hence, the general empirical specification looks like the one in model 1.

None of these studies hypothesizes or specifies how demonstration effects take place. Cheung and Lin (2004) shed some light on this issue. They study the effect of FDI on three types of patent applications in 26 provinces in China: invention patents (patents for new technical solutions), utility patents (patents for new technical solutions relating to the shape or structure of a product), and design patents (patents for new designs of shapes or patterns). They show that increased FDI in a province has a positive effect mainly on design patents. Since the content of such patents is most easily copied, they interpret this as evidence of demonstration effects. Hale and Long (2006) also find some circumstantial evidence of demonstration effects through network externalities.

Taking Stock

The work on opening the black box of knowledge spillovers from FDI seems a promising strand of research. In addition to obtaining more detailed insights into the exact mechanisms along which knowledge spillovers may come about, it yields more consistent empirical results than previous black box research. A few concerns nonetheless remain.

First, theoretical work on knowledge spillovers through vertical linkages is virtually absent. Most studies consider only pecuniary spillovers or knowledge transfer. Contributions in this field are much needed. It is not always clear that empirical studies are actually measuring knowledge spillovers and not knowledge transfers. Although the distinction may seem irrelevant from the host country's perspective, the policy implications of each are very different (Blalock and Gertler 2005, 2008). Empirical researchers in this field should at least be aware of this potential bias.

Second, much of the inferred effects of knowledge spillovers in the worker mobility literature are based on changes in wages. This assumes a very strong

relation between marginal worker productivity and wages. If workers are able to collectively bargain over their wages, changes in wage structure may be a misleading indicator of productivity and knowledge spillovers. Moreover, to the extent that local firms are explicitly hiring and paying former employees of multinational enterprise to provide training to their own employees, any subsequent productivity effect cannot be considered a knowledge spillover according to the definition adopted here (Castellani and Zanfei 2006).

Finally, research on the existence of demonstration effects is less developed—that is, without considering the extensive black box literature on intraindustry knowledge spillovers from FDI. The absence of theoretical contributions in this field and the multiplicity of definitions of demonstration effects make empirical assessment difficult, because it is not clear ex ante through which mechanisms such demonstration effects should take place. More conceptualization on this topic seems necessary before substantial results can be expected from empirical research.

Mediating Factors

> An explanation [*for the diverse conclusions in FDI spillover studies*] that seems plausible is that countries and firms within countries might differ in their ability to benefit from the presence of foreign-owned firms and their superior technology (Lipsey and Sjöholm, 2005, 23).

One strand of literature has tried to identify the mediating factors required for the effective transmission of knowledge spillovers. Such factors can be seen as necessary conditions for knowledge spillover potential to turn into actual knowledge spillovers. The absence (or presence) of these factors may crucially influence observed knowledge spillovers; not taking them into account can bias empirical results.

These factors usually pertain either to the receiving party (the host country, sector, region, or firm) or to the relations among the parties involved. Probably the best-known concepts in this field are absorptive capacity and spatial proximity. These are discussed below, followed by a brief review of two other mediating factors, intellectual property rights and host-country competition.

Absorptive Capacity and Backwardness

Two views exist in the literature on the role of the technology or productivity of a firm, region, industry, or country in capturing knowledge spillovers. Some researchers claim that technological backwardness should enhance knowledge spillovers, because the potential for improvement is large (Findlay 1978;

Wang and Blomström 1992). Others argue that firms need some minimum amount of absorptive capacity to be able to capture knowledge spillovers (Cohen and Levinthal 1989, 1990; Glass and Saggi 1998). Such absorptive capacity, created by investments in R&D or human capital, provides the basis of fundamental knowledge or technology necessary to assimilate and exploit external knowledge.

Some early contributors to this field (implicitly) suggest a complementary relation between backwardness and absorptive capacity. Findlay (1978, 2) argues that "the greater the backlog of available opportunities ... the greater the pressure of change within the backward region .... Of course, the disparity must not be too wide for the thesis to hold." This remark hints at the importance of some minimum level of absorptive capacity. Abramovitz (1986, 388) argues that "a country's potential for rapid growth is strong not when it is backward without qualification, but rather when it is technologically backward but socially advanced." He conditions the benefits of backwardness on the presence of social capabilities, hinting at the importance of some form of absorptive capacity.

In the empirical literature on knowledge spillovers from FDI, the following general model is encountered:

$$y_{ijt} = \beta_0 + \beta_1 \text{FDI}_{jt}\text{AC}_{it} + \beta_2 \text{FDI}_{jt}\text{BW}_{it} + \beta_3 \mathbf{X}_{it} + \beta_4 \mathbf{Z}_{jt} + \varepsilon_{ijt}. \tag{5}$$

where AC measures absorptive capacity and BW backwardness (both variables are not always included simultaneously).

Griffith, Redding, and Simpson (2002) consider the mediating effect of backwardness on knowledge spillovers from FDI in a sample of 13,000 manufacturing establishments in the United Kingdom (table 2). They measure backwardness as frontier-level TFP relative to the TFP of the local establishment, where frontier-level TFP is defined either as the highest establishment-level TFP at the four-digit industry classification level at time t or as the average TFP of the top three establishments with the highest TFP. Hence, an increase in BW implies that establishment i is becoming more backward. In model 5 the effect of BW (β_2) is positive and significant for both measures of backwardness, illustrating the importance of backwardness.

Griffith, Redding, and van Reenen (2004) use a similar measure of backwardness at the country-industry level. Their research yields positive and significant results for both backwardness and absorptive capacity.

Castellani and Zanfei (2003) use a slightly different measure of backwardness: the ratio of the average TFP level of foreign firms in two-digit industry j over firm i's TFP level. Absorptive capacity is measured as the TFP level of firm i. They find that only β_2 is positive and significant in a model similar to model 5. Peri and Urban (2006) obtain a similar result using a panel of German and Italian firms.

Table 2. Empirical Results on Effects of Absorptive Capacity/Backwardness and Geographic Proximity on FDI Knowledge Spillover

Factor	Study	Sample	Effect
Absorptive capacity/ backwardness	Griffith, Redding, and Simpson (2002)	13,000 manufacturing firms in United Kingdom, 1980–92	Backwardness: Positive
	Castellani and Zanfei (2003)	3,932 firms in France, Italy, and Spain, 1992–97	Backwardness: Positive Absorptive capacity: No effect
	Girma (2005)	7,516 firms in United Kingdom, 1989–99	Absorptive capacity: Inverted U-shaped effect
	Peri and Urban (2006)	40,000 firms in Italy 800 firms in Germany, 1993–99	Backwardness: Positive
	Girma and Görg (2007)	2,100 electronic firms in United Kingdom, 1980–92 4,800 engineering firms in United Kingdom, 1980–92	Absorptive capacity: U-shaped effect
Geographic proximity	Barrios, Bertinelli, and Strobl (2006)	338 plants in 26 counties in Ireland, 1983–98	Positive
	Girma and Wakelin (2007)	11,000 plants and 10 Nomenclature of Territorial Units for Statistics (NUTS) in 1 region in United Kingdom, 1980–92	Positive
	Nicolini and Resmini (2007)	26 sectors and 30 NUTS in 2 regions in Bulgaria, Poland, and Romania, 1998–2003	Positive

Source: Author's compilation.

Using a sample of 7,516 British companies Girma (2005) investigates the role of absorptive capacity in capturing knowledge spillovers from FDI. His measure of absorptive capacity is a firm's TFP level at time $t-1$ relative to the highest level of TFP in the firm's industry at the four-digit classification level. (This measure is roughly the inverse of the backwardness measure used in the three studies cited above.) Applying threshold regression analysis, among other methods, he finds an *inverted* U-shaped effect of absorptive capacity on FDI: the knowledge spillover mediating effect is maximized at intermediate levels of absorptive capacity. Using the same measure of absorptive capacity in a panel of British firms in the electronics and engineering industries, Girma and Görg (2007) instead find evidence of a U-shaped effect of absorptive capacity.[6] Grünfeld (2006) corroborates this result theoretically.

What, then, is the general conclusion regarding the mediating effect of backwardness and absorptive capacity on knowledge spillovers from FDI? Comparing

studies is difficult, because they use different empirical specifications and employ different measures of backwardness and absorptive capacity. Moreover, many of these studies disregard the relation between backwardness and absorptive capacity.

An exception is Castellani and Zanfei (2003), who consider the correlation between backwardness and absorptive capacity at the industry level. In their specification absorptive capacity (AC) is the denominator of backwardness (BW). Not surprisingly, they find an overall negative relation between backwardness and absorptive capacity. However, in their empirical estimation they ignore this relation. In terms of model 5 this implies that the marginal effect of AC_{it} on y_{ijt} is given by

$$\frac{\mathrm{d}y_{ijt}}{\mathrm{d}AC_{it}} = \mathrm{FDI}_{jt}\left(\beta_1 + \beta_2 \frac{\mathrm{d}BW_{it}}{\mathrm{d}AC_{it}}\right).$$

This total derivative of y_{ijt} with respect to AC_{it} shows that the marginal effect of a firm's absorptive capacity (AC_{it}) on its productivity (y_{ijt}) has both a direct component (β_1) and an indirect component (through its effect on BW_{it}). Given that AC is the denominator of BW, this implies that an increase in absorptive capacity will reduce backwardness ($\mathrm{d}BW_{it}/\mathrm{d}AC_{it} < 0$). Thus, even if the direct effect of AC (β_1) is positive, its indirect effect through BW ($\beta_2 \cdot [\mathrm{d}BW_{it}/\mathrm{d}AC_{it}]$) is clearly negative.

The empirical disregard for the relationship between backwardness and absorptive capacity applies to all studies that simultaneously include both measures. In general, if backwardness is measured in terms of relative TFP levels and absorptive capacity is measured in terms of absolute TFP levels, R&D stocks, human capital, and so forth the knowledge production function literature (Griliches 1979) suggests that a relation probably exists between backwardness and absorptive capacity, which should be taken into account empirically.

A simple way out of this problem is to use the AC measure of Girma (2005) and Girma and Görg (2007), who measure absorptive capacity as the inverse of backwardness: an increase in backwardness implies a simultaneous and proportional decrease in absorptive capacity and vice versa. Absorptive capacity as a relative concept also seems to make sense intuitively: as Castellani and Zanfei (2003) show, high absolute levels of TFP(AC) may still be accompanied by large technology gaps if foreign firms in the sector also exhibit extremely high (average) TFP levels. In such a situation absolute measures of absorptive capacity probably do not capture actual absorptive capacity.

Finally, some studies estimate backwardness relative to frontier-level TFP, where the frontier is the highest (average) TFP level of the relevant sector in general. Because knowledge spillovers from FDI are investigated, however, it seems more appropriate to consider the TFP of the relevant multinational enterprises as the frontier.[7]

Spatial Proximity

A well-established body of empirical literature suggests that spatial proximity (being geographically close to the knowledge source) is an important condition for capturing knowledge spillovers. Reasons for the purported relevance of geography can be traced to the individual knowledge spillover channels examined above. Researchers such as Girma and Wakelin (2007) argue that many of these channels have a clear spatial component. The limited geographic mobility of labor, for example, implies that knowledge spillovers through worker mobility are highly localized.

Theoretical work on the spatial dimension of knowledge spillovers from FDI is sparse. Martin and Ottaviano (1999) and Baldwin, Martin, and Ottaviano (2001) introduce spatially bounded knowledge spillovers in a new economic geography setting. Combining a two-region new economic geography model (Krugman 1991) with a Romerian-type endogenous growth model (Romer 1990), they investigate the influence of spatially bounded knowledge spillovers on growth rates in the two regions. Their results show that geography (firm location) matters for growth only when knowledge spillovers are spatially bounded. If spillovers are global, both regions grow at similar rates in long-run equilibrium. Knowledge spillovers from multinational enterprises are absent in these frameworks.

Jaffe, Trajtenberg, and Henderson (1993) and Jaffe and Trajtenberg (2002) make seminal empirical contributions on the spatial dimension of knowledge spillovers (not necessarily from FDI). By looking at patent citations while controlling for the fact that innovation activity itself may be localized, they show that knowledge spillovers are localized at various levels (country, state, and metropolitan statistical areas). Audretsch and Feldman (1996) show that geographic clustering of innovative activity is more pronounced in knowledge-intensive industries.

Keller (2002) attaches a number to the spatial decay of knowledge spillovers from R&D in the Group of Five large industrial countries to nine European countries. He finds the "half-life" of knowledge spillovers (the distance within which half of total knowledge spillovers are eroded) to be about 1,200 kilometers. Bottazzi and Peri (2003) find an even stronger localization effect of knowledge spillovers in the EU-15, where the effect of regional R&D (inputs) on the number of patents (outputs) vanishes beyond 300 kilometers.

Although a wide body of literature exists on the spatial dimension of knowledge spillovers, specific applications to knowledge spillovers from FDI are still relatively limited. The empirical specification can be extended to incorporate a regional effect:

$$y_{irt} = \beta_0 + \beta_1 \text{FDI}_{rt} + \beta_2 [\mathbf{w}_{rs} \cdot \mathbf{FDI}_{st}] + \beta_3 \mathbf{X}_{it} + \beta_4 \mathbf{Z}_{rt} + \varepsilon_{irt} \text{ s.t. } r \neq s \qquad (6)$$

where r and s index the regions. Hence β_1 measures the effect of FDI within firm i's region, and β_2 measures the effect of FDI in other regions. Sometimes the effect on firms in other regions is weighted by a matrix, **w**, that incorporates the distance between regions r and s. Region-specific characteristics (such as region size relative to population or GDP) are captured by $\mathbf{Z}_{rt}$. If knowledge spillovers from FDI are spatially bounded, one would expect β_1 to be positive and β_2 to be insignificant.

Barrios, Bertinelli, and Strobl (2006) construct an index that measures the extent to which local firms and multinational enterprises coagglomerate within counties. They find that productivity effects of FDI in Ireland are positive and significant only in counties that show a positive and significant degree of coagglommeration (see table 2).

Girma and Wakelin (2007) distinguish 10 regions that roughly correspond to the Nomenclature of Territorial Units for Statistics 1 (NUTS 1) classification in the European Union.[8] Their results indicate that the productivity of domestic plants is positively affected by FDI within but not outside the region (both weighted and unweighted by distance).

Nicolini and Resmini (2007) document positive knowledge spillover effects on regional (domestic) TFP from multinational enterprises located in the same region and negative spillover effects from the presence of multinational enterprise in other regions.

Intellectual Property Rights

Two offsetting effects make the relation between the strength of intellectual property rights and the extent of knowledge spillovers from FDI ambiguous. Strong intellectual property rights induce multinational enterprises to transfer more and higher quality knowledge to their subsidiaries, thereby increasing knowledge spillover potential, but they make it more difficult to capture knowledge spillovers (for example, through imitation). The net effect is not clear a priori.

Markusen (2001) studies the effect of changes in intellectual property rights protection on welfare and spillovers in a host developing country. He finds that if the multinational enterprise cannot write an enforceable contract with a local agent, increased intellectual property right protection makes spillovers less likely. Glass and Saggi (2002) show that increased intellectual property right protection in developing countries has a similar effect on multinational enterprises and national firms in industrial countries, so that FDI does not become relatively more attractive.

Most empirical research considers only the effect of intellectual property rights on the volume or composition of FDI or on the incentives for intrafirm technology transfer. Javorcik (2004a) investigates the effect of intellectual property rights on

the composition of inward FDI in the Russian Federation and five countries in Central and Eastern Europe. Branstetter, Fisman, and Foley (2006) analyze the effect of intellectual property rights protection on technology transfer from 1,000 U.S. multinational enterprises to about 5,000 of their foreign affiliates in 16 developing countries. The implication of their results for FDI knowledge spillovers are not clear.

Feinberg and Majumdar (2001) analyze the knowledge spillover effects of FDI in a sample of 65 domestic firms and 30 multinational enterprises operating in the pharmaceuticals sector in India during the 1980s and early 1990s, when intellectual property rights protection in the sector was reportedly weak. They find virtually no evidence of knowledge spillovers. The finding could be considered circumstantial evidence that weak intellectual property rights protection does not stimulate knowledge spillovers from FDI. Indeed, Allred, and Park (2007) conclude that there exists an optimal and positive degree of intellectual property rights protection that stimulates diffusion of knowledge from multinational enterprises.

Competition in the Host Country or Sector

Blomström, Globerman, and Kokko (2001) argue that greater competition may induce multinational enterprises to transfer more (high-quality) technology to their subsidiaries, increasing the potential for knowledge spillover. Theoretical models by Glass and Saggi (1998), Wang and Blomström (1992), and others show that this may be the case. Empirical studies do not appear to have explicitly studied the effect of host-sector competition on knowledge spillovers from FDI.[9]

Taking Stock

Research on the knowledge spillover-mediating roles of absorptive capacity and technology gaps remains inconclusive. Comparing studies is difficult because of differences in methodologies and measurement. Future empirical research might benefit from convergence in definitions of absorptive capacity and backwardness. It may also be useful to start thinking about absorptive capacity as a relative concept (Girma 2005; Girma and Görg 2007). Investigating the nonlinear mediating effects of these factors also seems to be a promising direction for future research (Girma 2005; Girma and Görg 2007; Falvey, Foster, and Greenaway 2007).

Specific applications regarding the spatial dimension of knowledge spillovers from FDI remain limited; more theoretical work on this topic is needed. Are there reasons to believe that the spatial dimension of knowledge spillovers from FDI will differ from that of knowledge spillovers in general? The answer hinges on the

specific spillover channels being considered. Knowledge spillovers transmitted through worker mobility are bound to be restricted geographically. The implications are less obvious for knowledge spillovers through vertical linkages and demonstration effects, because both supplier and customer relations and imitation and reverse engineering may easily cross national or regional borders. Studies investigating the spatial dimension of knowledge spillovers from FDI might benefit from clearly spelling out the spillover channels of interest and carefully considering their spatial dimension.

The influence of intellectual property rights regimes on FDI knowledge spillovers seems to be an important but neglected issue. More theoretical and empirical research is needed that analyzes the impact of intellectual property rights regimes directly on knowledge spillovers rather than indirectly through intrafirm technology transfer. Since the effect of intellectual property rights on knowledge spillovers is not clear a priori (because of offsetting mechanisms on spillover potential and technology access), a great deal of insight can still be gained.

FDI Heterogeneity

> To advance the literature on FDI spillovers, the questions "What kind of FDI?" and "What is the nature of [multinational corporation] activity in the local market?" need to be addressed. (Feinberg and Keane, 2005: p. 269)

A third stream of research acknowledges the heterogeneity of multinational enterprises' foreign activities and the effect on FDI knowledge spillovers (table 3). Some studies examine the relation between multinational enterprise ownership and knowledge spillovers. Others examine the relation between the nationality of the foreign investor or FDI motives and knowledge spillovers.

Ownership of the Multinational Enterprise

Müller and Schnitzer (2006) study the theoretical relation between knowledge spillovers and multinational enterprise ownership when the multinational enterprise engages in an international joint venture with the host-country firm. They document a tradeoff in which a larger ownership share induces the multinational enterprise to transfer more technology to its subsidiary, increasing spillover potential but reducing the extent to which the host-country firm is exposed to the technology. The actual relation between multinational enterprise ownership and knowledge spillovers may turn out to be an empirical matter.

Table 3. Empirical Results on Effects of FDI Heterogeneity on FDI Knowledge Spillover

Factor	Study	Sample	Effect
Multinational enterprise ownership	Blomström and Sjöholm (1999)	13,663 manufacturing firms in Indonesia, 1991	Minority and majority FDI shares had equal spillover effects
	Dimelis and Louri (2002)	4,056 manufacturing firms in Greece, 1997	Minority FDI shares had greater spillover effect than majority FDI shares
	Javorcik (2004b)	4,000 firms in Lithuania, 1996–2000	Shared foreign and domestic ownership had positive spillover effect
	Javorcik and Spatareanu (2008)	13,129 firms in Romania, 1998–2003	Shared foreign and domestic ownership had positive vertical spillover effect and negative horizontal spillover effect
	Abraham, Konings, and Slootmaekers (2007)	17,645 plants in China, 2000–04	Minority FDI shares had greater spillover effect than majority FDI shares
Nationality of parent company	Buckley, Clegg, and Wang (2007b)	130 industries in China, 1995	• No effect for FDI from Hong Kong, China; Macau, China; and Taiwan, China • Positive effect for FDI from other countries in high-technology sectors
	Buckley, Clegg, and Wang (2007a)	158 industries in China, 2001	• Positive effect for FDI from Hong Kong, China; Macau, China; and Taiwan, China, in labor-intensive industries • Positive effect for FDI from other countries in technology-intensive industries
	Abraham, Konings, and Slootmaekers (2007)	17,645 plants in China, 2000–04	• For locally owned enterprises, greater effect for FDI from Hong Kong, China; Macau, China; and Taiwan, China, than for FDI from other countries • For foreign-owned enterprises, the effect was opposite
	Javorcik, Saggi, and Spatareanu (2004)	50,957 firms in Romania, 1998–2000	• FDI from Asia and America had positive upstream spillover effect • FDI from the European Union had negative effect

Continued

Table 3. *Continued*

Factor	Study	Sample	Effect
	Girma and Wakelin (2007)	11,000 plants and 10 Nomenclature of Territorial Units for Statistics (NUTS) in 1 region in United Kingdom, 1980–92	• FDI from Japan and other countries had positive effect • FDI from United States had no effect
Motive for FDI	Girma (2005)	7,516 firms in United Kingdom, 1989–99	• Exploiting FDI had positive effect • Sourcing FDI had no effect
	Driffield and Love (2007)	11 manufacturing sectors in United Kingdom, 1987–97	• Exploiting FDI had positive effect • Sourcing FDI had no effect
	Protsenko (2003)	256 German FDI projects in Czech Republic, 1993–99	• Vertical FDI had positive effect • Horizontal FDI had negative effect

Source: Author's compilation.

Empirical research usually distinguishes between minority FDI (the foreign investor holds a minority share in the foreign affiliate) and majority FDI (the foreign investor holds a majority share in the foreign affiliate):

$$y_{ijt} = \beta_0 + \beta_1 \text{Min\_FDI}_{jt} + \beta_2 \text{Maj\_FDI}_{jt} + \beta_3 \mathbf{X}_{it} + \beta_4 \mathbf{Z}_{jt} + \varepsilon_{ijt} \qquad (7)$$

where Min_FDI and Maj_FDI measure the amount of minority and majority FDI in sector j. Some empirical studies distinguish between wholly owned subsidiaries and shared subsidiaries. Sometimes the intersectoral spillover effects of different types of FDI are investigated as well.

Blomström and Sjöholm (1999) were among the first researchers to consider this relation empirically. Their study of 13,663 Indonesian manufacturing firms reveals that both minority and majority FDI lead to spillovers, with no statistical differences between the estimated effects.

Dimelis and Louri (2002) consider a sample of 4,056 Greek manufacturing firms. In separate regressions they analyze the relation between multinational enterprise ownership and knowledge transfer (to the local affiliate) and the relation between multinational enterprise ownership and knowledge spillovers (to other local firms). The results broadly confirm the intuition in Müller and Schnitzer (2006): only majority-owned foreign affiliates experience increases in productivity as a result of knowledge transfer, and minority FDI is more likely than majority FDI to produce knowledge spillovers.

Javorcik (2004b) analyzes a panel of about 4,000 firms in Lithuania, distinguishing between horizontal (intraindustry) and vertical (interindustry)

spillovers. She finds that firms that are owned by both the foreign investor and a local firm create backward knowledge spillovers (to supplying industries), while wholly owned subsidiaries do not. She finds no evidence of horizontal or forward knowledge spillovers or statistical differences between the effects of minority and majority FDI.

Javorcik and Spatareanu (2008) analyze a panel of 13,129 Romanian firms. They find that shared foreign and domestic ownership induces positive vertical spillovers and negative horizontal spillovers. Wholly owned subsidiaries do not induce vertical spillovers and induce larger negative horizontal spillovers. These negative effects are explained by adverse competition effects.

Abraham, Konings, and Slootmaekers (2007) analyze the relation between minority- and majority-owned FDI and knowledge spillovers in an unbalanced panel of 17,645 plants in China. Their results show that minority FDI has a negative (competition) effect on locally owned enterprises' productivity and that majority FDI has no effect. The effect of minority FDI on foreign-owned enterprises is positive and larger than that of majority FDI.

Nationality of the Parent Company

Some recent studies argue that the nationality of the foreign investor affects the knowledge spillover effects of FDI (see table 3). Most studies in this field consider FDI in China, comparing the effects of FDI from Hong Kong, China; Macau, China; and Taiwan, China, (HMT_FDI) on the one hand and from Western countries (OTHER_FDI) on the other hand. The specification is similar to the one in model 7, with Min_FDI and Maj_FDI replaced by HMT_FDI and Other_FDI.

Buckley, Clegg, and Wang (2007b) argue that FDI from Hong Kong, China; Macau, China; and Taiwan, China, is less technologically advanced than that of investors from outside China. As a result, although initial increases in such FDI may induce positive spillover effects, beyond some threshold level the negative competition effect starts to dominate. They therefore predict a nonlinear spillover effect of increased FDI from these sources. This contrasts with the positive linear effect of FDI from Western countries (the knowledge spillover effect is expected to dominate, because it carries more advanced technology). Their empirical analysis of 130 Chinese industries confirms their expectations: FDI from outside China has the expected (linear) positive effect (albeit only in high-technology sectors).

Buckley, Clegg, and Wang (2007a) investigate the relation between FDI from Hong Kong, China; Macau, China; and Taiwan, China, and from outside China in a sample of 158 Chinese industries, taking into account receiving firms' and industries' characteristics. They find that such FDI generates more knowledge spillovers in labor-intensive industries and that FDI from outside China generates more knowledge spillovers in technology-intensive industries.

Abraham, Konings, and Slootmaekers (2007) show that the spillover effects of both minority and majority FDI from Hong Kong, China; Macau, China; and Taiwan, China, on locally owned enterprises are larger than those from FDI from other countries. The opposite holds for knowledge spillovers to foreign-owned enterprises.

Javorcik, Saggi, and Spatareanu (2004) compare the upstream knowledge spillover effects of FDI from Asian, European, and American (North and South) enterprises in a panel of 50,957 Romanian firms. They posit three reasons to expect weaker knowledge spillover effects from FDI from the European Union: the European Union is located closer to Romania, Romania was engaged in a preferential trade agreement with the European Union during the period of investigation, and inputs sourced from home-country suppliers by EU subsidiaries comply with Romania's rules of origin, which is not the case for Asian or American subsidiaries. All these mechanisms make knowledge spillovers through vertical linkages less likely for EU subsidiaries, because they stimulate imports of intermediate inputs from the European Union. The results confirm their expectations: FDI from Asia and America has positive vertical (upstream) knowledge spillover effects on Romanian firms. The effect is negative for FDI from the European Union, which the authors explain by pointing to increased competition in the downstream sector in which multinational enterprises are operating.

Girma and Wakelin (2007) distinguish between inward FDI into the United Kingdom from Japan, which accounts for the majority of R&D-intensive international companies in the electronics industry; from the United States, which has long invested in the British manufacturing industry; and from other countries. Their results indicate that Japanese and other international firms produce significant and positive knowledge spillover effects, whereas U.S. firms do not have a discernible spillover effect. The authors hint at the relative high R&D-intensity of Japanese FDI as an explanation for this result.

Motives for FDI

Most of the studies discussed above assume that FDI has knowledge spillover potential, that the firms engaging in FDI do so to exploit a technological or other ownership advantage abroad, part of which may spill over to the host country. This type of FDI is known as *technology-exploiting* FDI (Kuemmerle 1999; Le Bas and Sierra 2002). Most of the traditional literature on FDI refers to this type of investment (Hymer 1960; Dunning 1977; Markusen 2002).

Scholars have recently pointed out a different type of FDI—technology-seeking FDI—which is motivated by a desire to source or seek external foreign knowledge (Dunning and Narula 1995; Kuemmerle 1999; Fosfuri and Motta 1999; Siotis 1999; Le Bas and Sierra 2002). Firms engaging in technology-seeking FDI try to

capture knowledge spillovers from firms in the host countries in which they invest. Knowledge spillovers are expected to flow from local firms to the multi-national enterprise instead of the other way around.

A few studies investigate knowledge spillovers by distinguishing between these types of FDI. The empirical model is similar to that in model 7, with technology-exploiting and technology-seeking FDI substituted for Min_FDI and Maj_FDI. In a panel study of 11 manufacturing sectors in the United Kingdom, Driffield and Love (2007) find that technology-sourcing FDI does not generate knowledge spill-overs, whereas technology-exploiting FDI does. Girma (2005) obtains similar results.[10]

FDI can also be classified as horizontal (Markusen 1984), vertical (Helpman 1985), or export platform (Ekholm, Forslid, and Markusen 2007). Horizontal FDI is usually motivated by market-seeking incentives, vertical FDI by efficiency- or resource-seeking incentives, and export-platform FDI by the desire to find an efficient location from which to more profitably export to third countries. The extent of knowledge spillovers from these types of FDI may differ (Javorcik and Spatareanu 2005; Driffield and Love 2007; Beugelsdijk, Smeets, and Zwinkels forthcoming).

Protsenko (2003) examines the spillover effects of horizontal and vertical German FDI in the Czech Republic. He finds that vertical FDI generates positive knowledge spillovers, whereas horizontal FDI has effects largely through increased competition. These results suggest that the distinction between horizontal, verti-cal, and export-platform FDI is potentially important in determining the extent of knowledge spillovers.

Taking Stock

The work on the relation between multinational enterprise ownership and know-ledge spillovers has strong intuitive appeal, because it seems likely that not all types of subsidiaries (minority, majority) generate the same knowledge spillovers. Theoretical work in this area is scant, however; more insights are needed to guide empirical work.

The empirical results obtained so far are difficult to compare, because they take slightly different approaches. A fruitful extension in this area would be to consider the influence of multinational enterprise ownership along a continuum. Instead of analyzing the spillover effect of different categories of subsidiaries (minority, majority), researchers might analyze the influence of actual ownership shares (0–100 percent) on local firms' productivity. Such an approach would allow researchers to analyze nonlinear effects.

Studies distinguishing between the country origin of FDI often do so based on a variety of economic rationales (such as differences in expected R&D intensities, or

differences in local input sourcing). Future research should investigate whether these more general underlying economic rationales can be used to distinguish different types of FDI, instead of the more specific country of origin. Such an approach may stimulate the development of both more theoretical research in this area as well as a more general empirical application.

Distinguishing FDI motives may contribute to a better understanding of the likelihood of knowledge spillovers from FDI. Theoretical models in this field have looked only at the relation between FDI motives and firm heterogeneity. A useful extension would be a model in which the extent of knowledge spillovers is endogenously determined by firms' motives in pursuing FDI. Also more empirical research is needed that directly investigates this relation. Although the few studies reviewed above indicate that technology-seeking FDI does not generate knowledge spillovers, more recent empirical research indicates that this type of FDI may at least have a large potential of doing so (Feinberg and Gupta 2004; Cantwell and Mudambi 2005). More research investigating the differential knowledge spillover effects of horizontal, vertical, and export-platform FDI is also warranted.

Conclusion

> If country and industry differences are important to the impact of inward
> FDI on host countries, the main lesson might be that the search for uni-
> versal relationships is futile (Lipsey and Sjöholm, 2005, 40).

With so many dimensions and so many factors at the country, sector, regional, and firm level influencing the relation between FDI and knowledge spillovers, the search for universal relations may well be futile. This does not imply that the search for knowledge spillovers from FDI is futile, however.

The studies surveyed in this article that explicitly investigate the individual knowledge spillover channels identified in figure 3 (and summarized in table 1) all seem to conclude that knowledge spillovers from FDI do occur through these channels (except through forward linkages). Explicitly taking into account these knowledge spillover channels seems to be an important step forward in this literature.

The literature on mediating factors and FDI heterogeneity is inconclusive, at least partly because of the lack of comparability across studies caused by differences in methodologies and measurement. Several changes could improve results. First, researchers could move toward convergence, for example, by uniformly measuring absorptive capacity as a relative concept or measuring multinational enterprise ownership along a continuum rather than as a categorical variable.

Second, any study of knowledge spillovers should specify the channels analyzed. Such an approach would clearly delineate the possible role of mediating

factors or FDI heterogeneity. For example, the relevance of the spatial dimension as a mediating factor for knowledge spillovers strongly depends on the spillover channels considered; also, different types of FDI may spill over knowledge through different channels to different extents.

Third, deeper insight into the (conditional) existence of knowledge spillovers from FDI is not likely to come from any of the outlined approaches individually. Spillover channels, mediating factors, and FDI heterogeneity coexist and interact in determining the extent of knowledge spillovers. Theoretical and empirical research should therefore try to address them simultaneously (Wei and Liu 2006; Liang, 2008). Does the importance of absorptive capacity for capturing knowledge spillovers through demonstration effects vary with the degree of multinational enterprise ownership? Is the spatial dissipation of knowledge spillovers through backward linkages different for horizontal and vertical FDI? These kinds of inter-related questions should guide future work on this topic.

Two important overarching issues need to be noted. First, empirical work too often ignores the conceptually important distinction between intentional know-ledge transfers and unintentional knowledge spillovers. As Blalock and Gertler (2007, 2008) and Javorcik and Spatareanu (2005) clearly show, many of the esti-mated effects are more likely related to knowledge transfer than knowledge spill-over. From a policy perspective this distinction is very important: whereas the existence of knowledge spillovers (which are externalities) clearly warrants inter-ventionist government policy, the existence of knowledge transfer (which takes place through market mechanisms) clearly does not.[11] Mistakenly assigning the beneficial productivity effects of FDI to knowledge spillovers may convince govern-ments of many developing countries to undertake costly and wasteful FDI policies. Future empirical work on this topic should be very careful in labeling estimated positive effects of FDI as spillovers and even more careful in deriving far-reaching (costly) policy implications from them.

Second, a wide gap remains between theoretical and empirical research (one exception is Alfaro and Rodríguez-Clare 2004). Theory and empirics have devel-oped more or less independently. In many of the areas reviewed above, more theoretical work is needed. The definition and functioning of demonstration effects, the spatial dimension of knowledge spillovers from FDI in interaction with different spillover channels, and the relation between various motives for FDI and knowledge spillovers are just a few of the areas in which theory to guide future empirical work has been lacking. Given advances in the literature on firm hetero-geneity (Melitz 2003; Helpman, Melitz, and Yeaple 2004), the relation between FDI heterogeneity and knowledge spillovers seems a particularly promising field for future theoretical research.

The result of these recommendations may be to further highlight the weak gen-eralizability of research results. Sacrificing some generalizability in order to obtain

more detailed and conclusive results is preferable, however, to losing sight of important nuances in order to obtain more general results—an approach that has not, to date, yielded consistent results.

Notes

1. This survey does not review methodological developments in the empirical FDI spillover literature. Chapter 5 in Castellani and Zanfei (2006) includes a useful overview of recent methodological advances.

2. Other benefits of inward FDI, such as employment generation and knowledge transfers through licensing, take place through market mechanisms and thus are not arguments for active government involvement.

3. In a similar vein, Rogoff and his coauthors deal with the (macroeconomic) growth effects of capital account liberalization through foreign portfolio investment by investigating the necessary preconditions or mediating factors under which these effects arise (Prasad and others 2003; Kose and others 2006).

4. Keller (2004) provides an excellent survey of the wider literature on international technology diffusion, including knowledge spillovers from FDI.

5. The existence of adverse competition effects assumes that the multinational enterprise goes abroad mainly to produce for the local market (that is, it assumes that FDI is mainly of the horizontal type). For both vertical and export-platform FDI the adverse competition effect is less likely to occur and will be less severe if it does (Protsenko 2003).

6. Falvey, Foster, and Greenaway (2007) consider the simultaneous effects of backwardness and absorptive capacity at the country level. However, they essentially estimate an empirical growth model and focus on trade-related knowledge spillovers. Their results hint at the importance of backwardness over absorptive capacity, although the results vary with the specification and estimation method.

7. I thank an anonymous referee for pointing this out.

8. NUTS provides a single uniform breakdown of territorial units for the production of regional statistics for the European Union. NUTS 1 denotes the broadest level, NUTS 3 denotes the most disaggregated one.

9. Kathuria (2002) examines the effect of liberalization of Indian industries between 1989 and 1997 on knowledge spillovers from FDI. Although liberalization increased competition in general, the reforms applied mainly to trade liberalization. The effect on knowledge spillovers occurred mainly through higher FDI.

10. An extensive body of literature investigates this issue indirectly, by considering the relation between technology-exploiting and technology-sourcing FDI and firm heterogeneity. The results are ambiguous. Some studies find that only low-productivity firms engage in technology-sourcing FDI, which would imply that the knowledge spillover potential from this type of FDI is low (Kogut and Chang 1991; Hennart and Park 1993; Almeida 1996; Neven and Siotis 1996). Other studies show that high-productivity firms are more likely to undertake technology-sourcing FDI, which would imply that the potential for spillover is high (Cantwell and Janne 1999; Chung and Alcácer 2002; Berry 2006; Branstetter 2006; Griffith, Harrison, and van Reenen 2006).

11. If backward knowledge transfers increase competition in supplying industries, reducing prices on intermediate goods and end products, the wealth of consumers in the host country rises, so that the social returns of knowledge transfer exceed the private returns. In this case interventionist government policy could be warranted, as Blalock and Gertler (2008) note.

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