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Collecting the Pieces of the FDI Knowledge Spillovers Puzzle

Roger Smeets

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

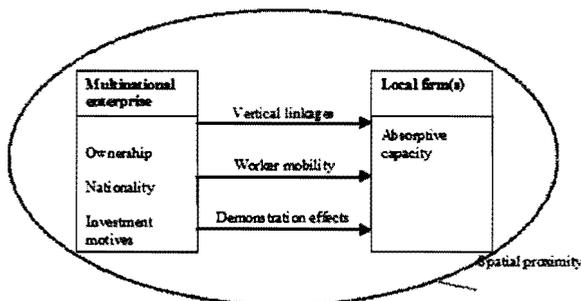
After setting the stage in the following section, the article is then structured around figure 1, a representation of the FDI knowledge spillover process and the pieces of the puzzle that may affect it.³ The section on opening the black box of FDI knowledge spillovers discusses the research on vertical 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

Figure 1. FDI Knowledge Spillovers Framework



Source: Author's schematization.

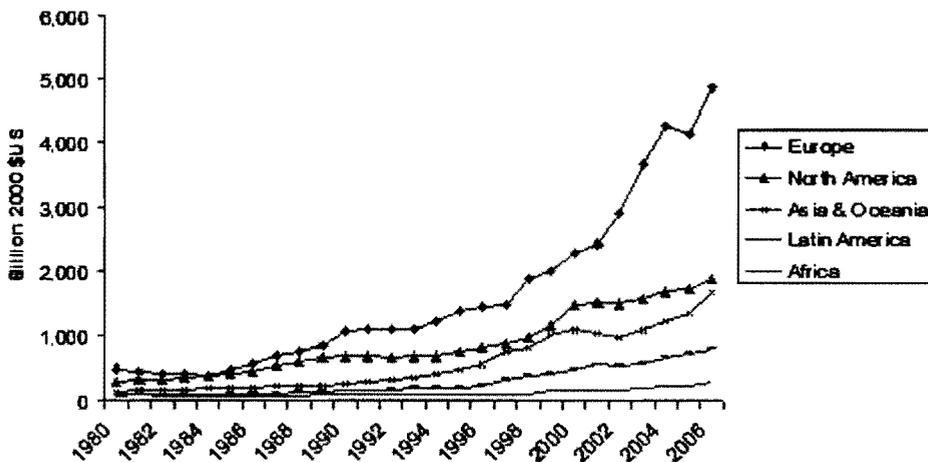
important benefactors. Developing countries, especially in Africa, lagged far behind. The picture is similar for FDI as a share of GDP (figure 3). On this measure countries in Latin America were catching up somewhat during the early 2000s, but Africa is still far behind.

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).

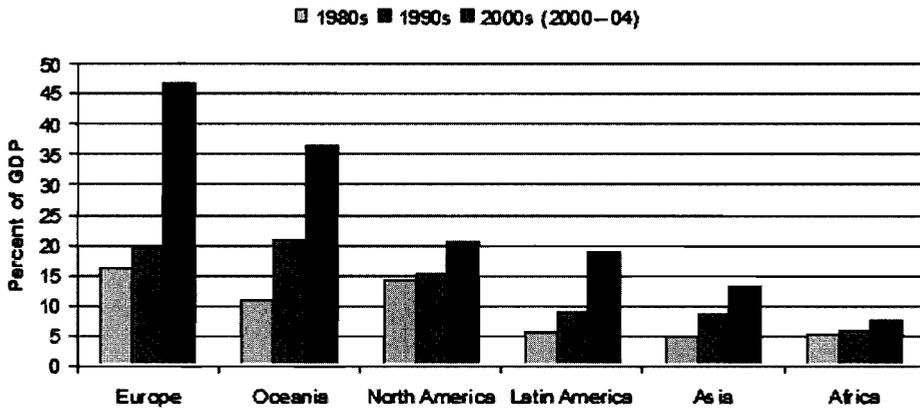
The literature has identified three main channels along which knowledge may spill over from a multinational enterprise to a local firm (Saggi 2006) (see figure 1). Demonstration effects involve the imitation, or reverse-engineering, by host-country firms of the products or practices of multinational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

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

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:

$$y_{ijt} = \beta_0 + \beta_1 FDI_{jt} + \beta_2 \sum_{k \neq j} (\alpha_{jkt}^O \cdot FDI_{kt}) + \beta_3 \sum_{k \neq j} (\alpha_{jkt}^I \cdot FDI_{kt}) + \beta_2 \mathbf{X}_{it} + \beta_3 \mathbf{Z}_{jt} + \varepsilon_{ijt} \quad (2)$$

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

<i>Channel</i>	<i>Study</i>	<i>Sample</i>	<i>Effect</i>
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 , X , 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 Trefimienko (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:

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

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:

$$w_{ijt} = \beta_0 + \beta_1 S_{jt}^M + \beta_2 \mathbf{X}_{it} + \beta_3 \mathbf{Z}_{jt} + \varepsilon_{ijt} \quad (4)$$

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:

$$y_{ijt} = \beta_0 + \beta_1 FDI_{jt} AC_{it} + \beta_2 FDI_{jt} BW_{it} + \beta_3 X_{it} + \beta_4 Z_{jt} + \varepsilon_{ijt}. \quad (5)$$

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
	Girma (2005)	7,516 firms in United Kingdom, 1989–99	Absorptive capacity: No effect 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
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

$$\frac{dy_{ijt}}{dAC_{it}} = FDI_{it} \left(\beta_1 + \beta_2 \frac{dBW_{it}}{dAC_{it}} \right).$$

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 ($dBW_{it}/dAC_{it} < 0$). Thus, even if the direct effect of AC (β_1) is positive, its indirect effect through BW ($\beta_2 \cdot [dBW_{it}/dAC_{it}]$) 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:

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

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, \mathbf{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 coagglomeration (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

<i>Factor</i>	<i>Study</i>	<i>Sample</i>	<i>Effect</i>
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 Sloomackers (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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 Sloomackers (2007)	17,645 plants in China, 2000–04	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • FDI from Asia and America had positive upstream spillover effect • FDI from the European Union had negative effect

Continued

Table 3. *Continued*

<i>Factor</i>	<i>Study</i>	<i>Sample</i>	<i>Effect</i>
	Girma and Wakelin (2007)	11,000 plants and 10 Nomenclature of Territorial Units for Statistics (NUTS) in 1 region in United Kingdom, 1980–92	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Exploiting FDI had positive effect • Sourcing FDI had no effect
	Driffield and Love (2007)	11 manufacturing sectors in United Kingdom, 1987–97	<ul style="list-style-type: none"> • Exploiting FDI had positive effect • Sourcing FDI had no effect
	Protsenko (2003)	256 German FDI projects in Czech Republic, 1993–99	<ul style="list-style-type: none"> • 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):

$$y_{ijt} = \beta_0 + \beta_1 \text{Min_FDI}_{jt} + \beta_2 \text{Maj_FDI}_{jt} + \beta_3 \mathbf{X}_{it} + \beta_4 \mathbf{Z}_{jt} + \varepsilon_{ijt} \quad (7)$$

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 Sloommaekers (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 Sloommaekers (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 multinational 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 spillovers, 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, vertical, 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 knowledge 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 universal 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 knowledge transfers and unintentional knowledge spillovers. As Blalock and Gertler (2007, 2008) and Javorcik and Spatareanu (2005) clearly show, many of the estimated effects are more likely related to knowledge transfer than knowledge spillover. From a policy perspective this distinction is very important: whereas the existence of knowledge spillovers (which are externalities) clearly warrants interventionist 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 governments 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 developed 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 heterogeneity (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 generalizability 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

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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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Can Survey Evidence Shed Light on Spillovers from Foreign Direct Investment?

Beata S. Javorcik

Although some economists remain skeptical of the existence of positive externalities associated with foreign direct investment (FDI), many countries spend large sums attracting foreign investors in the hope of benefiting from knowledge spillovers. Data collected through enterprise surveys conducted in the Czech Republic and Latvia suggest that the entry of multinationals affects domestic enterprises in the same industry or in upstream or downstream sectors through multiple channels. Some of these channels represent true knowledge spillovers while others have positive or negative effects on domestic producers in other ways. The relative magnitudes of these channels depend on host country conditions and the type of FDI inflows, which explains the seemingly inconsistent findings of the literature. The focus of the debate should shift from attempting to generalize about whether or not FDI leads to productivity spillovers to determining under what conditions it can do so. JEL codes: F21, F23, O24, O33

In the view of many policymakers, particularly those in developing countries, foreign direct investment (FDI) is not only a source of capital and additional employment but primarily a channel through which new technologies and know-how are transferred across international borders. Policymakers hope that knowledge brought by foreign affiliates will spill over to domestic firms and increase the competitiveness of their economies. This belief has led many countries to use externalities associated with FDI as a justification for providing fiscal and financial incentives to foreign investors.

The fact that large sums are often spent attracting FDI and the importance of technology transfer have led many academics to search for evidence of knowledge

spillovers from FDI. Their conclusions have been mixed. Early cross-section studies of intraindustry spillovers find a positive association between industry-level productivity and FDI; the conclusions of recent firm-level panel analyses are more ambiguous (see the literature surveys by Görg and Strobl 2001; Lipsey 2002; Saggi 2002; and Görg and Greenaway 2004). The meta-analysis of Görg and Strobl (2001) shows that cross-sectional studies tend to overstate the intraindustry spillover effects, possibly because the studies are unable to control for unobservable industry heterogeneity. Among firm-level panel analyses, those focusing on industrial countries are more likely to report positive findings on intraindustry spillovers than those using developing country data. More recent work examining interindustry spillovers has produced more encouraging results by providing evidence consistent with the existence of knowledge spillovers from multinationals to supplying industries (see Javorcik 2004 and Blalock and Gertler 2008). A review of the case study literature concludes that while the majority of case studies support the existence of FDI spillovers, under some circumstances such spillovers are unlikely to take place (Moran forthcoming).

Critics of globalization and academic skeptics have interpreted these mixed results as reflecting “extravagant claims about positive spillovers from FDI” that are not corroborated by the “sobering evidence” (Rodrik 1999, p. 37). They suggest that one dollar of FDI is worth no more than a dollar of any other kind of investment and that there is thus no case for special treatment of FDI.

Despite the mixed evidence, governments all over the world have continued their efforts to attract FDI inflows. The 1990s witnessed an explosion in the number of national investment promotion agencies. Between 1990 and 2005, the number of such agencies increased from 11 to 63 in developing countries and from 3 to 20 in developed countries. In 2004 alone, 59 of 108 countries surveyed in the World Bank’s Census of Investment Promotion Agencies offered some type of incentives to foreign investors (Harding and Javorcik 2007).

The contrast between the views of academic skeptics and the actions of governments has left observers wondering whether academics have simply failed to uncover spillovers that indeed exist or whether the generosity with which governments treat foreign investors is not really warranted. This article contributes to this debate by presenting information collected through enterprise surveys conducted in the Czech Republic and Latvia. Enterprise surveys can provide useful evidence that complements case studies and econometric analyses. Survey evidence is less prone than case studies to the criticism of not being representative and difficult to generalize. And in contrast to econometric analyses, which often treat the mechanism behind spillovers as a black box, surveys can capture the multiple channels through which spillovers take place.

The survey evidence presented here illustrates the myriad channels (including both real and pecuniary externalities) through which FDI inflows affect the

performance of domestic producers in a host country. Some of these channels are true knowledge spillovers, others exert a positive effect on domestic producers through demand shocks; some may have a negative impact on the observed performance of local firms. The methodologies employed in most econometric studies are unable to distinguish between the various channels. To complicate matters further, the relative magnitude of these channels depends on host country conditions and the type of FDI inflows, which may explain the seemingly inconsistent findings of the literature.

The article is structured as follows. The next section briefly describes the enterprise survey data used. Section II focusses on intraindustry spillovers. Sections III and IV discuss the effects of foreign entry on upstream and downstream industries. The last two sections present suggestions for future research and some policy recommendations.

The Data

The article draws on three enterprise-level surveys commissioned by the World Bank: in 2003 and 2004 in the Czech Republic and in 2003 in Latvia (for more details, see FIAS 2003, 2004; and World Bank 2007). The surveys were conducted by professional polling companies through face-to-face interviews at respondents' workplaces. All respondents were guaranteed full anonymity. The 2003 survey in the Czech Republic included 391 local manufacturing companies and 119 multinationals. About 20 percent of respondents were located in Prague, with the rest distributed across all regions of the country. The 2004 survey covered 466 domestic firms, 266 of them in the manufacturing sector and 200 in the service sector. The survey also included 167 multinationals. Seventeen percent of respondents were located in Prague. The Latvia survey covered 407 manufacturing firms, 11 percent of which had received FDI. About half of the interviewed firms were located in Riga, with the rest distributed around the country. All of the companies surveyed were private.

While one of the main goals of the Czech surveys was to learn about the implications of foreign entry for local firms, the Latvian survey contained only a limited component pertaining to this issue. This article therefore relies primarily on the Czech data, supplementing them with information from Latvia when possible.

Relying on survey data may be subject to the criticism that respondents may not answer the questions truthfully. This is unlikely to be a serious concern in this case, as all three surveys were conducted by highly reputable polling firms that guaranteed full anonymity to respondents. Respondents were free to decline being interviewed or to answer a particular question.

While some pitfalls are associated with reliance solely on survey data to investigate economic phenomena, enterprise surveys constitute an additional source of information that complements and enriches the conclusions of econometric evidence and the extensive case study literature on FDI spillovers. Survey data also help make sense of the seemingly contradictory evidence produced by statistical analyses, suggesting new directions for future research.

Intraindustry Spillovers

The entry of multinationals may affect local firms operating in the same sector through several mechanisms. The first mechanism relies on real externalities, such as the diffusion of knowledge through the demonstration effect. As local firms observe the actions of their foreign competitors, they learn about new technologies (some of which can be embodied in machinery or inputs that are relatively easily available for purchase), new marketing techniques, and new types of products. Local firms can also hire workers trained by multinationals. By doing so, they can 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.

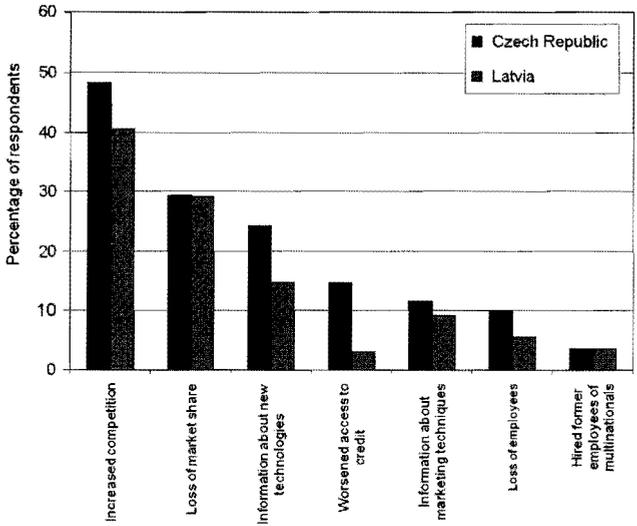
The second mechanism takes the form of pecuniary externalities and can be referred to as a competition effect. The entry of multinational firms increases the level of competition within the industry as long as some share of their output is sold in the host country. Even host countries with liberal trade regimes may experience an increase in competition. Producing locally reduces transportation costs and, in emerging markets, labor costs. It allows multinationals to reduce the price of their products relative to the prices they charged before entering the host country. In the long run, increased competition provides incentives for domestic producers to improve their performance; it also leads to exit of the worst performers and an increase in the average productivity level in the industry. In the short-to-medium run, however, weaker firms may experience a decline in observed performance as their market share shrinks.

Multinationals may also poach the best workers from their local competitors and make access to credit more difficult (because they may be lower-risk borrowers than their local competitors).¹ Both channels create negative pecuniary externalities that affect local firms. 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 from less efficient firms to firms that are better positioned to benefit from them. This in turn may benefit consumers through lower prices.

The third mechanism may work by affecting demand for intermediates. As Rodriguez-Clare (1996) notes, if multinational entry increases demand for intermediates, it may result in the expansion of upstream industries. A greater variety of inputs available will in turn benefit downstream industries, including the industry of multinational entry. Demand for intermediates may increase even in the presence of a liberal trade regime, as local sourcing may lead to saving on transportation costs and remove uncertainty about the timing of delivery (which is particularly important in host countries with poorly functioning customs service). The converse is also possible. If expansion of multinationals forces local firms to exit and multinationals use local inputs less intensively, a negative effect would be observed in upstream sectors as well as industries using these inputs.

The results of surveys from the Czech Republic (2003) and Latvia (2003) provide evidence of all the above mechanisms. Firms in both countries reported learning about new technologies and marketing techniques from multinationals (figure 1). In the Czech Republic, local firms seemed to benefit equally from direct competitors and multinationals operating in their sector with whom they were not competing. Moreover, both firms experiencing loss of a market share and those unaffected by foreign entry reported positive knowledge externalities associated with FDI (table 1).

Figure 1. Perceived Effects of FDI Inflows into the Same Industry by Survey Respondents in the Czech Republic and Latvia



Source: Javorcik and Spatareanu (2005).

Table 1. Knowledge Flows from Entry of Multinationals into Sector (percent of Czech firms reporting)

Item	From multinationals in the same sector that are		As a result of foreign entry into the same sector respondents	
	Competitors	Noncompetitors	Lost market share	Did not lose market share
Learning about new technologies	26	22	23	25
Learning about new marketing techniques	12	11	11	12
Benefiting from knowledge of employees trained by multinationals	5	2	3	4

Note: The sample size included 327 answers.

Data source: FIAS (2004).

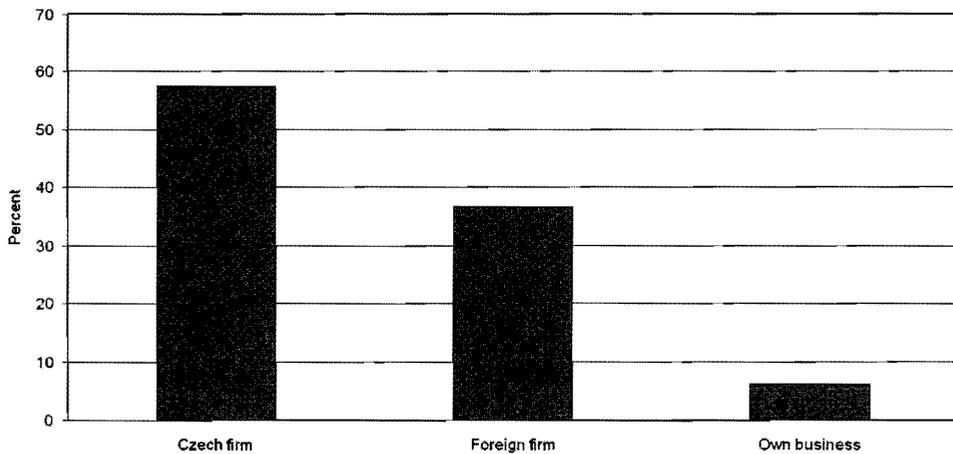
Survey respondents also reported benefiting from the knowledge of workers who had previously been employed by multinationals (figure 1). This channel of spillovers is less prevalent, however, because domestic firms may have a hard time competing with multinationals in wages. However, multinationals reported that when their employees leave, they usually find employment in local firms (figure 2).

Local respondents also reported an increase in competition resulting from foreign entry. Among domestic producers 41–48 percent said that foreign entry increased the level of competition in their industry; a smaller, though significant, percentage (29 percent) reported losing market share to the foreign entrants. Survey respondents mentioned that they had lost employees to multinational entrants, although this phenomenon did not seem to be very widespread. Finally, some respondents believed that entry of multinationals worsened their access to credit (see figure 1).

The survey suggests both positive and negative effects on the demand for upstream production from the entry of multinationals. On the one hand, 18 percent of respondents reported benefiting from foreign entry by becoming suppliers to multinationals operating in their sector. On the other hand, 21 percent of respondents whose Czech clients had been acquired by foreign investors stopped supplying these clients. Of those who continued the business relationship, five firms reported having to comply with higher quality requirements.

An important message to take away from these results is the difference in the reported effects of FDI inflows. While domestic firms in both countries reported similar patterns with respect to increases in competitive pressures and loss of market share, the benefits of knowledge spillovers were much more prevalent in the Czech Republic. Twenty-four percent of Czech firms, but only 15 percent of Latvian

Figure 2. Place of Employment of Former Employees of Multinationals in the Czech Republic



Note: Eighty-two multinational firms responded to the question.

Data source: FIAS (2004).

firms, reported learning about new technologies from multinationals. The difference in the ability to learn about marketing techniques was much less pronounced. Whether these differences stem from differences in the composition of FDI inflows or differences in local firms' ability to absorb knowledge spillovers, the key message is that host country conditions affect the extent of knowledge spillovers.

The vast majority of econometric studies cannot distinguish between the mechanisms described above; many studies do not even include rudimentary controls for the level of competition. It is therefore not surprising that the literature has produced seemingly inconsistent results on intraindustry spillovers. Rather than interpreting a study with a marginal improvement in the methodology as invalidating all earlier findings, it would be more productive to focus on ways of isolating individual mechanisms.

Some progress has already been made in this direction. Görg and Strobl (2005) use Ghanaian data on whether or not the owner of a domestic firm had previous experience in a multinational, which they relate to firm-level productivity. Their results suggest that firms run by owners who worked for multinationals in the same industry immediately before opening their own firm are more productive than other domestic firms. Crespi and others (2007) combine self-reported data on sources of new knowledge from UK innovation surveys with information on firm-level total factor productivity. They find that competitors are one of the key sources of knowledge contributing to firm performance. They also show that reported knowledge flows from competitors are positively correlated with the presence of multinationals in the same industry.

Spillovers To Upstream Sectors

While multinationals have a strong incentive to prevent knowledge leakage to their competitors, they may want to transfer expertise and know-how to their suppliers. Passing on information about new technologies or business practices (such as quality control processes or inventory management techniques) to suppliers reduces input costs, increases input quality, and thus benefits multinationals. If the benefits of knowledge transfer are not fully reflected in lower quality-adjusted prices, the actions of multinationals result in knowledge spillovers.

As Pack and Saggi (2001) show in a theoretical model, even if technology transferred by a multinational to a developing country supplier diffuses to other firms in the supplying industry and benefits competitors of the multinational, both the developing country supplier and the multinational can benefit. In the absence of knowledge diffusion in the supplying industry and entry in the buying industry, the developing country supplier and the multinational are in a bilateral monopoly. They impose a pecuniary vertical externality upon each other by charging a price above marginal cost; the double marginalization problem thus exists. Knowledge diffusion in the supplying industry stimulates new entry and brings the input price closer to marginal cost, benefiting the multinational. Entry into the industry of the multinational brings the downstream price closer to marginal cost, increases output, and benefits the developing country supplier. As a result, as long as the competition resulting from diffusion in the supplying industry and entry into the industry of the multinational are not too severe, both firms gain from diffusion that leads to entry in the downstream market.

Several recent studies find evidence consistent with spillovers to upstream sectors. Using firm-level panel data from Lithuania, Javorcik (2004) shows that the total factor productivity of Lithuanian firms is positively correlated with the extent of potential contacts with multinational customers in downstream sectors. A one standard deviation increase in foreign presence in the buying sectors is associated with a 15 percent rise in the productivity of Lithuanian firms in the supplying industry. The productivity effect occurs from investments with joint foreign and domestic ownership but not from fully owned foreign affiliates. This finding is consistent with the evidence of an increase in local sourcing undertaken by jointly owned projects. Evidence supporting FDI spillovers to upstream sectors has also been found in other countries (see Javorcik and Spatareanu 2008 on Romania, and Blalock and Gertler 2008 on Indonesia).

Even in the case of spillovers to local suppliers, however, one should not expect a uniform effect across countries or across industries within a country, for several reasons. First, the decision to purchase inputs locally will be driven by the host country's trade regime, efficiency, and the predictability of its customs service and transport costs. The choice of input source also depends on whether a multinational

Table 2. Determinants of Sourcing Patterns by Multinationals

<i>Determinant</i>	<i>Share of multinationals responding (percent)</i>
<i>Reason for importing inputs from abroad</i>	
Using company's global suppliers	46
Implementing decision of parent company	37
Unavailability of particular products from local firms	36
Desire to purchase higher-quality inputs	30
<i>Reason for buying inputs from other multinationals operating in host country</i>	
Using firm's global suppliers	45
More competitive prices	45
Savings on transport costs	34
Benefits of proximity	30
Higher-quality products	29
Products not available from local firms	29
<i>Reason for buying inputs from local suppliers</i>	
Low prices	71
Benefits of proximity	64
Savings on transport costs	56
Savings on import duties	44

Note: The sample size included 327 answers.

Data source: FIAS (2004).

follows a centralized sourcing arrangement in order to benefit from volume discounts or access to customized inputs (UNCTAD 2001). Indeed, using the company's global suppliers was the main reason multinationals operating in the Czech Republic reported using imported inputs. In other cases the decision reflected the fact that particular inputs or inputs of sufficient quality were not available locally (table 2).

Because it may take time to develop relationships with local suppliers, one would expect new FDI projects to be less likely to use locally produced inputs than would investors with longer experience in the host country. This is confirmed by Belderbos, Capanelli, and Fukao (2000), who find that the proportion of inputs sourced locally by Japanese multinationals increases with the number of years of operation in a given host country. In sum, in situations in which upstream sectors in the host country are underdeveloped or the multinational has very specialized input needs or relies on centralized input sourcing, the scope for spillovers to upstream sectors may be limited.

Second, even if multinationals source inputs in the host country, they may buy them from other multinationals operating there. It is relatively common for producers of parts and components to follow their clients to a new host country. In such a situation, FDI inflows would affect supplying industries only by stimulating FDI inflows into upstream sectors, which in turn would lead to intraindustry effects in upstream sectors (described in the previous section).

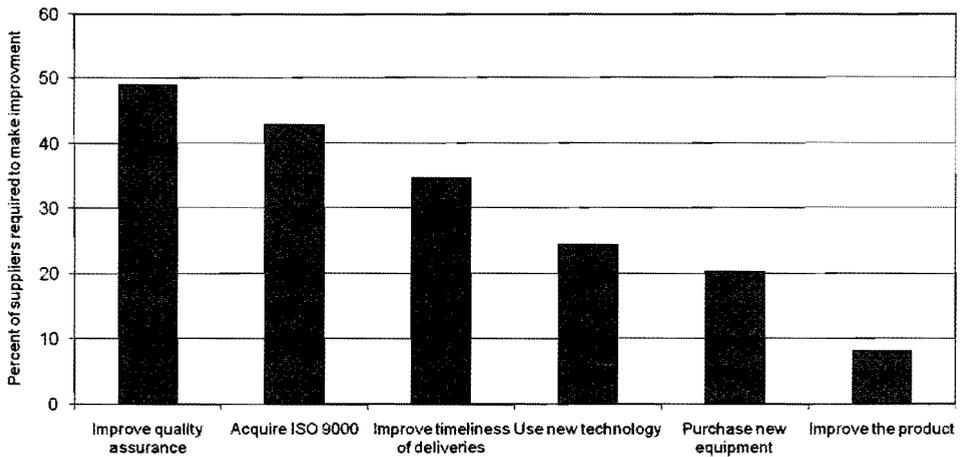
Third, in situations in which either a world-class supplying industry already exists or only basic inputs with limited technological content are needed, there is little scope for knowledge transfer. Multinationals may simply award contracts to the best local producers, and upstream benefits may be limited to increasing the demand for inputs and allowing upstream producers to benefit from economies of scale. The extent of these benefits hinges on multinationals increasing the overall demand for inputs (rather than replacing the demand from local competitors they forced to exit) and the production technology in upstream industries. The benefits of scale economies in the form of lower prices may be passed on to local input users in the sector of the multinational or other sectors.

Fourth—and more interesting from a development perspective—by imposing higher standards on their suppliers for product quality, technological content, or on-time delivery, multinationals may induce local producers in upstream sectors to make improvements. Is this situation different from firms learning about buyer expectations in foreign markets? Most likely it is, because information costs are much lower. Multinationals operate in the same country; contacting them does not require knowledge of a foreign language or entail high travel or communications costs. In some cases, a multinational may even be the party that initiates contact with a potential local supplier. Another difference is the prevalence of technical audits, which tend to be less widespread for export transactions. Some 20 percent (37 of 187) of Czech suppliers reported undergoing such an audit before signing a contract with a multinational; in some cases two or three audits were performed. The technical audits, while not considered by multinationals as a form of assistance, may be invaluable to local suppliers, as they may point out operational deficiencies of which they had not been aware.

Before signing a purchase order, multinationals often explicitly require future suppliers to make certain improvements. In the Czech Republic this was the case for more than a quarter of all suppliers surveyed (49 of 190). Almost half of the audits took place six months or more before the contract was signed. The most frequent requirements were improvements to the quality assurance process, acquisition of a quality certification (such as an ISO 9000), improvements to the timeliness of deliveries, use of a new technology, or purchase of new equipment (figure 3). The fact that improvements to the product were less frequent is consistent with the evidence suggesting that having a suitable product is in most cases a precondition for starting a dialogue with a potential multinational client.

The prospect of receiving a contract from a multinational also seems to induce local suppliers to undertake improvements on their own. Thirty-six percent of Czech suppliers reported making improvements with the explicit purpose of finding a multinational customer. These improvements included investing in new machinery and equipment, improving product quality, conducting staff training,

Figure 3. Types of Changes Required by Multinationals from Potential Suppliers in the Czech Republic



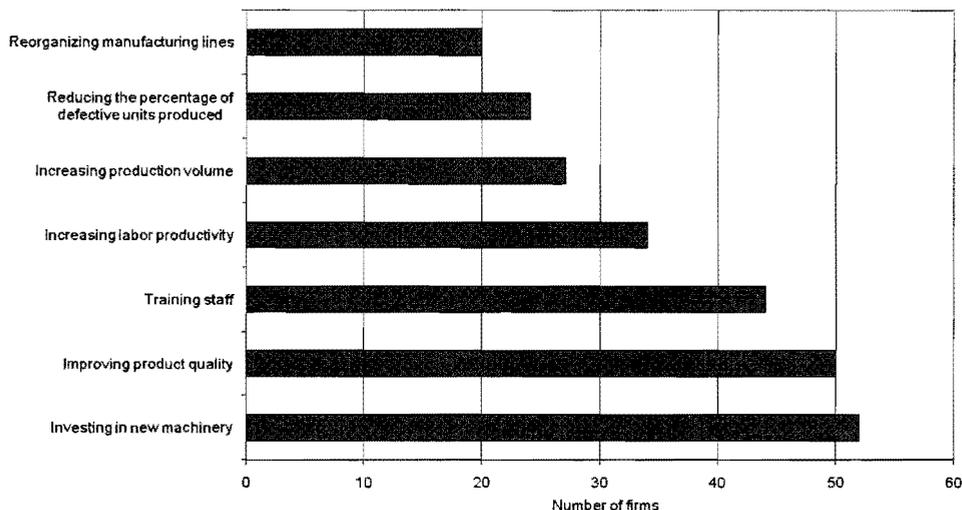
Data source: World Bank (2007).

increasing production volume, reducing the share of defective units produced, and reorganizing manufacturing lines (figure 4). Forty percent of Czech companies with ISO 9000 certification reported obtaining it in order to be able to supply multinational companies.

Fifth, multinationals often offer assistance to their current or prospective suppliers. To the extent that the cost of this assistance is not reflected in the lower prices multinationals pay for inputs, this assistance constitutes a knowledge externality. Forty percent of Czech suppliers surveyed in 2004 reported receiving some type of assistance from their multinational customer. The most common types of assistance extended was personnel training, advance payment, leasing of machinery, provision of inputs, and help with quality assurance and organization of production lines (figure 5).² The survey also indicated that multinationals offer assistance throughout their relationship with their suppliers. Assistance is often offered even before the contract is signed; it may also be provided both before and after completion of the first delivery.

The picture emerging from the survey of Czech firms is that the relationship between multinationals and local suppliers in a given country may entail many circumstances described above. The nature of the relationship may depend on the industry in question, characteristics of the multinational, and the level of sophistication of existing suppliers. As in the case of intraindustry effects, the relative importance of different mechanisms may differ depending on the country in question. Thus if two econometric studies focussing on different countries or the same country in different time periods find seemingly contradictory results, that does

Figure 4. Improvements Undertaken by Czech Firms in Order to Supply a Multinational

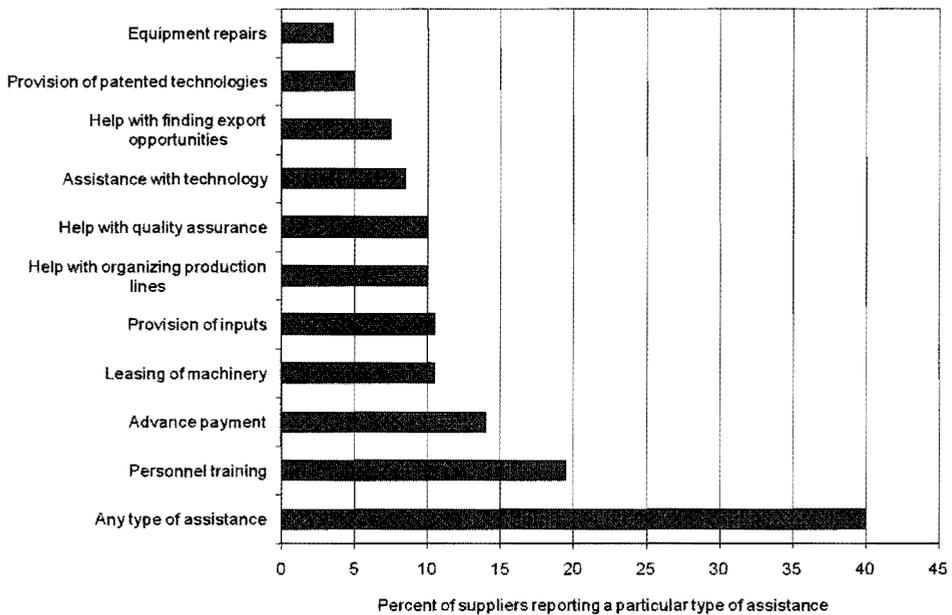


Data source: World Bank (2007).

not necessarily mean that one study casts doubt on the validity of the other study's methodology or that only one study has uncovered "the true relation." Expectations of multinationals as well as host country conditions may well have changed over time, with each study describing the reality of a given time period.

Finding a positive relation between the change in the presence of multinationals and productivity improvements in supplying sectors is consistent with the existence of knowledge spillovers, but it does not prove that such spillovers exist, for several reasons. First, in some cases it may reflect the efforts of suppliers to improve their performance in the hope of receiving contracts from multinationals. This is a case of a positive demand shock (entry of a multinationals) but not a knowledge spillover.³ Second, using industry-level deflators does not allow for an accurate adjustment of supplier's sales prices and thus may lead to overstating productivity improvements (if suppliers enjoy higher prices than other producers) or hide such effects (if multinationals require mandatory price cuts over the course of a relationship with a supplier). In the Czech Republic, for example, 37.5 percent of suppliers were required by their multinational customers to lower their prices by 1–30 percent (figure 6). To complicate matters further, mandatory price cuts affected both suppliers that benefited from the assistance extended by a multinational and those that did not receive such assistance. In sum, to understand the impact of multinationals on local suppliers it is necessary to go down to the level of suppliers rather than rely on industry-level information from the input–output matrix.

Figure 5. Types of Assistance Received by Czech Suppliers from Multinational Customers



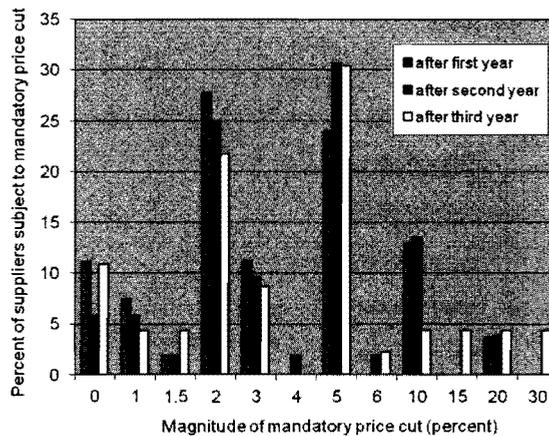
Data source: World Bank (2007).

Spillovers To Downstream Sectors

Starting with the theoretical contribution of Ethier (1982), researchers have argued that access to a greater variety of inputs raises the productivity of downstream industries. Access to a larger range or higher-quality inputs is one of the oft-cited arguments in favor of trade liberalization. A similar argument could be made for FDI inflows: entry of multinationals may have a positive impact on the performance of downstream sector by making new or more suitable inputs available to local producers.

No study has produced convincing and robust evidence in support of this channel of FDI spillovers. One difficulty in investigating this question empirically is that many multinationals produce primarily for exports; local enterprises in downstream sectors are thus rarely exposed to intermediates sold by these multinationals. However, even if the export orientation of multinationals (that is, the share of production sold abroad) is taken into account, as it is in Javorcik (2004), there is no evidence of productivity spillovers to downstream sectors. One possible explanation is that inputs tend to be accessible through imports; entry of multinationals is thus likely to play a smaller role relative to imports. To isolate the effect

Figure 6. Price Cuts Imposed on Czech Suppliers by Multinationals



Note: The percentage of suppliers subject to a price cut in a particular period is defined relative to the number of suppliers subject to a price cut at any time during the relationship with the multinational.

Data source: World Bank (2007).

of FDI, one would need to carefully control for the availability of imported inputs, which is almost never done in the studies of FDI spillovers.

Although the firm-level surveys cited in this article did not focus on this channel of FDI spillovers, they provide some evidence that its importance may be limited. In the 2003 Czech survey, 11 percent of respondents reported benefiting from foreign presence in their sector through access to inputs produced by multinationals; within this group two-thirds reported that these inputs had previously not been available in the Czech Republic.⁴ The figures are similar to those from the 2004 Czech survey, in which 10 percent of suppliers reported that multinationals had helped them with input provision. Inputs purchased from multinationals may have a greater effect on the user's productivity if they are accompanied by additional information or assistance on how to use them, which may be more difficult to obtain from producers located abroad. However, the 2003 survey indicated that only 6 percent of Czech firms within the group mentioned above received free assistance on how to use inputs purchased from a multinational.

The most likely source of spillovers to downstream industries may be the service sector, for two reasons. First, virtually all formal enterprises use basic services, such as telecommunications and banking; improvements in these sectors are therefore likely to affect all industries. Second, the performance of downstream sectors is tied more directly to the quality and availability of services supplied by providers operating domestically than it is for physical intermediate inputs. That is because the nature of the service industry and barriers to trade in services

mean that the scope for using cross-border trade to substitute for domestically produced service inputs is limited. Limited cross-border tradability of services also means that foreign service providers sell most of their output in the host country.

Foreign entry into the service industry may improve and expand the set of available producer services and introduce international best practices. It may also induce domestic competitors to make similar improvements. In Mexico, for example, Wal-Mart introduced cutting-edge retail practices (central warehousing, an appointment system, use of pallettes), which significantly cut distribution costs. These practices were quickly adopted by other domestic retail chains competing with Wal-Mart (Javorcik, Keller, and Tybout 2006).

A greater choice of service providers may affect the performance of the manufacturing sector in three ways. First, entry of internationally successful players into service industries may lead to higher quality and greater reliability of services. Electricity provision or international phone communications may become more reliable as a result of new investments in infrastructure; credit decisions may be made more quickly as competition among banks increases. These improvements will limit disruptions to production and decrease the operating costs in downstream manufacturing sectors.

Second, new services may become available as a result of foreign entry. Examples include new financial instruments, multimodal transport services, and digital value-added services in telecommunications. The availability of such services may allow manufacturers to introduce productivity-enhancing changes to their operations, such as receiving production orders online or setting up online bidding systems for suppliers.

Third, liberalization of services may lead to wider access to services, by increasing the availability of business services to smaller firms or expanding Internet coverage into rural areas, for example. Improved access may in turn enhance the competitiveness of smaller or remotely located enterprises. To the extent that these improvements are not reflected in prices of services, they may be considered spillovers.

The 2004 Czech survey reveals that local entrepreneurs had positive perceptions of opening the service sector to foreign entry. A vast majority of respondents reported that liberalization contributed to improvements in the quality, range, and availability of services inputs. The positive perceptions ranged from 55 percent of respondents asked about the quality of accounting and auditing services to 82 percent for telecommunications. With regard to the variety of products offered, the positive views of liberalization ranged from 56 percent of respondents evaluating accounting and auditing services to 87 percent of respondents asked about telecommunications. The corresponding figures for the effect on service availability ranged from 47 percent in accounting and auditing to 80 percent in telecommunications (figure 7).

Arnold, Javorcik, and Mattoo (2007) formally examine the link between FDI in services and the performance of domestic firms in downstream manufacturing. Using firm-level data from the Czech Republic for 1998–2003, they measure the presence of FDI in services by the share of service output provided by foreign affiliates. They employ two definitions. The first considers the output of any firm with at least 10 percent of foreign equity as foreign; the second weights the output of each provider by the foreign equity share. The manufacturing–services linkage is captured using information on the degree to which manufacturing firms rely on intermediate inputs from service industries. The econometric results indicate that opening services to foreign providers leads to improved performance of downstream manufacturing sectors. This finding is robust to several econometric specifications, including controlling for unobservable firm heterogeneity and other aspects of openness and instrumenting for the extent of foreign presence in service industries. The magnitude of the effect is economically meaningful: a one standard deviation increase in foreign presence in service industries is associated with a 3.8 percent increase in the productivity of manufacturing firms relying on service inputs.

In sum, the evidence suggests that while foreign entry in manufacturing sectors is likely to have a limited effect on downstream sectors, opening service industries to FDI may result in significant gains to downstream industries.

Future Research

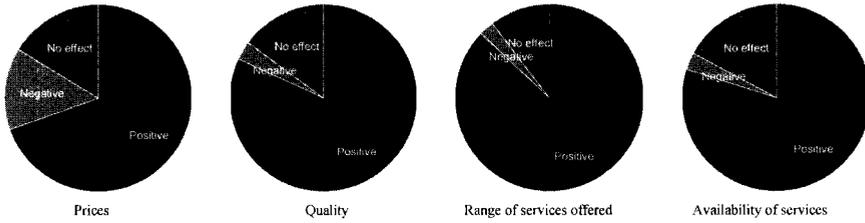
The survey evidence presented here has several implications for the direction of future research on FDI spillovers. First, it suggests that the focus of the debate should shift from attempting to generalize whether or not FDI spillovers exist to determining the conditions under which they are likely to do so. The nature and magnitude of FDI spillovers depends on the conditions in the host country, which determine both the type of FDI inflows as well as the extent to which local firms are likely to be affected (positively, negatively, or both) by foreign entry. Examining FDI spillovers in the context of one country at a time is unlikely to be very productive. What is needed is a multicountry study based on comparable high-quality, firm-level panel data. Such data would allow for examination of host country characteristics as determinants of both FDI inflows and spillovers from FDI. Conducting a meta-study focussing on the host country business environment and level of development could be another promising avenue for future research.

Second, more effort should be directed at understanding the exact mechanisms behind the observed patterns. Rather than correlating the performance of host country firms with the presence of multinationals in their or other sectors, researchers should look at the flows of workers between the two types of firms, identify

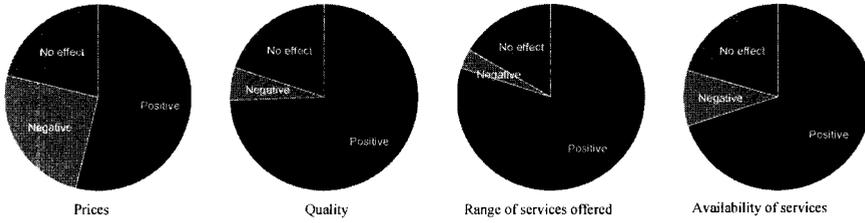
Figure 7. Perceptions of Opening Service Industries to Foreign Providers by Survey Respondents in the Czech Republic

Perceived impact of liberalization of ...

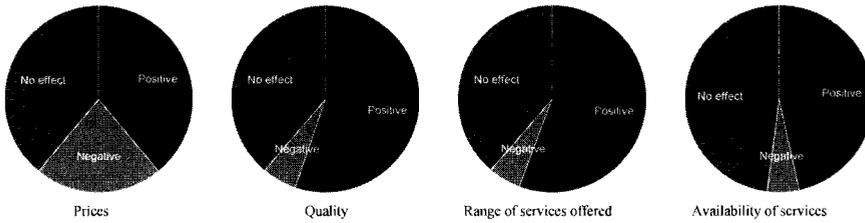
telecommunications sector on



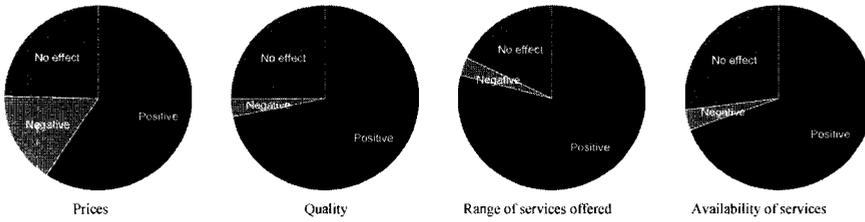
banking sector on



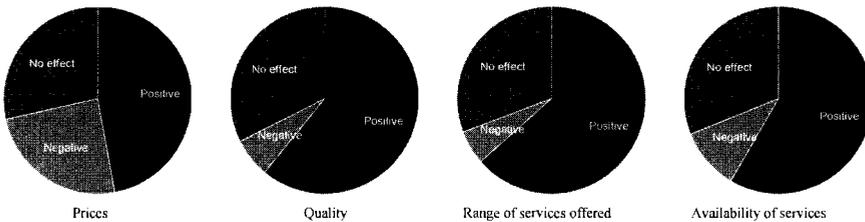
accounting sector on



insurance sector on



transport sector on



Source: Arnold, Javorcik, and Mattoo (2007), based on data from World Bank (2007).

domestic suppliers of foreign customers, consider the effect of foreign presence on the entry of new firms and their characteristics, and ask firms detailed questions about the sources of innovation. Some researchers have already pursued this line of study, but more work is needed. While it creates new challenges in terms of finding appropriate econometric strategies, collecting data, and overcoming the fear of relying on surveys, this area of research probably has the greatest potential.

Third, the scope of investigations should be extended to encompass the service sector. Anecdotal evidence suggests that the movement of service industry professionals to executive positions in other firms may constitute an important spillover channel to other service firms and to the manufacturing industry. For instance, McKendrick (1994) reports that local banks and financial institutions in Latin America and South Asia are filled with “alumni” of Citibank and BNP. Moreover, because the nature of the sector and trade barriers limit cross-border trade in services, opening service industries to foreign providers may constitute an important channel of spillovers to downstream manufacturing.

Conclusions: What Policy Advice Can Researchers Offer?

Many countries offer foreign investors more favorable treatment than they give 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 constitutes an example of a market failure and may serve as a justification for subsidizing FDI. Given the difficulties in assessing the benefits of such externalities, however, it is easy to extend subsidies beyond levels that can be justified based on the magnitude of spillovers. According to Haskel, Pereira, and Slaughter (2007), this was the case in the United Kingdom, which extended incentives to foreign investors that exceeded the value of spillovers on a per job basis. Overpaying is even more likely if countries compete 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).⁵ However, if the first handful of FDI projects or entry of a prominent multinational serves as a signal to other investors that a particular country is a good location for FDI, the justification based on the information asymmetries may apply only to the initial period after opening to FDI.

Another way of dealing with information asymmetry is to provide information through investment promotion agencies. The activities of such agencies include

building an image of the host country as a good place to do business, reaching out to prospective investors through seminars and missions, participating in trade shows and one-to-one direct marketing, and helping committed investors cut through bureaucratic procedures. As obtaining information on investment opportunities and the required procedures tends to be more difficult in developing countries than in industrial economies, investment promotion should be particularly effective in a developing country context.

Investment promotion efforts in developing countries appear to be effective. A recent study by Harding and Javorcik (2007) relies on the fact that most investment promotion agencies target particular sectors in their efforts to attract FDI, a strategy investment promotion professionals believe represents best practice. If investment promotion is effective, one would expect to see a greater increase in FDI inflows in priority sectors than in other sectors. This is indeed what Harding and Javorcik (2007) show. They find that sectors explicitly targeted by investment promotion agencies in developing countries saw FDI inflows double following targeting. No such pattern was observed for nontargeted sectors during the same period. They conclude that investment promotion is a viable policy option for developing countries that have sound business climates and wish to attract FDI inflows.

Notes

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1. In a firm-level analysis of Côte d'Ivoire, Harrison and McMillan (2003) find that borrowing by foreign firms exacerbates the credit constraints faced by domestic firms.
2. Not all of the types of assistance listed are associated with knowledge flows.
3. Javorcik (2004) explicitly controls for changes in demand from downstream sectors.
4. The question should have asked about inputs available from multinationals in any sector, not just the sector in which the respondent operates.
5. The same argument applies to foreign portfolio flows.

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The Growing Phenomenon of Private Tutoring: Does It Deepen Human Capital, Widen Inequalities, or Waste Resources?

Hai-Anh Dang • F. Halsey Rogers

Does private tutoring increase parental choice and improve student achievement, or does it exacerbate social inequalities and impose heavy costs on households, possibly without improving student outcomes? Private tutoring is now a major component of the education sector in many developing countries, yet education policy too seldom acknowledges or makes use of it. This survey of the literature examines the extent of private tutoring, identifies the factors that explain its growth, and analyzes its cost-effectiveness in improving student academic performance. It also presents a framework for assessing the efficiency and equity effects of tutoring. The results suggest that even taking equity concerns into account, tutoring can raise the effectiveness of the education system under certain reasonable assumptions. Guidance is offered for attacking corruption and other problems that diminish the benefits of private tutoring. JEL codes: I21, I22, D10.

Developing country policymakers recognize that education is a key determinant of individual productivity and economywide growth. But their sector diagnoses and policy attention have focused on public schools. Much less attention has been paid to the private school sector, and policy discussion rarely mentions what is emerging as a third important education sector: the private tutoring industry.

In many countries, private tutoring has arisen as a parallel education sector that provides supplementary instruction to students enrolled in the public school system. Substantial private tutoring industries can be found in countries as economically and geographically diverse as Cambodia, the Arab Republic of Egypt, Japan, Kenya, Morocco, Romania, Singapore, the United States, and the United Kingdom.

This survey cites evidence on the prevalence of tutoring in 23 developing and developed countries. In almost all of them, 25–90 percent of students at certain levels of education are receiving or recently received private tutoring. In some

countries, such as the Republic of Korea (hereafter Korea) and Turkey, spending by households on private tutoring now rivals public sector education expenditures.

Private tutoring has elicited mixed responses from policymakers. In some countries it is ignored; in others it is actively controlled and regulated. Private tutoring has been banned at various times in Cambodia, Korea, Mauritius, and Myanmar (Bray 1999a), out of concern that it exacerbates social inequalities, disrupts the public education system, and fails to increase academic performance or build human capital.

Policymakers need evidence to formulate good policy toward private tutoring. What factors (micro and macro) drive the demand for private tutoring? Do only rich households use private tutoring? How is private tutoring different from private or public education? What effects does private tutoring have on students' academic performance? Is private tutoring a cost-effective form of education? Does the evidence suggest that increased use of private tutoring is a welcome development or one governments should discourage?

Policymakers may find it preferable to formulate views on these questions before private tutoring becomes even more entrenched. Once it emerges as a major industry—especially if wealthier parents see it providing competitive advantages to their children—it will likely be harder for governments to adjust policy in ways that threaten vested interests.

This article reviews what is known about the determinants and effects of private tutoring and analyzes the equity and efficiency issues, with a focus on developing countries. It begins by establishing the economic importance of private tutoring in much of the developed and developing world. It then provides a simple framework of the supply of and demand for education, which guides the discussion of equity and efficiency issues. The next sections review the determinants of private tutoring, from both a micro and a macro perspective, and the effects of tutoring on student achievement, paying special attention to the statistical problems associated with identifying these effects and to recent studies that have addressing these problems. The last section uses these results and the theoretical framework to discuss the efficiency and equity implications of private tutoring, explore their implications for policy toward tutoring, and identify areas that may warrant more research.

The Widespread Phenomenon of Private Tutoring

Private tutoring is defined here as fee-based tutoring that provides supplementary instruction to children in academic subjects they study in the mainstream education system.¹ Because the literature focuses primarily on tutoring for

children or adolescents paid for by their households, tutoring can generally be considered a form of private education. However, the definition is broad enough to cover special tutoring programs financed by other sources, including the government (for example, remedial education programs).

There are good reasons why a private supplementary tutoring sector might emerge to complement the public and private schooling systems. Private tutoring can provide more individualized instruction than is possible in public schools, using a more flexible delivery mechanism. The private tutoring industry is also differentiated from the private school sector in that its existence depends on the mainstream education system; it does not stand alone as an independent educational activity. This aspect of private tutoring helps explain why it has been referred to as “shadow education” (Bray 1999a). Private tutoring is also less formal and more flexible than private schooling; it can include not only one-to-one tutoring but also group classes, it can be provided not only by full-time tutors and teachers but also by university students, retired teachers, university professors, and community members (Russell 1997). Because it supplements rather than replaces the public sector, the combination of public schooling and private tutoring is also more affordable for many households than private education would be.

Japan has been a pioneer in the provision of this type of supplementary education. Private tutoring has long been a huge commercial industry in Japan, with annual revenues reaching an estimated \$14 billion by the mid-1990s. Nine private tutoring schools were already listed on the Japanese stock exchange at that time, and the tutoring sector had become a “crucial component of Japanese education” (Russell 1997). Many Japanese students enroll in intensive tutoring programs during school vacations, including the important New Year's holiday. To stimulate school spirit, several private tutoring schools (*juku*) have had their students wear white headbands similar to those once worn in battle by samurai warriors (Rohlen 1980). About 30 percent of university students spend additional years after high school graduation cramming for their university entrance examinations, often in specialized private tutoring classes. At the top-ranked schools, more than 60 percent of students may have spent time after high school preparing for these exams (Ono 2007).

Japan is not alone in supporting a large and vibrant private tutoring industry. Tutoring is now widespread in many parts of the world, including developing countries (appendix table A.1).

Certain patterns are clear. First, while the incidence of tutoring appears highest in East Asia, private tutoring is an important phenomenon in countries of different sizes, levels of economic development, political institutions, and locations. In some cases, spending on private tutoring approaches the level of spending on the formal public school system. In Korea, for example, households

spent 2.9 percent of GDP on private tutoring in 1998—almost as much the 3.4 percent of GDP the public sector allocates to education (Kim and Lee 2004). In Turkey households spend more than 1.4 percent of GDP on private tutoring—close to the 2.0 percent the country spends on public education (Tansel and Bircan 2006).

Second, private tutoring is an important phenomenon not only for upper-secondary students preparing for university exams but also for students at the primary and lower-secondary levels. In some countries, such as Japan, it is widespread among upper-secondary graduates as well.

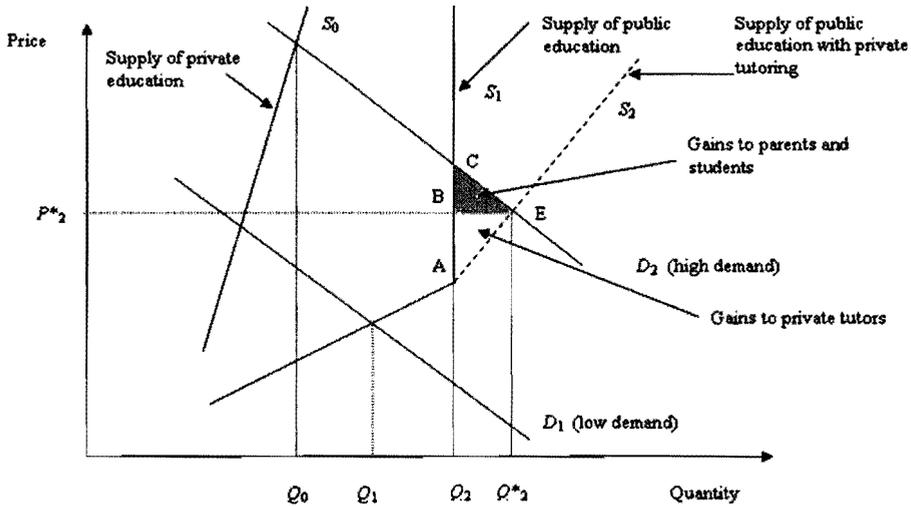
Third, the private tutoring industry appears to be growing in many countries, both in absolute terms and relative to the formal education sector. The percentage of students receiving tutoring is rising in Kenya and Mauritius, and the number of private tutoring firms is rising in Canada and Turkey (see table A.1).² Evidence on tutoring expenditures also supports the notion that the sector is growing. In Korea, for example, household spending as a share of GDP on private tutoring rose continuously, from 0.7 percent of GDP in 1977 to 1.2 percent in 1990 and 2.9 percent in 1998 (Kim and Lee 2004). Finally, anecdotal reports suggest that private tutoring is expanding in other countries as well. In both low-income countries (such as Vietnam; Dang 2007a) and high-income countries (such as the United States; Fuchs 2002; Borja 2005), some households in some areas have begun sending their children to private tutoring to give them an edge as early as preschool.

A Framework of Private Tutoring Supply and Demand

A simple graphical framework based on the standard microeconomic theory of supply and demand is useful in interpreting the private tutoring phenomenon. Consider the supply of and demand for education by a typical household where private tutoring is available (figure 1). The supply of education is represented by the supply curves S_0 for private education, S_1 for public education, and S_2 for public education with private tutoring. S_1 is different from S_2 in that while the two curves share a common solid upward-sloping part ending at point A, S_1 includes the solid vertical line rising from point A while S_2 includes a dashed diagonal line starting from point A. (It is possible to think about the dashed line as the supply curve for private tutoring alone.)

The rationale for the vertical part of S_1 (starting at point A) is that regardless of consumer demand, after a certain point public schools reach their capacity limit, preventing them from offering as much education—in terms of both quantity and quality—as parents or students want (that is, supply becomes perfectly inelastic).³ By contrast, the dashed portion of the supply curve S_2 (public

Figure 1. Education Supply and Demand with Private Tutoring



education with private tutoring) is flatter than the vertical part of S_1 , indicating the ability of private tutoring to meet the demand for education where the public education system cannot. This portion of S_2 is steeper than the lower part of S_1 , reflecting the assumption that even where public school is not free, private tutoring usually costs the household more than public schooling does.⁴

Even if tuition is not charged, a household incurs certain costs in sending a child to school (for example, school-related fees, the opportunity cost of the child not working). Household demand for education is represented by the demand curve D_1 (low demand) or D_2 (high demand). The demand curve D_2 represents a household that is assumed to have higher income, stronger education preferences, higher expectations about future returns, or some combination of these variables relative to a household whose demand is given by D_1 . (Other factors, such as the price of substitute goods and the number of buyers in the market, also shift the demand curve. The focus here is strictly on the factors cited above.)

The amount of education the household consumes is represented by the amount on the horizontal axis corresponding to the point where the supply and demand curves meet. If the representative household's demand for education is represented by the demand curve D_2 , the amount of public education the household consumes is Q_2 . In the presence of private tutoring the same household can consume a larger amount of education (Q^*_2), because the supply curve is no longer constrained by the vertical segment rising at point A. Were the household instead to enroll all their children in private school, the consumed amount of education would be lower, at Q_0 .

This “standard framework” underlies the discussion of the determinants and welfare consequences of tutoring. It incorporates certain assumptions that may not always be valid. One such assumption is that the market for private tutoring is competitive and that households are free to choose whether to purchase tutoring services. A second is that public schooling reaches a strict capacity constraint after a certain point, which is likely a better description of the short run than the long run. The last section of this article explores how relaxing these assumptions affects the analytical and policy conclusions.

Drivers of Private Tutoring

To understand the equity and productivity effects of the large and growing private tutoring sector and design effective policies, it is essential to understand the micro and macro factors that create demand for tutoring. Factors at the micro level may include the characteristics of individuals, households, schools, and communities. Macro-level factors may include the share of public spending allocated to public education, the characteristics of the education system and labor market, and national cultural values. Together these factors determine the level and slope of the tutoring demand curve for society as a whole. This section presents the evidence from the literature on both sets of explanatory factors.

Micro Factors

Standard economic theory would suggest that certain factors increase household demand for education: households' income, preference for education, and expectations about the returns to education for their children. These factors explain the heterogeneity of demand across household types. Compared with households on demand curve D_1 , which consume no private tutoring given the supply curve S_2 , households on demand curve D_2 consume $Q_2^* - Q_2$ of private tutoring.

Empirical research supports the theoretical prediction about which factors increase demand. Studies of Egypt (Assad and El-Badawy 2004), Japan (Stevenson and Baker 1992), Korea (Kim and Lee 2004), Turkey (Tansel and Bircan 2006), and Vietnam (Dang 2007b) are highlighted because they draw on nationally representative data. The private tutoring sector is also relatively prominent in all of these countries, which together capture some of the geographic variation in the phenomenon. (Buchmann 2002, Davies 2004, and Psacharopoulos and Papakonstantinou 2005 investigate the determinants of private tutoring using smaller data sets.)

The variables that most influence consumption of private tutoring in these studies are household income (household wealth in Egypt, household expenditure in Turkey and Vietnam); parental education; and urban location (table 1).

Table 1. Leading Determinants of Private Tutoring in Selected Countries

Independent variable	<i>Egypt, Arab Rep. of</i>	<i>Japan</i>	<i>Republic of Korea^a</i>	<i>Turkey^b</i>	<i>Vietnam^c</i>	
	<i>Per child expenditure on private tutoring</i>	<i>Participation in after-school private tutoring</i>	<i>Per child expenditure on private tutoring</i>	<i>Log of household expenditure on private tutoring</i>	<i>Primary students</i> <i>Log of per child expenditure on private tutoring</i>	<i>Lower-secondary students</i> <i>Log of per child expenditure on private tutoring</i>
Household income	Mixed results ^d	***	***	***	***	***
Father's years of schooling	**	***	***	**	Not significant	*
Mother's years of schooling	Not significant	***	***	***	*	Not significant
Urban location	***	***	***	***	*	Not significant
Number of observations	6,114	3,053	6,576	3,898	2,347	1,179
Econometric model	Tobit	Logit	Tobit	Tobit	Tobit	Tobit

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

^aSignificance level of the urban variable is inferred from the strong significance levels for the dummy variables indicating living in high-density residential areas, living in Seoul, and living in metropolitan city or small or medium-size city.

^bHousehold income is the log of total household expenditure. Father's years of schooling are for household heads.

^cHousehold income is the log of household expenditure per capita.

^dSignificance level of household income is inferred from that of dummy variables indicating households in different wealth quintiles, which range from insignificant to highly significant.

Source: Estimates are from the following: Egypt, Assaad and El-Badawy (2004); Japan, Stevenson and Baker (1992); Republic of Korea, Kim and Lee (2004); Turkey, Tansel and Bircan (2006); and Vietnam, Dang (2007b).

The last two variables arguably correspond to household preferences for education. These results are not unexpected, but they are surprisingly consistent across countries and fairly robust to the models used.⁵

Other factors that may matter across countries are grade level and household size. In Egypt students in diploma-granting grades spend more on private tutoring (Assaad and El-Badawy 2004). In Vietnam the closer students are to the last grade in their current school level the more they spend on private tutoring (Dang 2007b). In Korea, Turkey, and Vietnam the number of children in the household is negatively correlated with private tutoring expenditures (Kim and Lee 2004; Tansel and Bircan 2006; Dang 2007b). Presumably, the grade-level pattern reflects the use of private tutoring to prepare for school-leaving examinations. The household-size effect hints at the much-studied tradeoff between quantity and

quality (number of children and average child educational achievement; see, for example, Becker and Lewis 1973; Blake 1989). This variable is likely to be endogenous (see the next section), which may bias the estimates. Not all of these variables are used in all of the studies. It is thus not possible to investigate whether these patterns hold for all five countries or to draw firm conclusions from them.

Other variables that affect spending on private tutoring vary from country to country. This diversity of findings may reflect differences in the models or in the variables available in the data sets. It could also reflect country-level differences in tutoring patterns, perhaps as a result of differences in institutions, cultures, or relative prices.

Do students receive private tutoring for remedial or enrichment purposes? Are most students who receive tutoring performing at levels below or above their (conditionally) expected levels? Analyzing data from the 1995 Third International Mathematics and Science Study (TIMSS) in 41 countries Baker and others (2001) show that in three-fourths of these countries private tutoring is used significantly more often by low math achievers than by high achievers (controlling for family income, student, and community characteristics). They show that the probability of receiving private tutoring increases by 3.5 percent for each one-point decrease in TIMSS math scores in Denmark, Germany, and the United States.

The core explanatory factors common to all studies—income, parental education, urban location—echo those usually found to be important determinants of schooling attainment and performance in developing countries. In their study of 35 developing countries, for example, Filmer and Pritchett (1999) find that household wealth is strongly related to the educational attainment of children nearly everywhere. The multicountry analysis by Hanushek and Luque (2003) finds that on average parental education and family asset ownership are as important in explaining children's test scores in developing countries as they are in developed countries. Tansel (1997, 1998) finds that parental education, household consumption, and urban location are associated with higher educational attainment in Côte d'Ivoire, Ghana, and Turkey.

Macro Factors

Several factors are likely drivers of the demand for private tutoring at the macro level. First, the transition to a market economy substantially increased the amounts of private tutoring (supplied and demanded) in countries where it had not existed, including China, Vietnam, some African countries, and many Eastern European transition economies (Bray 1999a).

Second, tight linkages between education and work may result in intense competition for more education and thus private tutoring (Stevenson and Baker 1992). Private returns in the labor force are generally higher to higher education

than to secondary education (Psacharopoulos and Patrinos 2004), and the gap appears to be widening in many developing and developed countries (Brunello, Comi, and Lucifora 2000; Bourguignon and Rogers forthcoming). These high returns can lead to intensely competitive behavior by students and their parents, including the use of private tutoring to increase chances of university admission. An extreme form of these linkages is “diploma disease” (Dore 1976), whereby firms and governments rely heavily on a university degree as an initial screening tool for employment, in the belief that the degree signals skills that contribute to productivity but are hard to measure directly. This phenomenon has arguably fueled the demand for private tutoring in a number of countries (see Rogers 1996 for a model of this effect based on the experiences of Japan and Korea).

Third, parents may resort to private tutoring to compensate for the poor quality of a deficient public education system (Kim and Lee 2004). Low pay levels and weak monitoring of teachers in the public system can also cause teachers to force tutoring on students (Buchmann 1999; Silova and Bray 2006a), as formalized in a theoretical model by Biswal (1999).⁶

Fourth, cultural values may explain why private tutoring is more prevalent in some countries. Such values may be particularly important in East Asia (Bray 1999a).

Little formal empirical research has been done to test these hypotheses. The only cross-country study that has looked at the macro (economywide) factors determining the use of private tutoring is Baker and others (2001). Using data on 41 countries participating in the Third TIMSS assessment, they find that higher public education expenditures (as a share of GNP) and gross enrollment rates predict lower use of private tutoring. A high-stakes testing system has no significant impact on private tutoring.

The first result suggests that private tutoring is more popular in countries with weak and deficient public education systems. The analysis does not control for per capita income levels, however. This omission may bias the results, because income levels are highly correlated with both public education expenditures and gross enrollment rates.⁷

Impact of Private Tutoring on Student Learning

Understanding the policy implications of the growth of the private tutoring industry requires understanding not only its determinants—who is investing in tutoring and why—but also the consequences for those being tutored. Does spending on private tutoring yield substantial returns for individual learners? For society as a whole?

In standard models the presumption is that private tutoring must yield substantial increases in learning, because most students consider tutoring an investment

rather than consumption. If households consist of well-informed, sovereign consumers focused on learning—and ultimately on increased productivity in the workforce—one would expect significantly positive returns to individuals. But this is not the only possibility, for three reasons. First, consumers could be poorly informed about returns. Even econometricians find it challenging to tease out the returns to tutoring (as discussed below); it may be very hard for households to know for sure that their investment will pay off, particularly as any wage returns may be realized only after many years. Second, consumers may not be sovereign: parents who pay for tutoring may have objectives other than improving their children's learning and productivity, such as finding child care. Third, students may view tutoring as consumption rather than investment.

Endogeneity: Unobserved Factors may Affect Both Investment in Private Tutoring and Student Performance

Analyzing the evidence on learning gains attributable to tutoring is tricky because of the potential endogeneity of tutoring, which many studies have failed to address. For this reason this review of the literature focuses on the results from the handful of studies that have dealt with endogeneity.

A naive first approach to estimating the effects of private tutoring on performance would be to use micro-level data to estimate the following equation:

$$A = \alpha + \beta T + \gamma \mathbf{X} + \epsilon$$

where A is a student's academic performance; T is the student's attendance at or spending on private tutoring classes; \mathbf{X} is a vector of other student, household, school, and community characteristics (for example, the student's age and gender, the household's socioeconomic status and place of residence, and school quality); ϵ is the error term; and α , β , and γ are the parameters to be estimated, with β the estimated return to private tutoring.

This approach, at least as it is usually implemented, is likely to yield unreliable estimates of the coefficient on private tutoring, because students who receive private tutoring may differ in various unobserved but important dimensions from those who do not. One such dimension is the level of parental concern about their children's education. This variable is hard to measure and is therefore usually excluded from these analyses. Yet parents who place high value on their children's education may directly assist their children to succeed in school by helping them with their homework, for example, while also spending money on private tutoring.

Another example is a student's motivation for studies, which is also difficult to measure. Highly motivated students may be more willing to receive private tutoring than their less motivated peers, but they are likely also to outperform students who did not receive tutoring for reasons unrelated to tutoring.

Private tutoring is thus endogenous, in that these unobserved factors affect both investment in private tutoring and the performance at school. If not properly controlled for in regression analysis, these unobserved characteristics will end up in the error term, rendering the estimation results inconsistent and unreliable. This selection bias is commonly addressed in other contexts in the education literature, such as estimating whether religious and other private schools yield better student outcomes than public schools do (see, for example, Bedi and Garg 2000 and Newhouse and Beegle 2006 for public–private comparisons in Indonesia).

Three econometric techniques have been used to deal with the endogeneity of private tutoring. The first—and perhaps cleanest—approach is to run experiments that randomly assign students into comparable treatment and control groups. With such a set-up, researchers can use a straight difference-in-difference comparison of the gains in education outcomes for the two groups to estimate the returns to private tutoring.⁸ Even with this arrangement, however, interpreting the results is challenging, because students cannot be assigned to purchase private tutoring. Such studies must provide free tutoring, which may differ from tutoring that is paid for. Providing tutoring free seems likely to reduce its effectiveness in promoting learning; if anything, this should bias downward the estimates of the returns to tutoring.

A second approach, implemented *ex post* using observational data, relies on quasi-experimental identification of the effects of tutoring by using a difference-in-difference analysis as a program is rolled out across the country. Like the first approach, this approach has had to rely on tutoring provided by the program rather than purchased by households.

The third approach is to rely on instrumental variables that correlate with private tutoring attendance, expenditure, or both but that do not correlate with unobserved characteristics such as parental concern or student motivation.⁹ This approach has the advantage of measuring the effects of private tutoring sought as a result of household decisions rather than government programs. The disadvantage is that such estimates are likely to be more sensitive to econometric assumptions than are experimental and quasi-experimental estimates.

Evidence on the Impact of Private Tutoring

Research on the impact of private tutoring can be divided into studies that control for the endogeneity of private tutoring and those that do not (table 2). In addition to the standard type of tutoring paid for by the household, some studies include remedial education programs financed by sources other than households.

Studies that do not control for endogeneity yield mixed results on the impact of private tutoring on academic performance. They indicate that private tutoring has positive impacts in Japan (Stevenson and Baker 1992), Kenya (Buchmann

Table 2. Effects of Private Tutoring in Selected Countries

<i>Study</i>	<i>Country</i>	<i>Year</i>	<i>Level/grade/age</i>	<i>Main effect</i>	<i>Comment</i>
<i>Studies that control for endogeneity</i>					
Mischo and Haag (2002)	Germany	1998–99	Grades 5–11	Receiving private tutoring improved academic performance and motivational variables.	Study uses a form of matching in which students in tutoring identify a match in an attempt to account for unobserved differences between tutoring participants and nonparticipants.
Banerjee <i>et al.</i> (2007)	India	2001–04	Grades 3 and 4	Remedial education program increased average test scores for all children in treated schools 0.28 standard deviation. Computer-assisted learning program increased math scores 0.47 standard deviations. One year after the program, initial gains were reduced to 0.1 standard deviation.	Study uses randomized experiment method.
Suryadarma <i>et al.</i> (2006)	Indonesia	2002–03	Grade 4	Private tutoring had no impact on mathematics or dictation scores.	Variable indicating school clustering in terms of private tutoring is used as instrument for private tutoring.
Lavy and Schlosser (2005)	Israel	1999–2001	Underperforming high school students	Remedial education program increased the mean pass rate for the baccalaureate exam 3–4 percentage points for participating schools and 11–12 percentage points for participating students. Program expenditure per participant represented about 40 percent of the annual expenditure per high school student.	Study uses both difference-in-difference and instrumental variables methods. Instrumental variables for the proportion of students participating in the program include the interaction terms of school size, year dummy variable, and treatment status.

Ono (2007)	Japan	1995	Male high school and university graduates	Years spent after high school graduation cramming in private tutoring centers (<i>ronin</i>) improved the quality of the university that students attend, thus raising earnings indirectly (through this improvement in college quality).	Study uses instrumental variables method but does not control for other household, school, or community characteristics (such as parental education or household income).
Briggs (2001)	United States	1990–92	High school	Commercial private tutoring courses increased SAT math scores 14–15 points, SAT verbal scores 6–8 points, and ACT math and English scores 0–0.6 points; they decreased ACT reading scores 0.6–0.7 points.	Study does not report variables used as instruments for private tutoring and does not control for school characteristics.
Jacob and Lefgren (2004)		1997–99	Grades 3 and 6	Summer remedial programs increased math and reading achievement by about 12 percent of average annual learning gains for third-graders and 6 percent for sixth-graders.	Study uses regression discontinuity method.
Dang (2007b)	Vietnam	1997–98	Primary and lower-secondary school	Private tutoring improved students' academic performance.	Study uses private tutoring fees charged by schools as instruments for students receiving private tutoring.
<i>Studies that do not control for endogeneity</i>					
Stevenson and Baker (1992)	Japan	1980–82	High school seniors	For students in the first year out of high school, practice exams increased probability of entering university 16 percent; correspondence courses increased probability 25 percent. For students in the second year out of high school, attending special tutoring school increased probability	

Table 2. *Continued*

<i>Study</i>	<i>Country</i>	<i>Year</i>	<i>Level/grade/age</i>	<i>Main effect</i>	<i>Comment</i>
				of entering university 80 percent. Having a private tutor significantly reduced this probability, but this result most likely reflects the remedial character of this form of private tutoring in Japan.	
Buchmann (2002)	Kenya	1995	13–18-year-olds	Private tutoring reduced the chance of repeating grades and increased student academic performance.	Study does not control for school characteristics.
Lee and others (2004)	Republic of Korea	2000–01	Middle and high school	Preclass tutoring (private tutoring that teaches the school curriculum at least one month ahead of schedule) had no short- or long-term effects on student academic performance.	Study does not appear to account for student motivation for receiving private tutoring.
Cheo and Quah (2005)	Singapore	Not reported	Grade 8	Time spent with private tutor had negative impact on student academic performance.	
Ha and Harpham (2005)	Vietnam	2002	Eight-year-olds	Private tutoring had no significant effect on writing and multiplication test scores but doubled reading scores.	Study does not control for school characteristics.
<i>Source:</i> Authors' summary based on cited data sources.					

2002), and Vietnam (Ha and Harpham 2005) and negative impacts in Korea (Lee, Kim, and Yoon 2004) and Singapore (Cheo and Quah 2005). The results from these studies should be interpreted with caution, however, because of the endogeneity resulting from self-selection into tutoring (as some of the studies acknowledge). In addition, two of these studies do not control for school characteristics, which may further bias the estimation results.

Studies that control in some credible way for the endogeneity of private tutoring generally find that private tutoring boosts student academic performance. Tutoring is found to increase test scores in India (Banerjee and others 2007), mean pass rates on the baccalaureate exams in Israel (Lavy and Schlosser 2005), the quality of universities students attend in Japan (Ono 2007), Scholastic Aptitude Test (SAT) and ACT test scores (except for ACT reading scores) and academic performance in the United States (Briggs 2001; Jacob and Lefgren 2004),¹⁰ and student academic performance in Vietnam (Dang 2007b). The sole exception is in Indonesia (Suryadarma and others 2006), where tutoring was not associated with higher performance by fourth graders.¹¹ No studies appear to have examined whether the estimated negative correlations between private tutoring and achievement in Korea and Singapore change when endogeneity is properly addressed.

The three studies on India, Israel, and Vietnam are examined in some detail because they include cost data, making it possible to consider both the impact of tutoring on academic performance and the cost-effectiveness of tutoring. Furthermore, these studies reflect the variation in the usage and financing of tutoring. They include both low-income (India and Vietnam) and high-income (Israel) countries; they include estimation of tutoring effects on students of all academic abilities (Vietnam) and on underperforming students (India and Israel); and they include tutoring that is financed by a nongovernmental organization (NGO; India), publicly financed (Israel), and financed by households (Vietnam).

NGO-financed Remedial Tutoring in India. Pratham, a large Indian NGO, financed the implementation of a two-year in-school randomized tutoring program that targets poor children in two large cities. This remedial education program targeted children in grades 3 or 4 who had not mastered basic skills. These students were taken out of their classrooms and given two hours of supplemental instruction each day by young women from the community.

Banerjee and others (2007) find that this tutoring program improved student test scores by large and statistically significant amounts. Children randomly assigned to the treatment group improved their test scores by 0.6 standard deviations in the second year; control group children remaining in the regular classroom did not benefit. Overall, the test scores of children in schools participating in the program rose 0.14 standard deviations in the first year and 0.28 standard

deviations in the second year. These gains fell substantially one year after the program ended, however. More research is needed on the long-term impact of such programs.

Banerjee and others attribute the relative success of the program to regular teachers' lack of motivation to help lagging students and to the common background shared by the students and the tutors. They also show that this tutoring program is cost-effective. At about \$10–\$15 a month, the tutors' salary is equivalent to just 6–10 percent of the salary of a starting teacher. They calculate that scaling up the tutoring program would be much more cost-effective than hiring new teachers, at least in terms of raising test scores. The program, which has already reached tens of thousand of children across India, is estimated to cost about \$2.25 per student a year.

A second program used computers, rather than human tutors, to deliver the tutorials. This program raised math scores by 0.36 standard deviations the first year and 0.54 standard deviations the second year. However, it is much more expensive than the first program, at \$15.18 per student a year.

Government-financed Remedial Tutoring in Israel. Israel has been operating a remedial education program for underperforming high-school students since 1999. By 2004 the program was reaching about a third of all high schools (Lavy and Schlosser 2005). The objective of the program is to increase the number of students who earn baccalaureate certificates by providing them with increased instructional time. In each school the program identifies up to five students in the 10th, 11th, and 12th grades judged most likely to fail the exams. The classroom teachers then provide these students with after-school tutoring in the subjects in which they are weak.

To examine the effects of the program, Lavy and Schlosser (2005) use a quasi-experimental difference-in-difference methodology (supplemented by instrumental variables as an alternative identification strategy). Their approach relies on the fact that the program was rolled out over time, allowing them to compare learning gains in schools that received it early on with those in schools that received it later.

Lavy and Schlosser find that the program had a positive impact on both the students and the participating schools. The program increased the probability of a tutored student earning a baccalaureate certificate by 12 percentage points, an average improvement of 22 percent over the base rate. The targeted schools saw an increase of about 3.3 percentage points in mean pass rates on the baccalaureate exams, equivalent to an improvement of 6 percent over the base rate. The program did not appear to affect nontutored students.

At \$1,100 per tutored student (about 40 percent of annual expenditure per high school student in Israel) the average cost of the program is very high. Nevertheless, Lavy and Schlosser estimate the program's internal rate of return at

20 percent. Although this makes the remedial tutoring program less cost-effective than two other incentive-based programs in Israel examined by the authors, 20 percent is an impressive rate of return.

Household-financed Tutoring in Vietnam. Private tutoring is very popular in Vietnam, with about 34 percent of households with children in school purchasing private lessons. Ninety percent of these households allocate 1–5 percent of total household expenditure to private tutoring. Some 31 percent of primary students, 56 percent of lower-secondary students, and 77 percent of upper-secondary school students receive private tutoring (Dang 2007b).

Dang addresses the endogeneity of tutoring with an instrumental variables strategy that uses tutoring prices as the instrument. Using data from the Vietnam Living Standards Surveys for 1992–93 and 1997–98 he shows that private tutoring improves student academic performance. After controlling for other individual, household, school, and community characteristics he finds that raising annual spending on private tutoring from 0 to 20,000 dong (D)—about \$1.50 in 1998, equivalent to about 0.4 percent of mean consumption or 2 percent of spending on education by households with children in school—has strong positive effects on performance. For primary school students, tutoring reduces the probability of obtaining a “poor” academic ranking by about 1 percentage point, reduces the probability of average performance by 4 percentage points, and increases the probability of good or excellent performance by 5 percentage points. For the same increase in expenditure at the lower-secondary level it reduces the probability of poor performance by about 1 percentage points, reduces the probability of average performance by 7 percentage points, and increases the probability of good or excellent performance by 8 percentage points.

These estimates can be used to make a rough calculation of the cost-effectiveness of tutoring in promoting grade progression among lower-secondary school students. Students with “poor” academic rankings usually have to repeat grades in Vietnam. A year of lower-secondary schooling has a total cost (direct costs to households and the government plus assumed opportunity cost of forgone wages) of about D3 million a year. Everything else being equal, if the household’s aim is for the child to complete a given level of education, a reduction of 1 percentage point in the probability of earning a “poor” academic ranking reduces the expected costs of grade repetition by about D30,000. Similar calculations for primary students also show that D20,000 worth of private tutoring reduces the expected costs of grade repetition by about D25,000.¹² This means that the benefits from lower repetition rates alone exceed the costs of tutoring. The total benefits are likely to be much higher, because these calculations do not account for any economic benefits of better academic ranking categories or for avoided psychological costs associated with grade repetition.

Interpreting the Evidence

Recent studies that have dealt with the endogeneity of tutoring and estimated cost-effectiveness find that private tutoring has strong positive returns. Some caution is needed in interpreting the evidence, however, for several reasons. First, this line of analysis is made difficult by the nature of private tutoring transactions: typically it is the household (rather than an NGO or government) that decides whether to purchase private tutoring. It is hard to imagine how that decision could be randomized across households in order to obtain clean measurement of the returns to privately purchased tutoring. At best a government could randomize access to potential tutors—by, for example, flooding certain randomly chosen communities with unemployed graduates—and then examine whether households chose to consume more tutoring and if so how it affected student performance.

Second, estimation results from these studies should be considered in context and neither generalized to all students nor narrowed to specific subgroups of tutored students. Most of the studies cited in table 2 estimate only the average return for all students enrolled in tutoring. This approach implicitly assumes that all students share the same returns to private tutoring, regardless of their innate ability or socioeconomic background (exceptions include the studies by Jacob and Lefgren 2004; Lavy and Schlosser 2005; and Banerjee and others 2007.) If this homogeneity assumption is violated, the estimated benefits of tutoring will not apply to subgroups and may be biased as well (see Heckman, Lochner, and Todd 2006 and Heckman, Urzua, and Vytlačil 2006 for discussions of the heterogeneity in returns to education in instrumental variables models). For example, while the studies for India (Banerjee and others 2007), Israel (Lavy and Schlosser 2005), and the United States (Jacob and Lefgren 2004) show that remedial private tutoring improves student performance, this result may hold only for the grades evaluated.

It is not easy to take account of this heterogeneity in returns to private tutoring. Doing so requires detailed data on the student variables that may affect returns, as well as more sophisticated estimation techniques. Crafting more detailed policies demands more in-depth analysis of specific groups in particular contexts.

Third, the evidence presented here on the returns to investment in private tutoring refers only to private returns. Little is known about the social returns to private tutoring. Even if tutoring is completely financed by households, any externalities of private tutoring would need to be estimated before social returns could be calculated (but see discussion below on the social costs of tutoring in a signaling equilibrium).

Subject to these caveats, it appears that tutoring has strong positive private returns as a supplement to formal public school education. The programs on

which there is evidence may provide good starting points for policymakers seeking to design and implement supplementary education programs.

What Stance Should Policymakers Take toward Tutoring? Efficiency and Equity Considerations

How does private tutoring affect efficiency and equity? This section first analyzes this question while maintaining the assumptions that the market is perfect and the supply curve for public schooling perfectly inelastic after a certain point. It then examines how these conclusions change when these assumptions are relaxed.

Efficiency Considerations in the Standard Case

The micro evidence on private tutoring suggests that it generally improves student academic performance for the average tutored student. More limited evidence suggests that these improvements can be cost-effective. A question for policymakers is whether, from a broader social perspective, the availability of private tutoring increases overall welfare. Are the societal gains from private tutoring likely to exceed its costs?

No studies appear to have been conducted on the efficiency of private tutoring at the macro level. However, combining the micro evidence with the analytical framework set forth above can help answer this question.

The availability of private tutoring increases efficiency and welfare, under certain assumptions revisited below (figure 1). For a household whose demand for education is represented by demand curve D_2 , the availability of private tutoring raises consumption of education to Q_2^* . This is more than the amount of public education (Q_2) that the household consumes in the absence of private tutoring and more than the amount of private education (Q_0) that the household can afford. (If the household's demand for education is on the low-demand curve, D_1 , the household would consume no private tutoring given this supply curve.) Household consumer surplus increases by the amount represented by the triangle BCE. Tutors gain the producer surplus represented by the triangle ABE.

One other effect is not shown directly in figure 1. High-demand households that in the absence of private tutoring would have chosen private schools may now enroll their children in public school. As demand for public schools increases, the costs to the government might be expected to rise and the producer surplus to private schools to fall. But because public schools are assumed to be on the vertical portion of their supply curve—that is, they have reached their capacity—the

quantity of education provided by the government (and therefore government outlays) does not actually increase. Standard micro analysis makes it clear that the total gains to households and tutors should exceed the losses in the private school sector. Thus offering the opportunity to supplement public education with private tutoring increases welfare for households and society as a whole—at least in the standard model.

Equity Considerations in the Standard Case

Suppose policymakers are convinced that a robust private tutoring sector improves welfare but worry that it may increase inequality. There is indeed reason for concern. More privileged households—those with higher income and more education who live in urban areas—invest more in tutoring than other households do, and private tutoring appears to increase learning achievements for these children, at least on average. If learning achievement translates into higher lifetime earnings, one would expect the availability of household-financed tutoring to increase social inequalities.

One should not be too quick to equate tutoring with increasing inequality, however, or to assume that an equity-focused government should try to limit tutoring, for several reasons. First, when the appropriate counterfactual—what would happen in the absence of a private tutoring sector—is specified, tutoring may not increase educational inequality by as much as suggested above. Even productive tutoring may confer only a minor advantage on children from wealthier and more-educated households, because these households already give their children educational advantages in many other ways—by providing them with more books, more learning equipment, and even full-time private schooling, for example, or by teaching their children themselves. Even if it were enforceable, a ban on private tutoring would likely simply redirect the education expenditures of better-off households into these other investments. Furthermore, access to supplementary private tutoring may benefit poorer households if it helps their children compete with wealthier children enrolled in private schools.

Second, tutoring may emerge as an unintended result of other government education policies, including some policies aimed at promoting equity. Imagine, for example, that the government substantially increases its per student financing for public education in poor (low-demand) neighborhoods. This would shift the supply curve (S_2 in figure 1) downward. If the shift is substantial enough, it will induce low-demand households to consume more education, including more private tutoring.

To control educational inequality, governments may find it more effective to attack its roots than to discourage tutoring, which is in part a symptom of inequality. Korea took this tack in 1974, when it sought to control the growth of

private tutoring by adopting a secondary school equalization program (Kim 2005). That program switched to allocating secondary school entrance by lottery rather than examination, reducing the quality advantages of higher-ranking schools and the incentive for exam-preparation tutoring. While demand for tutoring has remained high, Korea is not generally believed to have severe intergenerational transmission of inequality through education.

Third, governments can use tutoring to improve equity. The household-financed tutoring in the market equilibrium in figure 1 benefits children from high-demand households, which tend to be wealthier, but governments and others can target special tutoring programs at underperforming students, as Israel (Lavy and Schlosser 2005) and the United States (Jacob and Lefgren 2004) have done. In effect, the government would be segmenting the market depicted in figure 1 by driving the supply curve downward for low-demand households only. In this case the equity implications are clearly positive, as long as the subsidy is financed progressively.

What if the Availability of Tutoring Impedes Public School Improvements?

The first assumption that needs to be relaxed is that public education is capacity-constrained—meaning that at the upper end of its range the supply of education is perfectly inelastic. This assumption is likely to hold only in the short term. Over the longer run, governments can and do take steps to increase the quantity of effective education, for example by expanding school capacity to allow longer schooling hours, improving teacher attendance and time on task, and ultimately hiring more teachers and building more schools. Such improvements extend the upward-sloping portion of the public supply curve in figure 1 and shift the vertical section outward.

Distinguishing between the short and long runs therefore matters. Under the earlier assumptions of the short-run standardized framework model depicted in figure 1, private tutoring occupied a neutral territory unaffected by the debate that pits public schools against private ones. Public and private schools are typically depicted as substitutes, which they generally are, at least at the level of the individual student (from the perspective of the school system as a whole, private schools may be viewed as a useful complement to government schools). But in the situation depicted in figure 1, tutoring is a complement to public schooling. It enables parents to invest in an optimal amount of education for their children, increasing both consumer and producer surplus.

Thus private tutoring and public education appear to be complements in the short run. In the long run—defined here as the time it takes to make substantial improvements in the quality and quantity of public schooling—private tutoring may substitute for public education. The availability of tutoring could diminish

parents' interest in lobbying for long-term improvements in public education. If urban elites find that tutoring gives their children an advantage in competitive examinations or the labor market and they fear that any future public school improvements would go primarily to schools serving disadvantaged areas, they may prefer the status quo. In Japan it has been argued that education reforms to expand public school activities have been blocked by the dependence on private tutoring to perform these tasks (LeTendre 1994). The tutoring market may serve as an outlet releasing political pressure for reform and quality improvement.

In the long run, private tutoring may provide less of a spur to public quality than competition from private schools does. Some scholars (Hoxby 1994; Rouse 1998; Bishop and Wossman 2004) argue that the loss (or potential loss) of students to private schools puts pressure on public schools to improve quality. Private tutoring would likely have no such effect, because it does not cause students to abandon public schools.

The question is not whether private tutoring enables or undermines the public sector's role as a provider of education. Public schooling will continue to be a part of virtually every national primary and secondary school system. The point is simply that where tutoring is widespread, it will likely have important effects on the quality and efficiency of public schools. Policy will need to take account of these effects over both the short and long terms.

What if Teacher Corruption makes the Tutoring Market Uncompetitive?

A second assumption underlying the standardized model is that the market for tutoring is competitive. This may not be the case. Public school teachers may have substantial market power as suppliers of private tutoring, especially in remote rural areas, where they may be the only potential suppliers of private tutoring.

More worrisome is the fact that teachers who are corrupt and poorly monitored sometimes force their public school students to take private tutoring lessons from them or omit part of the curriculum during regular classroom hours and save it for their tutoring lessons (Buchmann 1999; Foondun 2002; Glewwe and Jayachandran 2006; Silova and Bray 2006a). Others give preferential treatment to particular children in return for a fee. This practice may reduce teacher time and energy in mainstream classes, or it may encourage teachers to work additional hours.

Teachers' monopoly power reduces the consumer surplus of high-demand consumers. The dysfunctional monitoring system coupled with teacher corruption blurs the line between public education and private tutoring. Graphically, this would increase the slope of the (now ostensibly public) supply curve S_2 and shift it to the left in figure 1, forcing households to pay a higher price for the same amount of education. The more market power teachers have, the farther leftward

they may try to shift the supply curve. As one would expect, given teachers' monopoly power, consumer surplus falls by more than the gain in producer surplus to the teacher. In such cases, private tutoring is not likely to yield the substantial returns to tutoring documented in the empirical studies cited above.

This outcome is worse than the no-corruption competitive private tutoring equilibrium; for households it may also be worse than having no tutoring at all. In the worst case, tutoring fees are simply a net transfer from households to teachers: the amount of education provided remains the same, but the teacher delivers part of it for a fee outside of school hours. In rural areas, where teacher governance is poor and this type of corruption is most likely to flourish, the transfer will usually be regressive, because teachers tend to have considerably higher incomes than the average rural resident. Moreover, evidence on service delivery suggests that it is the poorest households that suffer most from failures in service delivery (World Bank 2003) and pay the largest bribes relative to their consumption level (Hunt and Laszlo 2005). As a result, the transfer will likely reduce equity and overall welfare.

This analysis of potential teacher corruption suggests that in the absence of mechanisms to control teacher corruption, allowing private tutoring may be counterproductive in some cases. Given the difficulties and undesirability of banning tutoring outright, it provides a rationale for measures to prevent public school teachers from tutoring their own students privately. Ukraine's education ministry imposed such a ban in 2004 in response to complaints from parents that teachers were providing "compulsory private tutoring" (Hrynevych and others 2006).

What if the Purpose of Tutoring is not only to Increase Human Capital?

How does the diagnosis change if tutoring is not necessarily productive from a societal perspective? The analysis assumed that an increase in education units consumed not only increases a student's future productivity (and hence wages) but also increases societal productivity by an equivalent amount. In theory this need not be the case. If tests measure student characteristics that have signaling value but no productive value, tutoring may not increase the productivity of tutored students, even though it increases their wages. This would be the extreme version of the signaling model introduced by Spence (1973). In such a signaling equilibrium policymakers would be right to worry about the social costs of the tutoring industry, which would in essence be an arms merchant in a negative-sum education arms race.

While this extreme theoretical case certainly does not apply anywhere, criticism of some aspects of otherwise high-performing education systems in Korea and Japan—both of which have very large private tutoring sectors—has cited the

perceived uselessness of some of the material tutoring students master in preparation for university entrance examinations. Concerns about the heavy financial burden of tutoring on parents have led to reform in Korea (Kim 2001).

These concerns are consistent with the argument that the long-term financial returns do not justify the costs of private tutoring. Empirical evidence suggests a bunching of private tutoring investment immediately before school-leaving or university entrance exams, which is consistent with a signaling story. Standardized tests for admission to law school in the United States, which have given rise to a large test-preparation industry, have been criticized for being widely used despite their inability to predict applicants' performance as lawyers (Haddon and Post 2006). The fact that students in the United States prepare for the Law School Admission Test (LSAT)—supposedly an aptitude test—by acquiring test-taking skills taught in tutoring courses suggests that the test results contain an element of signaling. If tutoring were contributing only to productive human capital, it would not likely raise scores on an aptitude test, at least not as a result of the short courses offered by tutoring companies.

Although it is analytically difficult to distinguish between the signaling and productive human capital stories, signaling incentives are likely to explain some tutoring in societies that make heavy use of tutoring (Rogers 1996; Chae, Hong, and Lee 2004; Lee 2007). But three points should be kept in mind. First, although a (partial) signaling story changes the situation depicted in figure 1 to a degree, it does not qualitatively change the conclusions. A signaling equilibrium makes the slope of the private tutoring supply curve steeper, by reducing the effective units of education (human capital) received, but the outcome does not change fundamentally.

Second, countries such as Korea that apparently make greater use of signaling are among the highest performers on well-designed, internationally normed student assessments such as the Programme for International Student Assessment (PISA) and the TIMSS. These high scores suggest that students are acquiring a large amount of real human capital even if they are also investing in signaling value.

Third, the appropriate response in the signaling case is probably not to discourage tutoring—as Korea did in 1980 by banning it—but to address the problem at its source. The government could, for example, revise university admissions policies so that they place less reliance on a single examination, which makes for a tempting signal of a student's ability.

Policy Implications

The evidence suggests that tutoring can raise educational outcomes as a complement to formal school systems. In the absence of corruption, and given the

assumptions discussed above, private tutoring increases the welfare of households and society as a whole. Private tutoring may place poorer households at some disadvantage relative to richer households, however, particularly when corruption distorts the tutoring market. Corruption also reduces the efficiency of the tutoring equilibrium. This section explores what these drawbacks imply for education policy in developing countries.

Government Policy and the Control of Corruption

Before turning to policy recommendations, it is useful to consider the policies governments have implemented. Bray (2003) divides governments into four types: those that ban private tutoring (type I), those that ignore it (type II), those that recognize and regulate it (type III), and those that actively encourage it (type IV; table 3).

Bray and Silova (Bray 2003, 2006; Silova and Bray 2006b) offer helpful detail on the different types of governments. They note that type I governments all failed in their attempts to ban private tutoring. Bans in Cambodia and Myanmar failed because those countries' institutions were too weak to implement the policy. In Korea and Mauritius the bans faced too much opposition from vested interests, forcing the governments to lift the bans and regulate private tutoring.

Type II governments ignore private tutoring. These governments can be divided into two groups based on their reasons for ignoring private tutoring. Countries in the first group (including Nigeria and Sri Lanka) have weak institutions and little capacity to monitor private tutoring. Countries in the second group (including Canada and the United Kingdom) have stronger institutions and adequate capacity to monitor private tutoring. They choose not to regulate the sector, either because they consider it to have small and insignificant effects or because they prefer to let market forces govern the sector.

Type III governments (such as Hong Kong, China; Mauritius; and Vietnam) take a more active role in controlling private tutoring. These governments recognize the importance of private tutoring and attempt to control it both directly and indirectly. They may prohibit private tutoring in early grades; forbid teachers from tutoring their own students; stipulate fees, class sizes, or syllabi for private tutoring classes; and reduce disparities across schools.

Type IV governments (including Singapore, South Africa, Tanzania) actively encourage private tutoring. These governments believe that private tutoring contributes to human capital development and that private tutoring is an effective means of tailoring education to the needs of students. Policies in type IV countries range from offering general encouragement to providing subsidies for private tutoring, training courses for tutors, and tax incentives.

It may be useful to add another dimension to this framework: control of corruption (see table 3). By this measure (taken from Kaufmann, Kray and Mastruzzi

Table 3. Government Policies toward Private Tutoring in Selected Economies

<i>Type</i>	<i>Policy</i>	<i>Measure</i>	<i>Country</i>	<i>Comment</i>
I	Prohibit private tutoring	Total ban on private tutoring.	Cambodia (7), Republic of Korea (65), Myanmar (1), Mauritius (67)	Tutoring was banned, but the bans were ineffective because of government's inability to enforce them.
II	Ignore private tutoring		Croatia (58), Georgia (45), Nigeria (6), Mongolia (37), Sri Lanka (49) Canada (94), United Kingdom (94)	Most of these countries have weak institutions and do not have the capacity to regulate private tutoring. These countries have strong institutions and the capacity to regulate private tutoring, but they consider the private tutoring market outside of their sphere of responsibility.
III	Recognize and regulate private tutoring	Generally prohibit private tutoring in early grades and prohibit teachers from tutoring their own students. Regulations are accompanied by inspections and sanctions on private tutoring fees, class sizes, and syllabi. Regulations are placed on infrastructure of private tutoring centers. Policies seek to reduce stratification in the education system, reduce disparities in schools, and raise public awareness about negative effects of private tutoring.	Hong Kong (China) (93), Lithuania (60), Republic of Korea (65), Mauritius (67), Ukraine (28), Vietnam (29)	

IV	Actively encourage private tutoring	Provide subsidies for private tutoring, disseminate information to link potential tutors and clients, offer training courses for tutors, and provide tax incentives for tutoring.	Singapore (98), South Africa (71), Tanzania (43)	These countries believe that private tutoring contributes to human capital development and caters to the needs of students.
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Note: Measures shown are for illustration purposes only; countries in each category may not implement all measures. The numbers in parentheses indicate percentile ranking in control of corruption (higher rankings represent greater control). The timing of the corruption measure does not always coincide with the timing of government actions. However, in all countries except Tanzania there has been little change in this index over time.

Source: Bray (2003, 2006); Silova and Bray (2006b); for Croatia, Dedic and others (2006); for Mongolia, Matiashvili and Kutateladze (2006); for Georgia, Dong and others (2006); for Lithuania, Budiene and Zabulionis (2006); for Ukraine, Hrynevych and others (2006); and for Vietnam, Dang (2007a). Corruption rankings are from Kaufmann, Kray, and Mastruzzi (2007).

2007), the first group in type I governments appears to have weak control of corruption, while the second group has sound control of corruption. (It should be remembered that neither group was successful in banning private tutoring.) Among type II governments, the first group has only weak to moderate control over corruption, while the second group has strong control. Control in Type III governments ranges from weak to strong; control in type IV governments ranges from moderate to strong. These associations between type and governance quality should be useful in gauging the feasibility of different policies.

A (tentative) Agenda for Policy Toward Private Tutoring

Some tentative policy recommendations can be proposed based on these results and the casual (but intuitive) observations about the association between corruption and government policies. First, since private tutoring is widespread and growing, it is time for governments to devote more attention to it. The benign neglect policy of type II governments runs the risk of letting tutoring-related corruption go unchecked in countries with weak control over corruption. Even countries in this group with stronger control over corruption may be missing opportunities to use tutoring to address imbalances between education supply and demand. Possible government actions range from monitoring (for example, collecting data on private tutoring attendance and private tutoring businesses) to trying to ensure that private tutoring can operate free of corruption and unnecessary barriers to competition.

There is still too little empirical evidence on the macro-level determinants of private tutoring. In particular, more cross-country data need to be collected to allow researchers to tease out the impacts of government policies and interventions (including, for example, education subsidies, public expenditure on education, high-stakes testing systems) on creating demand for private tutoring.

At the micro level, more research should be conducted on the household decision to send children to school (for example, the choice of private education over public education, with or without private tutoring; the choice between investing in the quantity and the “quality” of children), as well as the short- and long-term effects of private tutoring on student well-being (for example, student satisfaction levels, health status, labor-market outcomes, and so forth). Research should also investigate whether social returns to private tutoring differ from private returns.

Second, while it may be welfare enhancing to ban private tutoring when all tutoring is provided by corrupt teachers, a total ban is difficult to implement and is likely to have the unintended effect of preventing more beneficial tutoring by tutors who are not corrupt. Resources would be better allocated to monitoring and regulating—rather than trying to eradicate—private tutoring. Regulatory

approaches can focus on reducing opportunities for corruption by prohibiting public school teachers from tutoring their own students.

Third, private tutoring markets in economies with low levels of corruption are likely to be more competitive than those in economies in which corruption is more entrenched. If this is the case, private tutoring is likely to be welfare enhancing. Governments may even want to encourage the private tutoring industry, as Singapore, South Africa, and Tanzania have done. Policymakers should monitor the development of the industry and address concerns. This may require going to the root of the education quality problem rather than holding the private tutoring sector responsible. Where tutoring appears to exacerbate social and geographical inequalities, government action will be most effective if it targets the source of the underlying inequalities, possibly by equalizing public school finance across rich and poor districts.

Finally, governments may want to explore financing tutoring programs as a flexible means of educating disadvantaged children. While more evidence is needed, the findings on targeted government- and NGO-financed tutoring programs suggest that this can be an effective means of improving education outcomes for disadvantaged children. Such programs have the added benefit of avoiding any equity-efficiency tradeoffs: by increasing the productivity of disadvantaged children, they promote equity goals as well.

Appendix A

Table A.1. Incidence of Private Tutoring in Selected Countries

<i>Source</i>	<i>Country</i>	<i>Year</i>	<i>Level, grade, or age</i>	<i>Percentage of students tutored</i>	<i>Comment</i>
Silova and Kazimzade (2006)	Azerbaijan	2004	Secondary school	57	First-year university students received private tutoring in their last year of secondary school.
			University	92	
Ahmed <i>et al.</i> (2005)	Bangladesh	2004	Primary school	43	More boys received tutoring than girls.
Bray (1999b)	Cambodia	1997–98	Primary school	31	Some 90 percent of students in urban schools and 9 percent in rural

Continued

Table A.1. *Continued*

<i>Source</i>	<i>Country</i>	<i>Year</i>	<i>Level, grade, or age</i>	<i>Percentage of students tutored</i>	<i>Comment</i>
CME (2000)	Canada	1999	13- and 16-year-olds	5–17 for 13-year-olds, 8–20 for 16-year-olds	schools received private tutoring.
Aurini and Davies (2004)	Canada	1997	School-age children	n.a.	Between 1974 and 2004, the number of formal tutoring businesses in major Canadian cities grew 200–500 percent.
Stylianou <i>et al.</i> (2003)	Cyprus	2003	University	86	The surveyed university students reported that they received private tutoring in upper secondary school.
Suliman and El-Kogali (2002)	Egypt, Arab Rep. of	2000	Children 6–15	71	Data are from Egypt Demographic and Health Survey.
Psacharopoulos and Papakonstantinou (2005)	Greece	2000	University	80 percent attended group (cram) preparatory schools, 50 percent received individual private tutoring, 33 percent received both group and individual tutoring	
Bray and Kwok (2003)	Hong Kong, China	1996–98	Secondary school	35 percent in grades 1–3; 47 percent in grades 4–5; and 70 percent in grades 6–7	
NCES (1996)	Japan	1995	Grade 8	64 percent of eighth graders received weekly	Data are from 1995 Trends in International

Continued

Table A.1. *Continued*

<i>Source</i>	<i>Country</i>	<i>Year</i>	<i>Level, grade, or age</i>	<i>Percentage of students tutored</i>	<i>Comment</i>
				tutoring in mathematics; 41 percent received weekly tutoring in science	Mathematics and Science Study.
Onsomu <i>et al.</i> (2005)	Kenya	2000	Grade 6	88	Proportion of students that reported receiving private tutoring rose from 69 percent in 1998 to 88 percent in 2000. Data are from Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) II.
Kwak (2004)	Republic of Korea	2003	Primary school	83	Overall, 73 percent of Korean students received private tutoring. Study cites estimates from the Korean Educational Development Institute.
			Middle school	75	
			High school	56	
Budiene and Zabulionis (2006)	Lithuania	2004–05	University	62	
Kulpoo and Soonarane (2005)	Mauritius	2001	Grade 6	87	Proportion of pupils who received private tutoring rose from 78 percent in 1995 to 87 percent in 2001. Vast majority (91 percent) of students receiving tutoring paid for it. Data are from the Southern and Eastern Africa Consortium for

Continued

Table A.1. *Continued*

<i>Source</i>	<i>Country</i>	<i>Year</i>	<i>Level, grade, or age</i>	<i>Percentage of students tutored</i>	<i>Comment</i>
UNESCO (2000)	Romania	1994	Grade 12	32 in rural areas and 58 in urban areas received private supplementary tutoring	Monitoring Education Quality (SACMEQ) II. Study cites estimates from study undertaken by Romanian Institute for Sciences of Education on national sample of 12th graders.
George (1992)	Singapore	1992	Primary school Secondary school	49 30	
Glewwe and Jayachandran (2006)	Sri Lanka	2003	Grade 5	78	
Paviot, Heinsohn and Korkman (2008)	Tanzania	2000	Grade 6	56	The proportion of students receiving private tutoring rose from 46 percent in 1995 to 56 percent in 2000. Data are from Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) II
Tansel and Bircan (2006)	Turkey	2001	High school	35	Number of private tutoring centers rose from 174 in 1984 to 2,100 in 2002—close to the number of high schools in Turkey (2,500). Study uses estimates from Turkey's Private Tutoring Centers

Continued

Table A.1. *Continued*

<i>Source</i>	<i>Country</i>	<i>Year</i>	<i>Level, grade, or age</i>	<i>Percentage of students tutored</i>	<i>Comment</i>
Hrynevych <i>et al.</i> (2006)	Ukraine	2004	University	68	Association in 2003. Students received private tutoring during last year of secondary school.
Ireson and Rushforth (2005)	United Kingdom	2003	Grades 6 and 11	26	
Gordon and Gordon (2003)	United States	2000	Grade 13	30	
			Elementary school	n.a.	Almost 7 million elementary school students are believed to have received tutoring; tutoring industry earned \$5–8 billion.
Briggs (2001)	United States	1990–92	High school	14–21 percent took special courses to prepare for SAT/ACT; 8–14 percent received private group tutoring (commercial coaching classes); 6–8 percent received one-to-one private tutoring	
Dang (2007b)	Vietnam	1997–98	Primary school	31	About 34 percent of households with children in school sent their children to private tutors, with 90 percent of them allocating 1–5 percent of household expenditure to private tutoring.
			Lower-secondary school	56	
			Upper-secondary school	77	

Continued

Table A.1. *Continued*

<i>Source</i>	<i>Country</i>	<i>Year</i>	<i>Level, grade, or age</i>	<i>Percentage of students tutored</i>	<i>Comment</i>
Machingaidze <i>et al.</i> (1998)	Zimbabwe	1995	Grade 6	61	Prevalence of tutoring ranged from 36 to 74 percent across regions.
n.a., not available.					
<i>Source:</i> Based largely on Table II.1 in Dang (2007a).					

Notes

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1. The focus in this article is on private tutoring for academic subjects. Lipscomb (2007) and Barron, Ewing, and Waddell (2000) among others examine how nonacademic extracurricular involvement affects academic achievement.

2. The number of private tutoring colleges listed in the Yellow Pages in Sydney—the largest city in Australia—increased from 60 in 1989 to 222 in 2002 (Kenny and Faunce 2004). More evidence on the growth of private tutoring for several countries in Southern and Eastern Africa can be found in Paviot, Heinsohn, and Korkman (2008).

3. The public education system is known for its rigidity, lack of teacher incentives and accountability, and inadequate infrastructure, particularly in developing countries (Glewwe and Kremer 2006). Teacher absenteeism is also common in many countries (Chaudhury and others 2006). The supply curve need not become completely inelastic at the upper end (it is shown as such here only for ease of exposition); all that is necessary is that at the margin the public system be less able or willing to provide additional lessons than the private tutoring sector is.

4. Note that this is the (subsidized) public education supply curve—that is, the supply curve as viewed by households—not the underlying marginal cost of supplying public education. The cost of public schooling to households is assumed to be less than the cost of private schools, even though the underlying cost for private schools to produce education may be lower. No assumptions are made about the unit cost of private tutoring relative to the unit cost of private schools; the advantage of private tutors is their flexibility and ability to supplement the public system by providing as many additional hours (lessons) as households demand.

5. The dependent variables and other control variables differ across the models used in the studies for each country. The study of Japan, for example, looks at the probability that students participate in after-school private tutoring classes. The other studies assess the determinants of expenditure on private tutoring at the household or child level. Only the study of Egypt controls for parental presence in the household, and only the study of Turkey controls for whether the mother is single.

6. One rebel group in the northeastern state of Manipur in India has reportedly forbidden teachers and professors to provide private tutoring classes, in an attempt to stop the widespread situation in which they do not come to class because they are too busy supplementing their low salaries by tutoring. Not surprisingly, even the government-appointed official in charge of higher education in Manipur sympathizes with the rebels' efforts (Chronicle of Higher Education 2003).

7. The direction of bias depends on the correlation between income levels and the private tutoring variables. If this correlation is positive, the coefficients on the share of public expenditure in GNP and gross enrollment rates would be biased upward; if they are negative, the coefficients would be biased downward.

8. Difference-in-difference comparisons of randomized control trials treat the before-to-after changes in the control group as a baseline and then see how much the before-to-after changes in the experimental group deviate from this baseline. Another variant of the randomized experiment method is regression discontinuity design, which takes advantage of what are in effect natural experiments in the region around a discrete (and exogenous) jump in the variable of interest. For a rigorous treatment of these econometric methods see Wooldridge (2002).

9. Instrumental variables attempt to deal with endogeneity by isolating and using only the exogenous component of the variable of interest.

10. The evidence that private tutoring raises achievement in the United States is overwhelming. Other studies that find that private tutoring has positive effects on SAT scores include Becker (1990) and Powers and Rock (1999). A meta-analysis study of the effects of one-on-one tutoring programs in reading for elementary students with learning difficulties shows that these programs improve student reading skills (Elbaum and others 2000).

11. Certain features of the Indonesian finding (in which one of the authors participated) may restrict its general applicability. First, the test administered was simple: the math test consisted of only 12 questions, and the dictation test consisted of a single short passage. Second, because data on student attributes and investments were limited, the tutoring variable used was a crude one: whether or not the student was currently receiving tutoring.

12. These calculations revise and update those in Dang (2007a) and are available on request.

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Can Biological Factors Like Hepatitis B Explain the Bulk of Gender Imbalance in China? A Review of the Evidence

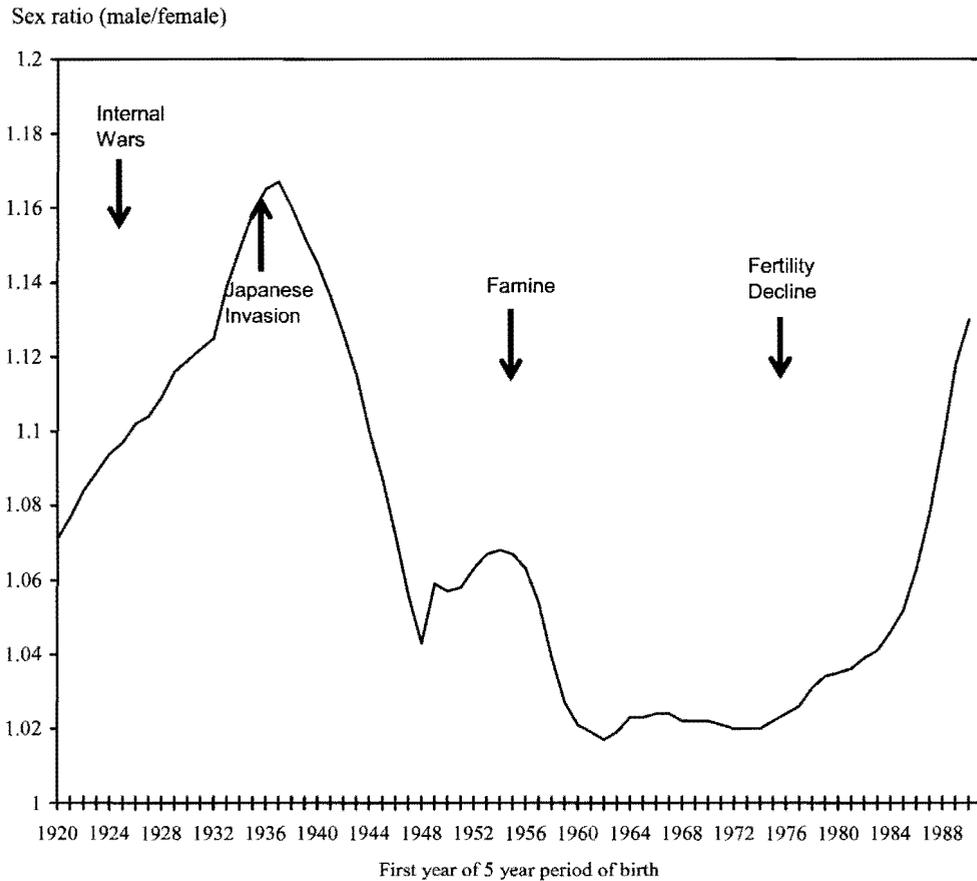
Monica Das Gupta

A recent study challenges the assumption that the large deficit of girls in East and South Asia reflects the preference for sons, suggesting that much of the deficit—as much as 75 percent in China—is attributable to hepatitis B (HBV). The claim is inconsistent with the results of a study based on a large medical data set from Taiwan (China), which indicates that HBV infection raises a woman's probability of having a son by only 0.25 percent. In addition, demographic data from China show that the only group of women who have elevated probabilities of bearing sons are those who have already borne daughters. This pattern makes it difficult to see how any biological factor can explain a large part of the imbalance in China's sex ratios at birth, unless it can be shown that it somehow selectively affects those who have borne girls or causes them to first bear girls and then boys. The Taiwanese example suggests that this is not the case with HBV, the impact of which is unaffected by the sex composition of previous births. The data thus support the cultural rather than the biological explanation for gender imbalance. JEL codes: J11, J13, J16

East and South Asia have large deficits of girls (Sen 1990; Coale 1991; Klasen 2002). This is not a new phenomenon. Sex ratios (the number of males divided by the number of females) in China were high throughout the twentieth century, especially during certain periods (figure 1). In India large shortfalls of girls have been evident since national censuses began in the late nineteenth century (Hutton 1931; Visaria 1969).

The size of the female deficit is striking, as Sen (1990) notes. In the 2000/01 censuses, the excess of boys over girls among children ages 0–4 was 17 percent in China, 10 percent in the Republic of Korea, and 8 percent in India.¹ The gap

Figure 1. Excess Sex Ratios in China, 1920–95



Note: Years indicate first year of five-year birth cohort. These estimates are possible because of the high level of accuracy of age-reporting in East Asia, where people know their animal year of birth in the 12-year cycle of animal years. The excess ratios peak among cohorts born just before a war or famine, because those who were young girls at the time of the crisis experienced the maximum excess mortality.

Source: Das Gupta and Li 1999, based on data from the 1953, 1964, 1982, and 1990 population censuses of China and the 1995 National One Percent Sample Survey.

was even larger in certain subregions: in two states in northwest India and several provinces in south and east China, boys outnumbered girls by 24 percent or more.

Several mechanisms underlie this shortfall of girls. These include female infanticide and neglect of young girls and, more recently, prenatal sex selection. The Chinese data show rising sex ratios at birth by birth order even before the advent of technology for detecting the sex of unborn children (Zeng and others 1993);

the same phenomenon has been recorded in India since the first censuses (Panigrahi 1972; Miller 1981). Research on the mechanisms of neglect of female children indicates mild discrimination in food and significant discrimination in medical care, especially in South Asia (Hutton 1933; Wyon and Gordon 1971; Chen, Huq, and d'Souza 1981; Das Gupta 1987; Basu 1989). Since the advent of sex-selection technology, there has been a shift from postnatal to prenatal sex selection among those who can access and afford this new technology (Goodkind 1996).

The problem is not one of generalized discrimination against girls, practiced perhaps unconsciously by parents who have internalized certain norms favoring boys over girls. As Das Gupta (1987) shows, excess female child mortality is concentrated among girls born to parents who already have a daughter. There is also a (far smaller) rise in mortality among boys born into families that already have a son. This indicates a conscious parental strategy to manipulate the sex composition of their children, especially to avoid raising several girls.

These results have been replicated in a large number of studies across South and East Asia (Choe 1987; Muhuri and Preston 1991; Zeng and others 1993; Park and Cho 1995; Arnold, Kishor, and Roy 2002; Bhat and Zavier 2007; Lin and Luoh 2007). These studies find that when parents have borne a daughter, subsequent girls are at sharply elevated risk of dying either before or after birth. High sex ratios at birth are caused either by sex-selective abortion or by cases of infanticide that are not recorded as births. Since sex-selection technology became widely available, its use has been found to be strongly correlated with the sex composition of children: the sex ratio at birth rises sharply if the parents have borne a daughter and have not yet borne a son. These studies also show discrimination against nonfirstborn sons, although it is very small compared with discrimination against nonfirstborn girls.

Across South and East Asia, it is widely believed that discrimination against girls reflects cultural factors that make girls much less valuable to their parents than boys. The roles of cultural and economic factors become closely intertwined because the culture—in the form of a strongly patrilineal family system—creates a situation in which girls are excluded from contributing to their parents' households after marriage (Das Gupta 1987, 1995; Park and Cho 1995; Croll 2001). A woman can contribute only to her husband's household and to care for his parents. Thus, raising a girl is viewed as "watering another person's garden" (Attane and Guilimoto 2007). In societies with bilateral kinship systems, such as those in Southeast Asia, where both sons and daughters can support their parents (Casterline, Chang, and Domingo 1993), child sex ratios are normal (Das Gupta *et al.* 2003, map 1).

On the basis of this understanding of the cultural and economic reasons underlying son preference, these countries have designed public policies to reduce

discrimination against girls. For example, both the Chinese and Indian governments have sought to increase gender equity through a wide range of interventions aimed at changing people's perception that girls are less desirable than boys and at bringing women into public life. These interventions include vigorous media campaigns to change ideas about gender roles and equity, legislation to enhance gender equity (Croll 2000; Das Gupta and others 2004), and financial incentives to parents to raise daughters (George 2000; *China Daily* 2006).

Oster (2005) has strongly challenged the assumption underlying these policies, arguing that up to 75 percent of the female deficit in China (and 20 percent in South Asia) can be accounted for by the high prevalence of hepatitis B (HBV). Her claim would suggest that instead of focusing primarily on the difficult task of altering parental preference for sons, the first plank of policy interventions should be the much simpler task of immunizing people against HBV.

There is much evidence that biological factors can cause gender differentials in health outcomes (Waldron 1983; Vlassoff and Bonilla 1994; Hansen, Moller, and Olsen 1999). Studies also show that the sex ratio at birth in Sweden rose by several percentage points over several centuries as women's nutritional status improved (Johansson and Nygren 1991). Other factors can also play a role. Norberg (2004) finds that sex ratios at birth are higher for women who are living with a spouse or partner before the child's conception or birth.

This article examines Oster's hypothesis, reviewing the medical and demographic evidence for and against it. Since her strongest conclusions are for China, the focus is on evidence from China. In contrast to her findings, the analysis here suggests that HBV infection has a very small effect on the female deficit in China. In fact, the patterns of sex ratio at birth in China (as in other Asian countries) are difficult to reconcile with a large role of biological factors of any kind.

Studies of the Relation between Hepatitis B Status and Sex Ratios at Birth

This section reviews the evidence from medical studies of the relation between HBV and sex ratios at birth and raises several questions about Oster's hypothesis.

Evidence from Micro-studies

Six micro-studies carried out by medical scientists find a relation between HBV and the sex ratio of births. Blumberg (2006) summarizes these results:

In a study in Greece, families in which either parent was a carrier of HBV had a higher ratio of boys to girls than families where the parents

(particularly the mother) had anti-HBs... Similar studies were done in five other populations; they were consistent with the initial results. [Authors's note: antibodies against the surface antigen of the Hepatitis B virus, indicating immunity to the virus.]

Chahnazarian, Blumberg, and London (1988) note that the populations studied were very small and that the sex ratios therefore fluctuate across studies. The magnitude of the effect is thus unclear, although the pattern is apparent. Summarizing the results from the three studies with the best data quality, they find that if either parent is an HBV carrier, the probability of a male birth is 1.47 times higher than in families in which both parents are uninfected. Given the small numbers of births, however, the confidence interval is so large that they can conclude only that the sex ratio at birth for children born to carrier parents is significantly different from the normal sex ratio at birth (of 1.06), and even this finding holds in only two of the three studies. Chahnazarian, Blumberg, and London tried hard to dissect the data from these three studies to see whether the carrier status of the father or the mother had a larger effect, but were unable to identify differential effects.

Such questions have potential relevance for medical science that goes far beyond sex ratios at birth. As Blumberg (1976, 288) notes, "This connection of HBV with sex selection may also explain why there is a greater likelihood of rejection of male kidneys by renal patients with anti-HBs and indicate how kidneys can be better selected for transplantation."

Oster's 2005 Study

Struck by these findings, Oster (2005) set out to test for them on a population level in a large number of countries. She uses a variety of data and analytical approaches, including cross-country analyses, time-series evidence using a natural experiment based on campaigns in Alaska and Taiwan (China) to vaccinate women against HBV, and an estimation of the proportion of the female deficit in China and India that is attributable to HBV.

Identifying a relation between sex ratios and HBV is not easy, for several reasons. First, the estimates of the prevalence of HBV have to be derived from scattered studies, which often represent a minuscule fraction of a country's population. As Oster (2005, table 10 footnote) notes, "HBV prevalence is calculated...by aggregating published studies... Only countries with more than 2,500 people tested for HBV [combining all studies] are used in the analysis." Second, only an indirect estimate of the effect of HBV status on the sex ratio at birth can be made, because the direct estimates from the micro-studies are based on very small numbers.

In her cross-country analysis, Oster finds a clear correlation between the sex ratio at birth and the prevalence of HBV. However, she notes that because of issues of data quality, these regressions omit data from Sub-Saharan Africa, where the sex ratio at birth is low and the prevalence of HBV high. And, as discussed below, similar issues of quality affect the data for many other developing countries that were not dropped from her analysis, including India, which she analyzes extensively.

Oster finds that vaccination campaigns clearly reduced the sex ratio at birth in Alaska. In Taiwan (China), the effect is less clear. Taiwanese vital statistics show that the sex ratio at birth hovered around 109 between 1996 and 2002, rising slightly to 110 in 2003–04.² This pattern does not suggest that the vaccination campaign had any significant effect on the sex ratio at birth, as girls who were vaccinated in 1984 (the year the campaign began) would have been 15 in 1999.

Oster (2005, 1166) then calculates the proportion of the female deficit in China and India that can be explained by the prevalence of HBV, combining her estimates of “the prevalence of hepatitis B and estimates of the effect of hepatitis on the sex ratio at birth to estimate and adjust the number of missing women.” These calculations appear to be estimates of the impact only of the mother’s (not the father’s) HBV status, as the prevalence data pertain only to pregnant women (2005, table 10).

Using these estimates of HBV prevalence and impact on the sex ratio at birth, Oster estimates that up to 75 percent of the “missing women” in China in the early 1990s and 20 percent of the “missing women” in South Asia are attributable to parental infection with HBV. Her conclusions are striking and have received much attention (Barro 2005; Dubner and Levitt 2005). Given their strong implications for policy, they warrant deeper exploration with more robust data.

Lin and Luoh’s 2007 Study

A very large national longitudinal data set from Taiwan (China) permits robust estimation of the impact of the mother’s HBV status on sex ratios at birth. These data were collected for a national HBV immunization program. Women were vaccinated against HBV, and babies born to women who tested positive were given a dose of HBV immune globulin within 24 hours of birth. These stringent requirements made for high-quality data collection for a very large sample covering up to 90 percent of births.

Using the data collected between 1988 and 1999, Lin and Luoh (2007) track the sex ratio of births to women whose HBV status was known. They find that women who were infected had only a 0.25 percent higher probability of having a son than other women. With a prevalence of HBV infection as high as 15 percent in the population, this translates into an increase of only 0.165 percent in the sex

ratio at birth, raising it from a baseline of 105.000 to 105.165. The sex ratio at birth for all births in the data set was 109, so HBV can account for only a tiny fraction of the elevation.

Oster (2005) estimates that the prevalence of HBV among pregnant women in China is 11.24 percent, which should result in a sex ratio at birth of 1.10. This is the basis for her estimate that HBV accounts for the bulk of excess male births in China. The findings from the detailed medical data set from Taiwan (China) suggest that she massively overestimates the impact of maternal HBV infection.

Blumberg and Oster's 2007 Hypothesis

In response to Lin and Luoh's (2007) study, Oster revised the premise of her argument. In a study with Blumberg, she now concludes that the effect of HBV on the sex ratio at birth is driven largely by the father's HBV status and that the mother's HBV status plays at most a much weaker role (Blumberg and Oster 2007). As in her earlier article, this study uses multiple approaches to arrive at its conclusions:

We present three pieces of evidence that this may be the case. First, using two of the original datasets on this topic we find that father's infection is more strongly correlated with sex ratio than mother's infection. Second, in population-level data from Taiwan we find that paternal cohort infection rates are more important than maternal cohort infection rates. Finally, we show using the IPUMS [Integrated Public Use Microdata Series] dataset that children born in the United States to men born in China are more likely to be boys, but this finding does not hold for children born to women from China. (Blumberg and Oster 2007, abstract)

Each of these analytical approaches raises some questions. First, Blumberg and Oster revisit the three individual-level data sets, on the basis of which Chahnazarian, Blumberg, and London (1988) concluded that sex ratios at birth were elevated if either parent was an HBV carrier and that the data did not permit them to conclude that one parent's status was more important than the other's. Blumberg and Oster run regressions on two of these three data sets to show that only the father's HBV status is significantly associated with a distorted sex ratio at birth. This conclusion is at odds not only with the previous analyses, but also with the evidence from a larger study on Greece that Blumberg and Oster cite in their paper (reproduced here in table 1). This larger study (Greece 2) documents an increase in the sex ratio at birth associated with HBV status that is similar to that in the two data sets Blumberg and Oster reanalyze (Greece 1 and the Philippines). However, unlike these two studies the Greece 2 data set includes information only on the mother's HBV status (Livadas and others 1979), so the observed differentials in the sex ratio at birth are associated with the mother's

Table 1. Offspring Sex Ratio by Parental Hepatitis B Status

Location	HBV status	Sons	Daughters	Sex ratio
Greenland	Positive	64	60	1.07
	Negative	174	194	0.90
Kar Kar Island	Positive	63	54	1.17
	Negative	163	206	0.79
Greece 1	Positive	90	51	1.77
	Negative	287	255	1.13
Philippines	Positive	66	41	1.61
	Negative	304	301	1.01
Greece 2	Positive	52	30	1.73
	Negative	1,006	955	1.05
France	Positive	20	12	1.66
	Negative	149	122	1.22

Notes: This table shows sex ratios among the children of carrier and noncarrier parents in four regions. *Data were collected by testing married women and, in all cases except Greenland, their husbands for HBV.* The citations for each study are as follows: Greenland—Drew, Blumberg, and Robert-Lamblin 1986; Kar Kar Island—Drew and others 1982; Greece 1—Hesser, Economidou, and Blumberg 1975; the Philippines—Chanazarian, Blumberg, and London 1988; Greece 2—Livadas and others 1979; France—Cazal, Lemaire and Robinet-Levy 1976.

Source: Blumberg and Oster 2007.

Author's Note: The "Greece 2" study tested only women (not men) for HBV (Livadas *et al.*, 1979). The italicized sentence in the footnotes to the table above is incorrect.

HBV status. Unless there was a near-perfect correlation between the mother's and the father's HBV status, these data would be inconsistent with Blumberg's and Oster's reformulated hypothesis.

Second, using population-level data from Taiwan (China) on HBV prevalence by age from testing done in primary school, Blumberg and Oster construct expected HBV prevalence by five-year age cohorts. They then examine the sex ratio of children born to parents who belong to different age cohorts, who have different probabilities of infection. Once again they find that only the expected HBV of the father's cohort affects the sex ratio at birth. It is difficult to assess this information, because Blumberg and Oster do not present basic information on the data, such as the number of age cohorts available for this analysis.³

Third, the authors use U.S. census data to look for patterns in the sex ratios of children born to Chinese immigrants, who are assumed to have levels of HBV prevalence similar to those in their place of origin. They find that the offspring of Chinese couples have an elevated sex ratio at birth, as do those of Chinese men who marry non-Chinese women. However, Chinese women who marry non-Chinese men do not show an elevated sex ratio at birth among their offspring. Blumberg and Oster interpret these findings as showing that only paternal HBV status drives the elevated sex ratio at birth.

However, there could be a completely different explanation for this phenomenon. The literature on son preference in China highlights the desire for sons to continue the husband's lineage, but not the wife's, since a lineage cannot be continued through a woman. Even if a man born in China marries a woman born in the United States, he would still be subject to pressure to continue his lineage; this would not apply to a woman born in China married to a man born in the United States.

Several questions thus arise about Blumberg's and Oster's claim that it is the father's and not the mother's HBV status that elevates sex ratios at birth.

The Demographic Evidence

The demographic data, like the medical data, are very difficult to reconcile with the hypothesis that HBV status, whether of the father or the mother, accounts for the bulk of the female deficit in China and India.

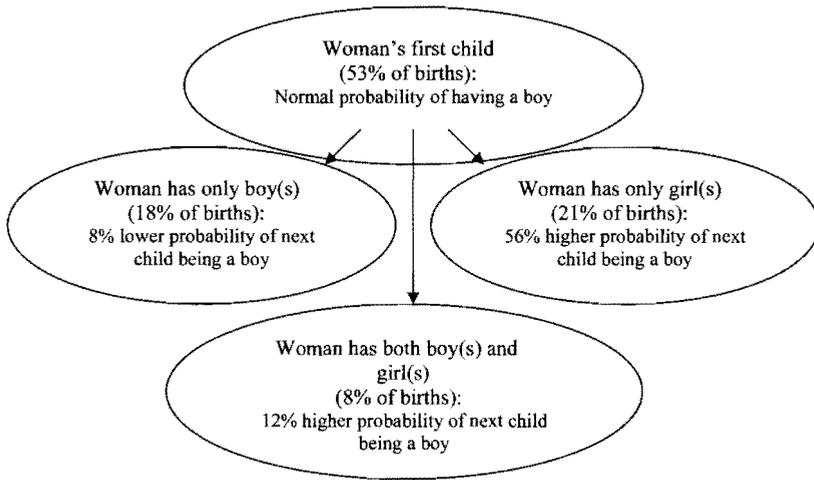
Only Women Who Have Borne a Daughter Show an Elevated Probability of Bearing Sons

A very clear pattern emerges from the more than 300,000 births in the 1 percent sample of the 1990 Chinese census. These data cover births during 1989–90, which is close in time to the period for which Oster (2005) calculates the proportions of the Chinese female deficit attributable to HBV. In this enormous database of births, the only group of women with elevated probabilities of bearing sons is women who have already borne daughters (figure 2). Those who have borne only sons show a mildly elevated probability of the next child being a girl—indicative of a mild preference for having a daughter if a son is already safely in place. A similar pattern is found in India (figure 3), although discrimination against girls is less pronounced there than in China.

Across East and South Asia, all the indicators—sex ratios at birth, sex ratios of aborted fetuses, and sex ratios of child mortality—show the same pattern of manipulation of family composition by parents, a pattern that is consistent with strong son preference. Whether females “go missing” is determined by the existing sex composition of the family into which they are conceived (Choe 1987; Muhuri and Preston 1991; Zeng and others 1993; Park and Cho 1995; Arnold, Kishor, and Roy 2002; Das Gupta 2005, Bhat and Zavier 2007; Lin and Luoh 2007). This suggests that cultural factors still provide the overwhelming explanation for the female deficit.

For Oster's hypotheses to be consistent with the demographic data, women would have to be especially prone to contracting HBV if they had borne a daughter or the disease would have to somehow lead to women first bearing daughters and

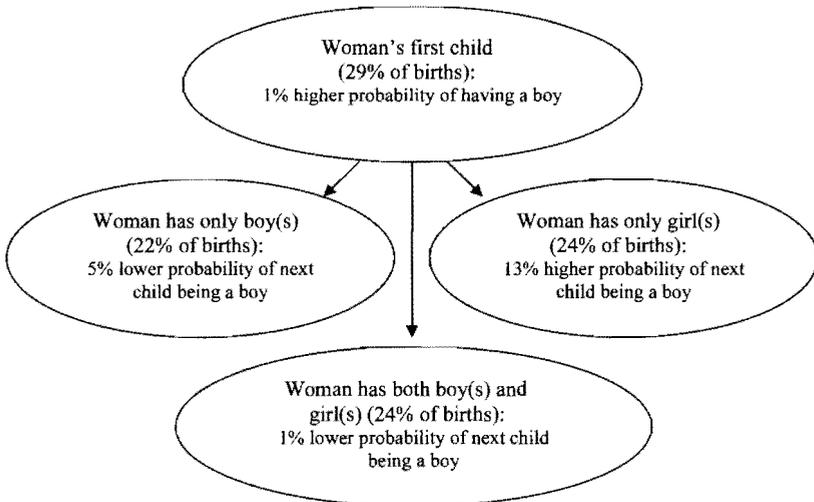
Figure 2. Probability of Bearing a Son, by Sex Composition of Woman's Existing Children, China, 1990



Note: The normal sex ratio at birth is 105–106 boys to 100 girls. The outer limits of the normal range are 104–107 (Chahnazarian 1988).

Source: Das Gupta 2006 based on data from Zeng and others (1993).

Figure 3. Probability of Bearing a Son, by Sex Composition of Woman's Existing Children, India, 1998–99



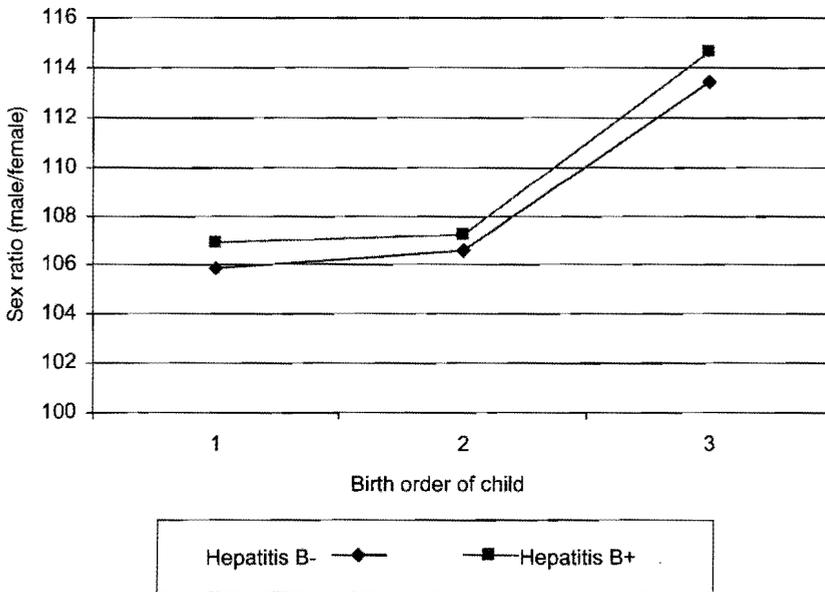
Source: Author's analysis based on data from Bhat and Zavier (2007).

then bearing an excess of sons. (Or men would have to be especially prone to contracting HBV if their wives had borne a daughter or the disease would have to somehow lead to their wives first bearing daughters and then bearing an excess of sons.) Either scenario would require a much more complex set of biological factors to be at work than is indicated by Oster or the micro-studies she cites.

Is it possible that somehow HBV works in these very complex ways? Lin's and Luoh's (2007) large medical data set makes it possible to examine this issue. They show that the impact of maternal HBV status is fairly constant across birth orders (figure 4). HBV+ and HBV- women show a similar sharp rise in the sex ratio at birth by birth order. This finding is consistent with that of studies across Asia that show that parents who have not yet borne a son have a higher probability of progressing to higher-order births and become increasingly desperate to ensure that they have a son (Choe and others 1992; Arnold, Choe, and Roy 1998; Larsen, Chung, and Das Gupta 1998). The fact that the HBV impact is fairly constant across birth orders suggests that it is unaffected by the sex composition of previous births.

Lin and Luoh (2007) also test the possibility that some complex biological factor makes women who are HBV+ more prone to bearing a son if they had previously borne girls. Their findings do not support this hypothesis. For women who have a third birth, the sex ratios at birth of HBV+ women remain

Figure 4. Sex Ratio at Birth by Mother's Hepatitis B Status and Birth Order of Child, Taiwan (China), 1988–99



Source: Lin and Luoh (2007, table 2).

marginally higher than those of HBV– women, but there is no significant additional impact of HBV status on the sex ratio at birth of the third child if the previous children were all girls (table 2).

Population-Level Evidence from Africa

Oster (2005, 1196) notes that Sub-Saharan Africa appears to offer evidence that is inconsistent with her hypothesis: “To the extent that it is possible to tell, it seems that Africa has relatively low sex ratios and relatively high HBV prevalence.” She notes that the absence of high-quality birth registration data in Africa make it difficult to use data on sex ratios at birth. She therefore compiles data from Demographic and Health Surveys carried out in 18 Sub-Saharan African countries, cautioning that these survey data suffer from defects such as recall bias. After conducting some regressions on these data, she concludes that “these results provide some comfort that Africa is not a particular challenge to the robustness of the HBV–sex ratio connection” (Oster 2005, 1198).

But the limitations of African birth registration data apply to many developing economies, including India, a country Oster analyzes extensively; if anything, the recall bias toward male births would be expected to be higher in India than in Sub-Saharan Africa considering the stronger son preference in India. Also odd is the fact that Oster does not use Garenne’s (2002) compilation and analysis of data on sex ratios at birth from 56 Demographic and Health Surveys conducted in 29 Sub-Saharan African countries.

Neither Garenne’s compilation of the data nor UN estimates show high sex ratios at birth in the African countries Oster lists as having especially high prevalences of HBV (table 3). This is another piece of evidence suggesting that neither parent’s HBV status has a significant effect on the sex ratio at birth.

Conclusions

The Chinese data strongly support the cultural explanation for the female deficit that high sex ratios at birth result largely from parental preference for sons. These

Table 2. Sex Ratio at Birth of the Third Child by Sex Composition of Previous Births, Taiwan (China) 1988–99

<i>Sex of previous two children</i>	<i>HBV+ mothers</i>	<i>HBV– mothers</i>
Both girls	122.4	121.4
At least one boy	110.5	110.9

Source: Lin and Luoh 2007, table 6, and personal communication specifying actual sex ratios underlying the regressions.

Table 3. Sex Ratios at Birth in Sub-Saharan African Countries with High Hepatitis B Infection Rates, 1995–2000

Country	Demographic and Health Survey	United Nations
Botswana	0.98	1.03
Liberia	1.05	1.03
Malawi	1.01	1.03
Mali	1.02	1.05
Togo	1.02	1.02
Zimbabwe	1.02	1.02
Sub-Saharan Africa	—	1.04

Note: Countries are those listed in Oster 2005 as those with high prevalence of Hepatitis B.

Source: Demographic and Health Survey data are from Garenne 2002, who cites data from national samples. Where there was more than one survey, data from the most recent year are shown. UN data are from United Nations Population Division 2003 and 2004.

data show that whether females “go missing” depends heavily on the sex composition of the family into which they are conceived. Girls with no older sisters have similar chances of survival as boys. In contrast, girls conceived in families that already have a daughter experience steeply higher probabilities of being aborted or of dying in early childhood.

The demographic data are difficult to reconcile with Oster’s hypothesis that most of the distortion in the sex ratios at birth in China is attributable to the prevalence of HBV. Her hypothesis is difficult to reconcile with the fact that the only group of women who have elevated probabilities of bearing a son are those who have already borne a daughter. Given the strong relation between the sex of children already born and the probability of the next child being a boy, it is difficult to see how any biological hypothesis can explain a significant part of the distortion in China’s sex ratios at birth unless it can be shown that the biological factor works in very complex ways, selectively affecting women (or men) who have borne girls or causing them to first bear girls and then boys.

The medical data from Taiwan (China) show that HBV infection raises a woman’s probability of bearing a son by only 0.25 percent. These data indicate that the effect of HBV status is fairly constant across birth orders, even though the sex ratio at birth rises sharply by birth order, strongly suggesting that the impact of HBV status is unaffected by the sex composition of previous births. The data show that HBV+ status does not selectively affect women who have borne girls. That there is no significant additional impact of HBV status on the sex ratio at birth of the third child if the previous children were all girls seems to rule out the possibility that biological factors can explain the complex patterns found in the demographic data.

Oster's hypothesis is interesting, but it cannot explain more than a very small part of the gender imbalance in China or other Asian countries with large numbers of "missing women." It appears that the governments of these countries have been correct to focus their policies on changing the cultural roots of son preference.

Notes

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1. For India the age group is 0–6.

2. The figures are from the *Taiwan Demographic Fact Book* (various issues). The author is grateful to Ming-Jen Lin for sharing these figures, which were compiled from the *Taiwan Demographic Fact Book* for his own research.

3. Blumberg and Oster (2007, table 4) mention that they use data collected from school testing conducted in the early 1990s, that the data on births are through 2002, that the parents must belong to different age cohorts, and that both parents' age cohorts must have been in school in the early 1990s when the testing was done. As women are typically younger than their husbands, the number of children born to the wives of men who were still in school in the early 1990s may not be large.

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Industrial Location in Developing Countries

Uwe Deichmann, Somik V. Lall, Stephen J. Redding, and Anthony J. Venables

Despite a diminishing role in industrial countries, the manufacturing sector continues to be an engine of economic growth in most developing countries. This article surveys the evidence on the determinants of industry location in developing countries. It also employs micro data for India and Indonesia to illustrate recent spatial dynamics of manufacturing relocation within urban agglomerations. Both theory and empirical evidence suggest that agglomeration benefits, market access, and infrastructure endowments in large cities outweigh the costs of congestion, higher wages, and land prices. Despite this evidence, many countries have tried to encourage industrial firms to locate in secondary cities or other lagging areas. Cross-country evidence suggests that fiscal incentives to do so rarely succeed. They appear to influence business location decisions among comparable locations, but the result may be a negative-sum game between regions and inefficiently low tax rates, which prevent public goods from being funded at sufficiently high levels. Relocation tends to be within and between agglomerations rather than from large cities to smaller cities or lagging regions. Rather than provide subsidies and tax breaks, policymakers should focus on streamlining laws and regulations to make the business environment more attractive. JEL codes: O18, R12, R38

Modern sector activity in developing countries exhibits pronounced spatial clustering. This occurs at different scales, ranging from the extreme specialization of some small towns in particular products to the dominance of primate cities in many countries. Identifying the causes and consequences of this concentration—and possible policies for dealing with it—can be done in several ways. One is to look at the benefits and costs of cities as a whole, investigating the determinants of city structure and urban performance (see Overman and Venables 2005 for a review). Another is to look at migration flows, a subject that has received a good deal of attention in the development literature (Lall, Selod, and Shalizi 2006).

A third way—the focus of this article—is to identify the determinants of the location of modern sector activity. Academic research seeks to understand how the characteristics of a location enhance firm-level productivity and how industrialization interacts with urbanization. While cross-country data can provide some insights into these issues, empirical research increasingly uses micro-data on firms to study the concentration and deconcentration of industrial activity.

These research questions are motivated by considerable policy interest in the determinants of industry location. City or regional managers want to attract domestic or foreign firms that bring employment and tax revenue. Provincial and national policymakers are concerned with overall urbanization patterns and the spatial distribution of economic activities across the country. A primary concern is that a high concentration of industries triggers what is often perceived as excessive urbanization in some areas and limited growth and economic opportunities in others. Policy interventions try to stimulate growth in secondary cities or lagging regions by steering industries away from large, established urban centers.

For both local and national policy formulations, it is necessary to determine the types of incentives and public investments that influence firm location. What complicates policymaking is the inherent tradeoff between efficiency and equity in intervening in market-driven concentration processes. Firms locate in already dense urban areas because they realize tangible benefits from being close to other firms and to consumers, thick labor markets, export hubs, governments, and regulators. Employment opportunities in these centers attracts migrants from other regions, increasing urban growth and demand for services. Local policies need to focus on managing growth through appropriate public investments.

Social and political factors put pressure on policymakers to move jobs to smaller towns and lagging regions, particularly in countries with geographically proportional political representation. Firms locate in these regions only if infrastructure investments or other incentives compensate for forgoing the agglomeration benefits of big cities. In the final analysis, the decision to invest public funds to influence private sector location decisions is political and depends on a country's priorities and available resources. In most cases these decisions are made with little explicit awareness of their full costs and benefits. Understanding these tradeoffs is therefore a high priority in light of rapid industrialization and urbanization in developing countries.

This article is organized as follows. Section I outlines some basic facts about growth, urbanization, and structural change. Section II surveys the forces that shape the location decisions of firms. It briefly outlines the theory and then reviews empirical studies of factors that determine location, noting that agglomeration forces, market access, and infrastructure provision all inhibit dispersion of activity. Section III turns to policy, reviewing the instruments countries have used to influence the relocation of industry to achieve regional development

objectives. Badly designed regulation and ill-conceived infrastructure investments can have strong negative effects. Fiscal incentives may sometimes lead to relocation between similar regions, but they are rarely sufficient to induce firms to move from productive urban agglomerations to lagging regions.

Section IV includes micro-data from India and Indonesia and sheds light on where modern sector activity is concentrated within the urban hierarchy and how this has changed over time. Despite large differences in geography and institutions, the two countries display a common pattern of deconcentration toward peri-metropolitan areas on the fringes of the largest cities and toward large secondary cities. This pattern suggests that as industrialization proceeds, it is the areas on the edge of existing urban agglomerations and in the next tier of cities that are likely to experience the most rapid growth. Understanding these patterns of urban development can help identify future infrastructure priorities and development bottlenecks.

The article focusses on formal-sector manufacturing, partly because of data availability. Services and other modern sector activities often represent a larger share of the workforce, even in most developing countries; it would clearly be desirable to have a better view of the role of the informal sector. However, considerable evidence suggests that manufacturing activity, income growth, and poverty reduction are linked. Research in India, for example, indicates that states that experienced rapid structural change also experienced more rapid rural and urban poverty reduction (Burgess and Venables 2004). This link highlights the critical role of labor-intensive manufacturing in enabling countries and regions to transition from low- to middle-income status (Collier 2007).

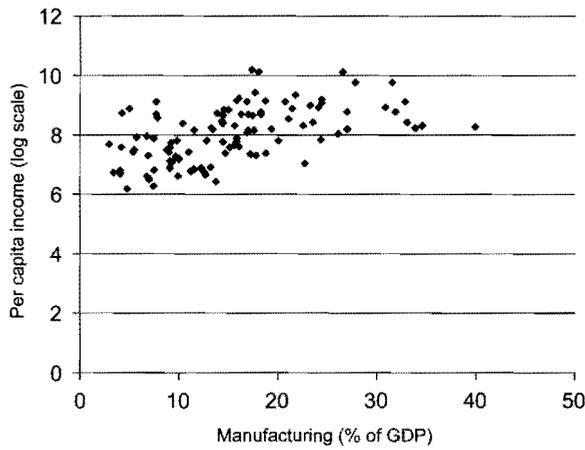
Economic Structure, Urbanization, and Income

How does urbanization vary with development? To what extent are differences in this relationship driven by manufacturing and other modern sector activities? How do these patterns correlate with income levels?

Manufacturing and per capita income have a nonlinear relation (figure 1). The manufacturing sector tends to grow up to some level as countries develop, after which it remains stable or diminishes in importance.

Ideally, what is wanted is a measure of modern sector activity, but manufacturing is a poor proxy for this. Instead, the share of agriculture is examined. Successful economies would be expected to undergo a greater structural transformation from agriculture to manufacturing than less successful economies. The correlation between per capita income and the importance of agriculture in the national economy is strongly negative (figure 2).

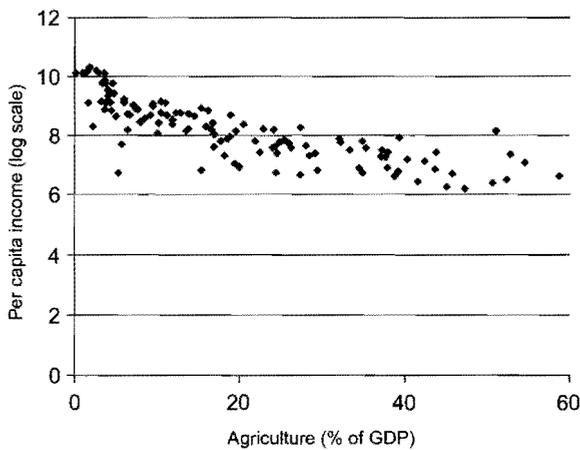
Figure 1. Manufacturing and per Capita Income, 2000



Source: World Bank (2005).

Figures 1 and 2 show the situation in 2000. Looking instead at changes over the period 1980–2000 shows a significant positive correlation between the increase in the share of manufacturing and the decline in the share of agriculture on the one hand and the growth of per capita income on the other. This relation indicates that, on average, successful economies experienced greater structural change from agriculture to industry than less successful economies.

Figure 2. Agriculture and per Capita Income 2000



Source: World Bank (2005).

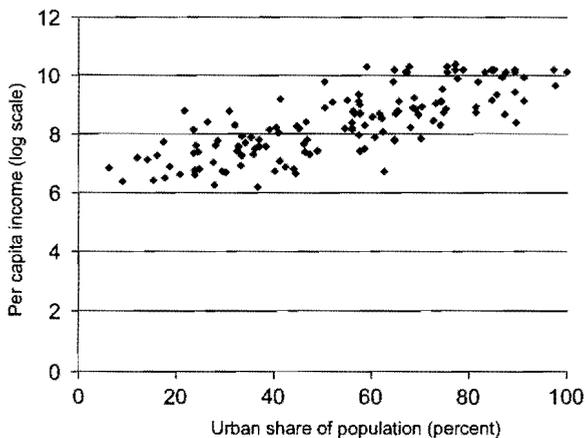
The relation between manufacturing and urbanization shows a positive, albeit weak, correlation across countries. Once again, modern sector activities other than manufacturing are important, and the negative correlation between agriculture and urbanization is much stronger than the positive relation with manufacturing. The relation is also stronger in changes: increasing manufacturing shares in income and increasing urban shares in population were positively associated over 1980–2000.

Finally, the relation between urbanization and per capita income is strongly positive (figure 3). For the poorest and the richest groups of countries, there is no association between the change in urbanization and the change in per capita income between 1980 and 2000. In contrast, among the middle range of countries the association is significant.

A substantial body of literature looks at urban structure. Henderson (2000) finds that national urban primacy (the dominance of the largest city) rises with growth from low income levels, peaks at low-to-middle levels (1987 per capita purchasing power parity of about \$2,500), and declines thereafter. This finding is consistent with that of Williamson (1965) and Shishido and Wheaton (1982), who find that spatial inequalities first increase and then decrease with the level of development.

Are high urban primacy rates in developing countries a temporary phenomenon, or are they structural? Historical evidence provides some indication. Today's industrial countries tend to have a more balanced urban system than most developing nations. Data on urban growth in the nineteenth century suggest that today's industrial countries did not go through a similar phase of very rapid and highly concentrated urbanization (Bairoch 1988).

Figure 3. Urbanization and per Capita Income 2000



Source: World Bank (2005).

Puga (1998) attributes these differences largely to two factors. First, transport costs were higher during European urbanization, and agglomeration benefits were therefore lower. Industrial development, and consequently migration, were therefore distributed over a larger set of urban areas. Second, the pool of agricultural workers that could potentially migrate to cities has been larger in developing countries than it was in Europe in the nineteenth century. Population growth in today's developing countries has tended to outpace the expansion of agricultural land, so that the quantity of land available per farmer is much smaller, increasing pressure to migrate. This in turn means that large rural–urban migration flows have not significantly reduced rural–urban wage differentials. Larger cities, which offer the highest returns, have therefore grown more rapidly than smaller ones. If, as happened in Europe, urban migration reduced wage differentials, smaller cities, even those that serve predominantly the agricultural hinterland, would be able to attract migrants.

Henderson (2000, 2002) reviews other likely reasons for the persistence of high primacy in developing countries. He notes that critical infrastructure is scarce and tends to be concentrated in the main metropolis of poorer countries. More generally, cross-country findings and historical experiences suggest that while manufacturing growth tends to raise per capita income, it is also associated with increasing urbanization and possibly with increasing spatial inequality.

Determinants of Industrial Location

The theory of industrial location is based on the relative profitability of activities in different locations, which depends on the prices and quality of inputs, the prices of outputs, and the efficiency of technology. Empirical studies of factors that determine location note that agglomeration forces, market access, and infrastructure provision all inhibit dispersion of activity.

Theory

The effects of higher wages, electricity, or land prices are qualitatively clear, although their magnitude varies empirically. Spatial variation in the revenue firms receive in selling their output is determined by access to markets (market size and transport infrastructure quality) and by competition from other suppliers. Locations from which large markets can be reached easily will be attractive for firms.

In standard models of firm location, good market access has a magnified effect on location decisions. Better market access of a location causes a greater than proportionate increase in the number of firms that choose to produce there, because firms prefer to locate in the larger market and export to smaller markets

(bearing transport costs) rather than vice versa. This dynamic tends to lead production to be more spatially concentrated than the population as a whole. The relative strength of these effects varies across sectors, so that in equilibrium (when labor costs may be higher in large centers), one would expect to see some sectors locating close to large markets and others being dispersed as firms choose locations with lower wages. This theoretical prediction has substantial empirical support (see Davis and Weinstein 2003).

Other effects will further amplify the tendency of some sectors to cluster. In addition to locating close to consumers, firms may gain from proximity to other firms in their own or related sectors. Three sorts of mechanisms drive these effects. One is forward and backward linkages between firms. Firms that produce intermediate goods tend to locate close to their consumers, the downstream firms that buy their products (a demand, or backward, linkage). Downstream firms gain from locating close to their suppliers (a cost, or forward, linkage). There will therefore be a tendency for such activities to locate near one another.

A second clustering mechanism arises from the advantages of being in a thick labor market. If specialist skills are required, workers' incentives to acquire these skills are greatest in a location in which there are many firms. Conversely, firms' ability to hire specialist workers is greatest in a location with many such workers. Thick labor markets also reduce the vulnerability of firms and workers to adverse shocks and improve the quality of matches between specialized workers and firms looking for particular labor skills.

Finally, clustering can have direct productivity effects. Knowledge spillovers, as firms in a location learn best-practice techniques by observing other firms, raise overall productivity. As firms observe the success of other nearby firms performing a specific activity, they may copy its practices (Rodrik 2004).

Each of these clustering mechanisms may operate over different spatial and sectoral ranges. Linkages, labor skills, and learning effects, for example, may all be highly sector specific, in which case "localization" of particular industries would be expected. Towns and cities become highly specialized, creating garment centers, software centers, financial services centers, and so forth. Other sectors may benefit from a large market and from urban diversity as a source of complementary inputs, knowledge spillovers, and productivity benefits. These are forces for "urbanization" economies, as firms benefit from urban scale as a whole rather than from concentration of their own sector.

Opposing these tendencies to cluster are dispersion forces in the form of agglomeration costs. Large cities typically have high prices for immobile factors (land and housing), high commuting costs and congestion, and pollution diseconomies. Wages need to be high to compensate workers for these costs. A more dispersed pattern of firms would therefore be expected in sectors in which wage costs are important and clustering benefits relatively unimportant. Sectors in

Table 1. Results of Selected Econometric Studies of Industrial Location in China, India, and Indonesia

<i>Location/study</i>	<i>Data</i>	<i>Factor prices</i>	<i>Labor and regulation</i>	<i>Electricity quality</i>	<i>Incentives</i>	<i>Market access/ transport infrastructure</i>	<i>Firms in supplier industry</i>	<i>Firms in own industry</i>
<i>China</i>								
Head and Ries (1996)	Foreign investments in 54 Chinese cities	No effect	—	Positive	Very positive	Very positive for railways and ports	Very positive	—
Amiti and Javorcik (2005)	Foreign investments	—	—	—	—	Positive; interprovincial trade barriers deter investment	Very positive	Very positive
<i>India</i>								
Lall and Mengistae (2005)	Firm data on 40 cities in 8 manufacturing sectors	Negative for some industries	Negative	Positive	Positive	Positive	—	Positive
Lall and Chakravorty (2005)	Firm investments	—	Negative	—	—	Positive	—	—
Mani, Pargal, and Huq (1997)	418 investment projects in 14 states	Positive for some industries	Negative	Positive	—	—	—	—
<i>Indonesia</i>								
Deichmann and others (2005)	Firm data from 294 districts in 15 industries	Negative for most industries	Negative for some industries	—	—	Positive for some industries	Positive for some industries	Positive for most industries
Henderson, Kuncoro, and Nasution (1996)	Firm data on nonfood manufacturing <i>kabupaten</i>	Negative	—	Positive	—	Positive (proximity to metropolitan area)	—	Positive
— Not available.								
Source: Authors' compilation.								

Similarly, Head and Ries (1996) show that after implementation of an open door policy in China in 1978, foreign firms preferred to locate in cities with large industrial bases and a history of foreign investment. These cities, such as Shanghai and Shenzhen, are also the main export hubs for China's manufacturing sector. The econometric work by Head and Ries controls for factors such as fiscal incentives and infrastructure, which make some regions more attractive than others.

In another study of China, Cheng (2007) shows the positive impact of existing Japanese firms on greenfield development by Japanese firms as well as the importance of high-quality support services. Lack of skilled labor and concentrations of state-owned enterprises discourage such investment.

The Mexican experience diverges from these trends, because trade with the United States pulls activity away from the traditional center of Mexico City toward northern agglomerations, such as Ciudad Juarez, Monterrey, and Tijuana. The border states increased their share of manufacturing employment from 21.0 percent in 1980 to 29.8 percent in 1993; over the same period Mexico City's share declined from 44.4 percent to 28.7 percent (Hanson 2005). The decline followed the opening of the Mexican economy to foreign trade and investment. A significant share of new establishments in the border states are branch plants of foreign corporations that take advantage of low wages and proximity to the U.S. market.

In both China and Mexico the focus of firm location decisions on regions that facilitate exports of manufacturing goods has led to increasing regional disparities of economic activity and, consequently, of welfare outcomes at the household level. In Mexico, for instance, there has been little expansion of economic activity in the south, and indicators of spatial inequality increased during the period of economic expansion in the north (Deichmann and others 2004).

Infrastructure and lagging regions. A longstanding question is whether infrastructure improvements—particularly improvements to transport infrastructure—encourage firms to move to lagging regions. The theory is ambiguous, because infrastructure improves access for both exports from and imports to lagging regions. Empirical studies indicate that policy has succeeded in moving firms to second-level locations but not to lagging regions.

Deichmann and others (2005) investigate the issue for Indonesia. They estimate a location choice model to illustrate the potential effects of transport improvements on the relocation of firms, particularly to the lagging eastern part of the country. They also simulate the effects of an upgrading of road densities in peripheral eastern Indonesia to a level similar to that of the country's major agglomeration, Jakarta. They find that there is some relocation of firms in transport-sensitive sectors but that it occurs only from major agglomerations to other large cities with similar amenities (such as Surabaya), not to the more peripheral parts of the country. This evidence suggests that without other forms

of public service provision and amenity creation, large-scale transport improvements are not sufficient to induce firms to relocate from agglomerations to peripheral areas.

Infrastructure links may enhance productivity and, combined with complementary investments, attract firms to lagging regions. But such investments can also have unintended consequences. Interregional transport improvements provide local firms with better access to the inputs and markets of more developed areas, but they also allow larger firms based in agglomerations to expand into lagging-region markets in competition with local producers. The higher transport costs of external producers are often more than made up for by economies of scale, better know-how, and lower overall unit cost of production.²

Clustering effects. Considerable evidence suggests that clustering forces are powerful determinants of firms' location decisions. A number of studies have sought to identify the sources of such effects, which include localization effects, supplier–customer linkages, and urbanization effects.

Using firm-level survey data from India, Lall and Mengistae (2005) find that localization economies, as measured by own-industry concentration, have significant bearing on firm location decisions across cities. This effect is highest for technology-intensive sectors. Deichmann and others (2005) find similar evidence for manufacturing firms in Indonesia. Localization effects are more important for high-technology firms (such as office computing) and natural resource-based industries (such as wood or rubber and plastic). They are less important for foot-loose industries, such as garments and textiles. While industry concentration provides many benefits, some of them can be offset by rising wages, land rents, and higher transport costs caused by congestion. The net benefits of own-industry concentration therefore vary across sectors and may be marginal for sectors with low-skilled labor and standardized technologies.

A similar picture emerges in the Republic of Korea. Henderson, Lee, and Lee (2001) estimate scale economies using city-level industry data for 1983, 1989, and 1991–93. They find localization economies of up to 8 percent, with more modest economies in sectors that use predominantly standardized technologies and low-skilled workers.

The second major type of benefits due to clustering stems from the close proximity to buyers and suppliers in own or related industries. Location models in Deichmann and others (2005) find that access to suppliers influences location decisions of firms in several industries (food and beverages, garments, chemicals, rubber). In contrast, firm profit models estimated by Lall, Funderburg, and Yepes (2004) for Brazil and Lall and Chakravorty (2005) for India do not find significant gains from supplier access after controlling for market access and other sources of agglomeration economies. Amiti and Cameron (2004) show that

externalities that arise from interindustry linkages are highly localized and have significant impacts on manufacturing performance (measured by wages) in Indonesia. Amiti and Javorcik (2005) find that market and supplier access in the province of entry are the most important factors affecting foreign entry in China. This finding is consistent with market fragmentation caused by underdeveloped transport infrastructure and informal trade barriers.

The third type of clustering is based on urbanization economies. Empirical studies by Bostic (1997) and Garcia-Mila and McGuire (1993) show that diversity in economic activity is positively associated with regional economic growth. Their finding confirms that of earlier empirical work examining the contribution of urbanization economies to productivity. Using U.S. manufacturing data at the two-digit Standard Industrial Classifications (SIC) level, Sveikauskas (1975) finds that a doubling of city size increases labor productivity 6 percent. Using Japanese data, Tabuchi (1986) finds that a doubling of population density increases labor productivity 4.3 percent.

The results from empirical studies on the relative importance of specialization and diversity are mixed. Glaeser and others (1992) find evidence only in favor of diversity. In contrast, Mirachy (1995) finds little evidence to support the diversity argument. Lall, Funderburg, and Yepes (2004) find evidence that diversity is the most important source of external cost reduction for Indian manufacturing establishments. Henderson, Kuncoro, and Turner (1995) show that in Indonesia the relative importance depends on the choice of industry. They find evidence of specialization externalities in mature capital goods industries and of diversity externalities in new high-tech industries. Their findings are consistent with product cycle theory (Vernon 1966), which predicts that new industries tend to prosper in large and diverse urban area but that with maturity their production facilities move to smaller and more-specialized cities. Localization economies, input-output linkages, and urbanization economies are not mutually exclusive. They may occur individually or in combination.

Regulation. Various measures of regulation are included in studies of firm location. Using the frequency of visits by government inspectors to plants in each industry and district as an indicator of enforcement, Lall and Mengistae (2005) find that predatory enforcement of business regulations has a significant negative effect on the attractiveness of Indian cities for employment in all broad sectors. Mani, Pargal, and Huq (1997) use Indian data to focus on environmental regulation and consider measures of the stringency of enforcement across states. Controlling for other variables, they find that the enforcement of environmental regulation has no effect on industrial location.

Probably the heaviest regulatory burden comes from employment legislation. Besley and Burgess (2004) find that pro-worker labor regulations in Indian states

are associated with lower output, employment, investment, and productivity in registered or formal manufacturing but higher output in informal manufacturing. In a survey of 1,000 manufacturing establishments in 10 Indian states, managers indicated that they would reduce their work force by 16–17 percent if labor markets were more flexible (Dollar, Iarossi, and Mengistae 2001). Such a reduction would increase labor productivity and contribute to economic growth.

The Role of Policy: Public Capital and Fiscal Incentives

Countries have used a variety of instruments to influence the relocation of industry to achieve regional development objectives. Most important among these instruments are the provision of public infrastructure, and tax reductions, subsidies, and other incentives that attract firms to lagging regions.

Research on the links between infrastructure and economic growth dates back to Hirschman's (1958) work on theories of unbalanced growth and to other development theories on the role of economic and social overhead capital in national and regional development (Rosenstein-Rodan 1943; Nurske 1953; Nadiri 1970). Renewed interest over the past 15 years is based on numerous econometric studies estimating aggregate production functions in which infrastructure enters as an input. Aschauer's (1989) study of the United States and Biehl's (1986) study of the European Union were among the first to use this approach. Both suggest that infrastructure investments have important effects on productivity and growth.

This conclusion sparked debate on the possible effects of reducing infrastructure investments on productivity in the United States and other developed countries. Morrison and Schwartz (1996) and Nadiri and Mamuneas (1991) find that infrastructure provision in the United States yields cost savings to firms. Deno (1988) finds positive effects of infrastructure on the profits of manufacturing firms in 36 metropolitan areas. Panel estimates of a translog cost function for 11 states in the Federal Republic of Germany for 1970–88 show that public capital formation encouraged private investment (Seitz and Licht 1992) and contributed to cost savings (Conrad and Seitz 1992). Data from Spain for 1964–91 confirm that public capital (roads, water infrastructure, ports, and urban structures) had a significant positive effect on value added (the estimated elasticity is 8 percent). The data also show that the effects of infrastructure on growth have diminished over time (Mas and others 1995). Evidence from developing countries based on similar analytical techniques is limited, largely because of the lack of reliable data on public capital stocks over time.

A drawback of production function-based studies is that it is difficult to identify the direction of causality between infrastructure investments and

economic growth. Did infrastructure lead to economic growth, or did rapidly growing regions invest in infrastructure? Infrastructure investments are driven by regional and interregional demand, construction costs, financing possibilities, and explicit regional policies. Failure to consider what drives infrastructure investment will bias upward estimates of infrastructure's contribution to growth. Furthermore, the effect of infrastructure investment on economic development (or vice versa) may occur simultaneously, there may be time lags in the effect of one on the other, or the effect may be anticipatory. The public sector may expand infrastructure investment to accommodate dynamic economic growth in particular regions, or it may respond to severe bottlenecks or invest in regional infrastructure in anticipation of future demand (Rietveld and Boonstra 1995; de la Fuente 2000). It is thus very important to consider both the feedback relation between investments and economic growth and the timing of the effects in quantifying infrastructure's contribution to economic performance.

Use of Fiscal Incentives

Fiscal incentives have been widely used to attract industries and stimulate the growth potential of lagging regions. The rationale for doing so is that to attract firms, lagging regions need to offset the costs associated with transport and logistics, weaker infrastructure, higher factor prices, and lower levels of public services and amenities.

The evidence on the impacts of fiscal incentives is mixed: there is no conclusive evidence to suggest that these policies have succeeded in transforming the fortunes of lagging regions. Direct grants have only limited influence on location decisions if they are not large enough to offset localization benefits in existing agglomerations (Devereux, Griffith, and Simpson 2007). Agglomeration economies make firms less sensitive to differentials in tax rates. Cities such as New York and São Paulo, for example, can tax firms more heavily than cities such as Bloomington, Indiana, or Natal, Rio Grande do Norte, as the following country cases illustrate.

Brazil has a long history of policies aimed at reducing the large economic disparities between the northeast and the rest of the country (World Bank 1987). The goal has been to attract "dynamic" industries by providing fiscal incentives, fiscal transfers, and direct investments in infrastructure and developed land. In recent years expenditures have reached \$3–\$4 billion a year, much of it in the form of "constitutional funds" (funds created in 1989 to finance economic activities in the North and Northeast regions).

Evaluations of aggregate outcomes, such as changes in GDP per capita, suggest limited impacts (Ferreira 2004). Carvalho, Lall, and Timmins (2006) evaluate the effect of these incentives on firm entry in the targeted regions. They find that the

allocation of constitutional funds did induce the entry of manufacturing establishments into lagging regions but that the effect was strongly conditioned on close proximity to firm headquarters.

Industrial development in the Republic of Korea has historically been concentrated around the large agglomerations of Seoul and Pusan. In an attempt to promote balanced regional growth and divert growth away from Seoul, the Korean government initiated large-scale programs in the 1960s and 1970s. Considerable resources were redistributed from major cities to less developed provinces in the form of block grants and other transfers.

Seoul, Pusan, Taegu, and Incheon generated the bulk of internal taxes in Korea, with Seoul accounting for about half of national internal taxes in 1983. Under the Local Share Tax Law of 1963, 13.2 percent of domestic taxes are annually earmarked for block grants, with each city's allocation based on the difference between its own revenues and its estimated needs based on standardized service provision assumptions. As a consequence of these policies, the dominance of Seoul and Pusan declined in the 1970s and 1980s, but growth continued just outside the boundaries of Seoul and Pusan and in a range of small and medium-size cities strung along the already developed Seoul–Pusan axis (World Bank 1986; Murray 1988). The goal of moving firms from the country's large agglomerations to less developed provinces was thus not achieved.

The Mexican government has historically used fiscal incentives to promote industrial development outside the three largest urban agglomerations of the Mexico City Metropolitan Area, Guadalajara, and Monterrey. Between 1970 and 1980 industries locating outside these three large cities were eligible for a 50–100 percent reduction in import duties and income, sales, and capital gains taxes, as well as accelerated depreciation and lower interest rates. Reviews of the program (World Bank 1977; Scott 1982) show that the impact on decentralization was either insignificant or undesirable. Taxes such as import duties on raw materials and capital goods were very low to begin with. Additional reductions had no effect on private location decisions and may thus have resulted in unnecessary losses of public revenues.

In Thailand, the Board of Investment tried to increase the growth rate of regions outside Bangkok in the 1970s and 1980s by offering tax holidays to new firms. The incentives did not result in a large shift of investment from Bangkok to regional cities. Their failure to do so can be attributed partly to problems with the design of the incentive program, which was in the form of deductions from taxable profits (World Bank 1980). Producers in regional cities faced persistent cost disadvantages, significantly reducing the profitability of new firms. Initial tax holidays were not a sufficient inducement. Moreover, eligibility criteria based on a minimum size cut-off (defined in terms of minimum capital investment, capital

assets, or production capacity) made most small-scale and agro-based local firms ineligible for incentives.

In each of these countries, fiscal incentives were used to try to divert growth from major agglomerations to smaller cities and lagging regions. In general, the programs were not adequate to offset gains from agglomeration economies and induce firms to start up or move to smaller urban centers. It is possible that policies that seek to redirect investment from major agglomerations to more comparable areas may alter location decisions at the margin.

Reviewing the literature on taxation and local economic development, Wasylenko and others (1997) show that firms are more sensitive to tax rates when comparing location choices within a metropolitan region (core or suburb) than when comparing locations across regions. Various studies based on U.S. data show that the smaller the area over which a firm is considering a location, the more similar are nontax factors across subareas. Within the metropolitan-wide labor market, for example, the same labor force would be available in all areas being considered, and other factor costs would be about the same. At the margin, tax rates or incentives thus become more significant. Studies using interregional or interstate data for the United States show that the average elasticity for the tax responsiveness of firm location and economic growth is -0.3 (Bartik 1994). In contrast, intraregional studies show much higher responsiveness of firm location decisions and employment to variations in tax rates, with elasticities of about -1.5 (Bartik 1991). Lall and Mengistae (2005) show that differences in the availability of credit and local land registration taxes across India's 40 main cities affected the location decisions of manufacturing firms in India. They estimate elasticities between -0.3 and -0.5 for the responsiveness of firm location to land registration taxes.

This evidence suggests that fiscal incentives have at best modest effects on location decisions across regions, particularly when the choice is between large agglomerations and small peripheral cities or lagging regions. In contrast, fiscal policies do appear to influence business location decisions among comparable locations. The effectiveness of fiscal policies among comparable locations may encourage fiscal competition in which each local jurisdiction tries to attract businesses by undercutting tax rates relative to its neighbors. A potential consequence of this type of fiscal competition is that competing regions may not see any changes to their economic base but will experience significant revenue reductions. For instance, tax rate wars have reduced taxation levels in the southern Indian states of Kerala, Karnataka, and Tamil Nadu. This may result in a negative-sum game between regions and inefficiently low tax rates, preventing public goods from being funded at sufficiently high levels (Rao and Vallaincourt 1994).

Micro-evidence on Urbanization and Industrialization

Micro-data from two large developing countries, India and Indonesia, provide evidence on how industrialization influences the urban hierarchy. The data for each country come from national production censuses that classify establishments by sector and location and report a number of economic variables describing the activity of each establishment. Despite differences in data and context between the two countries, a remarkably similar pattern of findings emerges.

Although Indonesia's population (about 221 million in 2005) is about one-fifth that of India's (about 1.1 billion in 2005), both are large developing countries with substantial modern sectors. India was relatively industrialized in 1960 but pursued inward-looking policies of state-led industrialization and central planning until the mid-1980s. This period saw sluggish growth and little change in the ratio of manufacturing to GDP. Following internal reform in 1985 and trade liberalization in 1991, economic growth began to accelerate.

Development of a modern manufacturing sector in Indonesia was held back in the 1970s and early 1980s by government regulations and trade restrictions. Significant export activity was limited to natural resources and agricultural products. Deregulation, privatization, and trade reform since the mid-1980s promoted a broader-based, competitive manufacturing sector and led to the emergence of new export industries. This trend accelerated with the end of the Suharto government in 1998. These reforms led to significant increases in per capita incomes, which rose 70 percent between 1985 and 1997.

Indonesia's geography as an island archipelago has historically hindered domestic trade and regional integration. Its urban hierarchy is dominated by Jakarta, where government functions and most domestic and international investment are concentrated. Highly centralized government structures have only recently given way to more decentralized decision-making power by state and local governments.

India, in contrast, has vast interior regions and a number of competing major agglomerations, such as Delhi, Kolkata, Mumbai, Chennai, Hyderabad, and Bangalore. India's federal structure and large geographic size perhaps allow for greater variation in policies and institutions (an example is labor regulation). Despite these differences industrialization has been accompanied by similar changes in the distribution of modern sector activity within the urban hierarchy in the two countries.

Micro-evidence from India

India's *Annual Survey of Industries* (MOSPI various years) provides comparable data for 1989–90 and 1996–97. Several trends emerge from these data. Not surprisingly, manufacturing is concentrated in the largest metropolitan areas.

The 386 Indian districts in the 1990s are grouped into five types: metropolitan centers, peri-metropolitan areas, secondary cities, tertiary cities, and towns and rural areas (table 2). In 1989 the share of manufacturing was larger than the share of population in metropolitan and peri-metropolitan areas and smaller than the share of population in all other areas, including secondary cities. Despite this bias toward metropolitan areas, in absolute magnitude most manufacturing in India was undertaken in small towns and rural areas.

Between 1989–90 and 1996–97 the largest increases in manufacturing activity were in secondary cities, where the share of manufacturing doubled, and in peri-metropolitan areas. This indicates some deconcentration of activity, albeit not to small towns and rural areas, which saw large declines in their shares of manufacturing. Despite this pattern of modest decentralization, metropolitan areas retained their dominance in rapidly growing industrial sectors.

Regression analysis provides additional insights into changes in manufacturing. For each district type, the share of employment in each industry relative to the share of employment in that industry for India as a whole is regressed on a number of industry characteristics (table 3). The results suggest that skill-intensive industries are significantly overrepresented in metropolitan and peri-metropolitan districts and underrepresented in tertiary cities, towns, and rural areas. High-productivity sectors are overrepresented in metropolitan areas, capital-intensive sectors are overrepresented in secondary cities, and sectors with large average plant size are overrepresented in peri-metropolitan areas. These results indicate that although there has been some decentralization of manufacturing to peri-metropolitan districts and secondary cities in India, metropolitan areas remain dominant in higher-skill and higher-productivity sectors.

Table 2. Distribution of Manufacturing across Location Types in India, 1989 and 1996

Location type	Number	Population		Share of manufacturing employment	
		Total (1991) (millions)	Share of total (percent)	1989 (percent)	1996 (percent)
Metropolitan center	7	40.4	5.1	15.7	13.5
Peri-metropolitan area	7	21.7	2.7	3.9	8.3
Secondary city	32	100.2	12.6	10.4	21.1
Tertiary city	36	86.5	10.9	7.5	10.2
Town or rural area	306	549.2	68.8	62.4	46.9

Source: Population data are from the 1991 Indian Census; manufacturing employment data are from MOSPI various years.

Table 3. Location of Industries in India by Feature

Item	Metropolitan center	Peri-metropolitan area	Secondary city	Tertiary city	Town or rural area
Industry growth	-0.004	0.009	0.017	-0.01	-0.012
Skill intensity	0.160**	0.058**	0.000	-0.068**	-0.151**
Capital intensity	-0.041**	0.001	0.019**	0.006	0.015
Productivity	0.024**	-0.005	-0.012	-0.005	-0.001
Plant size	0.008	0.013**	-0.007	-0.009**	-0.005
R ²	0.11	0.07	0.01	0.10	0.03

Dependent variable: Share of industry *i* in district type relative to share of industry *i* in India as a whole

** Significant at the 5 percent level.

Note: Factory data are aggregated to the industry level for each district type. Regressions are run separately for each district type. Data are pooled industry cross-sections for 1989–90 and 1996–97. Industry growth is the employment growth rate; skill intensity is the ratio of nonproduction to production worker employment; capital intensity is the ratio of fixed capital to employment; productivity is output per employee; plant size is employment per factory. Number of observations is 346.

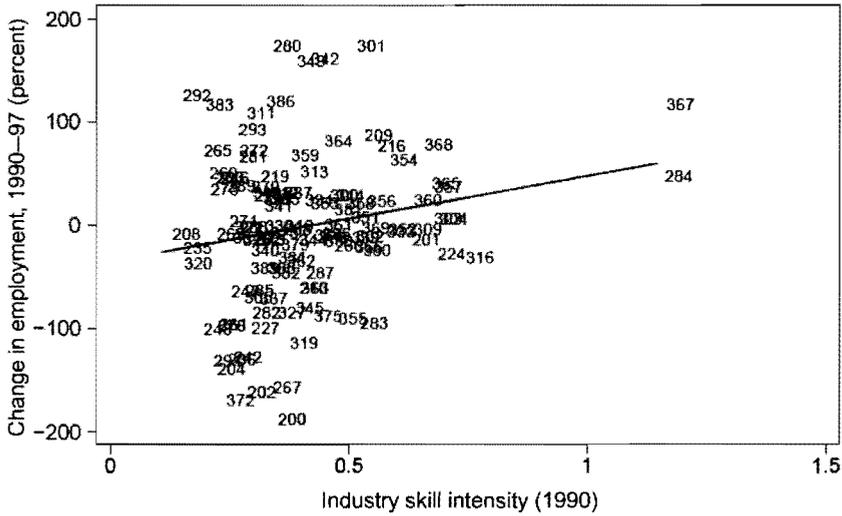
Source: Authors' analysis based on data from the *Annual Survey of Industries* (MOSPI various years).

Comparison of Greater Mumbai and the peri-metropolitan area of Thane, about 30 kilometers away, provides an interesting case study of metropolitan decentralization in India. Between 1990 and 1997 total manufacturing employment declined 5.2 percent in Greater Mumbai and rose 34.1 percent in Thane. On average more skill-intensive industries—including manufacture of computers and computer-based systems (SIC 367) and electronic valves and tubes and other electronic components (SIC 368)—saw more rapid rates of employment growth in Greater Mumbai (figure 4). Labor-intensive industries with rapid rates of decline included grain milling (SIC 204) and manufacture of made-up textile articles except apparel (SIC 267). Wide variation remains, however, across industries of a given skill intensity.

Very few industries that saw employment growth in Greater Mumbai did not also see employment growth in Thane (figure 5). Some industries—manufacture of electric fans and electric/electrothermic domestic appliances (SIC 364) and industrial machinery for industries other than food or textiles (SIC 354), for example—saw rapid employment growth in both districts. These industries may have experienced systematic employment growth across districts, but there may also have been employment spillovers between the urban center and its surrounding peri-metropolitan area.

Some labor-intensive industries—including spinning, weaving, and processing of synthetic textile fibers (SIC 247) and slaughtering, preparation, and preservation of meat (SIC 200)—declined in greater Mumbai but saw employment growth in Thane. This pattern is consistent with the notion that labor-intensive

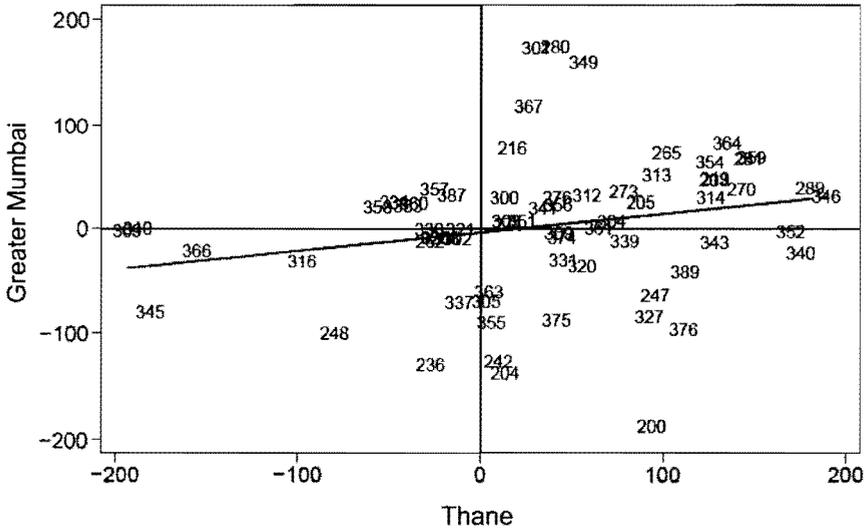
Figure 4. Changes in Employment and Skill Intensity by Standard Industrial Classification level in Greater Mumbai, 1990–97



Note: Factory data are aggregated to the district-industry level by Standard Industrial Classification codes [<http://exim.inidamart.com/sic-codes/>]. Skill intensity is the ratio of nonproduction to production worker employment.

Source: MOSPI (various years).

Figure 5. Changes in Employment by Standard Industrial Classification level in Greater Mumbai and Peri-Urban Thane, 1990–97



Note: Factory data are aggregated to the district-industry level.

Source: MOSPI (various years).

industries migrate out of the high-cost urban center to the lower-cost surrounding peri-metropolitan area.

Micro-evidence from Indonesia

Annual Indonesian industrial census data provide information on the geographic distribution of establishments with at least 20 employees between 1975 and 2001 (BPS various years). The units of analysis are the approximately 340 Indonesian districts (urban *kotas* and more-rural *kabupaten*).

Urban districts are based on the size of the city they represent; rural districts are based on their location with respect to those cities (table 4). The categories were adjusted somewhat to reflect the geography of Indonesia and the dominance of Jakarta, whose share of the population increased from 2 percent in 1950 to more than 6 percent in 2005. Despite congestion costs and high factor prices, this megacity of more than 13 million people continues to attract new residents and businesses. A separate urban category for the districts surrounding Jakarta (Jabotabek) was created to take account of change of firm location from Jakarta itself to neighboring areas.

Time series data on the share of establishments in each of the 10 geographic groupings indicate that central Jakarta lost ground in the garment sector (SIC 18) beginning in the 1980s (figure 6). From a high of about 25 percent, the share of the garment industry in the core city dropped to about 5 percent by 2000. A similar but less pronounced pattern is seen in other agglomerations and medium-size cities. This outmigration from cities coincided with an increase in the share of establishments in the Jabotabek region and its neighboring areas, probably as a result of the establishment of new rather than relocated firms. The strongest increase was in districts neighboring cities with at least 1 million

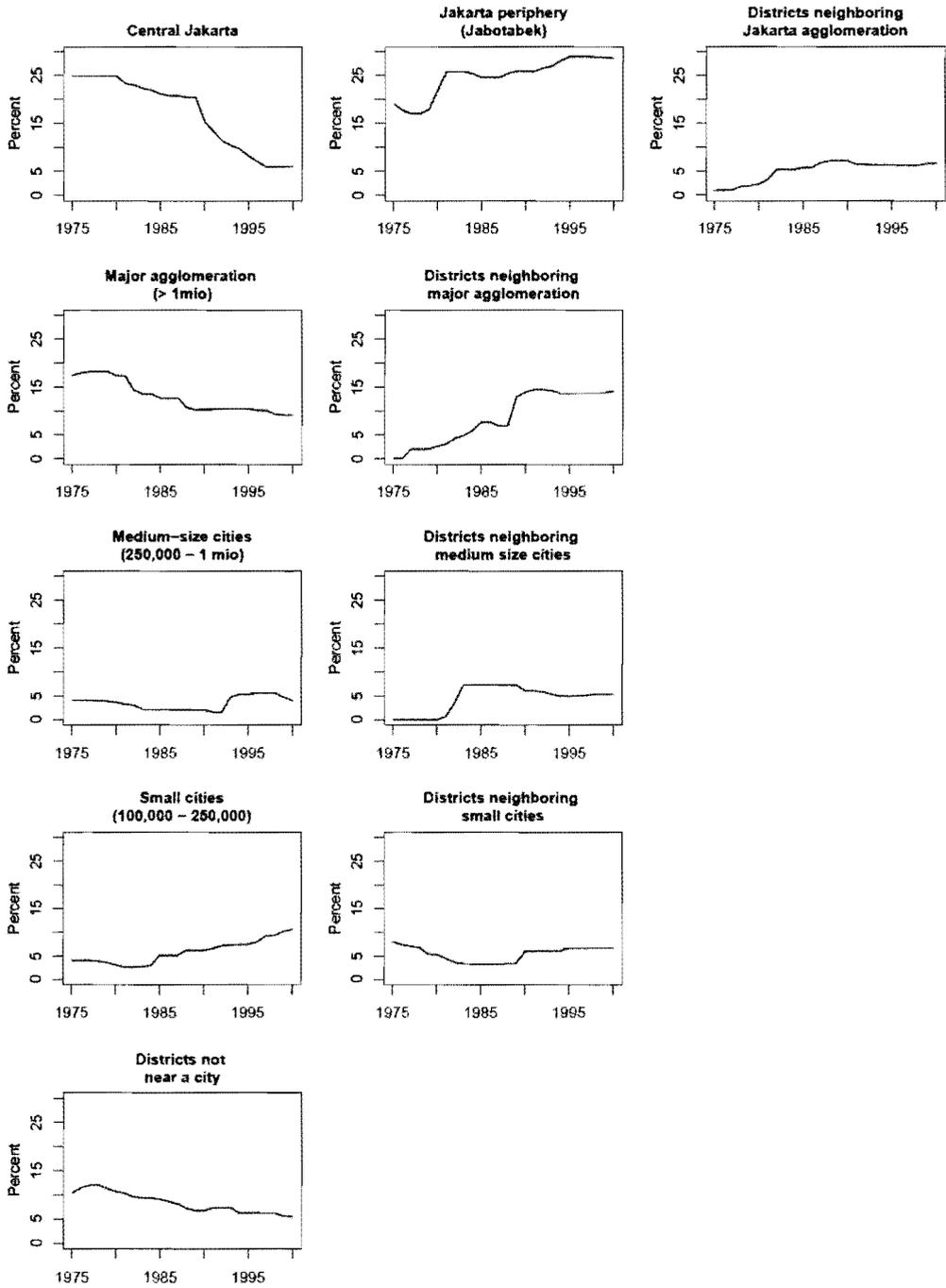
Table 4. Geographic Grouping of Indonesian Districts for Firm Location Analysis

<i>Core</i>	<i>Periphery</i>
Central Jakarta	Jakarta periphery (Jabotabek) Districts neighboring Jakarta agglomeration
Major agglomeration (>1 million) ^a	Districts neighboring major agglomeration
Medium-size city (250,000–1 million)	Districts neighboring medium-size city
Small city (100,000–250,000)	Districts neighboring small city
Other	Districts not near a city

^aBandung, Surabaya, Medan, Palembang, Makassar, and Semarang.

Source: Authors' classification.

Figure 6. Establishment Shares in the Garment Industry



Note: Data include all manufacturing firms in Standard Industrial Classification 18 with 20 or more employees.

Source: BPS (various years).

residents. Similar trends can be found in other large industries, such as chemicals, rubber, and plastics.

More modern sectors, such as machinery and equipment not elsewhere classified (SIC 29), experienced a steep decline in the share of establishments in large agglomerations and an increase in the number of establishments in or near Jabotabek. Electronics and communications equipment and the electrical machinery sector (SIC 31 and 32) show similar trends.

The graphs in figure 6 provide empirical evidence of the trend, identified by Henderson, Kuncoro, and Nasution (1996), showing that many manufacturing firms moved out of Jakarta to the peripheral areas of the Greater Jakarta metropolitan region in the mid-1980s. These moves were facilitated by the construction of toll-ring roads around the city, which allowed firms to retain most of the agglomeration benefits of the region while avoiding the rising production costs associated with congestion and higher land rents. Aggregate transport costs per unit of sales revenue dropped, because a larger market could be accessed by a better road network.

As in India, deconcentration in Indonesia did not lead to development in smaller towns and rural regions. Instead, firms relocated to districts close to major markets and export or transport hubs in order to continue to benefit from agglomeration economies while reducing production costs. Only manufacturing sectors that are closely tied to the natural resource base maintained relatively high establishment shares in the districts neighboring small cities and in districts far from urban centers. These include tobacco (SIC 16); wood products, including furniture (SIC 20 and SIC 36); and, to a lesser extent, food processing (SIC 15).

Conclusion

Economic growth is strongly associated with modern sector activity and urbanization. While considerable costs are associated with economic production in large urban centers, both the revealed preferences of firms and systematic empirical analysis suggest that the attractions of good market access and other agglomeration economies remain great. As urban centers fill up, firms relocate to the periphery of these centers or to other large cities. Attempts to alter this pattern through fiscal and other incentives have rarely been cost-effective.

For national policymakers, who need to balance the objectives of overall economic efficiency against the need to provide adequate opportunities and quality of life throughout the country, these findings have several implications. First, direct subsidies and tax breaks are costly and rarely lead to a sustainable reorganization of regional economic activities. More promising are spatially blind policies with low opportunity costs, such as streamlining laws and regulations. Investing in

transportation infrastructure and public services will provide large quality of life benefits for the resident population, even if they fail to attract firms.

Second, strategies that seek to make lagging regions competitive with large cities for high-skill manufacturing industries are unlikely to succeed. Empirical results suggest that firms are likely to relocate from cities into areas near large urban agglomerations rather than to smaller cities elsewhere, because agglomeration benefits continue to compensate for the costs of increasing congestion and higher wages.

There are thus no general recipes for economic development in poorer regions. Policies need to be tailored to develop local specialization in niche industries, in industries that do not require strong agglomeration economies, or in industries that draw on natural advantages linked to agriculture or service sectors.

Notes

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1. The focus here is on firms' ultimate location decisions. Similar econometric methods can be used to analyze intermediate variables that affect firm productivity. The cost of production in a particular industry and its location decisions may depend on similar independent variables, for example. (References to the literature on these effects are made where appropriate in the discussion in the next section.)

2. Henderson, Shalizi, and Venables (2001) note that the deconcentration of industry from the greater São Paulo region in Brazil to lower-wage hinterland cities followed the opening up of major transport corridors, first through São Paulo State and then into Minas Gerais, the interior state with the main iron ore and other mineral and agricultural reserves.

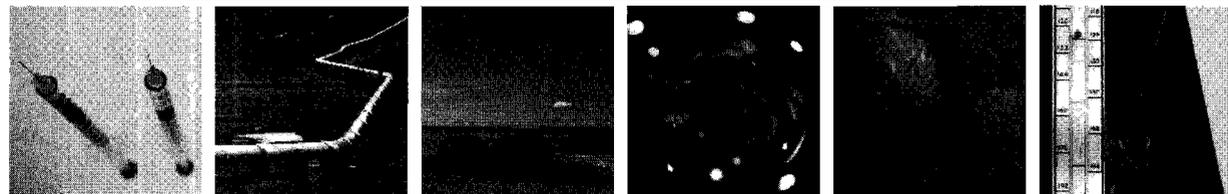
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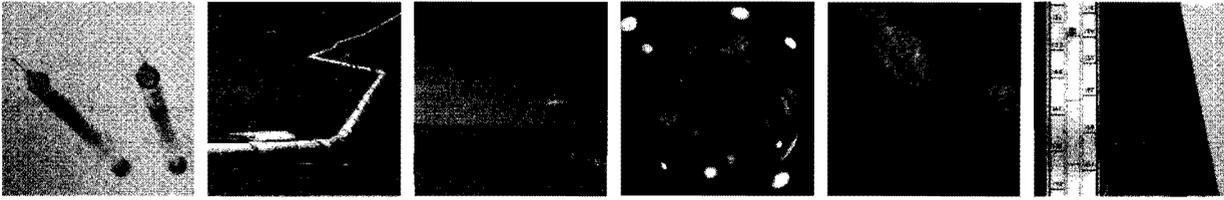
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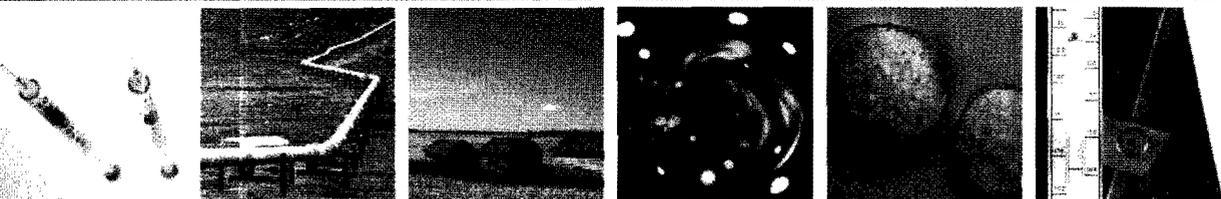
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