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Foreign Direct Investment and Externalities: The Case for Public Intervention

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Policymakers often argue that developing countries should encourage foreign direct investment (FDI) as a means of promoting economic growth. Central to the argument in support of FDI is the proposition of externalities—the total social benefits of FDI must exceed that internalized by the foreign entrant and its host economy partners. Using a rich dataset of Indonesian manufacturing firms, we investigate two rationales for policies encouraging FDI. First, we show that technology transferred from foreign entrants to local suppliers diffuses throughout the host country and generates welfare benefits to both firms and consumers. Second, we show that foreign investment is less vulnerable than domestic investment to liquidity constraints during times of financial crisis. Hence, FDI insures against market imperfections that limit credit availability in crisis. We discuss each of these externalities in turn.

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Technology Spillover from FDI

The literature on technology spillover from FDI largely refers to the effect of foreign entrants on local incumbents. Proponents of FDI have argued that local firms can observe and adopt the technology brought from abroad and hence improve productivity. This "spillover" of technology thus creates an externality justifying policies encouraging FDI.

In contrast, we argue that technology diffusion from FDI is more likely directed to local suppliers than to local competitors, as a strategy to build efficient supply chains for multinationals' overseas operations. By transferring technology to local suppliers, multinationals may be able to improve quality and lower the price of nonlabor inputs. Indeed, while multinational enterprises may invest overseas to obtain low-wage labor or to avoid costly barriers to foreign markets, they realize the full benefit of expansion only if the efficiency of supply markets abroad matches or exceeds that of their home manufacturing base. To lower the prices and raise the quality of inputs abroad, multinationals might deliberately transfer technology to local vendors.

Such a strategy would cause foreign technology to diffuse along supply chains, rather than through spillovers to competitors. Indeed, anecdotal evidence from interviews we conducted with multinational and local firm managers in Indonesia suggests close cooperation through vertical linkages. Such cooperation, described below, exemplifies the mechanisms through which learning from FDI can occur vertically.

A cost-reduction motive implies that multinationals transfer technology along the supply chain to suppliers because such a transfer confers a private benefit to them. Therefore, unless an additional social benefit occurs, there is no case for public subsidies to stimulate technology transfers from multinationals. However, we argue that market imperfections cause multinationals to transfer technology widely, inducing heightened competition that benefits the whole economy. Since the multinational does not take this benefit into account, the social benefits from the technology transfer are greater than the private benefits. Without public subsidy, the multinational may transfer less technology than would be socially optimal.

How might the social benefits develop? The primary motivation for multinationals to transfer technology to suppliers is to enable higher-quality inputs at lower prices. One problem with this strategy is that if the enabling technology is transferred only to one upstream vendor, then the multinational is vulnerable to holdup. To mitigate holdup risk, the multinational could diffuse the technology widely—either by direct transfer to additional firms or by encouraging spillover from the original recipient. The technology's wide diffusion would then encourage entry in the supplier market, thereby increasing competition and lowering prices. However, the multinational cannot prevent the upstream suppliers from also selling to the multinational's competitors in the downstream market. The lower input prices

may induce entry and more competition in the downstream market, thereby lowering prices and increasing output.

If prices fall enough, the multinational might be worse off by transferring technology to its upstream suppliers. In this case, the multinational would not have an incentive to transfer the technology. Pack and Saggi (2001), however, demonstrate that this concern is not justified under reasonable assumptions. As long as there is not too much entry, profits will rise in both the downstream and upstream markets, which suggests that the new surplus generated from increased productivity and reduced deadweight loss from increased competition might be split between consumers and producers in a Pareto improving distribution.

In this chapter we test the hypotheses that transfers of technology along the supply chain from FDI occur and that they lead to Pareto welfare improvements in terms of lower prices, higher production, and higher profits. The analysis is in two parts.

The first part measures the effect of FDI on local supplier productivity by estimating a production function using a rich panel dataset on local and foreign-owned Indonesian manufacturing establishments. Specifically, we test whether the productivity of firms increased when the share of their sector's output sold to foreign-owned firms increased. The results indicate that local firm productivity rises as the share of output sold to foreign-owned firms rises, which is consistent with the hypothesis that local suppliers acquire technology from the multinationals that buy the local suppliers' products.

The second part of the analysis examines the market and welfare effects of FDI technology diffusion, as hypothesized in Pack and Saggi (2001). We first estimate the effect of downstream FDI on upstream market concentration, prices, output, and value added. Further, we estimate the same metrics on firms in sectors downstream of sectors that supply multinational customers. We find that downstream FDI increases the output and value added of upstream firms and decreases prices and market concentration in upstream markets. We also find higher output and value added amongst downstream firms and lower prices and market concentration in markets downstream of markets supplying multinationals. This finding suggests that FDI leads to Pareto improving welfare effects—for example, benefits for consumers in terms of lower prices and for firms in the form of greater value added—transmitted both up and down the supply chain from FDI's technology spillovers.

Liquidity Insurance from FDI

A dramatic currency devaluation and a crippling decline of the banking sector are consequences of financial crises, as seen in East Asia, Latin America, and Russia. The combination of these two events can devastate

new investment. Whereas net exporting firms should benefit from better terms of trade and increase investment, the collapse of the banking sector may prevent access to needed credit. Although changing terms of trade affect firms equally, ceteris paribus, the degree to which liquidity constraints bind may vary by firms' ownership. In particular, firms with foreign ownership may overcome liquidity constraints if they can access overseas credit through their parent companies. The possibility that foreign firms could continue to invest when local firms could not suggests a second externality of FDI: some insurance against liquidity constraints.

The unprecedented scale of Indonesia's currency devaluation and the severity of its banking sector's troubles provide a unique setting for our study. The East Asian financial crisis had a devastating effect on the Indonesian economy. The official measure of GDP dropped 13 percent in 1998, and investment fell 45 percent in 1998 alone, followed by a smaller decline in 1999. Some of this devastation is surprising since the financial crisis was associated with the largest real devaluation in recorded history. A US dollar could buy four to six times as much volume of Indonesian exports in early 1998 as in mid-1997. Although rapid Indonesian inflation eliminated roughly half the nominal devaluation, a 2:1 real devaluation remains almost unprecedented. With this large a change in trade terms, conventional trade theory suggests that Indonesian firms should have enjoyed an export boom.

At the same time, this event is not known as a currency crisis but as a financial crisis (*krismon*, or monetary crisis, in Indonesian). Most banks in Indonesia were insolvent by 1998. Press reports indicated that many firms, even those that wanted to export, were unable to access capital. Lenders had difficulty distinguishing between insolvent borrowers—for whom new loans would go toward old loan repayment rather than productive investments—and firms that legitimately needed funds for ongoing operations or attractive investments. Moreover, even if a lender could identify solvent firms, International Monetary Fund (IMF) banking reforms may have reduced many banks' willingness to make *any* loans. Under threat of closure if they could not meet raised reserve requirements, in the short run banks may have preferred holding cash to granting even highly profitable loans.

It is plausible that these problems were less severe at plants with foreign owners, who presumably had access to the accounts and could confirm the desirability of new investment and monitor spending. Foreign owners, particularly large multinationals, could finance their Indonesian factories internally or through lines of credit available to the parent company.

We proceed as follows. The next three sections review the extant literature on technology transfer and introduce the conceptual framework and underlying theory for our study. The fifth section provides some background on manufacturing and FDI in Indonesia, and the sixth section describes the data. The seventh section details the identification strategy and results for

the productivity effects of FDI. The eighth section reviews the results for the market and welfare effects of FDI, the ninth section discusses liquidity insurance from FDI, and the final section provides a conclusion.

Conceptual Framework of Technology Transfer from FDI

Most of the literature recognizes two major channels for technology transfer from FDI: horizontal flows to local competitors (sometimes called "spillover" because it is largely an externality), and vertical flows to backwardly linked suppliers. We define technology broadly to mean the managerial practices, production methods, and other tacit and codified know-how by which a firm transforms capital, labor, and materials into a product. Below we describe the mechanisms by which local firms could learn through each channel and summarize the empirical evidence.[1] We first discuss horizontal transfer, which has been the focus of most empirical work, and suggest why recent studies have found mixed evidence of transfer through this channel. We next discuss vertical transfer, the emphasis of this chapter, and argue that the incentives of multinational investors could promote technology transfer through this channel. Finally, we describe why vertical transfers would induce competition and the circumstance under which the technology transfer induces a Pareto improvement in welfare.

Horizontal Technology Transfer

Multinational entry may provide positive technological externalities to local competitors through a number of mechanisms. First, the local firms may be able to learn simply by observing and imitating the multinationals. Second, employees may leave multinationals to create or join local firms. Third, multinational investment may encourage the entry of international trade brokers, accounting firms, consultant companies, and other professional services, which then may become available to local firms as well.

Multinational entry may also hurt local firms. First, foreign firms may hire talent away from local firms, thereby creating a "brain drain." Second, foreign firms, which often pay higher wages, may raise wages for all firms in competitive labor markets (Aitken, Harrison, and Lipsey 1996). If the higher wages do not reflect an improvement of employee capabilities, which may be the case if the multinational faces public pressure in its home market to improve overseas workers' conditions, then firms may substitute capital for labor in an otherwise (prior to the wage increase) inefficient manner.

1. Kumar (1996), Blomström and Kokko (1997), Keller (2001), and Moran (2001) provide extensive literature reviews.

Empirical studies of technology spillover have found mixed results. The studies, which regress local firm productivity on within-sector FDI, fall into two categories: those that use cross-sectional data (e.g., Caves 1974, Globerman 1979, and Blomström and Wolff 1994) and those that use panel data (e.g., Haddad and Harrison 1993, Kokko 1994, Aitken and Harrison 1999, and Haskel, Pereira, and Slaughter 2002). The former typically find a positive correlation between local firm productivity and FDI. However, cross-sectional analysis cannot distinguish whether FDI actually increases local firm productivity or whether multinational investors simply invest in inherently more productive sectors. Studies using panel data, which can control for investor selection bias, reach differing conclusions. On one hand, Aitken and Harrison's (1999) examination of Venezuelan factories finds net negative benefits to local firms, a result they attribute to the effect of foreign competition. On the other hand, Haskel, Pereira, and Slaughter (2002) employ similar methods with a panel dataset of factories in the United Kingdom and draw the opposite conclusion.

Host economy heterogeneity and limitations of production function estimation likely explain the contrary results. First, the technology gap between foreign and domestic firms likely varies by country and industry. In cases in which the gap is wide, local firms may lack the absorptive capacity needed to recognize and adopt the new technology. Similarly, the degree to which foreign and domestic firms actually compete in the same market will also vary. Domestic firms may produce for the local market, while multinationals produce for export. Because of differences in quality and other attributes, exported and domestically consumed goods may entail different production methods that reduce the potential for technology transfer. Second, multinationals may enact measures to minimize technology leakage to local competitors. In particular, multinationals with nonprotectable technology may not enter the market at all if they rely on a technological advantage to sustain rents. Again, the level of technology multinationals bring to the host economy and the degree to which it can be protected will vary widely. Last, production function estimation may confound the productivity gains from technology transfer with the efficiency losses from increased competition. If multinationals capture market share, then local firms may underutilize existing capacity in the short run. Although local firms will eventually redeploy slack resources, production function estimation will interpret nonutilized resources as a productivity loss in the short run.

Vertical Technology Transfer

Vertical technology transfer could occur through both *backward* (from buyer to supplier) and *forward* (from supplier to buyer) linkages. Because most multinationals in Indonesia are export oriented and generally do not sup-

ply Indonesian customers, we focus on technology transfer through backward linkages. That is, we examine the effect of *downstream* FDI on the performance of local suppliers.

Two arguments suggest that supply chains may be conduits for technology transfer. First, whereas multinationals seek to minimize technology leakage to competitors, they have incentives to improve the productivity of their suppliers—for example, through training, quality control, and inventory management. To reduce dependency on a single supplier, the multinational may establish such relationships with multiple vendors, which benefits all firms that purchase these vendors' output. Second, while the technology gap between foreign and domestic producers may limit within-sector technology transfer, multinationals likely procure inputs requiring less sophisticated production techniques for which the gap is narrower.

Evidence of technology transfer through vertical supply chains is well documented in case studies. For example, Kenney and Florida (1993) and MacDuffie and Helper (1997) provide a rich description of technology transfer to US parts suppliers following the entry of Japanese automobile makers. Until recently, empirical analysis, however, has generally been limited to small samples, such as the study by Lall (1980), which documents technology transfer from foreign firms through backward linkages in the Indian trucking industry. Kugler (2000) is the first large-sample empirical study and shows that FDI in one sector of Colombian manufacturing can precede productivity gains in another. Kugler, however, does not identify backward linkages or any particular causal mechanisms for the intersector spillover. Blalock (2002) and Javorcik (2004) find causal evidence of technology transfer through backward linkages in the manufacturing sectors of Indonesia and Lithuania respectively.

Anecdotal evidence from interviews with multinational and Indonesian firms points to the specific mechanisms through which vertical technology may occur.[2] An American firm reported that its process of qualifying domestic suppliers involved several stages over a few years. First, the American firm's engineers would visit the local factory to inspect its facilities and suggest needed modifications. Next, a sample product was sent to a testing facility in the United States. If the product was approved, the suppliers were sent to overseas training classes to learn the multinational's systems for inventory control, quality control, and cost accounting. Thereafter, the supplier would be asked to produce a small amount of the total production demand. Only after the supplier had successfully established a record of delivering on time and within specification would the multinational qualify it as a large-scale supplier.

Managers from a Japanese multinational reported a similar process. They added that it was common for them to introduce good suppliers to affiliate

2. We interviewed managers from two American, two Japanese, and two Indonesian firms in Jakarta during July 2000.

companies in their industrial group, both in Indonesia and in other countries. By doing so, they could increase their suppliers' economies of scale and smooth their capacity utilization. Likewise, the same Japanese firm reported that it often used suppliers in Malaysia and Thailand that were referred to it by affiliate companies. This reduced the dependence on local suppliers and ensured that Indonesian vendors were competitive within the region. The goal, noted by the manager, was to guarantee a reliable supply of parts from a handful of the best local firms in Southeast Asia.

Not all of the foreign firms reported success in local procurement. Another Japanese firm noted that it bought very little from local suppliers, other than cardboard boxes and paper packaging. The manager noted that although he would like to buy more locally and faced some pressure to do so, it was just not practical. Most local firms could not meet his requirements for quality, price, and delivery performance. Instead, he preferred to buy from the firm's established vendors in Japan. He added, however, that many of those vendors were themselves producing in Indonesia and surrounding countries.

Indonesian suppliers cited some benefits from selling to foreign customers. One vendor reported that his relationship with a large Japanese firm was valuable because the customer sent engineers from Japan annually to review his production methods and suggest improvements for cost reduction. He added that the Japanese firm's desire for extremely consistent product attributes had prompted him to invest in new machinery imported from Switzerland. In contrast, however, he stated that his relationship with an American buyer had been less successful. The Americans, he complained, had unobtainable goals for cost reduction, did not provide him with sufficient lead time for orders (necessitating that he pay expensive overtime wages), and offered no technical support to meet their requirements. In the end, the American firm rejected much of his supply on quality grounds (which he disputed), and he voluntarily severed the relationship.

Many of the reported mechanisms for technology transfer through supply chains would apply equally to exports. One Indonesian firm reported that it exported 100 percent of its output to Germany. Its main customer, a large German consumer goods company, reportedly sent efficiency experts to advise on how best to expand production capacity. In fact, during the day of the interview, four product designers from the German customer were at the plant advising how to adapt the product appearance to suit new consumer trends. The Indonesian manager observed that the increased sales, which were largely driven by lower labor costs following the massive devaluation of the rupiah in 1997, had strained his accounting resources. He complained that the higher volume made it difficult for his planners to know if production was on schedule. Consequently, he could not respond quickly to customer requests for time-critical orders. To solve the problem, the Indonesian manager had just ordered inventory control software from

Europe. When financing the purchase, one of the largest capital investments since building the factory, he had borrowed from the Jakarta branch of an American bank using the German customer's letter of intent to order as evidence of his creditworthiness.[3]

Market Competition and Welfare Effects of Technology Transfer

We hypothesize that multinationals transfer technology to suppliers to reduce input costs and increase quality. However, if the multinational aids only a single supplier, the supplier can play holdup and capture all of the rents from its increased productivity. In this case, the multinational would not benefit from the technology transfer. The multinational could overcome this vulnerability, however, by distributing the technology widely to multiple suppliers and potential entrants. This would create multiple sources of superior supply and would encourage entry (competition) that would lower prices. Total surplus rises because the new technology increases productivity and because the deadweight from imperfect competition falls. The downstream multinational captures some of the rent, because the prices it pays for supplies have fallen. However, if there is not too much entry, the suppliers may also capture some of the rent in terms of profits resulting from increased productivity and sales (Pack and Saggi 2001).

We would thus expect to see direct technology transfer to several suppliers, or a program that makes the technology broadly available to the supply sector. Moreover, technology leaks between the original local technology recipient and its rivals is possible. In fact, if any horizontal technology transfer is to occur, it seems more likely to happen among local supply firms than between foreign and local firms in the end-product market.

Although the multinational has an incentive to aid many suppliers, doing so may inadvertently aid competitors if the more productive supply base is a nonexcludable benefit. In other words, the multinational cannot prevent its now more productive suppliers from selling to the multinationals' rivals at lower prices in the downstream market. The lower supply prices may induce entry and increase competition so that prices fall in the downstream markets. This increases surplus by lowering costs of production and by reducing deadweight loss from imperfect competition. In addition, the lower supply prices increase surplus not only in the multinational's market but in all of the markets to which the suppliers sell.

3. A number of interviewed managers mentioned the role of foreign firms in helping Indonesian suppliers obtain credit during the Asian financial crisis. Because 1996 is the last year of empirical analysis for this study, this role does not affect the results in our study.

Generally, in a developing country, export-oriented foreign firms are more productive than domestic firms and seldom compete with domestic makers, so aiding local buyers may not concern multinationals. However, foreign firms may be concerned that their investment in the local supply chain will eventually benefit later foreign entrants. Given this possibility, foreign firms might be reluctant to transfer technology to suppliers.

Pack and Saggi (2001) show that, provided new competition is not too great, the benefits of a competitive supply base to the multinational buyer outweigh the rents lost to freeloading rivals. Perhaps surprisingly, technology diffusion and leakage to other local suppliers can also benefit the initial local recipient. In the case of a single supplier and single buyer with some market power, both parties set prices above marginal cost—the "double marginalization problem." If technology diffusion to other upstream firms allows more capable suppliers to enter, then one would expect market concentration and input prices to fall. Further, given the benefit of lower-priced inputs, firms downstream of that upstream sector will lower prices and increase output, and new firm entry may occur. The stronger demand downstream would, in turn, prompt higher output upstream that would help the initial technology recipient (Rodriguez-Clare 1996). Lower prices and greater volume clearly generate a surplus for consumers. Pack and Saggi (2001) note that in some cases, firms may also be able to capture some of the surplus because the benefits of lower input prices and higher volume outweigh the costs of greater competition. Hence, we would expect to see firm value added—a proxy for profitability—rise.[4] Figure 4.1 illustrates the total effect of FDI.

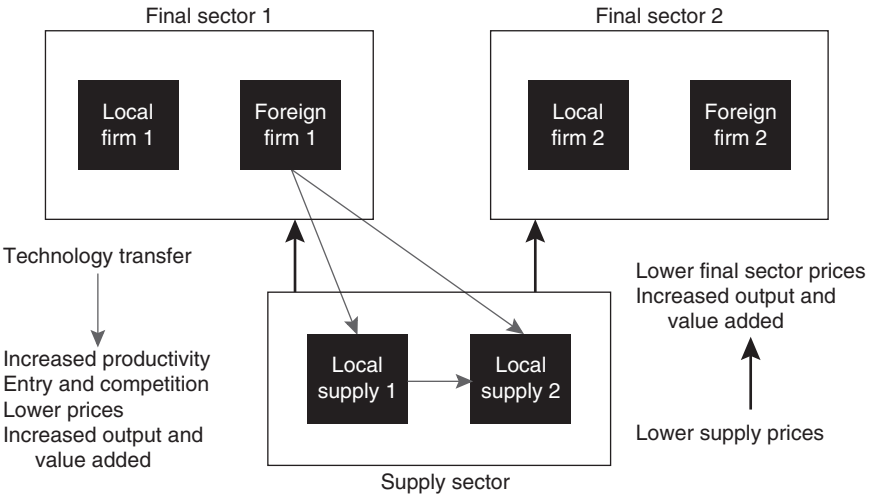
If this is true, then technology transfer to suppliers is in multinationals' interest, but the benefits accrue widely to all sectors and consumers not only through improved productivity but also through increased competition resulting in lower deadweight loss. Hence, technology transfer induces a Pareto improvement in welfare. However, a multinational might not take into account the social benefits of increased competition and, therefore, may transfer too little technology. In this case, it would be socially optimal to facilitate the transfer of technology from multinationals to local suppliers.

Testable Implications of Technology Transfer Through Supply Chains

Although the specific mechanisms for technology transfer described above are typically unobservable in the data, one can identify technology trans-

4. We define value added as revenue minus wages and the cost of materials and energy. This is similar to EBITDA—earnings before interest, taxes, depreciation, and amortization—a common proxy for profitability.

Figure 4.1 Flow of technology and welfare effects from FDI



fer indirectly by otherwise unexplained productivity gains. If vertical supply chains are conduits for technology transfer, then one would expect, ceteris paribus, that local firms in industries and regions with growing levels of downstream FDI would show greater productivity growth than other local firms. Furthermore, one would expect to see lower concentration, lower prices, higher output, and more value added in these beneficiary sectors, as well as in sectors downstream of them. The methodology for testing the productivity effects is described in the seventh section, and the methodology for testing the market and welfare effects is described in the eighth section. Both are preceded by some background on Indonesian manufacturing and a description of the data in the following two sections.

Conceptual Framework for FDI and Liquidity Insurance[5]

The imperfection of capital markets and liquidity constraints are well documented (Fazzari, Hubbard, and Petersen 1988; Hoshi, Kashyap, and Scharfstein 1991; and Minton and Schrand 1999; see also surveys by Hubbard 1998 and Caballero and Krishnamurthy 1999). The key insight of these papers is that some firms are likely to have access to capital and thus their invest-

5. Our discussion here summarizes material from Blalock, Gertler, and Levine (2004), to which interested readers are referred for a more in-depth discussion.

ment responds to future profit opportunities. Other firms are likely to have limited access to capital and thus investment responds to current cash flow more than to future profit opportunities. The referenced studies have used a number of strategies to identify firms at high versus low risk of liquidity constraints. The current analysis extends this literature by using foreign ownership as an indicator of high probability of liquidity constraints—an assumption we discuss at length below.

A second set of literature examines financial crises, with an emphasis on how they reduce banks' willingness to lend to borrowers with weak balance sheets (for example, Bernanke and Gertler 1989). Recent work has examined how currency and financial crises affect investment (see Aguiar 2002, Forbes 2002, Agenor and Montiel 1996, Reinhart and Calvo 2000). Many of these analyses have differentiated how the crisis affects the tradable sector (where a devaluation is likely to expand opportunities for profitable investment) from nontradable sectors. Like Desai, Foley, and Forbes (2003), which reviews US multinational investment during a variety of currency crises, we differentiate foreign-owned from locally owned firms within the tradable sector. We find that foreign-owned firms respond very differently from local firms to financial shocks.

A third set of literature examines how financial crises affect FDI (see, for example, Lipsey 2001). We extend this literature by explicitly comparing the response of foreign-owned and comparable locally owned firms. Thus we see whether the differences previous analyses have discovered are largely due to size and industry, or due to ownership itself. As such, we are part of the tradition of researchers examining how FDI affects the host economy differently from locally owned investment (see, for example, Aitken and Harrison 1999; Blalock and Gertler 2004).

Theories

First, we review what outcomes conventional trade theory predicts should follow a massive real devaluation. Then, we discuss theories of investment subject to financial constraints as well as a set of theories that are clearly relevant during a financial crisis. We close this section with a discussion of how foreign ownership might mitigate financial constraints and increase the relevance of standard trade theory predictions.

Trade Theory

Conventional trade theory assumes that relative prices are important, and no price is more important than the relative price of currency—the real exchange rate. When a currency undergoes a real devaluation, exports become more competitive. In addition, firms that compete against imported

goods become more competitive. These increases in competitiveness should have several testable implications: higher profits, more employment, and increased investment. A number of studies, such as Aguiar (2002), demonstrated such findings using firm data.

Working in the other direction, firms that import most of their raw and intermediate goods, in contrast, become less competitive. For firms that both import and export, trade theory predicts that net exports (exports minus imports) are what should predict shifts in competitiveness.

Trade theory predicts that the expansionary effect of devaluation will be muted if competitors also have devaluations. In Indonesia's case, Thailand and Malaysia, for example, also devalued around 1997 and China had also undergone a large devaluation shortly before. Because these countries' real devaluation was much smaller than Indonesia's, one would still predict higher net exports for Indonesia.

Trade theory also suggests that the expansionary effect of a nominal devaluation will be muted if inflation reduces the improvement in competitiveness. Such inflation is a common occurrence after nominal devaluations and often implies that the real exchange rate remains fairly stable. Indonesia, as expected, had a massive spike in inflation with the price level (as measured by the wholesale price index) roughly doubling from December 1997 to December 1998. Inflation fell to low levels by the start of 1999, and the cumulative inflation from 1997 to 2000 left the majority of the initial real devaluation intact.

In fact, US dollar exports of manufactured goods rose from 50 billion in 1996–97 to 53 billion in 1999 (IMF 2000, table 42). Thus, while exports were roughly flat in dollar terms and (presumably) in quantity terms, their value roughly doubled in inflation-adjusted rupiah terms assuming the relative price of exports remained unchanged.

Financial Constraints

Why did the dollar volume of manufacturing exports not increase? One reason may be the poor state of Indonesia's banking industry. Any downturn increases banks' lending risk because more of their customers are near bankruptcy. Indonesia's notorious lack of financial transparency and weak bankruptcy laws amplified this effect, since banks were unable to verify which customers were already bankrupt. Loans to bankrupt customers were unlikely to ever be repaid.

In addition, after the financial crisis banks stated that they preferred to lend to customers with whom they had an ongoing relationship (Agung et al. 2001). As numerous banks closed during and after the financial crisis, relationship-specific ties were broken, and some viable firms may have lost access to credit.

As the crisis continued, Indonesia established new regulatory mechanisms that forced most banks to recognize their underperforming loans (Enoch et al. 2001). The result was extremely low capital in banks, which further discouraged lending.

The outcome of the slower demand for and supply of credit was dramatic. Between 1996 and 2000 the real value of credit from commercial banks to the manufacturing sector fell by roughly half (comparing IMF 2000, table 35, on credit with the earlier tables on Wholesale Price Indexes (WPI) and Consumer Price Indexes (CPI)). Presumably credit from foreign sources fell even faster as foreign capital poured out of Indonesia during the crisis.

Lower demand for credit caused most of this decline in total credit. Nevertheless, if constraints on credit supply by potentially credit-worthy borrowers caused even a portion of the decline, it is unsurprising that investment fell. Analyzing surveys of banks and of manufacturing plants, Agung et al. (2001) concluded that lack of bank capital (as opposed to high borrower risk) caused much of the slowdown in lending.

Foreign Ownership and Financial Constraints

Above we argued that domestic banks may have refused loans to firms that could export profitably since the banks could not determine which firms were already bankrupt and unlikely to repay their loans. An Indonesian plant with substantial foreign ownership should not have this problem, as the foreign owner can document that the plant is, in fact, making money. Indeed, evidence suggests that foreign affiliates often substitute internal borrowing for external borrowing when operating in environments with poorly developed financial markets (Desai, Foley, and Hines 2003).

For firms that primarily sell to the domestic market, the benefits of foreign ownership may be slight; such firms frequently should contract output regardless of liquidity constraints. Thus, the hypothesis of foreign ownership as an antidote to financial crisis should be most visible for firms that export or compete with imports.

Three forces mitigate this hypothesis. First, some assembly plants import materials whose value constitutes a large proportion of final sales. Even so, the devaluation greatly reduced the cost of labor—the main cost as a share of value added. Nevertheless, to the extent that the percentage of imports and exports is exogenous, standard trade theory suggests that net exports (that is, exports minus imports) should matter more than the export share in predicting desired expansion after the devaluation and financial crisis.

Second, the financial crisis was accompanied by an increase in political risk. Foreign firms might consider the weaker currency insufficient to coun-

teract the risks of large capital losses. Particularly if managers are risk averse, they might be loath to invest in Indonesia if the economy were likely to implode so badly that basic infrastructure eroded, a civil war broke out, or some other catastrophic event that would depreciate assets occurred. For example, rioters opposed to IMF programs presumably led all foreigners to fear for their personal safety and that of their assets.

Although plausible, it is not clear why rising political risk affected foreign owners more than many domestic investors. That is, a substantial majority of Indonesia's large companies are owned by those closely associated with Suharto (Fisman 2001), by the ethnic Chinese minority in Indonesia, or by businessmen who are both. These groups had strong reasons to fear that either a new government might take over their businesses or a mob might destroy them. These risks may have been larger than those faced by foreign investors.

Third, firms with foreign equity ownership, as well as those that export, may disproportionately have been those with foreign debt. The devaluation vastly increased the rupiah cost-of-servicing debt denominated in dollars, yen, or other hard currencies.

Indonesian Manufacturing and Foreign Investment Policy

Indonesia's manufacturing sector is an attractive setting for research on FDI and technology transfer for several reasons. First, with the fourth largest population in the world and thousands of islands stretching over three time zones, the country has abundant labor and natural resources to support a large sample of manufacturing facilities in a wide variety of industries. Furthermore, the country's size and resources support a full supply chain, from raw materials to intermediate and final goods, and both export and domestic markets. Second, rapid and localized industrialization provides variance in manufacturing activity in both time and geography. Third, the country's widespread island archipelago geography and generally poor transportation infrastructure create a number of local markets, each of which can support independent supply chains. Fourth, a number of institutional reforms of investment law have dramatically increased the amount of FDI and export activity in recent years. In particular, the nature and timing of these reforms provide exogenous variation in FDI by region, industry, and time that will be exploited in the econometric identification. Last, Indonesian government agencies employ a number of well-trained statisticians who have collected exceptionally rich manufacturing data for a developing country. The remainder of this section provides some background on Indonesian manufacturing and foreign investment policy with the intent of highlighting institutional changes that contribute to the longitudinal variation we exploit in the econometric

identification. Readers not interested in this background may skip ahead without loss of continuity.

Growth in Manufacturing

The Indonesian economy and the manufacturing sector grew dramatically from the late 1970s until the recent financial crisis.[6] Indonesia enjoyed an average annual GDP growth rate of 6–7 percent, and manufacturing, which drove most of this growth, expanded from 11 percent of GDP in 1980 to 25 percent in 1996 (Nasution 1995). Government initiatives to reduce dependency on oil and gas revenue in the mid-1980s—principally liberalization of financial markets and foreign exchange, a shift from an import-substitution regime to export promotion, currency devaluation, and relaxation of foreign investment laws—facilitated the large increase in manufacturing output (Goeltom 1995).

Foreign Investment Policy

Over the past 40 years, government regulation has shifted dramatically from a policy antagonistic to FDI to a policy actively encouraging it (Wie 1994a, 137–66; Hill 1988; Pangestu 1996). Following independence from the Netherlands in 1945, the Sukarno government nationalized many of the former Dutch manufacturing enterprises. Weak property rights and socialist rhetoric kept foreign investment at a trickle throughout the 1950s and 1960s.

The first reforms came in 1967 as part of the "New Order" economic regime of Suharto, who had purged the government of left-wing elements during his rise to power. Many of the assets nationalized after independence were returned and the 1967 Foreign Investment Law No. 1 established a licensing procedure for foreign operations that remains the basis of current policy. Although, in principle, Foreign Investment Law No. 1 allowed FDI with few restrictions, in practice obtaining an operating license was onerous. Nevertheless, FDI, primarily from Japan, did begin to flow into labor-intensive sectors, such as textiles.

Negative nationalistic reaction to foreign investment and complaints from local firms prompted the Indonesian government to impose restrictions, particularly on entrants that produced for the local market. Opposition to FDI culminated in violent protests during the 1974 Jakarta visit of Japanese Prime Minister Kakuei Tanaka. Suharto responded with a presidential decree restricting the sectors open for new foreign investment and

6. Hill (1988) and Pangestu and Sato (1997) provide detailed histories of Indonesian manufacturing from the colonial period to the present.

limiting the maximum allowable foreign equity in manufacturing operations. Most notably, all new investment had to be through joint ventures with Indonesian partners, who were required to own at least 20 percent of equity initially and 51 percent within 10 years of operation.

Because of the restrictions on equity holdings, foreign firms adopted other mechanisms for controlling their operations. Japanese investors, for example, would maintain effective control of joint ventures in which they had minority equity stakes by increasing the debt-to-equity ratio and licensing or leasing production technology and equipment (Wie 1994b). Embedded in such arrangements was the option to withhold the financing, equipment, and know-how needed for the plant's viability if the foreign investor considered that it did not have effective control.

Following the collapse of oil prices in the mid-1980s, the Indonesian government began to seek outside investment more actively. From 1986 to 1994, it introduced a number of exemptions to the 1974 regulations. The exemptions were targeted to multinationals investing in particular locations, notably a bonded zone on the island of Batam (only 20 kilometers from Singapore), government-sponsored industrial parks, and undeveloped provinces of east Indonesia. The new policy also granted exemptions to investment in capital-intensive, technology-intensive, and export-oriented sectors. The exemptions typically allowed a lower minimum initial Indonesian equity stake, a lower long-term Indonesian equity target, and a longer period to achieve that target (often as long as 20 years). Moreover, the reforms reduced or eliminated import tariffs for certain capital goods and for materials that would be assembled and exported.

Finally, in 1994 the government lifted nearly all equity restrictions on foreign investment. Multinationals in most sectors were allowed to establish and maintain operations in perpetuity with 100 percent equity. In a handful of sectors deemed strategically important, a nominal 5 percent Indonesian holding was required with no further requirement to divest. These reforms have been accompanied by large increases in both the absolute and the relative value of foreign production in Indonesian manufacturing.

The Indonesian Financial Crisis

Beginning in August 1997, Indonesia, like other nations severely affected by the Asian financial crisis, experienced a sudden and widespread financial panic. By January 1998, the Indonesian rupiah (Rp) was worth 15 percent of its value six months earlier, and GDP growth fell from +8 percent in 1996 to –13 percent in 1998. Austerity measures, inflation, very high interest rates, and a massive credit crunch brought the crisis from the financial sector to manufacturing plants. Box 4.1 lays out a timeline of the crisis.

Box 4.1 Timeline of the Indonesian financial crisis

1997	
July 2	Thai baht is floated and depreciates by 15–20 percent
July 11	Widening of rupiah band
July 24	Currency meltdown with severe pressure on baht, ringgit, peso, and rupiah
August 14	Ending of rupiah band and immediate plunge
November 1	Sixteen banks closed, with promise of more to follow. Deposits were not guaranteed
November 5	Three-year standby agreement with IMF approved
Mid-December	Almost half of Indonesian bank deposits exit the system
1998	
Mid-January	Further downward pressure on the rupiah
January 27	Bank deposits formally guaranteed by the new superagency, the Indonesia Bank Reconstruction Agency
March 11	President Suharto reelected
Mid-May	Widespread rioting
May 21	Vice President Habibe succeeds Suharto as president

Source: Enoch et al. (2001).

Data

The analysis is based on data from the Republic of Indonesia's *Budan Pusat Statistik* (BPS), the Central Bureau of Statistics.[7] The primary data are taken from an unpublished annual survey of manufacturing establishments with more than 20 employees conducted by *Biro Statistik Industri,* the Industrial Statistics Division of BPS. Additional data include the input-output (IO) table and several input and output price deflators.

The principal dataset is the *Survei Tahunan Perusahaan Industri Pengolahan* (SI), the Annual Manufacturing Survey conducted by the Industrial Statistics Division of BPS. The SI dataset is designed to be a complete annual enumeration of all manufacturing establishments with 20 or more employees from 1975 onward. Depending on the year, the SI includes up to 160 variables covering industrial classification (five-digit International Standard of Industrial Classification (ISIC) code), ownership (public, private, or foreign), status of incorporation, assets, asset changes, electricity, fuels, income, output, expenses, investment, labor (head count, education, wages), raw material use, machinery, and other specialized questions.

7. We identify names in Bahasa Indonesian, the language of most government publications, with italics. Subsequently, we use the English equivalent or the acronym.

Table 4.1 Key variables affecting technology spillover, 1988 and 1996

	Number domestic firms	Number foreign firms	Horizontal FDI	Downstream FDI	Suppliers' downstream FDI
1988	8,888	276	.131	.060	.074
1996	14,912	888	.232	.094	.118

BPS submits a questionnaire annually to all registered manufacturing establishments, and field agents attempt to visit each nonrespondent to either encourage compliance or confirm that the establishment has ceased operation.[8] Because field office budgets are partly determined by the number of reporting establishments, agents have some incentive to identify and register new plants. In recent years, over 20,000 factories have been surveyed annually. Government laws guarantee that the collected information will be used only for statistical purposes. However, several BPS officials commented that some establishments intentionally misreport financial information out of concern that tax authorities or competitors may gain access to the data. Because the fixed-effect analysis admits only within-factory variation on a logarithmic scale, errors of under- or overreporting will not bias the results provided that each factory consistently misreports over time. Further, even if the degree of misreporting for a factory varies over time, the results are unbiased provided the misreporting is not correlated with other factory attributes used in the analysis.

Our analysis starts from 1988, the first year data on fixed assets are available. To avoid measurement error in price and other uncertainties introduced by the 1997–98 Asian financial crisis, 1996 is the last year for our analysis of technology spillover. The key variables are described in and summarized for 1988 and 1996 in table 4.1. The table indicates a large increase in the number of foreign factories, which increased from 276 in 1988 to 888 in 1996. On average, foreign factories are bigger (as measured by value added, employees, and capital), more capital intensive (as measured by capital per employee), more productive (as measured by value added per employee), and more export oriented (as measured by percentage of production exported). (See table 4.2.)

8. Because some firms may have more than one factory, we henceforth refer to each observation as an establishment, plant, or factory. BPS also submits a different questionnaire to the head office of every firm with more than one factory. Although the data from the head office were not available for this study, early analysis by BPS suggests that fewer than 5 percent of factories belong to multifactory firms. Thus, we generalize our results and discuss them in terms of firms.

Table 4.2 Descriptive statistics of foreign and domestic firms, 1988 and 1996

	Domestic	Foreign
1988		
log(capital)	11.257	14.086
Employees	124	364
log(materials)	11.171	14.421
log(energy)	7.388	8.881
log(value added)	10.438	14.068
log(value added per worker)	6.447	8.765
1996		
log(capital)	11.691	14.659
Employees	147	584
log(materials)	11.588	14.893
log(energy)	7.347	8.618
log(value added)	11.039	14.580
log(value added per worker)	6.973	8.967

Note: Capital, materials, energy, and value added are reported in thousands of 1988 rupiah.

We derived interindustry supply chains using IO tables published by BPS in 1990 and 1995. The tables show the value added of goods and services produced by the economic sector and how this value is distributed to other economic sectors. The IO tables divide manufacturing activity into 89 sectors, and BPS provides concordance tables linking the 1990 and 1995 IO codes to five-digit ISIC codes as described in Blalock (2002). We deflated output, materials, energy, and capital to express values in real terms. Blalock (2002) describes the deflator calculation in detail.

Not surprisingly, particularly in a developing-country environment, a high level of nonreporting and obvious erroneous responses to many of the survey questions occur, particularly to questions that require some accounting expertise (for example, for answers to questions regarding the replacement and book value of fixed assets). We removed establishments with especially numerous nonresponses to fundamental questions such as number of employees. In other cases, we imputed some variables to correct for nonreporting in just one or two years or to fix obvious clerical mistakes in data keypunching. We cleaned each variable independently and only removed establishments from the analysis for which the needed variables could not be constructed. For example, establishments with missing wage data could be used for output regression but not for value added regression. Thus, readers will notice slight differences in the sample count across different regressions. We also note that analysis on completely raw data yields very similar results to what we report, although standard errors are slightly higher. Blalock (2002) describes the process by which we prepared the data in more detail.

Productivity Effects of FDI

Our strategy to identify the effect of downstream FDI on productivity is to examine whether domestic establishments that sell more to foreign-owned firms produce more, ceteris paribus. We estimate this effect using a translog production function with establishment fixed effect, year-region dummies, and measures of FDI. The translog production function controls for input levels and scale effects. The establishment fixed effects control for time-invariant differences across sectors and firms, and the year-region dummies control for local market changes over time common to all firms in that region. Specifically, we define the establishment-level translog production function as:

$$\begin{aligned}\ln Y_{it} = {} & \beta_0 Downstream\_FDI_{jrt} + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \beta_4 \ln E_{it} \\ & + \beta_5 \ln^2 K_{it} + \beta_6 \ln^2 L_{it} + \beta_7 \ln^2 M_{it} + \beta_8 \ln^2 E_{it} \\ & + \beta_9 \ln K_{it} \ln L_{it} + \beta_{10} \ln K_{it} \ln M_{it} + \beta_{11} \ln K_{it} \ln E_{it} \\ & + \beta_{12} \ln L_{it} \ln M_{it} + \beta_{13} \ln L_{it} \ln E_{it} + \beta_{14} \ln M_{it} \ln E_{it} \\ & + \lambda_{gt} + \alpha_i + \gamma_t + \varepsilon_{it} \end{aligned} \tag{4.1}$$

where Y_{it}, K_{it}, L_{it}, M_{it}, and E_{it} are, respectively, the amounts of production output, capital, labor, raw materials, and energy (fuel and electricity) for establishment i at time t, and λ_{gt} is an indicator for the interaction of each of the four island groupings g and year t, α_i is a fixed effect for establishment i, and γ_t is a dummy variable for year t. A positive coefficient on downstream FDI indicates that it is associated with higher productivity. Output, capital, materials, and energy are nominal rupiah values deflated to 1983 rupiah. Labor is the total number of production and nonproduction workers. We assume that ε_{it} is independent and identically distributed.[9] We estimate equation (4.1) on a sample of locally owned factories.

Measuring Horizontal and Downstream FDI

We use a long-standing measure of horizontal FDI in the literature: the share of a sector's output in a particular market that is produced by foreign-owned firms. Specifically,

$$Horizontal\_FDI_{jrt} = \sum_{i \in jrt} \frac{Foreign\_OUTPUT_{it}}{\sum_{i \in jrt} OUTPUT_{it}} \tag{4.2}$$

where $i \in jrt$ indicates a factory in a given sector, region, and time, $OUTPUT_{it}$ is the output of factory i, and $Foreign\_OUTPUT_{it}$ is the output of factory i if the factory is foreign, and zero otherwise.

9. See Blalock and Gertler (2004) for more extensive empirical work that relaxes the constraint of i.i.d. error terms.

The measure of horizontal FDI varies by industrial sector, region, and time. The approach appeals to Indonesia's vast island geography and poor interregion transportation infrastructure in assuming local markets, so that any technology spillover from foreign firms to local rivals most likely occurs only between firms that are geographically close. We consider each of Indonesia's 23 provinces on the four main island groups of Sumatra, Java and Bali, Kalimantan, and Sulawesi, to be a separate region. Because there is little industrialization in the rural outer islands of the nation, we have not included them in the sample.

While horizontal FDI is straightforward to measure, downstream FDI is somewhat more complicated. In principle, we would like to measure the share of a firm's output that is sold to foreign-owned firms. However, we would then worry about the endogeneity of a particular factory's decision to sell to multinational customers. Moreover, and more importantly, this information is not available in our dataset. Instead, we proxy the share of an establishment's output sold to foreign firms with the share of a sector's output in a market that is sold to foreign firms.

How do we measure the share of sector j's output, in market k, that is sold to foreign firms in year t? From the IO tables we know the amount firms in one sector purchase from each of the other sectors. We also know the share of output in sector j that is produced by foreign-owned firms—for example, horizontal FDI. If we assume that a firm's share of a sector's use of a particular input is equal to its output share, then a measure of the share of a sector's output sold to foreign firms is the sum of the output shares purchased by other sectors multiplied by the share of foreign output in each purchasing sector.

For example, consider three sectors: wheat flour milling, pasta production, and baking. Suppose that half of the wheat flour sector output is purchased by the bakery sector and the other half is purchased by the pasta sector. Furthermore, suppose that the bakery sector has no foreign factories but that foreign factories produce half of the pasta sector output. The calculation of downstream FDI for the flour sector would yield 0.25 = 0.5(0.0) + 0.5(0.5). Formally, equation 4.3 expresses the calculation for sector j, region r, at time t.

$$Downstream\_FDI_{jrt} = \sum_{k} \alpha_{jkt} Horizontal\_FDI_{krt} \tag{4.3}$$

where α_{jkt} is the proportion of sector j output consumed by sector k. Horizontal FDI is our measure of the share of a sector's output in a local market that is produced by foreign-owned firms. Values of α_{jkt} before and including 1990 follow from the 1990 IO table, values of α_{jkt} from 1991 through 1994 are linear interpolations of the 1990 and 1995 IO tables, and values of α_{jkt} from 1995 on are from the 1995 IO table. Recall that α_{jkt} does not have a region r subscript because the IO table is compiled for the entire national economy.

Table 4.3 Descriptive statistics for measures of FDI

Variable	Mean	Standard deviation
Downstream FDI	.042	.097
Horizontal FDI	.112	.250
Suppliers' downstream FDI	.036	.062

The measure of downstream FDI varies by industrial sector, region, and time. Again, the approach appeals to Indonesia's vast island geography and poor interregion transportation infrastructure in assuming local markets—for example, the intermediate goods output is consumed by firms in the same region. Table 4.3 shows the mean and standard deviation for these two measures of FDI and a third one described in the next section. Table 4.4 displays the correlation between them. We note that sectors often buy from themselves. That is, the value of sector index *j* and index *k* may be the same. In sectors that sell heavily to themselves, some overlap between the three measures of FDI exists. To limit the estimation to the nonoverlapping variation in the three measures, we include both downstream FDI and horizontal FDI in our examination of productivity.

Productivity Results

Table 4.5 reports the results of estimating equation 4.1 using an establishment-level fixed-effect estimator on a sample of domestic firms.[10] Column (1) shows downstream FDI, column (2) shows horizontal FDI, and column (3) shows the effect of both. The coefficient on horizontal FDI is close to zero, suggesting that there is little learning from direct foreign competitors. In contrast, the effect of downstream FDI is large and significant, indicating that firms with growing FDI downstream acquire technology through the supply chain.

Because the estimation is a log linear production function, the coefficients approximate elasticities and have intuitive interpretations. The 0.087 coefficient on downstream FDI suggests that firm output increases over 8 percent as the share of foreign ownership downstream rises from 0 to 1. In practice, increases in share of downstream FDI of approximately 20 percent are common, suggesting that the actual realized productivity gain might be close to 2 percent (.2 times .087).

10. A Hausman test showed significant correlation between individual establishment effects and the other regressors, thereby rejecting a random-effects model.

Table 4.4 Correlation between measures of FDI

Variable	Downstream FDI	Horizontal FDI	Suppliers' downstream FDI
Downstream FDI	1.00		
Horizontal FDI	0.34	1.00	
Suppliers' downstream FDI	0.55	0.44	1.00

Note: Capital, materials, energy, and value added are reported in thousands of 1988 rupiah.

Market and Welfare Effects

The previous section, we believe, provides convincing evidence that productivity increases when the share of output purchased by foreign firms rises. This is consistent with downstream foreign-owned firms transferring technology to upstream suppliers. In this section, we examine the market and welfare consequences of transferring this technology and test whether it results in Pareto improvements in welfare as hypothesized in Pack and Saggi (2001). In particular, we test the hypotheses that (1) technology transfer upstream to suppliers results in entry, lower prices, increased output, and higher profitability in the upstream market; and (2) lower supply prices lead to entry, lower prices, increased output, and increased profitability in the downstream market.

Methods and Identification

Again, we are not able to directly measure the transfer of technology. Rather, we measure the sectors and location where and when foreign companies entered downstream of local companies. We examine the effect of changes in the share of output purchased by foreign firms on prices, concentration, and profitability in the supply sector. Specifically, we estimate several reduced-form models. Equation 4.4 measures the effect of FDI on concentration.

$$HI_{srt} = \beta_0 Downstream\_FDI_{jrt} + \alpha_{sr} + \lambda_{gt} + \gamma_t + \varepsilon_{srt} \quad (4.4)$$

where HI_{srt} is the Herfindahl concentration index for five-digit ISIC sector s in region r in time t. Note that we use the 89 IO table codes, indicated by subscript j, to define sectors for supply chains. However, for calculating concentration indexes, which do not require the IO table, one can more narrowly define industries by the 329 ISIC codes, indicated by subscript s. α_{sr} is a fixed effect for the interaction of sector s and region r, λ_{gt} is intended to capture time-variant conditions affecting particular island groupings of the country, and ε_{srt} is an error term. We use similar reduced-form equations to explore the effect of downstream FDI on prices, output, and value added.

Table 4.5 Production function estimation on domestic establishments

	(1)	(2)	(3)
Downstream FDI	0.087		0.090
	(4.33)		(4.40)
Horizontal FDI		–0.004	–0.009
		(0.34)	(0.88)
FDI in log(labor)	0.590	0.590	0.590
	(29.98)	(29.94)	(29.98)
log(capital)	0.109	0.109	0.109
	(12.67)	(12.66)	(12.66)
log(materials)	0.200	0.200	0.200
	(21.76)	(21.71)	(21.76)
log(energy)	0.123	0.124	0.123
	(17.98)	(18.17)	(17.99)
log(K)*log(K)	0.005	0.005	0.005
	(9.57)	(9.57)	(9.58)
log(L)*log(L)	0.026	0.026	0.026
	(10.53)	(10.52)	(10.53)
log(M)*log(M)	0.050	0.050	0.050
	(89.47)	(89.53)	(89.45)
log(E)*log(E)	–0.010	–0.010	–0.010
	(24.24)	(24.24)	(24.25)
log(K)*log(L)	0.028	0.028	0.028
	(16.35)	(16.41)	(16.35)
log(K)*log(M)	–0.028	–0.028	–0.028
	(32.50)	(32.51)	(32.50)
log(K)*log(E)	0.006	0.006	0.006
	(8.57)	(8.55)	(8.57)
log(L)*log(M)	–0.089	–0.089	–0.089
	(49.64)	(49.61)	(49.64)
log(L)*log(E)	0.023	0.023	0.023
	(15.88)	(15.80)	(15.87)
log(M)*log(E)	–0.005	–0.005	–0.005
	(6.52)	(6.60)	(6.51)
Constant	3.882	3.885	3.883
	(56.04)	(56.09)	(56.05)
Observations	108,100	108,100	108,100
Number of establishments	23,815	23,815	23,815
R-squared	0.81	0.81	0.81

Notes: Establishment fixed effects, island-year, and year dummy variables are included but not reported.
Absolute value of t-statistics is in parentheses.
Capital, materials, energy, and value added are reported in thousands of 1988 rupiah.

We then consider the hypotheses regarding feedback to the downstream market, in particular, that the lower supply prices induce entry, lower prices, and higher profits. We test this hypothesis by examining the effects of changes in foreign ownership in sectors purchasing from a particular supply sector on the performance of other sectors supplied by that sector. In other words, we question the effect of buying from sectors that supply multinationals and call this the suppliers' downstream FDI. We measure suppliers' downstream FDI as the value of downstream FDI in each of the sectors upstream of the focal sector weighted by the share of focal sector inputs provided by that sector.

$$Suppliers'\_Downstream\_FDI_{jrt} = \sum_{k} \alpha_{jkt} Downstream\_FDI_{krt} \qquad (4.5)$$

where α_{jkt} is the share of sector j inputs obtained from sector k.

We then reestimate our reduced-form equations for concentration, prices, output, and value added replacing downstream FDI with suppliers' downstream FDI to gauge the welfare effects in sectors downstream of those sectors supplying multinationals. We calculate the effect of horizontal FDI on the same metrics to capture the effect of direct competition with foreign firms on domestic industry.

Market and Welfare Results

We estimate the effect of FDI on concentration and prices at the market level—province markets in the case of concentration and national markets in the case of prices, for which we do not have regional variation. The effect of FDI on output and value added is calculated at the firm level.[11]

Concentration and Price

Both downstream FDI and suppliers' downstream FDI are significantly associated with a decrease in market concentration, measured by a Herfindahl index. This association suggests that foreign entry downstream will lead to more competition in upstream supply markets. Likewise, other sectors downstream of those upstream markets also show increases in competition.

In sector horizontal FDI, downstream FDI, and suppliers' downstream FDI are all associated with a decline in prices. In other words, FDI competition lowers prices in the entry market, the supply markets, and other markets downstream of the supply markets.

11. We report only general results here. Details of the estimation and regression tables are available in Blalock and Gertler (2004).

Output and Value Added

We next consider output and value added. Because these outcomes are measured at the firm level, we can estimate the effect of FDI separately on domestic and foreign firms. We first look at domestic firms. Given that FDI lowers prices, one expects to see an increase in output. Both downstream FDI and suppliers' downstream FDI increase output, likely through the effect of FDI on prices and the demand added by the new entry. In isolation, in-sector horizontal FDI has no effect on volume. However, when horizontal FDI is considered together with downstream FDI and suppliers' downstream FDI, it lowers output. This is likely due to some correlation among the three measures of FDI. Whereas downstream FDI and suppliers' downstream FDI reflect the benefits of technology transfer, horizontal FDI also has a competitive effect if foreign firms take away market share from domestic rivals. We next estimate value added to determine whether domestic firms capture any of the surplus generated from lower prices and higher output. Again, both downstream FDI and suppliers' downstream FDI lead to greater value added, suggesting that firms are capturing some of the welfare benefits of vertical technology transfer. Domestic firms, however, fare far worse when they compete directly with foreign entrants as evidenced by the lower value added associated with horizontal FDI.

We now turn to output and value added outcomes for foreign firms. To avoid the obvious endogeneity that an establishment's own foreign ownership adds to horizontal FDI, we have only included *other* firms' foreign equity in the calculation. As was the case with domestic firms, an increase in downstream FDI and suppliers' downstream FDI is associated with increases in both volume and value added. As with domestic firms, there is no direct effect of horizontal FDI in isolation. However, when horizontal FDI is included together with downstream FDI and suppliers' downstream FDI (thereby removing any part of horizontal FDI that might overlap with the downstream FDI measures), it significantly reduces both output and value added. We interpret this to mean that foreign firms benefit from the entry of other multinationals *provided* that the new entrants do not directly compete in the same sector.

Liquidity Insurance from FDI

Data and Methodology

We measure the effect of the crisis on three firm-level outcomes: value added, labor, and capital. Each of the three outcome measures captures different responses to the crisis. Value added should mirror profitability and reflect the overall effect of the devaluation. That is, exporting firms

with domestic materials should see value added rise even with no other changes in production. We expect labor to also reflect the overall effect of the devaluation, but subject to access to short-term working capital. Lastly, capital should reflect the expected persistent effect of the devaluation subject to access to long-term capital.

Experience with the data suggests that labor is one of the more reliable variables reported. Value added is also well measured because both the total value of output and wages are well reported. There were higher rates of nonreporting or obvious erroneous reporting for materials, but we have used interpolation and imputation to make corrections or remove data as needed. Our third measure, capital, represents the biggest challenge with data, because of the high levels of nonreporting firms and the inaccuracy of reported values. We used a number of methods to construct capital measures, as described in Blalock (2002). More generally, however, we avoid problems of capital estimation by not relying on either absolute capital levels or first differences in capital. As shown below, our identification comes from second differencing—the change in capital over time for one group of firms *relative* to another group.

Our methodology is twofold.[12] First, we compare the effect of the crisis on wholly Indonesian-owned firms, both exporters and nonexporters. Our aim is to establish exporters as beneficiaries of the rupiah devaluation. Second, we compare the postcrisis outcomes of Indonesian-owned exporters with those of foreign-owned exporters. The identifying assumption is that the rupiah devaluation should have affected foreign and domestic exporters in the same manner, all else being equal. We argue that changes in the investment patterns between foreign and domestic exporters, relative to their precrisis trends, could result from their different financing sources. Whereas domestic firms would either have to borrow from domestic banks struggling from insolvency or convince foreign banks of their creditworthiness, foreign firms could obtain internal credit through their parent companies.

As discussed above, exporters and foreign firms were more likely to have had debts denominated in US dollars, Japanese yen, and other hard currencies. In fact, because the Bank of Indonesia has historically supported a gradual depreciation of the rupiah against the dollar, many firms had borrowed abroad to take advantage of lower rates. With the implicit understanding that the exchange rate would not change dramatically in the short run, few firms had hedged their positions (Blustein 2001). In many cases, the change in the value of outstanding loans left many companies insolvent following the devaluation. In contrast, those with loans in rupiah enjoyed a large discount in the cost of repaying their debt.

12. Please see Blalock, Gertler, and Levine (2004) for a more detailed description of the methods and identification issues.

To control for the effect of debt on postcrisis outcomes, we constructed leverage measures—the ratio of debt to assets—for each firm. Unfortunately, the data do not reveal whether the debt was denominated in rupiah or hard currency. However, the data do reveal if a firm has received a loan from a foreign bank. To approximate foreign currency–denominated debt, we labeled the leverage of firms that had ever received any foreign loans as foreign leverage. Firms that had never reported receiving foreign loans were designated as having domestic leverage, which is mutually exclusive of foreign leverage.

Equation 4.6 estimates the effect of the crisis on firm outcomes.

$$\ln Outcome_{it} = \beta_0(Exporter * Post)_{it} + \beta_1(Foreign\_Leverage * Post)_{it} + \beta_2(Domestic\_Leverage * Post)_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \quad (4.6)$$

where $Outcome_{it}$ is the log of labor, the log of value added, and the log of capital in the respective specifications, $(Exporter * Post)_{it}$ is the interaction of indicators for a precrisis (anytime during 1994–96) exporting establishment i and postcrisis years (1999–2000), $(Foreign\_Leverage * Post)_{it}$ and $(Domestic\_Leverage * Post)_{it}$ are the interactions of foreign and domestic leverage, respectively, and postcrisis years, α_i is a fixed effect for factory i, and γ_t is a dummy variable for year t. We intentionally do not use data from 1997 and 1998. The rapid inflation and devaluation of the rupiah during this period made any interpolation of pecuniary terms difficult, if not impossible. By 1999, the currency had stabilized, and we believe that variance in monetary values reflects true firm heterogeneity rather than spurious noise resulting from widely volatile exchange rates.

We next estimate equation 4.6 for the population of just exporting firms and substituting $(Foreign * Post)_{it}$ for $(Exporter * Post)_{it}$.

$$\ln Outcome_{it} = \beta_0(Exporter * Post)_{it} + \beta_1(Foreign\_Leverage * Post)_{it} + \beta_2(Domestic\_Leverage * Post)_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \quad (4.7)$$

where *Foreign* is an indicator for firms with foreign equity.

It is important to note that the estimation uses only within-firm estimation. Time-invariant attributes of the firm, such as its management, industry, and location are all removed by the fixed effect. Equation 4.6 thus asks how the difference between domestic exporters and nonexporters changed after the crisis, *conditional on all the unobserved static characteristics of the firms.* Likewise, equation 4.7 asks how the difference between foreign and domestic exporters changed following the crisis, again, controlling for firm unobservables.

Liquidity Insurance Results

Table 4.6 shows the estimation of equation 4.6. Because of the rapid rupiah devaluation during 1997 and 1998, a difference of just a few weeks in the reporting date could dramatically affect values. To avoid this bias, the estimation includes only the pre- and postcrisis years and drops 1997 and 1998. The odd columns (1), (3), and (5) show the effect of exporting on value added, labor, and capital for the population of domestic firms. The even columns (2), (4), and (6) show the effect of foreign ownership on value added, labor, and capital for the population of all exporting firms.

Consider first the effect of exporting on postcrisis outcome. Among domestic firms, those that were exporters prior to the crisis saw their value added grow 20 percent relative to those that did not export. Further, the same exporting firms saw labor grow about 12 percent more that that of nonexporting firms. However, the pattern does not repeat for investment—there is no significant difference in capital postcrisis for domestic exporters versus domestic nonexporters.

Next consider the same analysis for the population of domestic and foreign firms exporting before the crisis. Those with foreign ownership saw value added grow 30 percent over domestic exporters. Foreign exporters likewise saw labor grow about 15 percent over domestic firms. Finally, exporters with foreign equity saw an increase in capital 8 percent greater than that of domestic exporters. The key observation here is that *all* exporters increased their value added and employment after the crisis, but *only* exporters with foreign ownership increased investment.

We next turn to the leverage measures, which are most telling for the population of domestic firms—see columns (1), (3), and (5). Whereas foreign multinationals are likely hedged against exchange rate fluctuations and largely insulated from the rupiah's value since they export mostly output, Indonesian firms are more likely to get caught with a burgeoning foreign debt. Indeed, the interaction of foreign leverage and the postcrisis indicator in the capital estimation (column 5) suggests that firms with large foreign debts invested less postcrisis than others.

Summary and Implications

Our findings have two key implications. First, FDI is a source of technology in emerging markets, and this technology generates welfare benefits that may warrant public policy intervention. Second, FDI can provide credit liquidity in times of financial crisis, a benefit that also warrants public intervention.

Both the econometric analysis and the manager interviews suggest that vertical supply chains are conduits for technology transfer from FDI. Indonesian factories in industries with growing downstream FDI experience

Table 4.6 Fixed-effect estimation on domestic establishments (models 1, 3, 5) and exporting establishments (models 2, 4, 6)

	(1) log (value added)	(2) log (value added)	(3) log (labor)	(4) log (labor)	(5) log (capital)	(6) log (capital)
Exporter*Postcrisis	0.203		0.123		–0.019	
	(9.87)		(16.03)		(1.12)	
Foreign*Postcrisis		0.339		0.154		0.088
		(8.17)		(8.56)		(2.26)
Foreign Leverage*Postcrisis	–0.000	0.022	–0.000	0.008	–0.001	0.023
	(0.93)	(2.11)	(0.21)	(1.76)	(3.04)	(1.83)
Domestic Leverage*Postcrisis	0.001	0.003	0.000	0.000	–0.001	–0.001
	(1.65)	(2.02)	(0.23)	(0.32)	(1.30)	(1.05)
1990	–0.571	–0.662	–0.203	–0.313	–0.490	–0.672
	(31.77)	(20.46)	(30.18)	(22.23)	(35.90)	(24.11)
1991	–0.452	–0.545	–0.164	–0.263	–0.448	–0.573
	(26.46)	(18.03)	(25.66)	(20.08)	(34.80)	(22.26)
1992	–0.339	–0.424	–0.122	–0.187	–0.347	–0.412
	(20.60)	(14.82)	(19.90)	(15.07)	(28.20)	(17.11)
1993	–0.228	–0.272	–0.061	–0.098	–0.267	–0.313
	(14.36)	(9.86)	(10.15)	(8.11)	(22.41)	(13.51)
1994	–0.093	–0.151	–0.016	–0.035	–0.172	–0.187
	(5.97)	(5.66)	(2.78)	(3.02)	(14.95)	(8.43)
1995	–0.091	–0.151	–0.003	–0.018	–0.142	–0.135
	(6.07)	(5.89)	(0.52)	(1.59)	(12.81)	(6.35)
1999	–0.293	–0.120	–0.112	–0.026	–0.428	–0.482
	(17.73)	(4.39)	(18.38)	(2.23)	(33.97)	(20.14)
2000	–0.372	–0.262	–0.110	–0.028	–0.426	–0.497
	(22.25)	(9.48)	(17.85)	(2.33)	(31.87)	(19.22)
Constant	11.854	13.524	4.637	5.476	12.403	13.827
	(1145.67)	(755.84)	(1197.81)	(704.54)	(1608.81)	(923.53)
Observations	62,817	22,515	65,110	23,037	46,819	16,179
Number of establishments	9,444	3,324	9,477	3,327	7,350	2,571
R-squared	0.03	0.04	0.03	0.06	0.07	0.08

Notes: Absolute value of t-statistics is in parentheses.

greater productivity growth, ceteris paribus, than other factories. This finding is consistent with the incentives of multinational enterprises, which only realize the full benefit of investment abroad if they can procure high-quality inputs at low cost. To build efficient supply chains overseas, many multinationals will strategically transfer technology to local vendors.

The observation of technology transfer alone is insufficient to inform public policy. If the full benefit of FDI is internalized between two private parties, then there is no need for government intervention. Our results show that FDI does indeed generate an externality—lower prices and greater output—that benefits suppliers, final goods makers, and consumers. Because the benefits of FDI in the economy exceed the private returns to both the multinational and its direct suppliers, the total amount of FDI will be less than the socially optimal amount without intervention.

Our analysis of investment during the financial crisis suggests another benefit of FDI. Trade theory suggests that exporting firms should increase profits, expand employment, and invest in new capital following a real devaluation. For domestic exporters, we observe the first two effects but do not see evidence of increased investment even though conditions warrant it. Liquidity constraints are a likely explanation. Whereas increases in employment could be financed through cash flow, capital investment required obtaining credit from a struggling financial sector. In contrast, exporters with foreign ownership did expand investment. A priori, we see no reason why investment would depend on ownership other than financing availability. While domestic exporters may have faced a credit crunch, exporters with foreign ownership could access credit through their parent company and, thus, insure themselves against liquidity constraints. The ability of foreign firms to sustain investment during times of crisis provides a form of liquidity insurance and hastens economic recovery.

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