

Technological Spillovers from Foreign Direct Investment—A Survey

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Increased foreign direct investment (FDI) flows have stimulated intensive debate and research on the impact of FDI on host economies. This paper surveys the substantial literature exploring FDI and spillover effects, summarizes the main findings from previous research, and identifies omissions in existing studies that should be included in future studies. The paper also reviews research on FDI in the People's Republic of China (PRC) alongside the general literature on FDI. The PRC literature is useful in illuminating the likely direction of FDI research in developing countries, especially transition economies.

I. INTRODUCTION

Foreign direct investment (FDI)¹ can potentially benefit domestic firms. The benefits arise from foreign firms demonstrating new technologies, providing technological assistance to their local suppliers and customers, and training workers who may subsequently move to local firms. Local firms can also learn by watching. Moreover, the very presence of foreign-owned firms in an economy increases competition in the domestic market. This competitive pressure may spur local firms to operate more efficiently and introduce new technologies earlier than would otherwise have been the case. Because foreign firms are not able to extract the full value of these gains, this effect is commonly referred to as the spillover effect (Kokko 1994).

The spillover effect has been identified as an important benefit accruing to domestic firms. It is also an important mechanism through which FDI promotes growth in a host country. Realization of this and other benefits from FDI has prompted governments to allow and encourage FDI inflow. There have been in-

¹Different countries use different definitions for FDI. The International Monetary Fund (IMF) broadly defines FDI as the establishment of, or acquisition of, substantial ownership in an enterprise in a foreign country; and in a narrower sense, as enterprises in which nonresidents hold 25 percent or more of the voting share capital.

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creasing flows of FDI across national borders over the past few decades. These have stimulated intensive debate and research on the role of FDI in host economies. A large number of studies have explored FDI and spillover effects.

The People's Republic of China (PRC) is a good case study to examine alongside the general literature on FDI. The PRC overturned its policy of economic isolation in 1978 and implemented far reaching economic reforms. Attracting FDI constitutes an important component of the country's Open Door policy. A series of measures have been adopted to attract FDI, spurred on by the belief that this inflow will introduce modern technology and stimulate export-led growth. This has resulted in an accelerated increase of FDI inflow. The PRC has emerged as one of the largest hosts of FDI in the world. In 2001, it received US\$44.2 billion in FDI inflow—making it by far the largest host among developing countries, and the sixth largest in the world after United States, Belgium, United Kingdom, France, and Netherlands. Studies on the PRC are particularly useful in illuminating the likely direction of FDI research in developing countries, especially transition economies.

This paper surveys the literature on FDI and spillover effects in general, and reviews research on FDI in the PRC specifically. It seeks to present the main findings from previous research and to identify missing aspects in existing studies that should be included in future studies. Given the vast amount of research in this area, this survey is by no means exhaustive. The survey begins with an examination of theoretical studies on spillover effects in Section II. Section III then reviews the empirical evidence on spillover effects, followed by a survey of the evidence on FDI in the PRC in Section IV. Section V presents conclusions and policy implications.

II. THEORETICAL STUDIES ON THE SPILLOVER EFFECT

A. Dependency Theory on the Impact of Foreign Investment in Host Countries

Early theories on the impact of foreign capital and multinational corporations (MNCs) on host countries can be found in the writings of the “dependency school.” Influential works of this school of thought include the ontology of dependency; Karl Marx on development and underdevelopment; Paul Baran's analysis of economic backwardness and economic growth; Andre Gunder Frank's analysis of the development of underdevelopment; and the writings of Samir Amin on unequal development (see Ghosh 2001 and Brewer 1990 for reviews).

Dependency school theory views foreign investment from the developed countries at the core of the world economic system as harmful to the long-term economic growth prospects of developing nations out in the periphery. It asserts that First World nations become wealthy by extracting labor and resources from

the Third World. It argues that developing countries are inadequately compensated for their natural resources and are thereby sentenced to conditions of continuing poverty. This kind of capitalism perpetuates a global division of labor that causes distortion, hinders growth, and increases income inequality in developing economies. To get out of this economically debilitating relationship, Third World nations must develop independently of foreign capital and goods.

Although the influence of the dependency theory peaked in the 1970s, debate on its validity continued beyond this time (see, e.g., Bornschier and Chase-Dunn 1985, Firebaugh 1998). Many papers advocating dependency theory perspectives use qualitative methods. Many do not distinguish types of foreign investment, although their criticisms imply they mean direct investment and multinational companies.

Dependency theory perspectives were adopted by various countries in the 1970s, most noticeably Latin American countries. A number of them adopted an import substitution strategy and demonstrated a hostile attitude toward foreign investment. These policies had a harmful effect on Latin American economies (Hein 1992). Their experiences contrast with those of some East and Southeast Asian economies that were designed to actively attract foreign investment into their domestic economies. These policies were accompanied by a period of rapid economic growth in East Asia during the 1970s and 1980s. This reality largely curbed the popularity of dependency theory, shifting attention to the study of FDI's contribution.

B. Industrialization Theory on FDI and Spillover Effects

Most recent theoretical models on FDI and spillovers lie within the framework of industrial organization theory. These models only started to emerge from the late 1970s after Hymer's (1976) pioneering study. Hymer's work drew attention to neglected aspects of MNCs' role as global industrial organizations and was a major departure from the orthodox economic theories. The standard neoclassical trade theory of Heckscher and Ohlin, for example, carried restrictive assumptions about the immobility of factors of production and identical production functions across nations. It postulated that no international difference existed at the scientific and technological levels, not to mention technology transfer and spillovers. In the neoclassical financial theory of portfolio flows, multinational enterprises had been viewed as simply arbitrageurs of capital in response to changes in interest rate differentials. Capital is seen to flow from countries where returns are low to those where it is higher to earn arbitrage rents. This theory did not distinguish between the roles played in a country's development by portfolio and FDI capital inflows (Dunning and Rayman 1985, Teece 1985).

Hymer's major contribution was to shift attention away from neoclassical financial theory. In his view, FDI is more than a process by which financial assets

are exchanged internationally. It also involves international production. By putting forward the idea that FDI represents not simply a transfer of capital, but the transfer of a “package” in which capital, management, and new technology are all combined, Hymer characterized FDI as an international extension of industrial organization theory.

Caves (1971 and 1974) and Kindleberger (1984) further extended the industrial organization theory of FDI. They emphasized the behavior of firms that deviate from perfect competition as the determinants of FDI. According to their perspective, MNCs face disadvantages imposed by both geographical and cultural distance in comparison to domestic firms. In order for a firm to undertake FDI in a foreign country, it must possess some special ownership advantage over potential domestic competitors. Technological superiority or possession of some intangible, rent-yielding assets such as management skills and brands are believed to provide such advantages. Compared to portfolio investment, FDI entails a cross-border transfer of a variety of resources, including process and product technology, managerial skills, marketing and distribution know how, and human capital. Neglect of this aspect can lead to a serious underestimation of the role of FDI in the recipient country. However, early theorists neither calculated the benefits and costs of technology transfers, nor explicitly analyzed their impact on a host country through spillover effects.

Koizumi and Kopecky (1977) were the first to explicitly model FDI and technology transfer. They used a partial equilibrium framework to analyze technology transfer from a parent firm to its subsidiary. Technology transfer was assumed to increase as foreign capital increased in the country. The transmission of foreign technology was viewed as “automatic” and technology was treated as a public good. They showed that two countries with identical production functions could follow different time paths and reach different steady state equilibria. The analysis implied that an increase in a country’s savings ratio would reduce foreign capital and, through its effect on technical efficiency, reduce its steady state capital intensity.

Findlay (1978) constructed a model to examine the relationship between FDI and technological change in a backward region. The rate of technological diffusion from an advanced country to a backward country was assumed to depend on two factors. Findlay first proposed that the rate of technological progress in a “backward” region is an increasing function of the technology gap between it and the “advanced” region on the basis of Gerschenkron’s hypothesis (1962), which states that the greater the relative disparity in development levels between a backward country and an industrialized country, the faster the catch up rate. Therefore, for a given amount of foreign presence, the larger the technological gap between the foreign and domestic firms, the larger the spillovers. Second, Findlay followed Arrow’s (1971) lead in considering technological diffusion as analogous to the spread of a contagious disease. Therefore, technology is most efficiently diffused

when there is personal contact between those with the knowledge of the innovation and those who adopt it.

These considerations led to the hypothesis that technological progress in a backward region increases in proportion to the extent to which it opens up to FDI. Findlay then considered the determinants of the relative growth rates of foreign and domestic capital. He demonstrated the effects of changes in various parameters in the steady state, such as the backward region's saving propensity and the tax rate of foreign profit, on the "backward" region's "dependency" on foreign capital. However, the model did not examine the factors that determine the transfer of technology from the "advanced" to the "backward" region.

Das (1987) utilized a price-leadership model from oligopoly theory to analyze the transfer of technology from the parent firm to its subsidiary abroad. This analysis recognized that domestic firms learn from MNCs and become more efficient. This increase in efficiency among domestic firms is assumed to be exogenous, and therefore costless to them. It is also assumed that the rate of increase in efficiency of the domestic firm is positively related to the level of activities of the MNC's subsidiary. He then modeled the problem of choice the MNC faces due to the cost imposed by the "learning from watching" benefits flowing to the domestic firm. Along the optimal path, he concluded that the MNC benefits from the technology transfer from its parent company in spite of the leakage of knowledge in the host country, and the host country benefits unambiguously. Thus, in spite of the free insights competing domestic firms gain, it is still worthwhile for the MNC to import better technology. This model recognizes that the MNC affiliates are aware of technology leakage, and determines their technology transfer behavior based on this recognition. Yet, the behavior of the local firm is still not explicitly taken into account in the model.

Wang and Blomstrom (1992) developed a model in which international technology transfer through MNCs develops endogenously by means of the interaction between a foreign subsidiary and a host country firm. They also follow Findlay in assuming a positive relationship exists between the technology gap and spillovers. This model is significant in that it is one of the few that recognizes the cost of transferring technology within MNCs. Since both the foreign subsidiary and the indigenous firm can make their own investment decisions to maximize profit, there is strategic interaction between them, where both firms solve their individual dynamic optimization problems subject to the other's actions in a game theory context. These considerations represent a major step forward compared with other models.

By solving the dynamic optimization problem, Wang and Blomstrom found that:

- (i) Technology transfer from a parent company to a subsidiary is positively related to the level and cost efficiency of a domestic firm's learning investment.
- (ii) The lower the subsidiary's discount rate, the more rapid the technology transfer. The higher the operation risks—for example, political instability or low potential economic growth—the more reluctant foreign firms will be to transfer technology.
- (iii) Some technology transfer proportional to the size of the technology gap always takes place irrespective of the subsidiary's active learning effort. The less costly the technology spillovers from the parent to subsidiary firms, the faster the technology transfer.

C. Assessment of Industrialization Theories of FDI and the Spillover Effect

In the models of Koizumi and Kopecky (1977), Findlay (1978), and Das (1987), the superior technology possessed by foreign firms is considered to be a “public good” in nature, and to be transferred automatically. However, the growing importance of international patent agreements and the licensing of technology suggests that technological knowledge is frequently a private rather than a public good, and that technology can rarely be automatically transferred. A major contribution of Wang and Blomstrom's model lies in its highlighting of the essential role played by competing host country firms in increasing the rate at which MNCs transfer technology. Both the MNC affiliate and the local firm are able to influence the extent of the technology transfer through their investment decisions.

However, some common features exist for all these models. These include the subject and object of technology transfer. There are two distinct processes in international technology transfer. One is technology transfer from the parent firm of a MNC to its subsidiary abroad. The second is technology transfer in the form of an externality from the subsidiary to native firms in the host country. Though some recognize/acknowledge the latter, all the models focus on technology transfer from a MNC to its own subsidiaries. Technology transfer from a subsidiary to domestic firms is taken for granted. In these models, a host country's production efficiency is formulated as an increasing function of the presence of foreign capital.

Furthermore, the assumption of Gerschenkron (1962), which suggests the wider the technology gap between the developed and developing country, the larger the potential for technological imitation, is incorporated into all the above models. To date, there remains ample scope for experiment and debate about the framework within which to analyze the relationship between the technological gap and the spillover effect. More and more evidence, however, shows that the assumption that technology transfers increase with a larger technology gap is not valid. For example, the dynamic game-theory model developed by Cheng (1984)

shows a change in technological leadership is more likely to occur where the initial technological disparity between countries is small.

D. FDI and the Spillover Effect in a Growth Theoretic Framework

While the models described above explored FDI and technology transfer directly, another strand of models investigate the effect of FDI on growth using a growth theory framework. These models indirectly touch upon the role of FDI in transferring technology. However, compared with the intensive theoretical research conducted on the relationship between trade and growth, studies on FDI and growth are relatively scarce.

In traditional neoclassical growth models of the Solow (1956) type, with diminishing returns to physical capital, and technological change being exogenous, FDI cannot affect the long-run growth rate. In the absence of international factor mobility, these theories predict that countries with the same preferences and technology will converge to identical levels of income and an asymptotic growth rate. Factor mobility reinforces this prediction. Capital will flow from capital-abundant countries to where it is scarce. In these circumstances, long-run equilibrium is characterized by the equalization of capital labor ratios and factor prices.

The emergence of new growth theories since the mid-1980s shifted attention away from the foci of earlier neoclassical modelling. Whereas neoclassical theory treated technological progress as an exogenous process and focused on capital accumulation as the main source of growth, the new growth theory has focused on the creation of technological knowledge and its transmission. It views innovation and imitation efforts that respond to economic incentives as major engines of growth. Therefore, it emphasizes the role of R&D, human capital accumulation, and externalities (see, e.g., Lucas 1988, Romer 1990).

For a similar reason, technology transfer through trade has become a popular area of research (Krugman 1979). However, the fact that the interrelationship between FDI and growth has not been the subject of intensive studies is a surprising omission in light of the apparent empirical importance of the relationship. Externalities and their impact on long-run growth have been a common element in endogenous growth models. FDI can lead to increasing returns to scale in domestic production through spillovers. Despite the rarity of research in this area, the advent of endogenous growth theory has opened new research avenues to study the channels through which FDI can promote long-run growth.

While primarily dealing with international diffusion associated with the trade in goods, Helpman (1993) briefly discusses the implications of international capital movements in the context of endogenous growth, focusing on how economies of scale interact with free capital movements. He observes that there may be agglomeration effects in capital accumulation where the externality comes from the capital stock. Technology transfer along with foreign investment is an explicit

element in Helpman's discussion. This is done in a rather crude manner in that MNCs and producers in developing countries are identical. Helpman (1993) himself stresses the need for a more thorough treatment of MNCs with respect to growth.

In one of the few exceptions that deal with FDI and growth, Wang (1990) builds a dynamic two-country model to study the interaction between growth and international capital movement. Perfect capital mobility links the two regions. Human capital plays an important role in determining the effective rate of return for physical capital and hence affects the direction and magnitude of international capital movements. With capital moving internationally, the model predicts that the steady-state income gap is narrowed by an increase in the growth rate of human capital and the technology diffusion rate in the less developed country. One message to emerge from the analysis is that opening up to FDI from more advanced countries has important benefits for a developing country. Foreign investment facilitates technological change, and hence increases the rate of income growth.

Walz (1997) incorporates FDI into an endogenous growth framework where MNCs play a critical role with respect to growth and specialization patterns. He extracts the idea of trade-related international knowledge spillovers used in Grossman and Helpman (1991) and applies them to FDI. Production activities of MNCs in the low-wage country improve the efficiency of potential innovations there. The knowledge spillover of MNCs' activities makes innovation in the low-wage country profitable. Allowing for imitation in the less developed country, the indirect transfer of technology through FDI provides the stimulus for active R&D and growth. Therefore, he predicts that policies promoting FDI will lead to faster growth.

Models using the growth theory framework primarily focus on technology transfer from the parent companies to subsidiaries. Technological spillover from a MNC subsidiary to domestic firms is assumed to be proportional to the presence of FDI in the host country. While this sort of epidemic diffusion model offers advantages in allowing one to relate the speed of diffusion to the amount of FDI inflow, the implicit assumption that technology spillover from a subsidiary to domestic firms is automatic is open to question.

III. EMPIRICAL STUDIES OF SPILLOVER

A. Case Studies

Compared to the relatively limited number of theoretical studies on the spillover effect, there is a rich body of empirical literature. Many investigations use case studies to examine individual spillover channels. Gershenberg (1987), Lim and Fong (1982), Mansfield and Romeo (1980), and Rhee and Belot (1990)

are a few examples of these. These studies present mixed evidence on the role FDI plays in generating technology transfer to domestic firms. The study of Rhee and Belot (1990) into Bangladesh and Mauritius suggests that the entry of foreign firms led to the creation of a booming domestic textiles industry. However, in a survey of 15 multinationals, Mansfield and Romeo (1980) found that only a small share of FDI had accelerated the local competitors' access to new technology.

B. Econometric Studies Supporting the Spillover Hypothesis

Studies employing econometric models started to appear from the early 1970s. These econometric studies share some common features. They investigate the relationship between FDI and productivity. Spillovers were considered to exist if a positive correlation between productivity and FDI was found. The dependent variable in these models was labor productivity. The explanatory variables included FDI, factor input, concentration ratio, and labor quality.

In the earliest analysis using econometric techniques, Caves (1974) tested the spillover benefits of FDI in the manufacturing sectors of Australia and Canada. His hypothesis for Canada was that if FDI has the virtue of increasing allocation efficiency, the profit rate of domestic firms should be inversely related to the competitive pressure from foreign firms. The results indicated profit in Canadian manufacturing industries did show a weak tendency to vary inversely to the foreign share. The 1966 data for 23 manufacturing industries enabled Caves to test the determinants of labor productivity in the domestic sectors of Australian industries. Using foreign firms' share of industry employment as a proxy for foreign presence, Caves found a positive correlation between the subsidiary share and the productivity level in competing domestic firms. Globerman (1979) used annual census data for four digit Canadian manufacturing industries in 1972 to conduct a study similar to that of Caves (1974). In Globerman's study, the dependent variable was the labor productivity in domestic manufacturing plants. The FDI variable was measured by the gross book value of depreciable assets at the end of 1971 divided by the total employees in US industries in 1972. The results also provided support for the proposition that spillover efficiency benefits domestic firms.

Most of the empirical studies about developing countries use data from Mexico, which gathers manufacturing data by ownership type. For example, Blomstrom and Persson (1983) carried out their analysis using data for 215 four digit Mexican industries from the 1970 census. They related labor productivity to capital intensity, labor quality, economies of scale, FDI, average effective work days during 1970, and the degree of competition measured by different concentration indices such as the Herfindal index. The study found strong support for the existence of spillover benefits from FDI.

Using data for 230 four digit Mexican manufacturing industries in 1970 and 1975, Blomstrom (1986) tested spillovers based on an efficiency index defined as the ratio between labor productivity and that of the best practice. The independent variables included the Herfindal index; market growth variables; the rate of technological progress, defined as the changes in labor productivity in the best-practice plants within each industry; and foreign share, defined as the share of employees in foreign plants. He found the entry of foreign firms had a significant effect on each industry's average productivity. However, it had no impact on technical progress in the least productive firms in each sector. He interpreted these findings as indicating that foreign entries into Mexico did not speed up technology transfer, but that FDI promoted efficiency by increasing competition.

Blomstrom and Wolff (1989) explored the extent to which the penetration of a sector by foreign-owned firms affects the productivity of local firms in that sector in Mexican manufacturing industries from 1965 to 1984. They also examined whether there is any evidence of convergence between that industry's productivity level and that of the US. The results showed that productivity levels of locally owned firms in Mexico had moved toward those of foreign-owned firms. Further, both the rate of productivity growth of local firms and their rate of catch-up to the multinationals were positively related to the degree of foreign ownership in an industry. The results thus provide support for the spillover hypothesis.

Most studies on spillover effects examine the impact of FDI on domestic firms' productivity growth. Some research tested the spillover hypothesis from a different angle. For example, Blomstrom, Kokko, and Zejan (1994) conducted a study to explicitly test the determinants of technology transfer. Their hypothesis, following Wang and Blomstrom's model, was that market rivalry and the availability of skilled labor may encourage the MNC to introduce more technology into their foreign operations. Using data for Mexican manufacturing firms from 1970 to 1975, they used foreign firms' technology payments abroad to construct a proxy for total technology imports, which makes up the dependent variable. The results reveal that there was a significant relationship between the technology imported by foreign affiliates and the local competitors' investment, output growth, and labor skills. The estimation results thus provided strong support for their hypothesis regarding foreign firms' technology imports. Using data from the manufacturing operations of US MNCs in 33 host countries in 1982, Kokko and Blomstrom (1995) conducted a similar test to examine how the technology imports of the US majority-owned foreign affiliates were related to proxies for the host countries requirement for technology transfer, level of competition, and learning capacities. Their findings also offered support for the hypothesis proposed by Wang and Blomstrom (1992).

Chuang and Lin (1999), employing Taipei, China firm-level data from the 1991 Industrial and Commercial Census, found that FDI, local technology pur-

chase, and outward foreign investment are substitutes for domestic firms' R&D activity. The major policy implications from this study were that governments in developing countries could initially adopt policies encouraging FDI to foster technology transfer and knowledge spillovers. However, once a country's technological capability is established, it appears critical to switch to policies that provide a favorable environment to stimulate R&D investment (for example, infrastructure improvement and protection of intellectual property rights). This point deserves a great deal of attention from a policymaking point of view.

Most attempts to measure the spillover effects of multinational enterprises on host countries have been cross sectional and limited to labor productivity in manufacturing for a single country. Hejazi and Safarian (1999) extended this approach by adding FDI stocks to foreign trade as a channel linking total factor productivity (TFP) levels between countries. Using TFP levels from the period 1971 to 1990, they found three main results: the coefficient estimated for FDI is higher than those for trade; the importance of the trade channel is greatly reduced once FDI is reduced; and overall spillover increases significantly with the inclusion of FDI. Their paper thus argued that technological spillovers are likely to be larger through multinational production and FDI than through international trade. Studies that ignore FDI as a channel of technological diffusion will be flawed in two aspects: the total spillovers will be underestimated, and the importance of international trade will be overestimated.

C. Econometric Studies Contradicting the Spillover Hypothesis

Most studies suggest that foreign presence will create a spillover effect. However, some studies have concluded that no productivity growth can be attributed to FDI, or that FDI may even have a negative effect on domestic firms' output growth.

Aitken and Harrison (1999) estimated the production function of a group of Venezuelan plants. They found that foreign equity participation is positively correlated with plants' productivity (the "own-plant" effect), but this relationship is only robust for small enterprises. When testing for spillovers from joint ventures to Venezuelan firms, however, they found that FDI had an overwhelmingly negative effect on domestic firms' productivity growth. Thus, the gains from foreign investment appear to be entirely captured by joint ventures. They suggested less emphasis should be placed on the spillover effect.

Okamoto (1999) examined the spillover hypothesis using firm-level data for Japanese investment in the US auto parts industry from 1982 to 1992. The study made three major findings. First, contrary to expectation, Japanese-owned firms were found to be less productive than their US counterparts, at least in 1992. Firm-specific technological and/or managerial advantages were not revealed in the US market. Second, US-owned suppliers improved their performance steadily be-

tween 1982 and 1992. Third, technology transfer from Japanese assemblers to US-owned suppliers seems to explain only a small part of their improvement in performance. The improvement in productivity observed in the 1980s and in the early 1990s appears to have been the result of increasing competitive pressure rather than technology transfer. Okamoto (1999), however, did not give a full explanation on the observed contradiction between the spillover hypothesis and the finding.

D. Studies that Differentiate between High and Low Technology Industries

Given the variation in conclusions about FDI and the spillover effect, it is not surprising that more recent studies have attempted to test the differences in spillovers between industries, usually by separating the sample into “high” and “low” technology groups and re-estimating the equation.

Cantwell (1989) found spillovers to be significant in industries where the technology gap between local and foreign firms was low. By analyzing the responses of local firms to the entry and presence of US multinationals in eight European countries from 1955 to 1975, he found the growth rate of output of local firms was catching up only in those industries or countries where local firms already possessed high technology levels. He therefore claimed that technological spillovers mainly took place in local firms that were initially strong, with the weaker local firms either being forced out of business, or confined to the limited segments of the market neglected by MNCs.

Haddad and Harrison (1991) investigated the relationship between productivity growth and FDI in 4,236 firms in Morocco from 1985 to 1989. Using the ratio of foreign assets to total assets at the sector level to proxy FDI, they found that the influence of FDI in reducing the dispersion of productivity was greater in low technology sectors.² They interpreted this as indicating that competition due to FDI was more important in pushing firms toward the best practice frontier than the transfer of technology. Furthermore, spillovers occurred only when the productivity gap between domestic and foreign firms was not too large.

Kokko (1994) argued that the variable findings of earlier studies suggest that host country characteristics may influence spillovers. He conducted a test using the information for 230 four digit Mexican manufacturing industries in 1970. Kokko (1994) demonstrated that spillovers are related to the complexity of MNC technology and the technology gap between locally owned firms and MNC affiliates. The foreign presence, measured by the ratio of foreign plants' employment to total employment in each industry, entered the equation along with other variables related to labor productivity. Kokko (1994) divided the sample into groups with

²They defined the high technology sectors as including machinery, transport, equipment, electronics, scientific instruments, and chemicals.

lower and higher technology gaps. He concluded that spillovers do not generally occur in technologically complex industries. Kokko suggested that efforts to promote FDI by a host government should focus on industries where the local technological capacity is already relatively strong. Kokko, Tansini, and Zejan (1996) later conducted a similar test using data for 159 Uruguay firms from 1988 to 1990 and reached a similar conclusion.

Tsou and Liu (1994) analyzed the relationship between labor productivity, technical efficiency, and the spillover effect based on data from Taipei, China's industrial and commercial census data in 1986 and 1991. They also divided the sample into two groups on the basis of whether they were characterized by a low technology gap or higher technology gap between FDI and local firms. The results confirmed that domestic firms only benefit from spillover effects when their technological capability is not much lower than the foreign counterpart. The implication is that domestic firms should improve their technology capability to be able to maximize the benefits they can derive from spillover.

Liu et al. (2000) examine intra-industry productivity spillovers from FDI in the UK manufacturing sector. They used panel data for 48 industries over the period 1991-1995. They divided local UK firms into two groups: one having a "strong" technological capability, and one having a "weak" technological capability. The model employed a single equation and regressed labor productivity with other variables, such as capital labor ratio, and average size of UK-owned firms. The results indicated that the mere presence of FDI has a positive impact on the productivity of UK-owned firms. It also showed that the extent to which local firms benefit from the introduction of advanced technology depends largely on their own technological capabilities.

E. Assessment of Previous Empirical Studies

Some studies have argued that the link between FDI and productivity might arise from the fact that MNCs pursue higher productivity and capital formation from the outset. The major problem with most existing attempts to measure spillover effects from foreign investment is that they do not investigate the link between FDI and growth in any detail. Although this problem has been recognized by various studies, only a few address it directly. Most regress labor productivity on FDI, which implicitly assumes that FDI is causally prior to, or at least independent of, economic growth. But causation can run both ways. The inflow of foreign investment could potentially react to the vitality of the domestic economy. Bell and Pavitt (1993) observed that FDI has generally been a consequence, rather than a cause of rapid industrialization in developing countries.

Empirical evidence shows that foreign firms increase investment in response to the expansion of sales associated with GDP growth. Bandera and White (1968) found a significant correlation between US FDI to the European Union

(EU) and EU GNP, and concluded that one motive for investing abroad is the desire to penetrate a growing market. In a large sample of developing economies, Renber et al. (1973) found that the flow of FDI into them was dependent on their GDP. Thus, it is possible that there may be a two-way process, with growth being fostered by FDI, and FDI induced by growth, or even a one-way process from growth to FDI. As a result, one could find positive spillovers from foreign investment where no spillover occurs. Most empirical studies have employed the single equation approach, but because of the simultaneity problem, this may affect credible estimates for policy analysis.

Kholdy (1995) employed the Granger-Causality test to investigate the direction of causation between FDI and spillover efficiency in a number of developing countries for the period 1970-1990. His findings do not support the spillover hypothesis, but rather, FDI is attributed to countries with higher factor endowments, an internal market, and more advanced technology in domestic production. The evidence on the direction of causality between FDI and growth highlights the importance of growth as a crucial determinant of FDI inflow.

Another problem with most of these studies is that they apply labor productivity as a proxy for technology. They test for the existence of spillovers by measuring the effect of foreign presence, generally expressed in terms of the share of employment in the foreign firms in each industry's total employment, on labor productivity in local firms. Although labor productivity provides one measure of technological advantage, it is a partial measure that varies with capital intensity as well as the level of other factor inputs.

A third problem is that by ignoring causality, many studies fail to include some important factors in the productivity equation. They emphasized the importance of factor input and labor quality. However, factors such as R&D and trade intensity are often not considered. The results from models that omit important variables are incomplete or misleading.

Many earlier empirical studies did not provide a careful analysis of the underlying causes for the potential negative or positive impact of FDI on domestic firms' productivity. Some more recent studies make useful attempts to tackle this issue by splitting samples into high and low technology groups. The overwhelming finding from these studies is that spillovers are more pronounced in low-tech industries where the technology gap between domestic and foreign firms is low. These conclusions do not support the basic Gerschenkron (1962) assumption used in most theoretical studies and upon which a number of government policies toward FDI are based. While many countries actively encourage the inflow of FDI in high tech industries, the findings of these recent studies suggest that, at least in light of the spillover effects, the benefit may be lower when the technology gap between domestic and foreign invested firms is too wide. Such findings have important implications for policymakers.

Many studies, however, continue to pay insufficient attention to the mechanism through which spillovers take place. In particular, few explore the extent to which the behavior and idiosyncrasies of domestic firms determines the presence and magnitude of spillovers. Furthermore, due to the complexity of this issue, the difficulty in measuring spillovers, and data constraints, most studies focus on examining whether FDI is positively correlated to factors such as labor productivity. Few focus on producing quantitative estimates of the magnitude of spillovers. The spillover effect from FDI thus remains an issue requiring further empirical attention.

IV. FDI STUDIES IN THE PRC

The PRC is a good case study to use in conjunction with the general literature on FDI. The country has attracted an impressive amount of FDI since it embarked on economic reform more than two decades ago. Its utilization of FDI in the context of a relatively controlled introduction of market forces into its economy from 1979 merits careful study, particularly for the possible lessons it holds for other transition economies.

FDI flows into the PRC have attracted a great deal of interest within both academia and policy-making circles. Existing studies on FDI in the PRC can broadly be classified into three categories: those that examine the pattern of FDI in the PRC, those that examine the determinants of FDI in the PRC, and those that assess the impact of FDI on the economy.

A. Studies on Patterns of FDI in the PRC

A large amount of research has been devoted to studying the general profile of FDI in the PRC. Kamath (1990 and 1994) and Pomfret (1991 and 1994) reviewed the experience of the PRC's open door policy and discussed lessons to be drawn from its experience. Eng and Lin (1996) investigated foreign investors' penetration of the PRC economy and their efforts to build a competitive edge for operations in local and international markets. Fukasaku, Wall, and Wu (1994) provided a chronological catalogue and evaluation of the PRC's FDI policy. Chi and Kao (1994) analyzed the general location and industrial distribution, sources, and types of FDI by examining data from a sample of foreign enterprises registered in 1991 over a period of 5 years. Wei (1995) investigated whether the PRC has reached its potential in attracting FDI. Freeman (1994) described the FDI profile by sector and region in the PRC and Viet Nam.

Efforts have also been made to assess the PRC's legal and policy framework. He analyzed the ideological changes behind this, and assessed the legal-institutional framework of FDI in the PRC. Kwon (1989) analyzed the taxation framework for FDI in the PRC. Huang (1995) offered a careful study of FDI in-

flows and related policies. Hayter and Han (1998) discussed the economic dilemmas posed by FDI in the formation of policies. They view the “open policy” as a geopolitical strategy of the government to enhance technological and industrial capability by seeking know-how from MNCs. Zhang (1994) argued that developing country governments can not only activate existing, but also create new, location-specific advantages by analyzing the performance of FDI in the PRC. Potter (1995) reviewed the structure and performance of foreign investment laws and policies. He pointed out that problems and inconsistencies still prevail despite the fact that the PRC’s legal regime for FDI has evolved significantly since 1978 in terms of basic laws relating to contract, taxation, foreign exchange, and other regulations.

B. Studies of the Determinants of FDI in the PRC

In contrast to the large number of studies on the patterns of FDI in the PRC, relatively little research has been done to test the determinants of FDI. Wang and Swain (1995) investigated the determinants of FDI from 1978 to 1982. Using a single equation model, their study demonstrated that market size had a positive effect on FDI inflow, while wage rates and imports had a negative effect. This study is one of the few that applies econometric techniques. However, it was criticized by Matyas and Korosi (1996) for inconsistencies in its numerical results and limited degree of freedom. The model estimated 12 coefficients from 15 observations, leaving only 3 degrees of freedom.

To increase the degree of freedom, Liu et al. (1997) analyzed the determinants of FDI in the PRC based on FDI inflow from 22 countries/regions from 1983 to 1994. Their study showed a positive relationship between the market size variable and FDI inflow, and a negative relationship between the wage rate and FDI inflow. Broadman and Sun (1997) focused on the determinants of geographical and sectoral distribution of FDI in the PRC. These determinants include market size, labor costs, and human capital. The results showed that regional GDP is the most important factor in determining foreign investors’ location choice in the PRC.

Head and Ries (1995) developed a model in which tax incentives, infrastructure, labor costs, and self-reinforcing agglomeration effects determine the location of FDI. Their monopolistic competition model predicts that the arrival of FDI in a city will stimulate entry by local suppliers, creating upstream growth, which, in turn, makes the city more attractive to foreign investors. The hypothesis is supported by estimation results using data on 931 investments in 54 cities from 1984 to 1991.

C. FDI, Technology Transfer, and Growth

It is now commonly agreed that FDI has been beneficial to the PRC's capital formation, output and income generation, and export growth (Lardy 1996, Kueh 1992). Chen, Chang, and Zhang (1995) critically assessed the role of FDI in the PRC since 1978 on GDP, domestic savings, fixed asset investment, foreign trade, and the transition to a market economy. They concluded that FDI had contributed to economic growth by augmenting the resources available for capital formation and by increasing export earnings. In an attempt to analyze the relationship between FDI and growth, Shan et al. (1997) constructed a vector autoregression (VAR) model on the basis of quarterly time series data over the period 1985 to 1996. The results indicated that there is two-way causality between FDI and growth.

Assessments differ over FDI's contribution to technology transfer in the PRC. Huang (1995) stated that FDI introduced advanced technologies. Lan and Yong (1996) studied technology transfer and adaptation in the northeast city of Dalian by interviewing 36 firms, concluding that FDI had transferred advanced technology. However, many others have argued that relatively little advanced technology had been transferred. Kamath 1990, for example, argues that given the preponderance of real estate, commercial, tourism-related FDI, and FDI in labor-intensive manufacturing industries, the major transfer has been low-level technology in areas classified by the government as "nonproductive."

Despite the large number of studies, the relationship between FDI and spillovers in the PRC is far from clearly defined. Work based on in-depth quantitative analysis is scarce due to the difficulties in obtaining data and the complexities of defining the relationships. Most studies are based on intuitive reasoning and are descriptive in nature. There is also a lack of comparative studies between firms in different ownership categories and industries in the PRC. One exception is Pan and Parker (1997), who compared management attitudes in three kinds of firms in the PRC. However, their study was based on only 16 enterprises. The applicability of their conclusions may be limited by the small sample size.

V. FDI AND THE SPILLOVER EFFECT: THE REMAINING ISSUES

The postwar era has witnessed an increasing flow of direct investment across national borders. This has stimulated intense debate and research on the role of FDI on host economies. This has greatly improved our understanding of FDI. However, there are still issues that need to be addressed, both at the policy-making level and the analytical level.

A. FDI Research and Policy Issues

Recent theoretical models not only argued for FDI as a vehicle for technology transfer, but also used rigorous analysis to prove that the learning investment and cost efficiency of MNC affiliates operating locally had a significant bearing on spillover effects. Furthermore, political stability and high growth potential in a host economy will also make MNCs more willing to transfer technology. These conclusions have important policy implications.

While theoretical studies focus on technology transfer from a parent company to its subsidiary, most empirical studies aim to test the hypothesis that FDI leads to technological advancement and improvement in efficiency in domestic firms. Many studies provide evidence that FDI can act as a conduit through which new ideas, technologies, and working practices can be transferred to domestic firms. However, some studies find little evidence of spillover effects from FDI inflow. This mixed empirical evidence suggests that spillover benefits cannot be assumed, but rather, research needs to identify the specific conditions under which spillovers occur.

Some studies have specifically investigated the relationship between the technology gap between MNCs and domestic firms and the spillover effect. Their overwhelming conclusion is that spillovers are strongest in industries where the gap between domestic firms and foreign firms is low. This conclusion does not support policies pursued by many countries in seeking to attract FDI in high-tech industries.

Numerous studies have explored issues relating to FDI inflow in the PRC. They generally confirm that FDI has greatly contributed to the PRC's economic development since the beginning of economic reform. Statistics concurs with these findings. In 1999, FDI firms produced 26.1 percent of gross industrial output, accounted for about 20.0 percent of net fixed capital asset, and generated over US\$10 billion of tax revenue. There were more than 5,500,000 people employed in FDI firms. Export share of foreign-invested firms reached 54.8 percent in 1999. This has greatly enhanced the PRC's position as a trading nation. From 1980 to 1999, the PRC has moved from the 26th largest exporter in the world to the 9th.

The role of FDI in transferring technology to the PRC is more controversial however. While some studies find that FDI transfers technology to the PRC, others state that FDI has not fully met expectations in this regard because FDI is mainly distributed in labor-intensive industries. Given that one important motivation for the government to attract FDI was, and still is, to improve the PRC's overall level of technology, a careful study of the relationship between FDI and technology spillover is needed. In light of the findings from the mixed empirical results, studies of spillovers in the PRC need to be more specifically integrated into domestic policy frameworks and assessments of firms' behavior. Such analysis can shed light on the mechanisms through which spillovers take place and help

to maximize the benefits of FDI to the PRC economy. The lessons to be derived from this exercise will also provide useful indicators on the most appropriate FDI policies to use in other developing countries.

Until now, policy frameworks in most developing countries have tended to focus predominantly on attracting FDI, particularly in high-technology areas. Policy initiatives have largely bypassed measures to enhance spillover benefits from FDI. There are now a large number of studies that suggest it is difficult for domestic firms to extract the benefits of spillovers when a large technology gap exists between domestic and FDI firms. FDI policy should be placed in a broader economic policy context in order for host economies to maximize the benefits they derive from FDI inflow. Policies can play a role by investing in basic infrastructure, education and training, and encouraging domestic firms themselves to invest in technological development and to increase domestic technological capability.

B. Areas for Future Research

Existing studies have greatly improved our understanding of the role of FDI in host economies. However, there are still lacunae that need to be addressed by future research. Most of the existing theoretical models focus on technology transfer from a parent company to its subsidiary, while spillovers from a subsidiary to domestic firms have been assumed to be automatic. Moreover, most studies incorporate the Gerschenkron (1962) assumption, which considers that the greater the relative disparity in technology level between firms/countries, the faster spillover takes place. Empirical studies suggest this may not be a valid assumption. FDI has not been given an important role in the literature pertaining to growth theory. More rigorous theoretical work is needed to explore the relationships between FDI and spillovers, FDI and domestic firms, and the role of FDI in promoting growth.

At the empirical level, many studies suffer from the problem of omitted variables. The vast majority of studies employ a single equation OLS model to regress labor productivity on FDI. The possible two-way causality between FDI and productivity growth is ignored. More importantly, few provide careful analysis of the underlying influences on the impact of FDI on domestic firms' productivity, or examine under what conditions spillover benefits are most pronounced. More work is needed on the process of technology spillovers from FDI, in particular, to evaluate the mechanisms through which spillovers operate.

While the literature on FDI in the PRC has grown rapidly, most is of a descriptive nature. Because of methodological difficulties and the lack of data, little empirical investigation has been conducted to analyze the relationship between FDI and domestic firms. Comprehensive analyses need to not only study the behavior of FDI firms, but also domestic firms and institutions. Careful theoretical investigation, empirical analysis, and detailed case studies will all strengthen our understanding of the impact of FDI on the PRC economy.

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