Does Foreign Direct Investment Benefit Domestic Companies via Increased Productivity: Horizontal, Backward, and Forward Linkages

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Working Paper Series Vol. 2006-07
May 2006

The International Centre for the Study of East Asian Development, Kitakyushu

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Abstract

While the literature has explored the relationship between FDI and productivity, a consensus has yet to be reached regarding FDI's impacts on the productivity of domestic companies in host countries. This paper expands upon the findings of previous works by introducing endogenous input decision-making and vertical linkages across industries. The analysis shows that, on average, FDI improves domestic companies' productivity through the horizontal and backward channels, but does not affect the increase in productivity of domestic companies through forward linkage. Additionally, the mechanisms of backward spillovers vary depending on industry's structure.

JEL classification: F2; O1; O3

Keywords: FDI; Productivity; Technology spillovers

We acknowledge comments and suggestions by Li Ming Dong and seminar participants at the ICSEAD, etc., and thank Molly Sherlock and Terence Fung for their research assistance. The first author acknowledges financial support from the Research Foundation of the City University of New York and the second author from the ICSEAD. We also would like to thank to Eric Ramstetter for providing the industry survey data of Thailand and Robert Lipsey for his support for this project. All errors are ours.

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1. Introduction

Does Foreign Direct Investment (FDI) really assist host countries in achieving development? International organizations advocate access to the global economy via foreign direct investment, specifically for developing countries. Anti-globalization movements do not necessarily agree that foreign direct investment positively influences host countries. Self-interested, multinational companies may exploit a host country's resources, impairing subsequent development. For the purposes of long-run economic growth, it may be better to protect domestic infant industries rather than rely on foreign capital. Industrial policy regarding FDI is one of the major policy debates faced by the World Bank and IMF today.

This paper studies whether FDI benefits domestic companies in host countries via increased productivity. The literature has explored the impacts of FDI on domestic companies' productivity (see Görg and Strobl (2001) for a survey). Caves (1974) on Australia, Globerman (1979) on Canada, and Blomström and Persson (1983) on Mexico are seminal empirical studies. More recent works include Kokko (1994) on Mexico and Blomström and Sjöholm (1999) on Indonesia; both use cross-sectional analysis. Haddad and Harrison (1993) on Morocco and Aitken and Harrison (1999) on Venezuela employ firm-level panel data analysis. In spite of the multitude of studies conducted, the literature has yet to reach a consensus regarding the impacts of FDI on domestic companies' productivity.

We expand upon the findings of previous works by uniquely incorporating two new elements to the analysis. One is endogenous input decision-making. The other is vertical linkages across industries. The regressions in the aforementioned literature treat inputs as exogenous variables. However, input levels do vary with firm-specific characteristics. For example, firms with positive productivity shocks may use more inputs. The literature studies the potential correlation between input levels and firm-specific productivity shocks in estimating production functions (e.g., Griliches and Mairesse, 1995). Ignoring the possibility that input choice may be endogenous could bias coefficient estimates. Problems might arise when analyzing FDI's productivity spillover on domestic companies. Our analysis incorporates input endogeneity by using estimation methods proposed by Levinsohn and Petrin (2003).[1]

The literature to date has studied only horizontal spillovers (or intra-industry spillovers). Specifically, previous empirical studies examine whether the presence of multinational companies affects the productivity of domestic companies operating in the same sector. Theoretical works discuss FDI's

[1] The literature often uses the estimation procedure proposed by Olley and Pakes (1996) in order to handle the simultaneity problem (or endogenous input decision-making). Keller and Yeaple (2003) and Javorcik (2004) introduce Olley and Pakes' method into their analysis on FDI's productivity spillovers. Olley and Pakes' method is applicable to plants with non-zero-investment. We need to truncate plants without investment from sample in order to use Olley and Pakes' method. Levinsohn and Petrin propose alternative method that is applicable to the situation in developing countries, where many plants report no investment.

spillover effects via vertical linkages (Rodorigues-Clare, 1996; Markusen and Venables, 1999). Thus, we examine whether FDI affects the productivity of domestic suppliers that sell intermediate goods to the industrial sector. The final component of our analysis looks at the productivity of domestic companies that purchase intermediate goods from the industrial sector. To date, Javorcik (2004) is the only published empirical work that incorporates both endogenous input decision-making and inter-industry productivity spillovers (or vertical spillovers). Using firm-level panel data from Lithuania, Javorcik demonstrates that FDI has positive spillover effects on the productivity of intermediate goods suppliers. We examine whether the results hold when applied to a country with different characteristics, particularly Thailand. Thailand has experienced success under a policy of FDI-led growth, making the country relevant for analyzing the FDI's impacts on productivity spillovers.[2]

The analysis uses plant-level panel datas from an industrial survey from 1998 to 2000. The survey was conducted by the National Statistical Office (NSO) of Thailand. Our analysis focuses on the time period after the East Asian Crisis of 1997, when Thailand experienced a large increase in FDI inflows. The results show that, on average, FDI improves domestic companies' productivity in the same sector as well as in upstream sectors, but does not affect the productivity of domestic companies in the downstream sector. We further investigate FDI's impacts by comparing the results from two sub-samples: industries with large and small foreign shares. It turns out that horizontal and backward spillovers operate only in small foreign share industries. In large foreign share industries, even the effects of horizontal spillovers disappear once we control for the market inefficiency. Domestic companies in small foreign share industries (where multinational companies are not dominant) may learn from multinational companies. Technology spillovers may not operate after multinational companies force inefficient domestic companies to exit, leaving the multinationals to dominate. The final piece of our analysis, allowing for endogenous input decision-making, indicates that domestic companies enjoy backward spillovers due to increased demand for intermediate goods. However, technology improvements are not observed.

The paper proceeds as follows. In Section 2, we summarize the data used for the analysis. Section 3 describes the empirical model used for studying productivity spillovers. Results of the analysis are presented in Section 4. Section 5 concludes the paper and suggests future lines of research.

[2] Thailand has welcomed FDI since the 1960s. However, FDI inflows into Thailand began to increase significantly in 1988. It was during this time that the government shifted its trade policy from import substitution, as was typical in the 1960s and 1970s, to export promotion which prevailed throughout the 1980s. Correspondingly, the economic growth rate increased from 5.9% (the average rate between 1980 and 1987) to 9.1 % (the average rate between 1988 and 1995). More recently, Thailand experienced another large increase in FDI after the Asian Financial Crisis. This paper considers the more recent FDI intensive time period.

2. Data

We use a plant-level panel dataset from an industrial survey conducted by the National Statistical Office (NSO) of Thailand between 1999 and 2001. The NSO conducted surveys on manufacturing establishments by using the combination of stratified sampling and systematic sampling. The NSO stratified establishments in each province according to industry codes and the number of workers. Then samples were selected from each province-industry-worker stratum using systematic sampling. The samples cover nearly half of the establishments operating in Thailand and, thus, represent Thailand companies from various industries and sizes. The survey provides information on ownership, output, labor, capital, material and electricity costs, location, and industrial classification. The survey provides information on the prior years date (e.g., the 2001 survey provides 2000 data). The analysis examines Thailand manufacturing from 1998-2000. The inflow of FDI increased rapidly during the period, making this specific time period particularly relevant for analyzing technology spillovers. Figure 1 shows FDI inflows into Thailand from 1985-2000. Thailand experienced a large increase in FDI inflows after 1997. Our analysis focuses on the period after the East Asian Crisis of 1997.[3]

Other data sources include the Bank of Thailand and the National Economic and Social Development Board of Thailand (NESDB). We deflate variables using industry specific price indices obtained from the Bank of Thailand (see Appendix). The base year is 2000. Additionally, the regression analysis requires information on input-output tables and depreciation rates of capital. We obtain the information from the NESDB.

Table 1 presents the sample's summary statistics. We have 13,766 observations (about 4,500 plants in each year) after eliminating outliers and establishments with missing variables. The sample includes 23 industries at the 2-digit ISIC level. A comparison of our sample with that of Javorcik (2004) highlights where we expect to find different outcomes. The presence of multinational companies within the same industry is more dominant in Thailand. The mean horizontal value is 0.48 in Thailand, while the mean horizontal value is 0.19 in Lithuania. Multinational companies in Thailand bought more intermediate goods from upstream industries as compared to multinationals in Lithuania. However, the ratio of multinationals that sold their goods to downstream industries is similar in both countries. The mean backward and forward values are both 0.09 in Thailand. In Lithuania, the mean backward value is 0.05 and the mean forward value is 0.07. Other differences include the trend of FDI by sector. In Lithuania, the food and textile sectors attract a large share FDI, while the majority of FDI flows into the electrics and transport machinery sectors in Thailand. The origin of FDI is another interesting aspect worthy of note. Table1-2 shows the trend of FDI by source countries. Japanese multinational companies

[3] Table 1 shows a significant increase in FDI from 1997 onward. We use a plant-level panel dataset between 1998 and 2000. 1997 plant-level panel dataset is not available.

are dominant in Thailand. FDI come from countries geographically closer to the one where the investment was taking place. The following empirical analysis proves useful in examining whether these differences affect FDI's impacts on productivity spillovers.

3. Model

We use the following model to examine the impacts of FDI on domestic companies' productivity:

$$\begin{aligned} \ln Y_{ijrt} &= \beta_0 + \beta_1 \ln K_{ijrt} + \beta_2 \ln L_{ijrt} + \beta_3 \ln M_{ijrt} + \beta_4 \ln F_{ijrt} + \beta_5 Foreign_{ijrt} \\ &+ \beta_6 Horizontal_{jt} + \beta_7 Backward_{jt} + \beta_8 Forward_{jt} + HHI_{jt} + \alpha_t + \alpha_r + \alpha_j + \varepsilon_{ijrt}. \end{aligned} \quad (1)$$

Output, Y_{ijrt}, is the real output of firm i in industry sector j in region r at time t. The output is calculated by deducting sales for changes in inventories of finished goods and taxes. The first of the four input variables is capital, K_{ijrt}, measured as the value of fixed assets at the beginning of the year. The second input, labor, L_{ijrt}, is the number of workers. Materials, M_{ijrt}, is the value of material inputs. Finally, F_{ijrt}, is firm i's electricity expenses. $Foreign_{ijrt}$ is an indicator variable for foreign capital, taking a value of 1 if firm i contains foreign equity and 0 otherwise.[4]

We examine horizontal and vertical linkages between domestic companies' productivity and foreign direct investment by using the following time-variant, sector specific variables. $Horizontal_{jt}$ measures intra-industry spillovers. We calculate an average foreign presence in sector j at time t by using the weight of firm i's output to total output in the sector to which firm i belongs. The weight captures the magnitude of firm i's effects on other companies in the same sector:

$$Horizontal_{jt} = \left(\sum_i Foreign_{it} * Y_{it} \right) \Big/ \sum_{i \in j} Y_{it} .$$

$Backward_{jt}$ measures spillover effects on domestic companies that supply intermediate goods to the same industry sector j:

$$Backward_{jt} = \sum_k \alpha_{jk} Horizontal_{kt} ,$$

[4] It would be more appropriate to use the share of foreign investors among firm i's total equity. Unfortunately, the survey does not provide this information.

where α_{jk} is the share of sector j 's output supplied to sector k. This measure excludes goods supplied for final consumption, imports of intermediate goods, and inputs supplied within the sector. $Forward_{jt}$ measures spillover effects on domestic companies that purchase intermediate goods from the same industry sector j :

$$Forward_{jt} = \sum_{m} \sigma_{jm} \left(\left(\sum Foreign_{it} * Y_{it} \right) / \sum Y_{it} \right).$$

In the equation above, σ_{jm} is the share of inputs that industry j bought from industry m among sector j 's total input purchases.[5] Inputs purchased within the sector are not included.

FDI affects domestic companies' productivity through two different channels. The first is knowledge spillovers. Domestic companies learn how to employ superior technologies already used by multinational companies. The second is an efficiency improvement via structural changes in the market. The entry of multinational companies will cause more competition in the host country, which may induce domestic companies to operate more efficiently. The literature shows that market competition is positively correlated with productivity (Nickell, 1996). Following Javorcik (2004), we include the Herfindahl index, HHI_{jt}, which measures industry concentration.[6] This term aims to separate the effects of changes in the market structure from knowledge spillovers.

Other terms incorporate unobservable factors that may influence output levels. Year fixed effects, α_t, are time varying elements that affect all regions and industries in a given year. Regional fixed effects, α_r, are time and sector invariant elements that differ across regions. For example, higher quality infrastructure in a particular region would be controlled for with a regional fixed effect. Industry fixed effects, α_j, capture time and region invariant elements that differ across industries.

The Simultaneity Problem

Estimating equation (1) using least squares assumes that production inputs are exogenous. However, decisions regarding input usage are endogenous if the levels of inputs used vary with firm-specific characteristics. Firms may use more inputs if firms experience positive productivity shocks. The

[5] Firms can export their goods. Intermediate goods sold to the foreign market may not cause spillover effects on domestic companies. It seems to be desirable to exclude these goods in calculating the value of forward spillovers. Unfortunately, our data do not contain enough information to allow for this distinction.

[6] The index is calculated as the sum of squared market shares of the four largest producers in a given sector.

literature has studied the potential correlation between input levels and firm-specific productivity shocks in estimating production functions [see the seminal work by Marshack and Andrews (1944) and recent work by Griliches and Mairesse (1995)]. This simultaneity problem violates the conditions under which ordinary least square methods will obtain unbiased and consistent estimates. The problem may be more severe for inputs that adjust quickly (Marshack and Andrews, 1944).

Previous works often use the semiparametric estimation procedure proposed by Olley and Pakes (1996) in order to handle the simultaneity problem. Olley and Pakes use investment to control for correlation between input levels and unobserved firm-specific productivity shocks in estimating the parameters of the production functions. Olley and Pakes' method is only applicable to plants reporting non-zero-investment. Unfortunately, many plants in developing countries do not report positive levels of investment. In our sample, nearly two-third of firms do not have investment greater than zero. In order to use Olley and Pakes' method we would need to truncate the sample. Truncating these firms changes the nature of the sample, which can be avoided in this case.

Levinsohn and Petrin (2003) propose an alternative method, using intermediate inputs such as electricity to address the simultaneity problem.[7] The method allows the analysis to proceed without reducing the sample size. Another benefit to Levinsohn and Petrin's method is it's applicability to non-convex adjustment cost cases. Non-convexity occurs when adjustment costs cause kinked points in the investment demand functions. Plants may not respond to productivity shocks (Levinsohn and Petrin, 2003, p.318).

Our analysis uses a semiparametric estimation by referring to Levinsohn and Petrin (2003). Let us provide a step-by-step exposition of the estimation procedure. Consider the following production function:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_f f_{it} + \omega_{it} + \eta_{it}, \tag{2}$$

where y_{it} is output, l_{it} is labor, k_{it} is capital, m_{it} is material input, and f_{it} is electricity expenses of firm i at time t. All terms are measured in logarithm units. We assume that labor, materials, and electricity expenses are variable inputs that can adjust instantly. Capital is assumed to be a fixed input that requires time to adjust. The firm selects variable inputs and a level of investment, i_{it}, at the beginning of every period. Capital accumulates according to $k_{it+1} = (1-\delta)k_{it} + i_{it}$, where δ is the rate of depreciation. Thus, capital is a state variable that the firm controls. The error term is additively separable,

[7] Another method is Blundell and Bond's (2000) GMM estimator. The method uses lagged inputs and is not applicable to our short time-series sample.

composed of an index of the firm's efficiency (or productivity), ω_{it}, and a measurement error, η_{it}. The firm chooses input levels based on productivity and, thus, ω_{it} is a state variable. The index, ω_{it}, is observed by the firm, but it cannot be observed by econometricians. Since input levels are correlated with productivity, ordinary least square methods yield biased coefficient estimates. The error, η_{it}, is not forecastable when the choice of inputs is made and, thus, does not affect the firm's input decisions.

We use electricity expenses to control for correlation between input levels and unobserved firm-specific productivity shocks in estimating the production function's parameters. In the model, electricity expenses are a function of the two state variables, $f_{it} = f_{it}(\omega_{it}, k_{it})$. This function is assumed to be strictly increasing in ω_{it} for any k_{it}. This implies that a positive productivity shock leads to more input usage. This monotonicity assumption allows us to express unobserved productivity, ω_{it}, using observable electricity expenses, f_{it}, and capital, k_{it}, as $\omega_{it} = \omega_{it}(f_{it}, k_{it})$. Using this, we rewrite (2) as

$$y_{it} = \beta_l l_{it} + \beta_m m_{it} + \varphi_{it} + \eta_{it}, \text{ where } \varphi_{it} = \beta_0 + \beta_k k_{it} + \beta_f f_{it} + \omega_{it}(f_{it}, k_{it}). \qquad (3)$$

We follow three steps to estimate the production function. First, estimating (3) provides consistent estimates of the coefficients on labor and materials. The estimation procedure requires specifying the unknown functional form of φ. We approximate the function of φ using a third-order polynomial expansion in electricity expenses and capital. Next, we consider the following expectation to identify the coefficients on capital and electricity expenses:

$$E[y_{it+1} - \beta_l l_{it+1} - \beta_m m_{it+1} \mid k_{it+1}] = \beta_0 + \beta_k k_{it+1} + \beta_f f_{it+1} + E[\omega_{it+1} \mid \omega_{it}]. \qquad (4)$$

We assume that ω_{it} follows a first-order Markov process. Let innovation in productivity over last period's expectation be $\xi_{it+1} = \omega_{it+1} - E[\omega_{it+1} \mid \omega_{it}]$. Denote $g(\omega_{it}) = \beta_0 + E[\omega_{it+1} \mid \omega_{it}]$. The production function is rewritten as

$$y_{it+1} - \beta_l l_{it+1} - \beta_m m_{it+1} = \beta_k k_{it+1} + \beta_f f_{it+1} + g(\varphi_{it} - \beta_k k_{it} - \beta_f f_{it}) + \xi_{it+1} + \eta_{it+1}. \qquad (5)$$

Estimating (5) provides consistent estimates of the coefficients on capital and electricity expenses. In the procedure, we substitute the estimates of β_l, β_m and φ into (5) and approximate the unknown functional form of g using a third-order polynomial expansion of $\varphi - \beta_k k - \beta_f f$.

Finally, the production function is estimated. From the production function, we calculate a measure of total factor productivity as the difference between the actual output and predicted output:

$$TFP_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_f f_{it}. \quad (6)$$

We conduct the analysis by regressing the TFP measure on the variables in Equation (1).

4. Results of the Analysis

Table 3 shows the results of estimating Equation (1). Columns (1)-(2) show the results using the whole sample. Columns (3)-(6) present the results using sub-samples, where we stratify the sample based on industry's foreign share. The analysis corrects standard errors for clustering within industry-year cells as in Javorcik (2004). We study the effects of aggregate variables (the time-variant, sector specific horizontal and vertical variables) on micro units (the real output of individual firm). Previous works show that analysis without correcting for correlation among observations within the same group understates standard errors of coefficient estimates and, thus, leads to overestimated t-statistics (e.g., Moulton, 1990).[8]

The analysis indicates that domestic companies could benefit from foreign direct investment. In Columns (1)-(2), the estimates of horizontal spillovers are positive at a statistically significant level. The higher the within industry foreign presence, the higher is the productivity of domestic companies. Similarly, the coefficients of backward spillovers are estimated to be positive. While the estimates are not at statistically significant at conventional levels, the results are suggestive of (very) weak backward spillovers. The estimates of forward spillovers are negative and are not statistically significant. The presence of multinational companies does not affect the productivity of domestic companies in the downstream sector. These results are not sensitive to the inclusion of the Herfindahl index (see Column 2).[9]

We obtain results similar to those in the literature. Javorcik (2004) estimates backward spillovers to be positive and forward spillovers to be negative but not statistically significant. The latter result is intuitive. We often observe that multinational companies go abroad to explore markets for final products and seldom sell their products to downstream sectors. Additionally, the manufacturing industry in Thailand experiences horizontal technology spillovers. The result is consistent with that of Takii (2005).

[8] The literature, such as Kloek (1981), Greenwald (1983), and Moulton (1986), shows that "the magnitude of the downward bias for the standard errors increases with the average group size, the intraclass correlation of the disturbances, and the intraclass correlations of the regressors (Moulton, 1990, p. 335)."

[9] The coefficient of the Herfindahl index is estimated to be negative. The result agrees with the findings in the literature (e.g., Nickell, 1996). Productivity is negatively correlated with a less competitive market. While we obtain the predicted sign, the coefficient is not estimated to be statistically significant level.

He studies Indonesian manufacturing industry, although his study includes only horizontal spillovers, not backward or forward spillovers.

Table 4 shows the results adjusting for endogenous input decision-making (i.e., the results from estimating Equation (6)). Columns (1)-(2) show the results using the whole sample. Columns (3)-(6) present the results from sub-samples, where the sample is stratified based on industries' foreign share. The results obtained here are similar to those obtained previously. Forward spillovers are estimated to be negative and are not statistically significant. The degree of the impacts is also similar. However, backward spillovers increase in magnitude (e.g., from 31.7 percentage points in Column (1) of Table 3 to 39.9 percentage points in Column (1) of Table 4). Although still not significant at conventional levels, the estimates improve statistical significance under the later specification. It is possible that, on average, domestic suppliers can benefit from the presence of multinational companies, although the relationship cannot be established at a statistically significant level.

Columns (3)-(6) in Table 3 present the results using the sub-sample. We stratify the sample into two sub-samples: industries with a large foreign share and industries with a small foreign share. We classify industries as being industries with a large foreign share if the mean foreign share index of an industry is greater than 10%. Industries are classified as being industries with a small foreign share if the mean foreign share value of an industry is less than 10%. Large foreign share industries include "Manufacture of radio and television, office, accounting and computing, coke and refined petroleum products," and small foreign share industries include "Manufacture of food products and beverages, tobacco products, and wood products, and Publishing." The analysis examines whether there are differences regarding productivity spillovers between the two groups.

Table 3 shows that spillover effects operate only in small foreign share industries. Columns (3)-(6) show that in industries with a small foreign share, the coefficients of horizontal and backward spillovers are estimated to be positive at statistically significant levels. However, the coefficient of backward spillovers is not statistically significant in industries with a large foreign share. Also, the coefficient of horizontal spillovers shows a weak relationship (the p-value is 0.15) in large foreign share industries. The results imply that productivity spillovers operate both horizontally and backwardly in the industries where multinational companies are not dominant. It is possible that domestic companies in these industries have greater potential for learning from multinational companies. Another feature is that the coefficient of horizontal spillovers is no longer statistically significant in large foreign share industries, once the analysis includes the HHI (Column 4). The estimated coefficient of HHI is positively related to the output level, implying that domestic companies in less competitive markets are more productive. A less competitive market may be the result of multinational companies entering these industry sectors and forcing inefficient domestic companies to exit the market. Contrasting the results in Columns (3)-(6), the exit of inefficient domestic companies caused productivity improvement in large foreign share industries. Productivity spillovers do not operate after multinational companies eliminate inefficient domestic companies and dominate the market.

Columns (3)-(6) in Table 4 show the results of the sub-sample adjusting for endogenous input decision-making. We obtain similar results to those found in large foreign share industries. No productivity spillovers are observed via either horizontal or forward linkages. However, the results in small foreign share industries change regarding backward spillovers. The effects disappear once we adjust for endogenous input decision-making. A possible interpretation is that the entry of multinational companies increased demand for intermediate goods. Thus, the analysis using exogenous input decision-making indicates a positive correlation regarding backward spillovers. Domestic companies enjoyed productivity improvements due to increased demand for intermediate goods but not due to technology improvement. Additionally, the coefficient on backward spillovers in large foreign share industries changes sign, becoming positive. The coefficient on backward spillovers shows a weak relationship after adjusting for endogenous input decisions. While the impacts are not statistically significant, FDI seems to benefit domestic companies in the upstream location. In large foreign share industries, multinational companies may establish facilities for not only final goods but also intermediate goods. The situation requires that local companies compete with multinational affiliates by improving their production technology. It is possible that such competition helps to improve the productivity in large foreign share industries. The productivity improvement does not result from increased demand for intermediate goods.

5. Concluding Remarks

This paper studies the impacts of FDI on domestic companies' productivity. Although numerous attempts have been made to study productivity spillovers, the issue of the impacts of FDI on domestic companies' productivity remains unresolved. Our exposition is distinct, since we introduce endogenous input decision-making and vertical linkages across industries into the analysis of previous works. The importance of these two factors has been acknowledged in the literature on productivity spillovers in recent years. To date Javorcik (2004) is the only publication to incorporate both effects. We examine whether her results hold in other countries with different characteristics, when using a different estimation method. The method is more appropriate to the situation in developing countries.

The results show that, on average, FDI improves domestic companies' productivity in the same and upstream sectors, but does not affect the productivity of domestic companies in the downstream sector. The results are similar to the Lithuania case presented in Javorcik. We further investigate FDI's impacts by comparing the results from two sub-samples: industries with large and small foreign shares. Both horizontal and backward spillovers turn out to operate only in small foreign share industries. Domestic companies in small foreign share industries enjoy backward spillovers due to increased demand for intermediate goods, but not from technology improvements.

This analysis provides governments with potentially useful information for industrial policy regarding FDI. Hosting FDI could benefit domestic companies via increased productivity, specifically companies in sectors where multinational companies are not dominant. Additionally, FDI could be beneficial to upstream sectors. Of course, the analysis is by no means complete. We acknowledge that selection bias may be present. The exit of poorly performing firms increases productivity. However, our data includes only surviving firms. Olley and Pakes (1996) propose an estimation method to resolve this issue using balanced panel data. Unfortunately, the National Statistical Office of Thailand does not collect data on the same establishments year after year, and, thus, does not track the exit (and entry) of establishments. Our panel data sources are unbalanced. It is also difficult to identify establishments in the current data set since the survey does not provide an identification code. Our analysis attempts to incorporate a part of the selection problem by using the Herfindahl index, as in Javorcik. The availability of rich data sets will improve the accuracy of the analysis.

The analysis presented here does provide support for the following insight: FDI's impacts on domestic companies' productivity vary at different stages of industrial development. FDI benefits domestic companies in the same sector and in the upstream sectors in the initial stage, where multinational companies are not dominant. Domestic companies in the same sector may learn from multinational companies' advanced technology. The presence of multinational companies may cause increased demand for intermediate goods. This increased demand results in backward spillovers. At the second stage, when multinational companies come to dominate, domestic companies in the same sector do not enjoy a productivity increase via the same channel. This is true for domestic companies in the upstream sectors. However, backward spillovers may operate via a different channel. Domestic companies need improve upon existing production technologies in order to provide higher quality intermediate goods to downstream sectors, where multinational companies have high standards for their inputs. While the current dataset does not allow us to explore these questions, all of these topics represent potential future lines of research.

References

1. Aitken, B.J. and Harrison, A. 1999. Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. *American Economic Review* 89 (3): 605-618.
2. Blalock G. and P.J. Gertler. 2004. Firm capabilities and technology adoption: evidence from foreign direct investment in Indonesia, mimeo, Cornell University.
3. Blomström, M. and Persson, H. 1983. Foreign investment and spillover efficiency in an underdeveloped economy: evidence from the Mexican manufacturing industry. *World Development* 11: 493-501.
4. Blomström, M. and Sjöholm, F. 1999. Technology transfer and spillovers: Does local participation with multinationals matter? *European Economic Review* 43: 915-923.
5. Blundell, R. and S. Bond. 2000. GMM Estimation with persistent panel data: An application to Production functions. *Econometric Reviews* 19(3): 321-340.
6. Caves, R.E. 1974. Multinational firms, competition, and productivity in host-country markets. *Economica* 41: 176-193.
7. Globerman, S. 1979. Foreign direct investment and "spillover" efficiency benefits on Canadian manufacturing industries. *Canadian Journal of Economics* 12: 42-56.
8. Görg, H. and E. Strobl. 2001. Multinational companies and productivity spillovers: A meta-analysis. *Economic Journal* 111: F723-F739.
9. Greenwald, B.C. 1983. A general analysis of the bias in the estimated standard errors of least squares coefficients. *Journal of Econometrics* 22: 323-338.
10. Griliches, Z. and J. Mairesse. 1998. Production functions: The search for Identification. In *Econometrics and Economic Theory in the Twentieth Century: The Ragnar Frisch Centennial Symposium* (Cambridge University Press): 169-203.
11. Haskel, J.E., Pereira, S.C. and Slaughter, M.J. 2002. Does inward foreign direct investment boost the productivity of domestic firms? NBER working paper 8724.
12. Javorcik, B.S. 2004. Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages, *American Economic Review* 94(3): 605-627.
13. Keller, W., and Yeaple, S.R. 2003. Multinational enterprises, international trade, and productivity growth: firm level evidence from the United States. NBER working paper 9504.

14. Kloek, T. 1981. OLS estimation in a model where a microvariable is explained by aggregates and contemporaneous disturbances are equicorrelated. *Econometrica* 49: 205-207

15. Kokko, A. 1994. Technology, market characteristics, and spillovers. *Journal of Development Economics* 4: 279-293.

16. Levinsohn J. and A. Petrin. 2003. Estimating Production Functions Using Inputs to Control for Unobservables. *Review of Economic Studies* 70: 317-341.

17. Markusen, J.R. and A.J. Venables, 1999. Foreign Direct Investment as a catalyst for industrial development. *European Economic Review* 43(2): 335-56.

18. Marschak, J. and W.H. Andrews. 1944. Random simultaneous equations and the theory of production. *Econometrica* 12 (3, 4): 143-205.

19. Moulton, B. 1986. Random group effects and the precision of regression estimates. *Journal of Econometrics* 32, 385-397.

20. Moulton, B. 1990. An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units. *Review of Economics and Statistics* 72(2), 334-338.

21. National Statistical Office. Various Years. Report of the Manufacturing Industrial Survey, Whole Kingdom. Bangkok: National Statistical Office.

22. Nickell, S. 1996. Competition and Corporate Performance. *Journal of Political Economy* 104: 724-746.

23. Olley, G. S. and A. Pakes. 1996. The Dynamics of Productivity in the Telecommunications Equipment Industry, *Econometrica* 64(6): 1263-1297.

24. Pakes, A. 1994. Dynamic structural models, problems and prospects Part II: Mixed continuous-discrete control problems, and Market interactions, in *Advances in Econometrics*, ed. By C. Sims. Cambridge: Cambridge University Press.

25. Rodriguez-Clare, A. 1996. Multinationals, linkages, and economic development, *American Economic Review* 86(4): 852-873.

Figure 1-1: Net Foreign Direct Investment by Sector in Thailand

(US$ million)

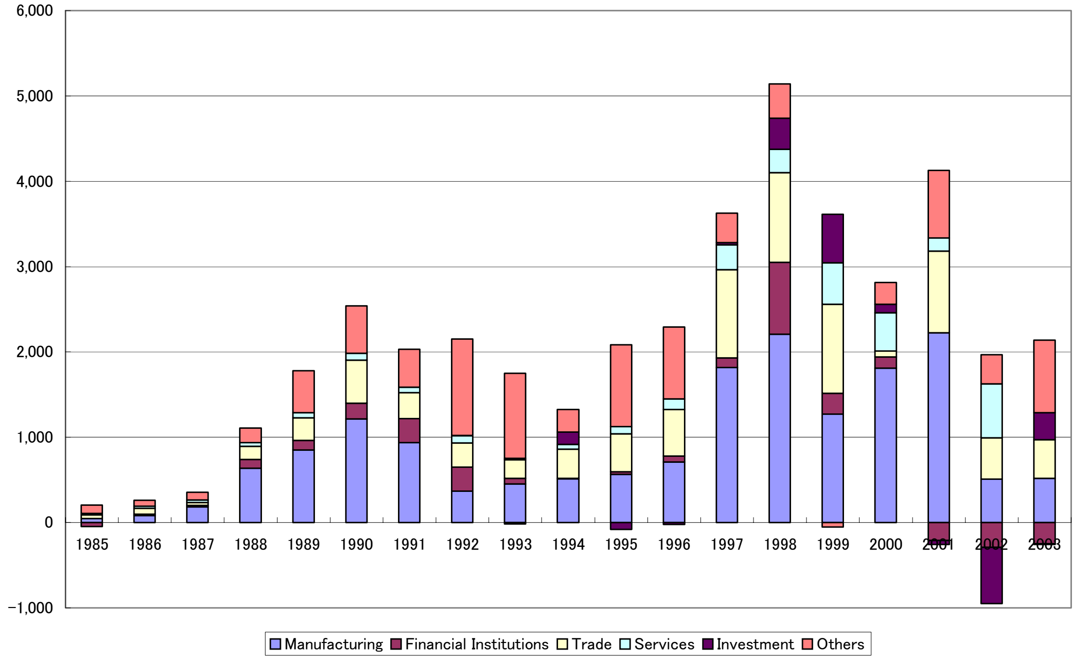
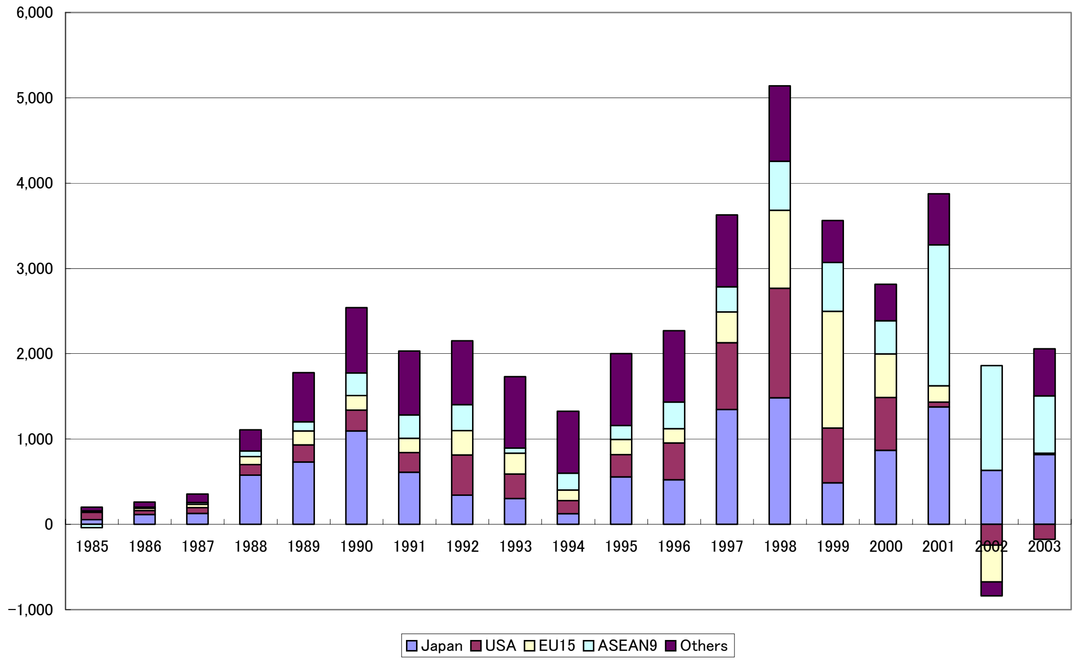


Figure 1-2: Net Foreign Direct Investment by Country in Thailand

(US$ million)



Source: Bank of Thailand, Balance of Payment Data
(http://www.bot.or.th/bothomepage/databank/EconData/EconFinance/index03e.htm)

Table 1 Summary Statistics

	Mean	Std. Dev.
Foreign	0.127	0.332
Horizontal	0.478	0.220
Backward	0.095	0.111
Forward	0.094	0.065
Herfindal	0.060	0.101
log(Output)	2.408	2.187
log(Capital)	2.055	2.024
log(Labor)	3.496	1.354
log(Material)	1.936	2.391
log(Electricity)	10.812	2.171
log(TFP)	0.257	0.488
Sample size	13766	

Table 2 Spillover Variables and Characteristics of Industries

		2000							Change in 1998-2000				
		MNC	Local	Share	HOR	BAC	FOR	H4	Share	HOR	BAC	FOR	H4
15	Manufacture of food products and beverages	94	1240	7.0	39.1	0.3	5.6	0.89	0.64	7.18	0.00	1.31	0.07
16	Manufacture of tobacco products	4	77	4.9	5.3	0.0	1.6	89.01	3.00	-45.40	0.00	-0.37	-73.37
17	Manufacture of textiles	45	286	13.6	56.1	13.1	8.9	5.63	0.68	7.98	-13.23	-1.34	-4.17
18	Manufacture of wearing apparel dressing and	13	120	9.8	30.8	0.6	29.2	7.12	-5.55	-37.54	-0.04	4.44	-2.61
19	Tanning and dressing of leather manufacture of	17	110	13.4	9.3	0.4	12.3	2.99	1.16	-4.35	0.03	-2.04	-1.11
20	Manufacture of wood and of products of wood	8	174	4.4	10.8	12.4	5.1	2.93	-1.14	-2.73	-2.76	-2.20	-2.34
21	Manufacture of paper and paper products	14	72	16.3	23.0	0.5	8.8	10.81	0.22	-15.26	0.14	-3.16	-4.23
22	Publishing, printing and reproduction of recorded	11	170	6.1	15.6	18.3	2.9	7.33	0.90	9.23	6.26	-1.31	0.17
23	Manufacture of coke, refined petroleum products	8	13	38.1	87.6	1.5	19.2	26.22	19.91	82.09	-0.24	8.39	-6.69
24	Manufacture of chemicals and chemical products	49	127	27.8	50.0	16.8	5.1	6.00	-1.63	-2.86	-4.39	-1.38	-3.18
25	Manufacture of rubber and plastic products	41	210	16.3	41.4	6.1	0.3	2.00	-4.06	-3.21	1.09	-0.22	-1.36
26	Manufacture of other non-metallic mineral	28	444	5.9	34.5	16.0	16.0	3.92	1.51	-33.53	3.32	1.45	-1.97
27	Manufacture of basic metals	14	69	16.9	76.3	6.9	10.2	14.66	4.73	39.52	0.14	1.86	-12.64
28	Manufacture of fabricated metal products, except	57	406	12.3	49.7	39.1	3.7	7.18	0.55	-8.02	5.99	0.41	-4.50
29	Manufacture of machinery and equipment n.e.c.	40	123	24.5	93.0	18.7	23.9	9.66	-0.46	15.41	5.17	-0.94	-2.59
30	Manufacture of office, accounting and computing	18	5	78.3	85.3	13.7	17.3	16.87	-1.74	-12.62	4.52	3.14	8.40
31	Manufacture of electrical machinery and	22	47	31.9	85.3	0.5	12.5	15.72	-11.22	-3.20	0.11	3.85	-13.44
32	Manufacture of radio, television and	39	19	67.2	95.1	4.7	19.5	16.82	-2.17	-3.23	-0.67	2.95	-4.53
33	Manufacture of medical, precision and optical	19	33	36.5	85.7	5.3	6.3	12.31	-2.49	11.06	0.57	-2.65	0.56
34	Manufacture of motor vehicles, trailers and	32	183	14.9	92.2	0.0	15.3	22.69	-4.54	0.70	0.00	1.10	1.01
35	Manufacture of other transport equipment	11	56	16.4	72.9	0.9	21.8	9.47	2.99	27.42	-0.74	-1.25	-3.34
36	Manufacture of furniture manufacturing n.e.c.	59	322	15.5	40.1	0.5	10.7	5.37	0.59	-21.24	0.07	0.98	2.85
37	Recycling	1	12	7.7	5.8	8.6	19.9	64.15	-4.81	-0.10	-4.21	0.89	-21.75
	Total	644	4318	13.0	51.5	8.0	12.0	15.64	-0.15	0.32	0.05	0.60	-6.55

Notes: MNC: Firms with foreign capital; Local: Firms without foreign capital; Share: the number of MNCs divided by the total number of firms; H4: the HHI index. Share is expressed in percentage. The original values in 'HOR', 'BAC', 'FOR' and 'H4' are multiplied by 100.

Table 3 Spillovers with exogenous input decisions

	whole [1]		whole [2]		small [3]		small [4]		large [5]		large [6]	
Capital	0.059	***	0.059	***	0.054	***	0.053	***	0.066	***	0.065	***
	0.000		0.000		0.000		0.000		0.000		0.000	
Labor	0.224	***	0.224	***	0.198	***	0.203	***	0.233	***	0.235	***
	0.000		0.000		0.000		0.000		0.000		0.000	
Material	0.728	***	0.728	***	0.763	***	0.761	***	0.706	***	0.706	***
	0.000		0.000		0.000		0.000		0.000		0.000	
Electricity	0.012	**	0.012	**	0.014		0.012		0.011	*	0.011	*
	0.014		0.015		0.135		0.166		0.057		0.056	
Foreign	0.118	***	0.118	***	0.149	***	0.149	***	0.142	***	0.143	***
	0.000		0.000		0.000		0.000		0.000		0.000	
Horizontal	0.149	**	0.147	*	0.415	***	0.346	***	0.066		0.008	
	0.067		0.069		0.001		0.005		0.156		0.891	
Backward	0.317		0.314		1.325	***	1.247	***	-0.092		-0.050	
	0.258		0.265		0.000		0.000		0.416		0.660	
Forward	-0.518		-0.518		-1.936	***	-1.749	***	-0.026		-0.062	
	0.380		0.374		0.000		0.000		0.855		0.647	
Herfindal			-0.052				-0.263	***			0.247	**
			0.459				0.000				0.050	
Constant	-0.182	***	-0.180	***	-0.174	*	-0.146		-0.065		-0.061	
	0.001		0.001		0.064		0.101		0.315		0.346	
Sample size	13766		13766		6124		6124		7642		7642	
R-squared	0.958		0.958		0.958		0.958		0.956		0.956	

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level.
Values in the first lines are coefficient estimates and values in the second lines are p-values.
All models include year, region, and industry dummies.
Standard errors are corrected for clustering region-year cells.

Table 4 Spillovers adjusted for endogenous input decisions

	whole [1]		whole [2]		small [3]		small [4]		large [5]		large [6]	
Foreign	0.196	***	0.196	***	0.257	***	0.257	***	0.178	***	0.178	***
	0.000		0.000		0.000		0.000		0.000		0.000	
Horizontal	0.137	*	0.135	*	0.433	***	0.425	***	-0.031		-0.061	
	0.084		0.088		0.000		0.000		0.652		0.331	
Backward	0.399		0.395		0.064		0.038		0.642		0.621	
	0.149		0.153		0.925		0.957		0.156		0.159	
Forward	-0.504		-0.504		-0.769		-0.756		-0.182		-0.136	
	0.397		0.390		0.210		0.222		0.712		0.773	
Herfindal			-0.058				-0.023				0.284	*
			0.406				0.740				0.058	
Constant	0.131	***	0.132	***	0.092	**	0.094	**	0.610	***	0.532	***
	0.008		0.007		0.035		0.034		0.000		0.001	
Sample size	13766		13766		6124		6124		7642		7642	
R-squared	0.126		0.126		0.103		0.103		0.113		0.113	

*** Statistically significant at the 1% level; ** at the 5% level; * at the 10% level.
Values in the first lines are coefficient estimates and values in the second lines are p-values.
All models include year, region, and industry dummies.
Standard errors are corrected for clustering region-year cells.

Appendix

Data sources

1. Production variables: The industrial surveys conducted by the National Statistical Office (NSO) contain plant's sales, the number of plants, capital stock, the number of employees, and intermediate goods purchased and other necessary information for our research. Data are classified by 4-digit ISIC industry level as well as 5 region categories. We use 1998, 1999 and 2000 surveys. Plant's output, capital, and intermediate goods are deflated by corresponding (industry specific) producer price indices (base year is 2000) that comes from the Bank of Thailand (http://www.bot.or.th/bothomepage/databank/EconData/EconData_e.htm). Depreciation comes from NESDB, *Capital Stock of Thailand 2004* (http://www.nesdb.go.th/econSocial/macro/macro_eng.php).

2. Spillover variables: Input-Output Tables of 1998 and 2000 with 180 sectors compiled by the NESDB are used (http://www.nesdb.go.th/econSocial/macro/macro_eng.php) for calculation of backward and forward effects. 180 sectors are aggregated into 23 manufacturing sectors tables. 1998 IO data were used for the compilation of 1998 and 1999 dataset while 2000 IO data were used for the compilation of 2000 dataset. Since these IO tables are noncompetitive imports input-output tables that make possible to separate the domestically produced intermediates from imported materials in transactions matrix, we calculate all linkage variables by using domestically produced intermediates only that is ideal for our analytical purpose.

3. Other variables: Electricity expenditure that is used as an instrument variable in the estimation is deflated by consumer price index compiled by the Bank of Thailand (http://www.bot.or.th/bothomepage/databank/EconData/EconData_e.htm). Herfindahl index is calculated as the sum of the squared market shares of the four largest producers in a given sector from industrial survey of each year. Total output of each sector is calculated as the sum of total sales of that sector. The demand in the sector j is calculated from

$$Demand_{jt} = \sum_k a_{jk} \cdot Y_{kt} \ ,$$

where a_{jk} is the IO matrix coefficient and Y_{kt} is sales in sector k in real term.

Variables, deflators, and sources are summarized in the following table (Table A):

Table A: Data and Data Sources

Variable Name	Deflator	Source
Output	Industry-specific PPI	Bank of Thailand
Capital Stock	PPI of capital equipments	Bank of Thailand
Intermediate Input	PPI of intermediate materials	Bank of Thailand
Foreign Share		Bank of Thailand
Horizontal Effect		Bank of Thailand
Electricity Expenditure	Consumer price index	Bank of Thailand
Depreciation (δ)		NESDB, *Capital Stock of Thailand* 2004
α (Backward) and σ (Forward) Effects		NESDB, Input-Output Tables, 1998 and 2000

Bank of Thailand: http://www.bot.or.th/bothomepage/databank/EconData/EconData_e.htm
NESDB: http://www.nesdb.go.th/econSocial/macro/macro_eng.php