CHAPTER 9

Vertical and Horizontal FDI Technology Spillovers: Evidence from Thai Manufacturing

ARCHANUN KOHPAIBOON[1,2]
Faculty of Economics, Thammasat University

This paper examines Foreign Direct Investment (FDI) spillover, using an unbalanced panel data set of the manufacturing survey of Thailand during the period 2001-03. In this paper, not only are both horizontal and vertical FDI technology spillovers examined, but the former is also assumed to vary across industries. The key hypothesis is that horizontal FDI spillovers depend on the trade policy regime as well as the absorptive capability of locally owned plants. Our panel data econometric analysis highlights the important role of the trade policy regime as a conditional gain of horizontal FDI spillovers. In particular, positive horizontal FDI spillovers are found only in an industry operating in a relatively liberal environment. Interestingly, imposing an assumption of identical horizontal FDI spillovers across industry could result in biased estimates of vertical FDI spillovers. The key policy inference highlights the relative importance of the trade policy regime in harnessing the gain from foreign presence. Liberalizing the foreign investment regime thus has to go hand in hand with liberalizing the trade policy to gain FDI technology spillovers. Our finding here gives a warning not to overemphasize the role of linkages. It is the quality rather than magnitude of linkages that should be used a proxy of the magnitude of vertical FDI spillovers.

[1] I would like to thank Professor F. Kimura, Mr. S. Umezaki and all participants at the Workshop 'Deepening East Asia Economic Integration: Part II Firm-level Analysis, organized by Economic Research Institute for ASEAN and East Asia (ERIA), December 23, 2008 and February 9, 2009. The opinions expressed in this paper are the sole responsibility of the author and do not reflect the views of the ERIA.
[2] Archanun Kohpaiboon : archanun@econ.tu.ac.th.

1. Issues

Enticing multinational enterprises (MNEs) to set up affiliations is placed high on the policy agenda in many countries, especially developing ones, as their entry would bring in much-needed capital, new production technologies, marketing techniques and management knowhow. While all of these potential benefits of Foreign Direct Investment (FDI) are viewed as important, particular emphasis is placed on technological gains in the productivity and competitiveness of the domestic industry, known as FDI technology spillovers (henceforth referred to as FDI spillovers). As a result, the expectation of gaining from technology spillover persuades many developing countries to offer various incentives in order to attract FDI. Nonetheless, only in some investment-receiving (host) countries are FDI spillovers empirically found.

While tangible efforts have recently been made to gain a better understanding of the factors that determine the presence of FDI spillovers, they have not thus far borne fruit (Crespo& Fontoura, 2007). The existing literature divides into two broad themes. First, horizontal FDI spillovers are assumed not to be automatic but are hypothesized as being a function of the economic environment and domestic policies in host countries. In this literature, two determinants have been generally recognized as conditioning gains from FDI. These are the trade policy regime and the absorptive capability of locally owned enterprises.[3] While both of these factors are acknowledged, most researchers have examined only the role of absorptive capability. This may be because of the difficulty of finding a reliable proxy for protection across industries. So far only a few studies (e.g. Kokko *et al.*, 2001; Kohpaiboon, 2006a) have examined empirically the role of thetrade policy regime. Additionally, there is a dearth of studies that bring absorptive capacity and the trade policy regime together in examining FDI spillovers. A major caveat of literature in this field is that it concentrates only on spillovers taking place within a given industry, (i.e. horizontal FDI spillovers).

[3] See the comprehensive survey in Görg & Greenaway (2004), Crespo & Fontoura (2007), and Hayakawa *et al.* (2008).

In fact, a number of recent studies[4] argue that it is more likely that FDI spillovers would take place through backward and forward linkages (i.e. vertical FDI spillovers) as opposed to horizontal ones. That is, where foreign investors involve themselves with indigenous enterprises in upstream and/or downstream industries, it is very likely that the latter will gain technological benefit from the former. MNEs would have an incentive to prevent information leakage to their competitors, including local enterprises, thereby reducing the possibility of horizontal spillover taking place. By contrast, there would be incentive for them to transfer knowledge to their local suppliers because such knowledge transfer would benefit the MNEs in terms of getting better input quality and/or cheaper costs, and receiving inputs on time. It is also plausible that spillovers from MNEs in upstream industries exist to provide inputs that either were previously unavailable in the country or to make them technologically more advanced or less expensive, or to ensure that they are accompanied by the provision of complementary services (Javorcik, 2004).

Empirical studies examining the presence of vertical FDI technology spillovers are sparse (Blomström *et al.* 2000; Lin & Saggi, 2005). The notable exception is Javorcik (2004) and Blalock & Gertler (2008) which examined cases in Lithuanian and Indonesian manufacturing sectors, respectively. Their key finding supports the relative importance of vertical against horizontal FDI spillovers. In particular, it was found that vertical FDI spillovers were statistically significant. Nevertheless, a major caveat in these two studies is that their empirical model contains the implicit assumption that horizontal FDI spillovers are identical for all industries. As argued above such an assumption is rather restrictive. In addition, the correlation between protection and the extent of industries generating backward linkages tends to be positive, and omitting the trade policy regime in examining FDI spillovers could create bias in the results.

Against this backdrop, this paper examines the presence of FDI technology spillover in Thai manufacturing. Panel data econometric analysis is conducted, using the Industrial Survey conducted by the Office of Industrial Economics, Ministry of Industry, during the period 2001-2003. This is the most up to date and reliable plant survey available so far. In the empirical model, we follow the general practice in this

[4] They are Rodŕigueze-Clare (1996), Markusen & Venables (1999), Javorcik (2004), Lin & Saggi, (2005), Blalock & Gertler (2008).

research area, in which the productivity equation of locally owned plants in the manufacturing sector is estimated and the statistical relationship between plants' productivity and the extent of foreign presence is examined. This paper contributes to the existing literature in two ways. First, in our econometric analysis both horizontal and vertical FDI spillovers are examined. So far there have been few studies (e.g. Javorcik (2004) and Blalock & Gertler (2008) examining both spillovers simultaneously. Additionally, our measure of backward and forward linkages takes into consideration both direct and indirect (inter-sectoral) repercussions. This is different from Javorcik (2004) and Blalock & Gertler (2008) in which only the direct linkage is included. Secondly, we allow horizontal FDI spillovers to vary across industries. Trade policy regime and absorptive capability are included in the empirical model as the key factors determining the extent of horizontal FDI spillovers.

Thai manufacturing is a good laboratory for the issue in hand for two reasons. First, Thailand has been a large FDI recipient throughout the past three decades. However, few studies have examined technology spillover in Thai manufacturing. So far there have been two studies, Kohpaiboon (2006a) and Kohpaiboon and Jongwanich (forthcoming), both of which are based on the Industrial Census of 1996. Hence, this paper not only provides up-to-date evidence but also re-examine the relative importance of spillover channels, and horizontal versus vertical spillovers. Secondly, Thai manufacturing is broad-based as opposed to neighbouring countries, covering a wide range of industries from traditional labour- intensive industries like garment and footwear to several key industries in the machinery and transport equipment sector such as automotive, electronics, and electrical appliances. Hence, evidence drawn from Thai manufacturing would provide an insightful lesson for other countries.

The paper is organized as follows: Section 2 provides an analytical framework illustrating possible channels where FDI spillover could take place as well as the role of key determinants conditioning FDI spillovers. In Section 3, patterns of labour productivity across industries are discussed and related to the extent of the foreign presence and the effective rate of protection. The following section explains the empirical model used in this paper (Section 4). Section 5 presents data and variable construction and regression results are in Section 6. Conclusion and policy inferences are in the final section.

2. Analytical Framework

While MNEs have the potential to generate considerable impact on host countries' economies, it is often argued that spillovers are the most desirable benefit of all. In general, there are at least three channels through which FDI spillovers can occur. The first channel is the demonstration effect. The presence of foreign firms can have a demonstration effect that allows local firms to become familiar with superior technologies, marketing and managerial practices used in foreign affiliates. Thus, spillover can take place in the form of imitating the foreign subsidiaries' technology. Over and above this, the presence of foreign affiliates can exert pressure on local firms exhibiting technical or allocation inefficiencies to adopt more efficient methods. This allows local firms to survive successfully or even compete with foreign firms. Since both demonstration and competition effects are likely to occur simultaneously, these two effects are regarded in the literature as a single channel of spillover.

Linkage is the second channel of FDI spillovers. Where foreign investors are linked to upstream and downstream industries in host countries, the linked indigenous firm has the possibility of gaining technological benefits. The former is referred to as backward linkage and the latter as forward linkage. By backward linkage, foreign investors establish an inter-firm relationship with local suppliers and create demand for inputs from local suppliers in upstream industries. When these local firms are engaged to supply certain raw materials, the high quality, reliability and speed of delivery that MNE affiliates demand force them to enhance productivity. Moreover, in some cases, local suppliers in upstream industries receive technical and managerial training in the production of the required inputs. This is likely to generate additional economic activity and income, and to transfer technological and management skills to the host country.

Similarly, forward linkage effects are created when one industry uses another industry's output as its inputs. Every activity that does not by its nature cater exclusively to final demand induces attempts to utilize its outputs as inputs in other industries. Benefits for domestic suppliers resulting from the presence of MNEs may be extended to other domestic firms that produce end-user consumer goods. The most evident link is observed in the MNEs' supply of higher quality inputs and/or at a lower price to domestic producers of end-user consumer goods. The sum of the backward and forward linkages gives a total linkage effect, which can be seen as the growth in other new industries induced by establishing an MNE affiliates.

The last channel is labour mobility. Foreign affiliates generally play a more active role than local firms in educating and training local labour. Through this training and subsequent work experience, workers become familiar with the foreign affiliates' technologies and production methods. FDI spillovers through this channel occur when employees of foreign affiliates move on to local employers or set up their own business, using knowledge gained during their previous employment.

Empirically, most econometric studies have only examined the presence of FDI spillovers through the demonstration and linkage channels simply because of data availability. Analysis of labour mobility is very limited as researchers must have access to information about top managers' backgrounds. Unfortunately, such information is not usually available.[5] Secondly, in theory, FDI spillovers through the demonstration effect can take place either within the same industry or across industries. In practice, it is very difficult to measure the demonstration effect across industries so that spillovers through demonstration effects are usually referred to as horizontal FDI spillovers. On the other hand, FDI spillovers through linkage occur when MNEs are located in a given industry, and benefit upstream and downstream industries. These are regarded as FDI vertical spillovers.

The recent studies such as Rodŕigueze-Clare (1996); Markusen & Venables (1999); Lin & Saggi (2005); Javorcik (2004); and Blalock & Gertler (2008) highlight the relative importance of vertical FDI spillovers as opposed to horizontal ones. In particular, they argue that vertical FDI spillovers are likely. For example Blalock & Gertler (2008) argue that it is hard to believe that horizontal FDI spillovers are likely. Firstly, the technology gap between foreign and domestic firms may often be wide. Local firms may lack the absorptive capacity needed to recognize and adopt new technology. Similarly, the degree to which foreign and domestic firms actually compete in the same market will also vary. It is possible, for example, that domestic firms may

[5] To the best of our knowledge so far, the only econometric analysis of spillovers through labour mobility is undertaken by Görg and Strobl (2002), using firm level data in Ghana.

produce for the local market while MNEs produce for export. Because of differences in quality and other attributes, exported and domestically consumed goods may entail different production methods thereby reducing the potential for technology transfer. In contrast, technological benefits to local firms through vertical linkages are much more likely simply because MNEs have incentives to improve the productivity of their suppliers with the expectation of input cost reduction and quality improvement in return. Moreover, MNEs are likely to procure inputs requiring less sophisticated production techniques for which the gap is narrower.

The key finding of Javorcik (2004) and Blalock & Gertler (2008) supports the core hypothesis, i.e. only vertical FDI spillovers through backward linkages are found. Noticeably, the empirical model in both studies implicitly assumes that horizontal FDI spillovers, if they exist, must be identical in all industries. In particular, locally owned enterprises operating in two different industries (e.g. capital versus labour intensive industries, restrictive versus liberal trade regime) would benefit identically from foreign presence in their industries. This assumption seems to contradict a number of studies pointing out the heterogeneity of spillovers (Görg & Greenaway, 2004; Crespo & Fontoura, 2007; Hayakawa *et al.* 2008).

In fact, the recent effort is to clarify what kinds of heterogeneity in MNEs and/or indigenous firms are crucial. So far there have been two factors identified, namely the absorptive capability of indigenous firms and the trade policy regime. Whether a local firm benefits from MNC presence depends on its capacity for assimilating knowledge- its absorptive capability (Kokko *et al.* 1996; Girma *et al.*, 2001; Girma & Görg, 2003; Kinoshita, 2001; Girma, 2005). The hypothesis in the literature points out that the higher the absorptive capability, the greater the spillover the local firm in the host country can expect. Note that the absorptive capability is referred to as the technological gap between MNE affiliates and indigenous firms (Kokko, 1994; Blomstrom & Sjohölm, 1999; Sjohölm, 1999).

The trade policy regime is another factor to be considered, although there are few empirical studies examining its role in conditioning FDI technology spillovers. As pioneered by Bhagwaiti (1973) as an extension to his theory of immiserizing growth and further developed by Bhagwati (1985, 1994); Brecher & Diaz-Alejandro (1977); and Brecher & Findlay (1983), technology spillover tends to be smaller, or possibly even negative, under a restrictive, import substitution (IS) regime compared with a liberalizing, export promotion (EP) regime (referred to as the 'Bhagwati's hypothesis'). FDI inflows enticed by an import substitution (IS) trade regime tend to be market-seeking and are invested mostly in the industries where proprietary assets are important. This creates barriers to entry for local firms and thus constrains technology and efficiency spillovers. In contrast, the export promotion (EP) regime is more conducive to generating favorable spillover effects because, under such a regime, FDI is mostly attracted to industries in which the country has comparative advantage, i.e. efficiency-seeking FDI. In such industries local firms have a greater potential to catch up with foreign firms and achieve productivity improvement. Additionally, domestic firms already exposed to foreign competition will probably have a great capacity not only to absorb foreign technology but also to counter the competition provided by MNEs in the local market, thereby precluding a negative impact through the competition channel (Crespo & Fontoura, 2007).

While recognizing the important role of absorptive capability, trade policy is highlighted in this paper because it is highly policy relevant and there is room for improvement in the context of developing countries. While progress on tariff reduction has occurred as a consequence of the Uruguay Round, it is clear that much remains to be done. There has been a considerable decline in average tariff rates in developing countries, especially in Asia and Africa, but this has occurred in an uneven manner thereby increasing tariff dispersion. This implies that countries with low average tariff rates are likely to have very high tariff peaks and exhibit escalation at higher levels of disaggregation (Jongwnaich & Kohpaiboon, 2007).

More importantly, ignoring these two key determinants from econometric analysis of FDI spillovers studies could result in biased estimates as a consequence of omitting relevant variables. This is especially true for the trade policy regime simply because there is likely to be a positive correlation between protection and the extent of industries generating backward linkage. This is in line with the infant industry argument. Pioneered by Hirschman (1958), investible resources should be geared toward industries that have maximum linkages with the rest of economy. Such industries are usually capital intensive and economies of scale still matter; so that protection against foreign competition is always granted to give them time to gain more production efficiency.

The widely cited example is the development strategy for automotive industry in developing countries which are likely to be a combination between restrictive local content requirement measures and a high cross-border protection. Although industrial linkages were a part of import substitution industrialization strategy that has became less important since the 1980s, promoting linkages and policy-induced ones in particular have continued to linger in the minds of policymakers and development analysts (Athukorala, 1998; Pursell, 2001).

3. Patterns of Labour Productivity and Foreign Presence in Thai Manufacturing

This section aims to illustrate productivity difference between foreign and indigenous plants across industries disaggregated into 4 digit ISIC classification in the Thai manufacturing sector. As well, the productivity difference is examined together with key variables in the paper's core analysis, namely capital-labour ratio, the extent of foreign presence (*FOR)*, effective rate of protection (*ERP)*, and backward linkages index (*BLI).*[6] Productivity here is measured by labour productivity, value added per workers. Difference in labour productivity between foreign and locally owned plants as a per cent of the latter's productivity is calculated.[7] The calculated productivity difference is plotted together with difference in capital labour ratio between these two types of firms as shown in Figure 1 to reveal whether the former is more productive than the latter after accounting for difference in the capital-labour ratio. These indicators are the average figure during the period 2001-03.

[6] See full detail in Appendix 1.

[7] We do not report absolute number of labour productivity simply because they vary largely across industries. For example, value added per worker of indigenous plants in 2001 was widely ranged from 95,891 baht/workers (ISIC 2029: other special purpose machinery) to 67,800,000 baht/workers (ISIC 1554: Soft Drink Industry). Since our interest here is to address the issue whether foreign plants always exhibit higher labour productivity than indigenous ones instead of explaining difference of labour productivity across industries, we decide to report only the percentage difference. Absolute value added per workers is available upon the author's request.

The scattered plot in Figure 1 suggests that foreign plants generally have higher labour productivity than locally owned ones. Most of industries stay above the horizontal axis implying the positive productivity difference. The difference is averaged out at 107 per cent with the maximum of nearly 400 per cent in dairy product (ISIC 1520) and the minimum of -61.8 per cent in alcoholic beverages (ISIC 1551). Nevertheless, the positive productivity difference is largely due to the fact that foreign plants tend to be more capital intensive than their local counterparts as indicated by the observed positive relationship between productivity and capital-labour ratio differences. A (Spearman) rank correlation between difference in labour productivity and capital-labour ratio is about 0.44 and statistically significant at the conventional level (5 per cent). Hence, the observed figure of positive labour productivity difference is inadequate to conclude that foreign plants are superior to local ones unless the capital-labour ratio is taken into consideration.

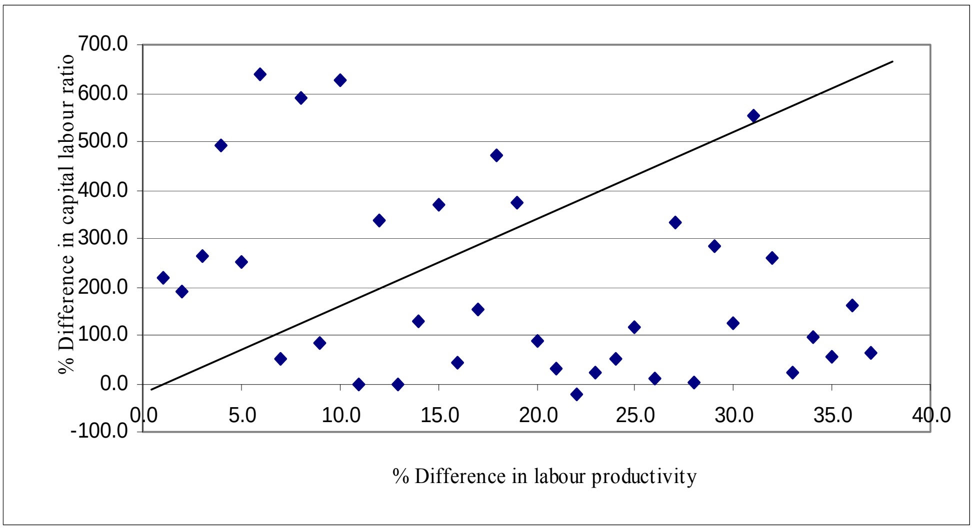
There are six industries experiencing a negative and significant (greater than 30 per cent) difference in labour productivity: i.e. locally owned plants have higher labour productivity than foreign ones. They are alcoholic beverages (ISIC 1551), Tobacco (ISIC 2925), veneer sheets (ISIC 2021), Paper pulp and paperboard (ISIC 2101), Toys (ISIC 3694) and animal feeds (ISIC 1533). A common pattern observed among them is there are Thai conglomerates playing important roles. One obvious example is alcoholic beverages (ISIC 1551) dominated by two Thai conglomerates such as Thai Beverages Public Company, and the Singha Corporation. Similarly, in animal feeds and paper pulp industries, there are two Thai MNEs, the Chareon Pokphand Group (CP Group) and Siam Cement Group, respectively.

We also examine foreign presence (*FOR*) measured in terms of output share[8], effective rate of protection (*ERP*) and backward linkage index (*BLI*) in order to view their correlation with the average of plant productivity. *BLI* here is constructed based on the Leontief inter-industry accounting framework which provides for the capture of both direct and indirect (inter-sectoral) repercussions in the measurement process. It shows the total units of output required, directly and indirectly, from all sectors

[8] See further discussion on why output share is our preferable choice in this study in Section 4.

(including the unit of output delivered to final demand by the given sector) when the demand for the industry's product rises by one unit.

Figure 1. Correlation between Productivity Gap and Difference in Capital-labour Ratio between Foreign Establishment and Indigenous Plants during the Period 2001-03



Notes: Productivity gap $\%\Delta(VA/L)$ $\%\Delta(VA/L)$ is measured as the difference in labour productivity between foreign establishment and indigenous plants as a per cent of labour productivity of the latter. % Difference in capital labour ratio between foreign establishment and indigenous plants $\%\Delta(K/L)$ is measured in the similar way as productivity gap. Linear line here is based on the simple ordinary least square estimation in which $\%\Delta(VA/L)$ $\%\Delta(VA/L)$ is a dependent variable and $\%\Delta(K/L)$ as the explanatory variable. This is to draw general statistic inference.

$$\%\Delta(VA/L) = \underset{(7.01)^{***}}{77.8} + \underset{(5.86)^{***}}{0.14}\ \%\Delta(K/L)$$

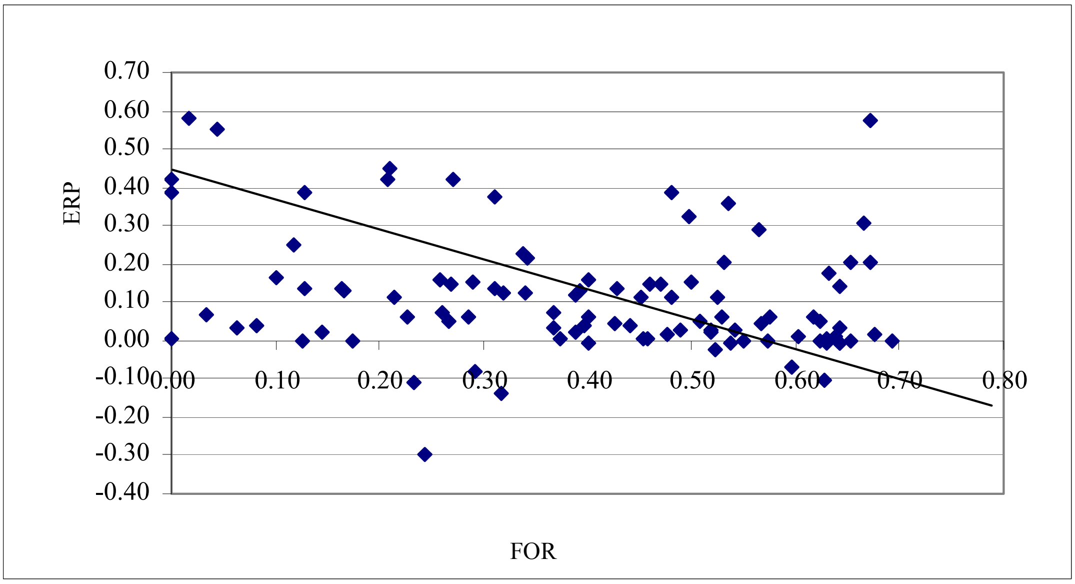
$$\%\Delta\left(\frac{VA}{L}\right) = \underset{(7.01)^{***}}{77.8} + \underset{(5.86)^{***}}{0.14}\ \%\Delta\left(\frac{K}{L}\right)$$

, where t-statistics is in parentheses.

Sources: Author's compilation. See the full data in Appendix 1.

Generally, foreign plants tend to locate in industries having a low effective rate of protection, as we found a negative correlation between *FOR* and *ERP* of -0.25 (Figure 2). The negative correlation is consistent with the trend of FDI inflows at the more aggregated level. Up to the late 1970s, FDI was predominantly in import-substitution industries such as textiles, automobiles, and chemicals. From then on, an increasing share of FDI was directed to more export-oriented activities. To begin with, export-oriented FDI went into light manufacturing industries such as clothing, textiles, footwear and toys. More recently, labour-intensive assembly activities in the electronics and electrical goods industries have been the main attraction to foreign investors. Interestingly, there is no clear relationship between *FOR* and *BLI* as their simple correlation approaches zero (Figure 3). This reconfirms the proposition that FDI inflows in Southeast Asia including Thailand predominantly belong to the efficiency-seeking/export-oriented categories (Hill & Athukorala, 1998).

Figure 2. Correlation between Foreign Presence (*FOR)* and Effective Rate of Protection (*ERP*)



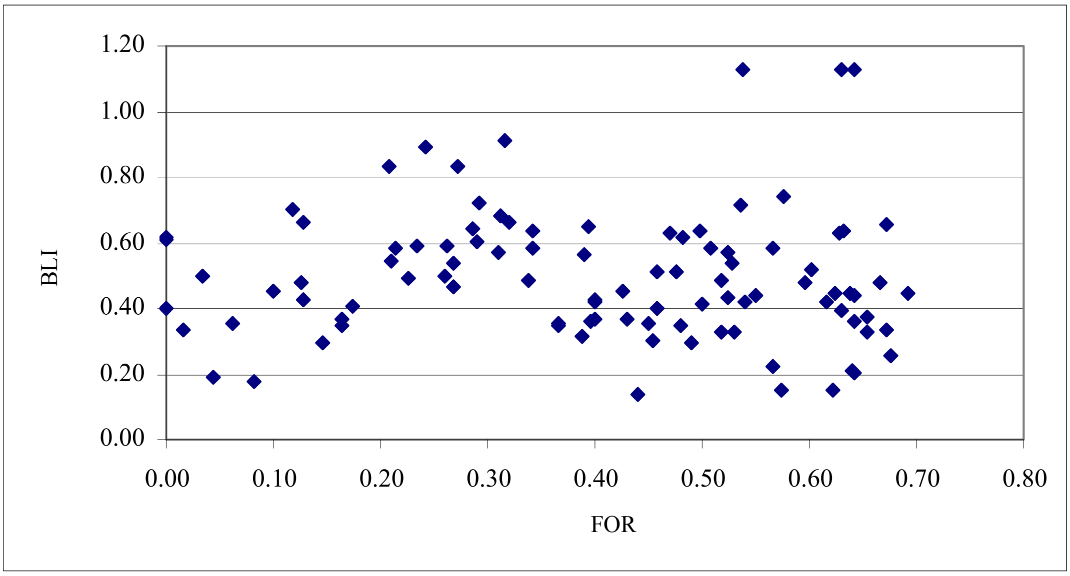
Notes: Linear line here is based on the simple ordinary least square estimation in which *FOR* is a dependent variable and *ERP* as the explanatory variable. This is to draw general statistic inference.

$$FOR = \underset{(18.7)^{***}}{0.44} - \underset{(-2.66)^{***}}{0.33}\ ERP$$

, where t-statistics is in parentheses.

Sources: Author's compilation. See the full data in Appendix 1.

Figure 3. Correlation between Foreign Presence (*FOR)* and Backward Linkage Index (*BLI*)



Notes: The statistical relationship between *FOR* and *BLI* is not significantly different from zero based on the simple ordinary least square estimation in which *FOR* is a dependent variable and *BLI* as the explanatory variable.

$$\underset{}{FOR} = \underset{(12.9)^{***}}{0.41} - \underset{(-0.08)}{0.004}\ BLI$$

, where t-statistics is in parentheses.

Sources: Author's compilation. See the full data in Appendix 1.

4. Model

To examine the presence of technology spillover, we follow the standard practice in the literature. This begins with estimating the production function of locally owned enterprises (Griliches, 1992; Javorcik, 2004; Crespo & Fontoura, 2007; Blalock & Gertler, 2008) A translog functional form is chosen to avoid the restriction imposed in the Cobb Douglas forms that were popular in the previous empirical studies of Thai manufacturing (e.g. Khanthachai *et al.*, 1987; Tambunlertchai & Ramstetter, 1991), i.e. unity of elasticity of substitution and log-linear relationship between inputs and outputs. The translog function form also controls for input levels and scale effects on value added. It is specified as equation (1);

$$\ln Y_{ij} = \beta_0 + \beta_1 \ln K_{ij} + \beta_2 \ln PL_{ij} + \beta_3 \ln NL_{ij} + \beta_4 \ln K_{ij} \ln PL_{ij} + \beta_5 \ln K_{ij} \ln NL_{ij} + \\ + \beta_5 \left(\ln PL_{ij}\right)^2 + \beta_6 \left(\ln NL_{ij}\right)^2 + \beta_7 \left(\ln K_{ij}\right)^2 + \beta_8 X_{ij} \qquad (1)$$

where Y_{ij} = value added of plant *i* of industry *j*,

PL_{ij} = number of production workers of plant *i* of industry *j*,

NL_{ij} = number of non-production workers of plant *i* of industry *j*,

K_{ij} = fixed assets of plant *i* of industry *j*, and

X_{ij} = controlling variables in affecting plant productivity of plant *i* of industry *j*.

In equation 1, there are three primary inputs, physical capital and two types of labour (i.e. production and non-production workers). The latter is done to allow marginal products from them to be different. Controlling variables include both firm- and industry-specific factors.

The first controlling variable is the plants' market orientation nature (MKT_{ij}). One clear-cut finding in the literature of the export-productivity nexus is that exporters are found to have higher productivity than non-exporters as firms would expect more intense competition in the global market than in the domestic market. In addition, there are sunk costs induced by exports.[9] Hence, the nature of market orientation is included in the model with the theoretical expected positive sign. MKT_{ij} is measured a binary dummy variable which equals to 1 if firms' export-sale ratio exceeds 25 per cent and zero otherwise. The rationale of not using an actual export-output ratio is because the relationship between market orientation and productivity could be non-linear. Firms planning to export must enhance their productivity to a certain level before export so that a positive relationship between market orientation and productivity is expected within a certain range of the export-output ratio only. In this study, 25 per cent is arbitrarily used so that sensitivity analysis is conducted by using 20 and 30 per cent as alternative cutting points. Nevertheless, the regression results are not sensitive to the cutting points.[10]

[9] Even though there is ongoing debate about whether firms become more productive before export (self-selection) or experience productivity gains after export (learning from export). See the recent survey in Wagner (2007) and works cited therein.

[10] Results are available upon author's request.

As guided by the theory and previous empirical work on the determinants of plant productivity differences, two industry-specific factors are taken into consideration. These are producer concentration and trade protection. Because of its ease of measurement, producer concentration is often used by policy makers to signal the intensity of product market competition and justify any action in preventing any possibly anti-competitive behaviour. Here producer concentration is measured by output share of the four largest firms (*CR4*). The formulae to calculate *CR4* are in equation (2).

$$CR4_j = \frac{\sum_{i=1}^{4} s_{ij}}{\sum_{i=1}^{n} s_{ij}} \quad (2)$$

The impact of *CR4* on plant productivity remains ambiguous nonetheless. On the one hand, pioneered by Schumpeter (1942), productivity-enhancing activities typically involve large fixed costs, are irrecoverable upon exit, and are subject to a large degree of risk and uncertainty. Hence, the expectation of some form of transient *ex post* market power is required for firms to have the incentive to invest in such activities. This is especially true in the context of developing countries whose domestic market remains small (Roberts & Tybout, 1996). Perfect competition is not necessarily conducive for productivity improvements. On the other hand, the market power required is not a sufficient condition for firms to commit to these activities as suggested by a number of empirical studies (Symeonidis, 1996; Ahn, 2002). In fact, as these activities are not costless, a certain degree of market competition is needed to force each individual firm to speed up the adoption of new technology (Porter, 1990; Aghion, et al. 1999). In many circumstance, the high level of producer concentration could retard productivity improvement.

Protection is the second industry-specific variable controlled in the model. The effect of protection on plant productivity has been long recognized in numerous previous studies but is ambiguous (e.g. Corden, 1974: Hart, 1983; Martin & Page, 1983; Scharfstein, 1988; Rodrik, 1991). While protection can create economic rents that can be used for productivity improving activities, in practice an opposite effect can be seen.

By insulating firms from foreign competition, high protection tends to induce producers to become 'unresponsive' to improved technological capability as well as to requests for improvement in the quality and price of what they offer (de Melo and Urata, 1986; Moran, 2001). This in turn results in a general deterioration of technological and management skills. Hence, the sign of trade protection is theoretically ambiguous. Protection is proxied by the effective rate of protection (*ERP*). Even though there is no consensus between *ERP* and the nominal rate of protection (*NRP*) amongst economists as to choice of one over the other (Corden, 1966; Cheh, 1974), political bargains in Thai manufacturing are struck over *ERP* rather than *NRP* based on the econometric evidence of Jongwanich & Kohpaiboon (2007).

An interaction term between CON_j and ERP_j is introduced to rectify the major weakness of producer concentration in measuring the degree of product market competition. At best, producer concentration cannot capture dynamic aspects of competition especially from imports. As mentioned above, competition is important for the positive impact of concentration on productivity. In the competitive environment, the less productive firms tend to be "weeded out", so a highly concentrated industry structure would be more conducive for firms to continue their innovative activities. By contrast, in the absence of significant market competition, economic rents generated as a result of high producer concentration are likely to be captured by its managers (and workers) in the form of managerial slack or lack of effort. All in all, this suggests that the impact of producer concentration tends to be conditioned by the degree of market competition so that the interaction term is introduced. The coefficient corresponding to the interaction is expected to be negative.

The extent of foreign presence in an industry *j* (FOR_j) is introduced to examine horizontal technology spillovers, in some previous empirical studies, foreign presence can be captured by either output, employment or capital shares. Expressing the foreign presence as an employment share tends to underestimate the actual role of foreign affiliates because MNE affiliates tend to be more capital intensive than locally non-affiliated firms.[7] On the other hand, the capital share can easily be distorted by the presence of foreign ownership restrictions. Such a restriction was in effect in Thailand during the study period (Kohpaiboon, 2006b). Hence, the output share is the preferred proxy.

As suggested in the previous studies, horizontal spillovers can be either positive or negative, depending on the absorptive capability of local plants and the nature of the trade policy regime. The absorptive capability of the local plant is measured by the ratio of supervisory and management workers to total employment (*QL*) as supervisory and management workers are regarded as skilled labour. The higher the ratio, the higher the labour quality. The expected sign of the corresponding coefficient is positive. Trade policy regime is proxied by *ERP*. The higher the *ERP*, the less the horizontal spillovers, so that the negative sign of the interaction term is expected.

As argued above, FDI can also generate vertical spillovers through the linkage channel. To do so, inter-industry linkage is established according to the Leontief inter-industry accounting framework. Consider an input-output framework of the 'complementary import' type (i.e. the input-output table, in which the import content of each transaction is separately identified and allocated to an import matrix)[11];

$$X = A^d X + Y^d + E \tag{3}$$

where X = column vector of total gross output,

$A^d = \left[a_{ij}^d \right]_n$, $a_{ij}^d = X_{ij} / X_j$ = domestic input-output coefficient matrix,

Y^d = column vector of domestic demand on domestically produced goods, and
E = column vector of export demand on domestically produced goods.

Solving equation (1) for X ,

$$X = \left(1 - A^d\right)^{-1} \left[Y^d + E\right] \tag{4}$$

where $(1\text{-}A^d)^{-1}$ is the Leontief domestic inverse (LDI) matrix.

Consider a row vector *j,* each element in the row, say b_{ij}, indicates amount of industry *j*'s output demand by an additional unit of industry *i*'s output produced, i.e. derived demand for industry *j'*s output from industry *i's* production. Note that b_{ij} captures both direct and indirect (inter-sectoral) repercussions in the measurement

11 Another type of Input-output (I-O) table is a 'competitive import' type in which all imports (intermediate plus final) are treated as competing with domestic production and thus imports are not separated from domestic transactions (Bulmer-Thomas, 1982).

process. This is different from Blalock (2001), Schoors & van der Tol (2001) both cited in Javorcik (2004: 612) and Blalock & Gertler (2008) whose backward linkage proxy captures only the direct demand for industry *j*, an element in input-output matrix. A product between each element in row vector *j* and its corresponding degree of foreign presence (FOR_j) measures to a certain extent derived demand from foreign presence for industry *j*'s output. Hence, the sum of the product from column 1 to n indicates total derided demand for industry *j*'s products from foreign plants, backward linkages from foreign plants. The higher the $BACK_j$, the greater the backward linkages. This implies the greater vertical spillover through backward linkages and the positive sign of coefficient corresponding to $BACK_j$ is expected. Note that inputs supplied within the industry *j* are excluded as they are already captured by FOR_j.

In a column vector *i* in LDI matrix, each element, say b_{ik}, indicates demand for industry *k*'s output to be used as inputs for producing a unit of industry *i*'s output. When we multiply each element in column vector *i* with its corresponding foreign share (FOR_k), the product indicates intermediates of industry *i* supplied by foreign plants located in in industry *k*. Hence, the sum of products would reflect a fraction total intermediates used in industry *i* supplied by foreign plants, i.e. the forward linkage from foreign presence. The greater the value of $FORW_j$, the larger, the extent of foreign presence in upstream industries. Hence, the corresponding coefficient is hypothesized to be positive. For the same reason as before, inputs purchased within the industry *j* are not included.

Finally, two sets of binary dummy variables are included in the model. First, two time dummy variables (*t2002* and *t2003*) are included to capture time-specific fixed effects, with 2001 as the base dummy. Secondly as argued in a number of studies such as Cohen & Levin (1989) and Moulton (1990), studies of the firm size-innovative activity relationship need to control for industry effects at a high level of aggregation, e.g. 2-digit level, especially when using a sample covering many industries. In particular, standard errors are corrected to take into account the fact that the measures of potential spillovers are industry-specific while the observations in the dataset are at the firm level. Falling to make such a correction could lead to a serious downward bias in the estimated errors thus resulting in a spurious finding of statistical significance of the aggregate variation of interest. It becomes even more important for those undertaken in the context of developing countries where large firms are likely to be diversified and operate in more than one industry.[12] As a result, industry dummy variables at the 2 digit ISIC industry classification are introduced.

All in all, the estimating equation of FDI technology spillover is as follows (theoretical expected sign is given in parenthesis);

$$
\begin{aligned}
\ln Y_{ijt} = {} & \gamma_0 + \gamma_1 \ln K_{ijt} + \gamma_2 \ln PL_{ijt} + \gamma_3 \ln NL_{ijt} + \gamma_4 \ln K_{ijt} \ln PL_{ijt} + \gamma_5 \ln K_{ijt} \ln NL_{ijt} + \gamma_6 \ln NL_{ijt} \ln PL_{ijt} + \gamma_7 \left(\ln NL_{ijt}\right)^2 \\
& + \gamma_8 \left(\ln PL_{ijt}\right)^2 + \gamma_9 \left(\ln K_{ijt}\right)^2 + \gamma_{10} MKT_{ijt} + \gamma_{11} CR4_j + \gamma_{12} ERP_j + \gamma_{13} CR4_j * ERP_j + \gamma_{14} FOR_j \qquad (5) \\
& + \gamma_{15} ERP_j * FOR_j + \gamma_{16} QL_{ijt} * FOR_j + \gamma_{17} BACK_j + \gamma_{18} FORW_j + \gamma_{19} t2002 + \gamma_{20} t2003 + \gamma_{21} ID_j + \mu_{ij}
\end{aligned}
$$

where

$\ln Y_{ijt}$	=	Value added of plant *i* in industry *j* at time *t* ,
$\ln PL_{ijt}$	=	Number of production workers of plant *i* in industry *j* at time *t* ,
$\ln NL_{ijt}$	=	Number of non-production workers of plant *i* in industry *j* at time *t* ,
$\ln K_{ijt}$	=	Fixed assets of plant *i* in industry *j* at time *t* ,
CON_i (+/-)	=	Producer concentration of industry *j* measured by the sum of market share of top four plants ,
ERP_j (+/-)	=	Effective rate of protection in industry *j* ,
MKT_{ijt} (+)	=	Market orientation of plant *i* in industry *j* at time *t* measured alternatively by binary dummy variable, which equals to 1 if the export-output ratio exceeds 25 per cent and zero otherwise,
FOR_j (+/-)	=	Foreign presence in industry *j* measured by output share of foreign plants to total sales captured horizontal spillovers,
$FOR_j * QL_{ijt}$ (+)	=	MNE technology spillover gain conditioned by QL_{ijt} (i.e. Absorptive capability hypothesis) ,
$FOR_j * ERP_j$ (-)	=	MNE technology spillover gain conditioned trade policy regime (i.e. Bhagwati's hypothesis) ,
QL_{ijt}	=	Quality of labour of plant *i* in industry *j* at time *t* measured by the ratio of supervisory and management workers to total employment ,
$BACK_j$ (+)	=	Backward linkages spillover from foreign presence to industry *j*,
$FORW_j$ (+)	=	Forward linkages spillover of foreign presence to industry *j* ,
t2002	=	Time dummy for 2002 which is one if observation is in 2002 and zero otherwise,
t2003	=	Time dummy for 2003 which is one if observation is in 2003 and zero otherwise,

[12] The conglomerate nature of large firms is very prominent in Southeast Asian economies (Studwell, 2007).

ID_j = Industry dummy at 2 digit ISIC classification, and

μ_{ijt} = A stochastic error term, representing the omitted other influences.

5. Data and Variable Construction

In this study, the Industry Survey by the Office of Industrial Economics, Ministry of Industry (OIE Survey) during the period 2001-03 is used.[13] The survey is available from 2001 to 2006 but the quality of unpublished returns of the last three years survey (2004-6) is rather problematic. In particular, they are subject to inconsistency in industry identification of samples, to a matching problem between sales figures and other plants' basic information allocated in separated sheets, and to a sharp decline in sample number.[14] Hence, only the OIE survey during the period 2001-03 is used in this paper.

There are 4,365, 3,986, and 3,521 plants in the 2001, 2002 and 2003 Surveys, respectively (Table 1). The survey was first cleaned up by identifying duplicated samples (i.e. plants belonging to the same firm which filled in the questionnaire using the same records) in the survey. The procedure followed in dealing with this problem was to treat as duplicates the records that report the same values of the five key variables of interest in this study, namely registered capital, output value, domestic sales, domestic raw materials, imported raw materials. As a consequence, nine samples were identified and dropped. Secondly, plants were removed which had not responded to one or more of the key questions and which had provided seemingly unrealistic information such as the negative value added, no report of worker numbers, capital stocks, or the initial capital stock of less than 10,000 baht. Finally, we excluded micro-enterprises which are defined as plants with less than 10 workers. After the data cleaning above the number of samples dropped to 3,373, 3,328 and 3,153 samples for Survey 2001, 2002 and 2003. On average, the coverage of the OIE survey accounted for around 40.1, 49.6, and 24.8 per cent of value added, gross output, and workforce,

[13] The alternative data set is the 1997 industrial census that is quite dated and has been empirically used in a number of studies (e.g. Kohpaiboon, 2006a; Kohpaiboon & Ramstetter, 2008; Jongwanich & Kohpaiboon, 2009; Kohpaiboon & Jongwanich, forthcoming).

[14] In particular, the number of plants covered in the OIE Survey 2006 dropped sharply to less than 2,000 plants.

respectively, of the manufacturing sector. Table 1 provides a summary of survey characteristics and the extent to which it represents the whole manufacturing sector.

Table 1. Sample Coverage of Office of Industrial Economics Survey

Year	% of Thai Manufacturing Sector			Number of Plants	
	Value Added	Output	Employment	Before Cleaning	After Cleaning
2001	45.3	52.6	24.5	4,365	3,373
2002	41.1	53.7	25.5	3,986	3,328
2003	33.8	42.4	24.5	3,521	3,153
Average	40.1	49.6	24.8		

Source: Author's compilation from OIE Survey whereas value added and output of the manufacturing sector are from National Economics and Social Development Board (NESDB). Labor force is from Key Indicators for Asia and the Pacific 2008, Asian Development Bank.

All nominal variables are converted to real terms (1988 price) by the corresponding producer price deflator at the 4-digit ISIC classification. Value added is defined as the difference between gross output and raw materials net of changes in inventories, whereas capital stock is represented by the value of fixed assets at the initial period. The other information related to plant-specific variables (i.e. *OWN* and *MKT*) are reported in the survey.

CR4 is obtained from Kophaiboon & Ramstetter (2008) in which the concentration is measured at the more aggregate level (e.g. many measured at the 4-digit whereas some at the 3-digit ISIC classification) to guard against possible problems arising from the fact that two reasonably substitutable goods are treated as two different industries according to the conventional industrial classification at high level of disaggregation. Data on *ERP* estimates are from Jongwanich & Kohpaiboon (2007). They are *ERP* 2003 estimates, reflecting the protection structure in 1997-2003 as there was no major change in tariff during this period. In addition, the *ERP* series used is the weighted average of import-competing and export-oriented ERP. The latter is referred to ERP estimates for exporters who are eligible for various tariff rebate programs. Since ERP is based on the input-output (IO) industrial classifications, the official concordance is used to convert them into 4-digit ISIC. In a case that there is not one-to-one matching in the concordance, the weighted average is applied using value added as a weight.

The ideal dataset for measuring $BACK_j$ and $FORW_j$ is detailed information of inter-industry relationship between local and foreign enterprises, how much the former sells to or buys from the latter. Nevertheless, our choice is driven in part by data limitations. Hence inter-industry relationship to measure $BACK_j$ and $FORW_j$ is based on Thailand's input-output table consisting of 180 economic activities (42 in agriculture and primary sectors 93 in the manufacturing sector and the rest in the service sector). One caveat when using Thailand's input-output table is that car assembly and several metallic parts manufactures such as body parts and inner panels are lumped into a single category, (IO 125 motor vehicle) so that backward linkages measured would be to a certain extent underestimated. The same procedure applied for *ERP* is used to match input-output (IO) industrial classifications to 4-digit ISIC.

To measure *FOR* using OIE survey would be problematic as the survey coverage is rather limited. As discussed the surveys cover at most 50 per cent of the manufacturing sector's gross output and it is likely that foreign affiliates are covered in the survey because of their relatively large firms. Hence, *FOR* measured from the survey tends to be overestimated and reflect the extent of foreign plants in the survey rather their actual presence in the sector. This would also mitigate any possible simultaneity bias in estimating the spillover equation (see below for further discussion). Hence, in this study, *FOR* is constructed using the Industrial Census 1996 which accounted for 76.2 per cent of the manufacturing sector's gross outputs. In the census, all plants with FDI (regardless of the magnitude of the foreign share in their capital stock) are considered to be foreign rather than local plants. The cutting point (i.e. zero per cent) seems to be slightly higher than what is widely used by the International Monetary Fund (IMF) and other institutes such as the Organization for Economic Co-operation and Development (OECD), the US Department of Commence as well as several scholars studying multinational firms (IMF, 1993; Lipsey, 2001), i.e. 10 per cent. However, the choice is dictated by data availability. Information on foreign ownership in the census is reported with a wide range, i.e. zero, less than 50, greater 50 and 100 per cent foreign shares. Tables 2 and 3 provide a statistical summary of all variables discussed above and their correlation matrix.

Table 2. A Statistical Summary of the Key Variables

	Unit	Mean	SD	Min	Max
VD_{ijt}	(ln) million baht	16.32	1.92	6.00	24.00
K_{ijt}	(ln)million baht)	16.11	2.36	5.00	24.00
NL_{ijt}	(ln) workers	2.71	1.35	0.00	7.00
PL_{ijt}	(ln) workers	4.50	1.44	0.00	9.00
MKT_{ijt}	zero-one dummy	0.29	0.45	0.00	1.00
CON_j	(ln) proportion	0.44	0.11	0.23	0.69
ERP_j	(ln) proportion	0.12	0.14	-0.30	0.58
FOR_j	(ln) proportion	0.36	0.15	0.00	0.69
QL_{ijt}	(ln) proportion	0.16	0.11	0.00	0.67
$BACK_j$	(ln) proportion	1.08	0.90	0.02	7.17
$FORW_j$	(ln) proportion	1.23	1.00	0.00	5.27

Notes: (a) Mean = simple average; SD = standard deviation; Min = minimum; and Max = maximum; (b) Estimates of VD_{ijt}, K_{ijt}, NL_{ijt} and PL_{ijt} are the logarithmic transformation of their value. The other variables are converted into logarithmic form as log (1+*x*) where *x* is the variable

Source: Author's computations based on data sources described in the text.

Table 3. Correlation Matrix of the Variables

	VD_{ijt}	K_{ijt}	NL_{ijt}	PL_{ijt}	MKT_{ijt}	CON_j	ERP_j	FOR_j	QL_{ijt}	$BACK_j$	$FORW_j$
VD_{ijt}	1.00										
K_{ijt}	0.75	1.00									
NL_{ijt}	0.71	0.65	1.00								
PL_{ijt}	0.77	0.66	0.72	1.00							
MKT_{ijt}	0.28	0.19	0.27	0.40	1.00						
CON_j	-0.11	-0.13	-0.06	-0.07	0.05	1.00					
ERP_j	0.01	-0.05	0.01	0.09	0.12	0.15	1.00				
FOR_j	-0.03	-0.05	-0.07	-0.05	-0.01	0.11	-0.15	1.00			
QL_{ijt}	-0.10	-0.04	0.30	-0.36	-0.22	0.00	-0.12	-0.02	1.00		
$BACK_j$	0.01	-0.01	-0.03	-0.01	-0.01	0.10	-0.03	0.25	-0.01	1.00	
$FORW_j$	-0.11	-0.05	-0.13	-0.20	-0.22	0.04	-0.23	0.19	0.09	0.09	1.00

Source: Author's computations based on data sources described in the text.

6. Regression Results

To examine the presence of spillover from FDI, an unbalanced panel econometric procedure is applied. We used the random effect estimator as our preferred estimation technique. The alternative fixed effect estimator is not appropriate because our model contains a number of time-invariant variables (CON_j, ERP_j and FOR_j, $BACK_j$, and $FORW_j$) all of which are central to our analysis. A major limitation of the random effect estimator compared to its fixed effect counterpart is that it can yield inconsistent and biased estimates if the unobserved fixed effects are correlated with the remaining component of the error term. However, this is unlikely to be a serious problem in our case because the number of explanatory variables is larger than the number of 'within' observations (Wooldridge 2002, Chapter 10). The random effect estimator also has the added advantage of taking caring of the serial correlation problem. The results are reported in Table 5. Nevertheless, the corresponding pooled cross-section estimations are reported for the purpose of comparison. The random-effects and pooled cross-section estimates are remarkably similar, suggesting that unobserved effects would be relatively unimportant in our model.

Studies of FDI spillovers are subject to a criticism about a possibility of a simultaneity problem. The positive relationship between foreign presence and plant productivity might be interpreted as reflecting the fact that foreign investment gravitates towards more productive industries rather than representing any technology spillover from FDI (Haddad & Harrison, 1993; Aitken & Harrison, 1999). The general response in the literature is to undertake fixed-effect panel estimation. Nevertheless, our estimation results are less likely to be subject to a simultaneity problem as *FOR* in this study is a pre-determined variable obtained from the 1996 industrial census. In theory, it is arguable that a pre-determined variable might contain expectations of future outcomes hence the simultaneity problem remains unsolved. For example, current investment of MNEs would be a result of their expectation of productivity gains in the future. This argument is less likely to apply for this study since foreign presence here is measured by output share of current economic activities, and is unlikely to contain any future expectation. Even though *FOR* reflects the distribution of foreign presence in 1996, as argued in Ramstetter (2003), the relative importance of foreign firms remains unchanged during the past decade starting in 1996.

6.1. Is the Foreign Plant More Productive than The Locally-owned One?

Before we examine whether there are FDI spillovers and its relative importance between horizontal and vertical spillovers, we ask a simple question; is the foreign plant is more productive than the locally owned one? Even though it is theoretically expected that MNC affiliates should be more productive than locally non-affiliated firms (Caves, 2007), it is not always true as suggested in several empirical studies such as Ramstetter (2006) in the case of Thai manufacturing. Menon (1998) and Oguchi *et al.* (2002) in the case of Malaysian manufacturing.

To do so, Equation 5 discussed above is modified. First, the sample will cover both foreign- and locally owned plants. Second, *FOR* and its related variables (its interaction terms with ERP_j and QL_{ijt} as well as $BACK_j$, and $FORW_j$) are replaced by ownership variable (*OWN*) measured by a binary dummy variable which equals to 1 if foreign ownership is greater than 10 per cent and zero otherwise. By definition, FDI reflects the objective of an entity resident in one country to obtain a long-term relationship between the direct investor and the host country enterprise, in which the former has a significant degree of influence on the management of the latter. However, the significant degree does not necessarily mean majority ownership. Hence this study follows the dominant current definition by the International Monetary Fund (IMF) and other institutes such as the Organization for Economic Co-operation and Development (OECD), the US Department of Commence as well as several scholars studying multinational firms, which use 10 per cent.[15] Nevertheless, we also use the actual foreign ownership share (*OWN1*) as an alternative measure to examine the sensitivity of results. A statistical significance of *OWN* indicates the productivity difference.

The result of the productivity determinant equation is reported in Table 4. The first and second columns are the results of pooled cross-sectional and random-effected estimations, respectively. Our following discussion will be based on the latter because of the reasons discussed above. The estimated equation passes the *Wald*- test for overall statistical significance at the 1 per cent level. The statistical significance of coefficients corresponding to the primary inputs (capital, production workers and non-production workers), their interactions, and some of their squared terms suggests that the assumption imposed in the Cobb-Douglas production function is not supported by plant-

[15] For example, the early Harvard studies under the direction of Raymond Vernon: Vaupel & Curhan, (1969: p.3) and Wilkins (1970), both cited in Lipsey (2001)

level panel data of Thai manufacturing. Even though translog functional form specification is likely to be affected by the multicollinearity problem and standard error is inflated, coefficients associated with the squared values of capital and production workers are statistically significant at the one per cent level or better. It suggests that such a multicollinearity problem would not create any severe effect on the regression outcome. In particular, in the presence of the multicollinearity problem the effect still shows up, simply because the true value itself is so large that even an estimate on the downside still shows up as significant (Johnson, 1984: 249).

A coefficient corresponding to *OWN* is statistically significant. It suggests that all other things (e.g. inputs level and scale effects) being equal, the foreign plant tends to exhibit higher value added than the locally owned one. The coefficient of 0.21 indicates that the productivity difference between foreign and locally owned plants is about 21 per cent on average after controlling input levels and scale effects. We also find that exporting firms tend to exhibit a higher level of productivity than non-exporting ones as the coefficient corresponding to *MKT* turns out to be positive and significant. Such evidence supports the consensus in the literature of the export-productivity nexus that export-oriented plants tend to be more productive than domestic-oriented plants.

Impacts of producer concentration and trade protection on plant productivity are to certain extent consistent with the findings of previous studies, i.e. Kohpaiboon & Jongwanich (forthcoming) using the , Industrial Census 1996 data set. That is, the net impact of producer concentration on plant productivity is not automatic, but does depend on the degree of tariff protection. Tariff reduction must reach a certain level before the potential positive impact of producer concentration on productivity is observed. Similarly, insulating firms from foreign competition is not sufficient to promote plant productivity improvement. In a highly concentrated industry, high protection tends to induce producers to become 'unresponsive' to improved technological capability and to retard productivity growth.[16]

---

[16] Statistical significance of the interaction coefficient is very marginal at 15 per cent (one-tailed test). As seen in Section 6.2 when the sample covers only locally owned firms, the interaction term turns out to be statistically significant at five per cent. This would be consistent to the aggregate trend discussed in Section 3 that foreign plants in Thailand tend to be located in efficient-seeking industries especially electronics, electrical appliances and automobiles. In fact FDI in automobile industry started with the traditional tariff-hopping style which aimed for a highly protected domestic market. As argued in Kohpaiboon (2006b and 2007), FDI inflows increased significantly in the

Table 4. Regression Results of Productivity Determinants

	OLS	RE
INTP	11.99 (48.70)***	11.88 (48.32)***
$\ln K_{ij}$	-0.17 (-6.01)***	-0.14 (-5.21)***
$\ln K_{ij}^2$	0.01 (8.71)***	0.01 (8.76)***
$\ln NL_{ij}$	0.41 (8.50)***	0.41 (9.25)***
$\ln NL_{ij}^2$	-0.002 (0.20)	0.005 (0.62)
$\ln PL_{ij}$	0.40 (10.35)***	0.36 (10.35)***
$\ln PL_{ij}^2$	0.024 (2.74)***	0.02 (2.43)**
$\ln K_{ij} \ln NL_{ij}$	0.02 (4.08)***	0.01 (3.73)***
$\ln K_{ij} \ln PL_{ij}$	0.01 (1.8)**	0.01 (2.67)***
$\ln NL_{ij} \ln PL_{ij}$	-0.09 (-10.20)***	-0.09 (-10.94)***
$t2002$	-0.04 (-1.76)*	-0.04 (-2.06)**
$t2003$	-0.037 (-1.50)	-0.03 (-1.42)
MKT_{ij}	0.07 (3.11)***	0.08 (2.62)***
OWN_{ij}	0.21 (8.82)***	0.21 (6.51)***
Industry-specific		
CON_j	0.63 (3.53)***	0.72 (3.36)***
ERP_j	0.79 (2.11)**	0.88 (1.94)**
$CON_j ERP_j$	-1.01 $(-1.05)^{\delta}$	-1.09 $(1.02)^{\delta}$
# Observations	9,815	9,815 (3,963 groups)
F-stat	1132.9 ***	19788.5 ***
R-sq	0.78	0.78
RESET	1.50 (p=0.21)	

Notes: OLS = Ordinary Least Squares whereas RE = Random Effect Estimation; The number in the parenthesis of OLS is *t*-statistics constructed from robust standard error whereas that of RE

1990s with a shift in investment motivation to efficiency-seeking. Such foreign plants are keen to improve their production efficiency and strengthen their international competitiveness. This occurs even in a highly concentrated environment. Therefore, when foreign plants are included, this could weaken the proposed non-linear relationship among productivity, producer concentration and protection to some extent.

is z-statistics. RESET is the RESET- functional form misspecification tests; ***,**, * and $^{\delta}$ indicates a statistical significance at 1, 5, 10 and 15 per cent level, respectively.
Sources: Author's estimation.

6.2. Horizontal and Vertical FDI Spillovers

In this subsection the core hypothesis of this paper, namely the presence of horizontal and vertical FDI spillovers, is addressed. Their regression results are reported in Table 5. While both pooled cross-sectional and random-effect estimations are reported in the first two columns of Table 5 for the sake of comparison, our discussion will emphasise random-effect estimations. The overall significance test (*Wald* test) is passed at the one per cent level. In general, most of the firm- and industry-specific variables (i.e. *K*, *NL*, *PL*, *MKT*, *CR4, ERP* and $CR4*ERP$) turn out to be statistically significant and are in line with what are found in the productivity determinant equation in the previous section.

Regression results support the hypothesis that horizontal FDI spillovers can vary across industry. The found negative coefficient of *FOR*ERP* fails to reject the 'Bhagwati hypothesis'. Given the extent of foreign presence, locally owned plants operating in industries with more liberal trade regimes exhibit higher value added than those operating in the less liberal regimes. The evidence that the coefficient of *FOR* is not statistically different from zero points out that foreign presence could either negatively or positively affect the local plant's productivity, depending on the nature of the trade policy regime, i.e. *ERP* greater or less than zero. As shown in Figure 2, there are many export-oriented industries experiencing negative ERP such as processed foods (ISIC 1511 and 1512), leather products (ISIC 1911). The negative figure is largely due to the presence of cost in tariff drawback schemes (e.g. bank guarantees). The econometric findings in these studies are also in line with those in previous studies, i.e. Balasubramanyam *et al.* (1996), Athukorala & Chand (2000), Kohpaiboon (2003: 2006a) and Kokko *et al.* (2001).

Table 5. Regression Results: Horizontal and Vertical FDI Technology Spillover

	Heterogeneous Horizontal Spillovers		Identical Horizontal Spillovers	
	Pooled-cross Section	RE	Pooled-cross Section	RE
INTP	11.92 (39.39)***	11.92 (38.56)***	12.03 (39.32)***	12.08 (39.48)***
$\ln K_{ij}$	-0.15 (-4.19)***	-0.13 (-4.01)***	-0.15 (-4.25)***	-0.14 (-4.14)***
$\ln K_{ij}^2$	0.009 (5.06)***	0.01 (5.51)***	0.009 (5.22)***	0.009 (5.64)***
$\ln NL_{ij}$	0.37 (5.81)***	0.36 (6.38)***	0.37 (6.00)***	0.36 (6.46)***
$\ln NL_{ij}^2$	-0.01 (-0.85)	-0.002 (-0.18)	-0.01 (0.91)	-0.002 (-0.23)
$\ln PL_{ij}$	0.36 (7.43)***	0.32 (7.64)***	0.36 (7.47)***	0.32 (7.65)***
$\ln PL_{ij}^2$	0.01 (1.19)	0.01 (1.33)	0.01 (1.07)	0.01 (1.18)
$\ln K_{ij} \ln NL_{ij}$	0.02 (4.21)***	0.018 (3.84)***	0.02 (4.14)***	0.02 (3.93)***
$\ln K_{ij} \ln PL_{ij}$	0.02 (2.52)***	0.02 (2.77)***	0.02 (3.02)***	0.02 (3.27)***
$\ln NL_{ij} \ln PL_{ij}$	-0.08 (-6.76)***	-0.08 (-7.50)***	-0.08 (-7.08)***	-0.08 (7.63)***
$t2002$	-0.04 (-1.42)	-0.04 (-1.75)*	-0.04 (-1.41)	-0.39 (-1.74)*
$t2003$	-0.04 (-1.42)	-0.03 (-1.42)	-0.04 (-1.43)	-0.03 (-1.42)
MKT_{ij}	0.10 (3.66)***	0.10 (2.71)***	0.10 (3.62)***	0.10 (2.65)***
Industry-specific				
CON_j	0.90 (3.77)***	0.99 (3.56)***	0.88 (3.70)***	0.95 (3.41)***
ERP_j	2.07 (4.50)***	2.14 (3.68)***	1.66 (3.40)***	1.51 (2.71)***
$CON_j ERP_j$	-2.85 (-2.12)**	-2.11 (-1.57)*	-3.66 (-2.86)***	-2.98 (-2.25)**
FOR_j	0.25 (1.28)*	0.26 (1.09)	-0.75 (-0.57)	-0.18 (-1.13)
$FOR_j ERP_j$	-2.55 (-2.85)***	-3.53 (-3.65)***		
$FOR_j QL_{ijt}$	-0.18 (-0.27)	-0.16 (-0.23)		
$BACK_j$	0.02 (0.66)	0.02 (0.82)	0.03 (1.29)*	0.04 (1.77)*
$FORW_j$	-0.01 (-0.67)	-0.01 (-0.50)	-0.01 (-0.54)	-0.01 (-0.35)
# Observations	6,907	6,907 (2,843 groups)	6,907	6,907 (2,843 groups)
F-stat	565.3***		597.2***	
Wald-test (χ^2)		11194.6***		11122.52***
Overall R-sq Within Between	0.74	0.74 0.02 0.80	0.74	0.74 0.02 0.80
RESET	0.55 (p=0.65)		0.82 (p=0.48)	

Notes: OLS = Ordinary Least Squares whereas RE = Random Effect Estimation; The number in the parenthesis of OLS is *t*-statistics constructed from robust standard error whereas that of RE is *z*-statistics. RESET is the RESET- functional form misspecification tests: ***, **, * and $^{\delta}$ indicates a statistical significance at 1, 5, 10 and 15 per cent level, respectively.

Sources: Author's estimation.

The interaction between foreign presence and absorptive capability is not statistically different from zero. The statistic insignificance does not reject the role of absorptive capability in conditioning gains from horizontal FDI spillovers. The failure to uncover its statistic significance could be due to a measuring problem. In particular, the definition of non-production workers in the survey is wide, covering not only supervisors and management workers but also clerical and administrative staff. Interestingly when identical horizontal spillovers are relaxed, statistical significance of vertical spillovers from both backward and forward linkages is not found. The coefficient corresponding to $BACK_j$ is positive but not statistically different from zero. The coefficient corresponding to $FORW_j$ turns out to be negative but insignificant.

In general, the key finding in this study (that there are only horizontal spillovers, not vertical ones) run counter to that of Javorcik, (2004) and Blalock & Gertler (2008) relating to Lithunian and Indonesian manufacturing sectors, respectively. They have uncovered a statistically significant positive spillover through backward linkages but not horizontal spillovers. We suspect that the failure to appropriately control for relevant explanatory variables may have biased the results of these studies. Interestingly, our data set permits us to replicate their results through similar (arbitrary) variable choice. That is, equation 5 is re-estimated by dropping two interaction terms with horizontal FDI spillovers, i.e. imposing an assumption of identical horizontal spillovers. The results are in line with Javorcik (2004) and Blalock & Gertler (2008). Only the coefficient corresponding to $BACK_j$ is statistically significant at 10 per cent.

We rather argue that our model is more preferable as the results seem to be in line with the industrialization path in developing countries including Thailand. As argued in Hugh (2001) several developing Southeast Asian economies pursue the so called 'dualistic approach' in opening up international trade, i.e. they are still reluctant to cut tariffs but opt for tariff drawback schemes as a key instrument to promote an export-led industrialization strategy. For instance, Thailand has been conservative in opening the door for foreign made goods for the past three decades, as indicated in the fact that its applied tariff rates remain at the highest of the six original ASEAN countries (Jongwanich & Kohpaiboon, 2007).

Under such a policy setup, two options are available for entrepreneurs, including MNEs. In Option 1, entrepreneurs aim to be a part of the global economy in which resource allocation is directed according to factor proportion consideration for neo-classical efficiency. Firms in this option tend to be more export-oriented. By contrast, Option 2 encourages entrepreneurs to set up plants and supply highly protected local markets in order to benefit from protection-induced economic rents. Even though MNEs can occur in both options, MNEs existing in the first option (efficiency-seeking MNEs) tends to be more beneficial than those in the second option (market-seeking MNEs) argued in Athukorala and Chand (2000) based on US MNEs experience.

In this circumstance, backward linkages would hardly occur and nor would vertical spillovers. Export-oriented firms including MNEs are unlikely to source local intermediates because of the presence of intermediate tariffs so that they seem to operate in 'enclaves' in isolation from local suppliers. In the meantime, highly protected domestic markets encourage indigenous suppliers to find their own niche markets that are not directly related to what exporting firms want. As long as the policy-induced incentive structure still creates the economic rents, it would be difficult to find qualified suppliers.

That would explain why MNEs which have played an important role in Thailand's industrialization generate limited backward linkages to indigenous firms. Limited backward linkages are observed in several leading export-oriented industries in Thailand such as the automotive, garment and hard disk drive industries (Kohpaiboon, 2006b; 2007 and 2008 and 2009). For example, while locally assembled vehicles in Thailand are reliant largely on locally manufactured parts, as illustrated by the proportion of imported parts to vehicle production, the number of purely Thai firms must be around 10 suppliers, comparing to 287 MNE suppliers. Another example, the ratio of imported fabric to garment production in Thailand has been increasing since 1996 (Kohpaiboon, 2008: Figure 4). The same evidence is also found in the case of the Hard Disk Drive industry (Kohpaiboon, 2009).

7. Conclusion and Policy Inferences

This paper examines FDI spillovers in Thai manufacturing, using industrial surveys during the period 2001-03. A panel data econometric analysis of plant productivity determinants of locally owned plants is undertaken. The paper goes beyond the existing literature in two ways. First, both horizontal and vertical FDI spillovers are tested. In addition, both direct and indirect (inter-sectoral) repercussions are captured in the measurement process of industrial linkages. Secondly, horizontal FDI spillovers are allowed to be different from one industry to the other instead of assuming identical values across industries.

The key finding is that advanced technology associated with MNE affiliates does not always spill over to the local plants operating in the same industry. The extent of spillovers depends on the nature of the trade policy regime. Only industries operating under a liberal trade policy regime experience positive horizontal FDI spillovers. Neither backward nor forward spillovers are found in our study. This seems to be in contradiction with the existing literature highlighting the relative importance of backward linkages as a likely FDI spillover channel. Statistical significance of vertical spillovers through backward linkages is found only if an assumption of identical horizontal FDI spillover is in place. Such an assumption seems to be restrictive. The finding that export-oriented plants have higher productivity than domestic-market-oriented ones further highlight the role of trade policy regime on plant productivity improvement process. Trade liberalization and its induced contestability environment are an effective catalyst for firms to continue to improve their productivity. Besides, only in low tariff environment, the positive impact of producer concentration on plant productivity is observed.

Two policy inferences can be drawn from this study. First these results further highlight the relative importance of the trade policy regime for productivity enhancement and thus development policy. Liberalizing the foreign investment regime thus has to go hand in hand with liberalizing trade policy to maximize gains from MNE presence. Trade liberalization itself also creates contestability environment that is conducive for firms to continue improving their productivity. Secondly, while the relative importance of the linkage channel and its corresponding spillovers seems to be a convincing argument, our work here provides a warning for policymakers not overemphasize it. The conducive role of the backward linkage channel is a result of natural links that are driven by economic concerns and can be distorted by policy measures. The ability of the policy domain to forge linkages seems to be limited. Policy-induced linkages are not perfectly substitutes for natural linkages. This issue is increasingly important under a rising threat of the return of nationalism and protectionism in the incoming global economic recession. The *magnitude* of linkages is not a good proxy of the magnitude of vertical FDI spillovers. The *quality* of backward linkages is a far better indication. Where quality is concerned, backward linkages driven by economic concerns as well as motivated by capability of indigenous suppliers are by far superior to that induced by policy measures.

Appendix 1: Patterns of Labour Productivity (%Δ(*VA*/*L*)), Capital-Labour Ratio (%Δ(*K*/*L*)), Foreign Presence (*FOR*), Backward Linkage Index (*BLI*) and Effective Rate of Protection (*ERP*) of Thai Manufacturing

ISIC	Description	$\%\Delta\left(\frac{VA}{L}\right)$	$\%\Delta\left(\frac{K}{L}\right)$	*FOR*	*BLI*	*ERP*
1511	Production, processing and preserving of meat and meat products	13.1	105.6	0.32	0.91	-0.14
1512	Processing and preserving of fish and fish products	10.2	-46.2	0.29	0.72	-0.08
1513	Processing and preserving of fruit and vegetables	0.8	42.8	0.27	0.47	0.15
1514	Manufacture of vegetable and animal oils and fats	30.9	-27.2	0.13	0.42	0.39
1520	Manufacture of dairy products	391.7	24.2	0.21	0.58	0.12
1531	Manufacture of grain mill products	42.6	-61.5	0.13	0.66	0.14
1532	Manufacture of starches and starch products	160.9	277.7	0.39	0.57	0.12
1533	Manufacture of prepared animal feeds	-36.2	14.8	0.23	0.59	-0.11
1541	Manufacture of bakery products	80.1	104.4	0.12	0.70	0.25
1542	Manufacture of sugar	16.0	47.4	0.21	0.84	0.42
1543	Manufacture of cocoa, chocolate and sugar confectionery	72.2	295.5	0.32	0.66	0.12
1544	Manufacture of macaroni, noodles, couscous and similar farinaceous products	40.4	64.4	0.27	0.84	0.42
1549	Manufacture of other food products n.e.c.	122.0	-43.8	0.51	0.59	0.05
1551	Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials	-61.8	-36.7	0.00	0.61	0.42
1552	Manufacture of wines	n.a.	n.a.	0.67	0.65	0.57
1553	Manufacture of malt liquors and malt	249.1	281.2	0.02	0.34	0.58
1554	Manufacture of soft drinks; production of mineral waters	84.4	111.8	0.48	0.51	0.02
1600	Manufacture of tobacco products	217.4	-57.1	0.04	0.19	0.55
1711	Preparation and spinning of textile fibres; weaving of textiles	102.2	121.0	0.47	0.63	0.15
1712	Finishing of textiles	n.a.	n.a.	0.34	0.58	0.22
1721	Manufacture of made-up textile articles, except apparel	8.1	-68.4	0.54	0.71	0.36
1722	Manufacture of carpets and rugs	n.a.	n.a.	0.58	0.74	0.06
1723	Manufacture of cordage, rope, twine and netting	n.a.	n.a.	0.34	0.64	0.12
1729	Manufacture of other textiles n.e.c.	118.9	244.6	0.63	0.64	0.18
1730	Manufacture of knitted and crocheted fabrics and articles	-0.6	37.9	0.39	0.65	0.13
1810	Manufacture of wearing apparel, except fur apparel	18.0	-11.4	0.31	0.68	0.37
1911	Tanning and dressing of leather	65.2	161.9	0.24	0.89	-0.30
1912	Manufacture of luggage, handbags and the like, saddlery and harness	25.9	196.6	0.34	0.49	0.23

ISIC	Description	$\%\Delta\left(\frac{VA}{L}\right)$	$\%\Delta\left(\frac{K}{L}\right)$	*FOR*	*BLI*	*ERP*
1920	Manufacture of footwear	-8.7	-16.0	0.29	0.64	0.06
2010	Sawmilling and planing of wood	27.8	186.0	0.15	0.29	0.02
2021	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board and other panels and boards	-49.0	-10.3	0.37	0.35	0.03
2022	Manufacture of builders' carpentry and joinery	61.3	49.4	0.06	0.35	0.03
2029	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials	n.a.	n.a.	0.21	0.54	0.45
2101	Manufacture of pulp, paper and paperboard	-44.6	106.5	0.52	0.33	0.03
2102	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	53.2	78.5	0.16	0.35	0.13
2109	Manufacture of other articles of paper and paperboard	112.3	100.3	0.50	0.41	0.15
2221	Printing	23.3	-20.6	0.10	0.46	0.17
2320	Manufacture of refined petroleum products	370.3	817.6	0.44	0.14	0.04
2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds	87.0	160.7	0.37	0.35	0.07
2413	Manufacture of plastics in primary forms and of synthetic rubber	81.0	88.7	0.46	0.51	0.15
2421	Manufacture of pesticides and other agro-chemical products	n.a.	n.a.	0.64	0.44	0.03
2422	Manufacture of paints, varnishes and similar coatings, printing ink and mastics	97.8	164.2	0.60	0.52	0.01
2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	276.1	56.0	0.17	0.41	0.00
2424	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	284.8	424.7	0.52	0.49	0.02
2429	Manufacture of other chemical products n.e.c.	n.a.	n.a.	0.53	0.54	0.06
2430	Manufacture of man-made fibres	75.2	120.0	0.63	0.63	-0.10
2511	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	282.2	156.0	0.57	0.58	0.29
2519	Manufacture of other rubber products	-3.8	38.1	0.29	0.61	0.15
2520	Manufacture of plastics products	45.8	70.1	0.31	0.57	0.14
2610	Manufacture of glass and glass products	188.9	404.5	0.49	0.30	0.03
2691	Manufacture of non-structural non-refractory ceramic ware	111.0	140.7	0.39	0.31	0.02
2692	Manufacture of refractory ceramic products	205.8	444.0	0.52	0.57	0.11
2693	Manufacture of structural non-refractory clay and ceramic products	249.5	110.1	0.03	0.50	0.07
2694	Manufacture of cement, lime and plaster	100.3	154.5	0.13	0.48	0.00
2695	Manufacture of articles of concrete, cement and plaster	143.1	53.5	0.27	0.54	0.05
2696	Cutting, shaping and finishing of stone	-24.4	-71.8	0.08	0.18	0.04
2710	Manufacture of basic iron and steel	154.2	175.8	0.23	0.49	0.06
2720	Manufacture of basic precious and non-ferrous metals	386.3	3501.8	0.40	0.42	-0.01

ISIC	Description	$\%\Delta\left(\frac{VA}{L}\right)$	$\%\Delta\left(\frac{K}{L}\right)$	*FOR*	*BLI*	*ERP*
2731	Casting of iron and steel	374.6	1223.0	0.63	1.13	0.00
2811	Manufacture of structural metal products	76.1	53.6	0.45	0.35	0.11
2812	Manufacture of tanks, reservoirs and containers of metal	159.0	161.2	0.48	0.34	0.12
2891	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	n.a.	n.a.	0.54	1.13	0.00
2892	Treatment and coating of metals; general mechanical engineering on a fee or contract basis	32.3	219.0	0.64	1.13	0.00
2893	Manufacture of cutlery, hand tools and general hardware	162.1	188.8	0.40	0.37	0.16
2899	Manufacture of other fabricated metal products n.e.c.	187.0	264.9	0.37	-2.70	0.00
2911	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines	265.9	491.4	0.64	0.44	0.01
2912	Manufacture of pumps, compressors, taps and valves	129.9	252.5	0.43	0.45	0.05
2913	Manufacture of bearings, gears, gearing and driving elements	311.3	640.6	0.65	0.33	0.20
2914	Manufacture of ovens, furnaces and furnace burners	113.7	52.0	0.63	0.39	0.00
2915	Manufacture of lifting and handling equipment	285.9	589.8	0.64	0.36	0.14
2919	Manufacture of other general purpose machinery	207.8	82.2	0.54	0.42	0.03
2922	Manufacture of machine-tools	157.4	625.8	0.46	0.40	0.00
2924	Manufacture of machinery for mining, quarrying and construction	n.a.	n.a.	0.16	0.37	0.14
2925	Manufacture of machinery for food, beverage and tobacco processing	-59.2	338.2	0.00	0.40	0.00
2929	Manufacture of other special purpose machinery	n.a.	n.a.	0.55	0.44	0.00
2930	Manufacture of domestic appliances n.e.c.	64.7	128.8	0.62	0.44	0.05
3000	Manufacture of office, accounting and computing machinery	9.5	368.5	0.69	0.44	0.00
3110	Manufacture of electric motors, generators and transformers	114.2	43.2	0.45	0.30	0.00
3120	Manufacture of electricity distribution and control apparatus	79.7	151.6	0.64	0.20	-0.01
3130	Manufacture of insulated wire and cable	219.7	469.6	0.62	0.42	0.06
3140	Manufacture of accumulators, primary cells and primary batteries	234.1	372.8	0.60	0.48	-0.07
3150	Manufacture of electric lamps and lighting equipment	48.8	87.1	0.40	0.36	0.04
3190	Manufacture of other electrical equipment n.e.c.	17.1	29.5	0.57	0.23	0.04
3210	Manufacture of electronic valves and tubes and other electronic components	32.1	-24.1	0.68	0.26	0.02
3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	45.3	23.5	0.57	0.15	0.00
3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods	-16.0	51.4	0.62	0.15	0.00
3311	Manufacture of medical and surgical equipment and orthopaedic appliances	35.5	117.1	0.52	0.43	-0.02

ISIC	Description	$\%\Delta\left(\frac{VA}{L}\right)$	$\%\Delta\left(\frac{K}{L}\right)$	*FOR*	*BLI*	*ERP*
3312	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment	99.3	10.0	0.64	0.21	0.00
3320	Manufacture of optical instruments and photographic equipment	198.9	333.2	0.65	0.38	0.00
3410	Manufacture of motor vehicles	235.7	1.4	0.67	0.33	0.20
3420	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	9.5	285.4	0.53	0.33	0.20
3430	Manufacture of parts and accessories for motor vehicles and their engines	86.3	126.2	0.43	0.37	0.14
3591	Manufacture of motorcycles	226.4	553.3	0.48	0.62	0.39
3592	Manufacture of bicycles and invalid carriages	201.8	259.8	0.00	0.62	0.39
3610	Manufacture of furniture	49.6	23.5	0.26	0.50	0.16
3691	Manufacture of jewellery and related articles	11.5	94.0	0.40	0.42	0.06
3693	Manufacture of sports goods	22.7	56.5	0.67	0.48	0.31
3694	Manufacture of games and toys	-39.7	162.8	0.26	0.59	0.07
3699	Other manufacturing n.e.c.	68.0	62.9	0.50	0.64	0.33
	Average	106.93	204.87	0.40	0.46	0.11
	Max	391.67	3501.79	0.69	1.13	0.58
	Min	-61.79	-71.76	0.00	-2.70	-0.30

Sources: Author's compilation. See details of variables construction in the text.

References

Aghion, P., M. Dewatripont, and P. Rey (1999). ‘Competition, Financial Discipline and Growth’, *Review of Economic Studies,* **66**: 825-52.

Ahn, S. (2002). ‘Competition, Innovation and Productivity Growth: A Review of Theory and Evidence’, *OECD Economic Department Working Paper,* 317, OECD.

Aitken, B.J. and A.E. Harrison (1999). ‘Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela’, *American Economic Review*, **89** (3): 605–618.

Athukorala, P. (1998). *Trade Policy Issues in Asian Development,* Routledge, London

Athukorala, P., & S. Chand, (2000). ‘Trade Orientation and Productivity Gains from International Production: A Study of Overseas Operations of United States TNCs’, *Transnational Corporations*, **9** (2): 1-30.

Balasubramanyam, V.N., M. A. Salisu, and D. Sapsford (1996). ‘Foreign Direct Investment and Growth in EP and IS Countries’, *Economic Journal*, **106** (434): 92-105.

Bhagwati, J. (1973). ‘The Theory of Immiserizing Growth: Further Applications’, in M.B. Connolly, and A. K. Swoboda (eds.), *International Trade and Money*, University of Toronto Press, Toronto.

Bhagwati, J. (1985). *Investing Abroad: Es'mee Fairbairn Lecture*, Lancaster University Press, Lancaster.

Bhagwati, J. (1994). ‘Free Trade: Old and New Challenges’, *Economic Journal*, **104** (423), 231–46.

Blalock, G. (2001). 'Technology from Foreign Direct Investment: Strategic Transfer through Supply Chains', Paper presented at the Empirical Investigations in International Trade Conference at Purdue University.

Blalock, G. and P.J. Gertler (2008). ‘Welfare Gains from Foreign Direct Investment through Technology Transfer to Local Suppliers’, *Journal of International Economics,***74**: 402-421.

Blomström, M., A. Kokko, and Z. Mario (2000). *Foreign Direct Investment: Firm and Host Country Strategies*, Macmillan Press, London.

Blomstrom, M. and F. Sjohölm (1999). ‘Technology Transfer and Spillovers: Does Local Participation with Multinationals Matter?’, *European Economic Review,* **43**: 915-923.

Brecher, R.A. and C. F. Diaz-Alejandro (1977). ‘Tariffs, Foreign Capital and Immiserizing Growth’, *Journal of International Economics*, **7** (4)**:** 317–322.

Brecher, R.A. and R. Findlay (1983). ‘Tariff, Foreign Capital and National Welfare with Sector-Specific Factors’, *Journal of International Economics*, **14** (3): 277–88.

Bulmer-Thomas, V. (1982). *Input-output Analysis in Developing Countries: Sources, Methods and Applications,* J.Wiley & Sons, Chichester.

Caves, R. (2007). *Multinational Enterprise and Economic Analysis*, 3rd edition, Cambridge University Press, Cambridge.

Cheh, J. H. (1974). 'United States concessions in the Kennedy round and short-run adjustment costs', *Journal of International Economics*, **4** (4): 267-274.

Corden, W. M. (1966). 'The Structure of a Tariff System and the Effective Protective Rate,' *Journal of Political Economy*, **74** (3): 221-37.

Corden, W. M. (1974). *Trade Policy and Economic Welfare*, Clarendon Press, Oxford.

Crespo, N. and M. P. Fontoura (2007). 'Determinant Factors of FDI Spillovers: What Do We Really Know?', *World Development*, **35** (3): 410-425.

De Melo, J. and S. Urata (1986). 'The Influence of Increased Foreign Competition on Industrial Trade and Profitability', *International Journal of Industrial Organization,* **43** (3): 287-314.

Girma, S. (2005). 'Absorptive Capacity and Productivity Spillovers from FDI: A Threshold Regression Analysis', *Oxford Bulletin of Economics and Statistics,* **67**(3): 281-306.

Girma, S. and H. Görg (2003). 'Foreign Direct Investment, Spillovers and Absorptive Capacity: Evidence from Quantile Regressions, *GEP Working Paper*, No. 2002/14.

Girma, S., D. Greenaway, and K. Wakelin (2001). 'Who Benefits from Foreign Direct Investment in the UK?', *Scottish Journal of Political Economy*, **48**(2): 119-33.

Görg, H. and D. Greenaway (2004). 'Much Ado about Nothing? Do Domestic Firms Really Benefit from FDI?', *World Bank Research Observer*, **19**: 171-97.

Görg, H. and E. Strobl (2002). 'Spillovers from Foreign Firms through Worker Mobility: An Empirical Investigation', *IZA Discussion Papers*, No. 591, Institute for the Study of Labor, Bonn.

Griliches, Z. (1992). 'The Search for R&D Spillovers', *Scandinavian Journal of Economics***, 94**: 29-47.

Haddad, M. and A. Harrison (1993). 'Are There Positive Spillovers from Direct Foreign Investment? Evidence from Panel Data for Morocco', *Journal of Development Economics*, **42** (1): 51–74.

Hart, O. (1983). 'The Market Mechanism as an Incentive Structure', *Bell Journal of Economics*, **14** (autumn), 366-82.

Hayakawa, K., F. Kimura, and T. Machikita (2008). 'Firm-level Analysis of Globalization: A Survey', *ERIA Discussion Paper*, No.2008-01, Economic Research Institute for ASEAN and East Asia (ERIA), Jakarta.

Hill, H. and P. Athukorala (1998). 'Foreign Investment in East Asia: A Survey', *Asian-Pacific Economic Literature,* **12** (2): 23–50.

Hirschman, A.O. (1958). *The Strategy of Economic Development*, Yale University Press, New Haven.

Hugh, H. (2001). 'The Evolution of Dual Economies in East Asia', in D. Lal and R.H. Snape (eds.), *Trade, Development and Political Economy: Essays in Honour of Anne O. Krueger,* Palgrave McMillan.

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): 605-27.

Johnson, J. (1984). *Econometric Methods*, 3rd edition, McGraw-Hill, New York.

Jongwanich, J. and A. Kohpaiboon (2009). 'Export Performance, Foreign Ownership and Trade Policy Regime: Evidence from Thai Manufacturing,' *ERD Working Paper*, No.140, Economics and Research Department, Asian Development Bank

Jongwanich, J. and A. Kohpaiboon (2007). 'Determinants of Protection in Thai Manufacturing', *Economic Papers* **26**(3): 276-94

Khanthachai, N., K. Tanmavad, T. Boonsiri, C. Nisaisook and A. Arttanuchit (1987). *Technology and Skills in Thailand,* Institute of Southeast Asian Studies, Singapore.

Kinoshita, Y. (2001). 'R&D and Technology Spillovers though FDI: Innovation and Absorptive Capacity', *CEPR Discussion Papers,* No. 2775.

Kohpaiboon (2003). 'Foreign Trade Regimes and the FDI-Growth Nexus: A Case Study of Thailand', *Journal of Development Studies*, **40** (2): 55-69.

Kohpaiboon, A. (2006a). Foreign Direct Investment and Technology Spillover: A Cross-industry Analysis of Thai Manufacturing', *World Development*, **34**(3): 541-56.

Kohpaiboon, A. (2006b). *Multinational Enterprises and Industrial Transformation: Evidence from Thailand*, Edward Elgar, Cheltenham.

Kohpaiboon, A. (2007). 'Thai Automotive Industry: Multinational Enterprises and Global Integration', *ERTC Discussion Paper*, No.2007/4 Faculty of Economics, Thammasat University.

Kohpaiboon, A. (2008). *MNEs and Global Integration of Thai Clothing Industries: Policy Implication for SME Development,* Report submitted to Institute of Developing Economies, Japan.

Kohpaiboon, A. (2009). *Trade Policy and International Production Networks in Asia: A Case Study of Hard Disk Drive (HDD) Industry in Thailand*, (work in progress).

Kohpaiboon, A. and J. Jongwanich (forthcoming). 'Market Structure, Foreign Ownership and Productivity in Thailand' in E.D. Ramstetter, F. Sjöholm, and C. Lee (eds.) in *Producer Concentration, Foreign Ownership, and Firms' Performance in East Asia.*

Kohpaiboon, A. and E.D. Ramstetter (2008). 'Producer Concentration, Conglomerates, Foreign Ownership, and Import Protection: Thai Manufacturing Firms a Decade after the Crisis', *ICSEAD Working Paper*, March 2008, International Centre for the Study of East Asian Development, Kokura.

Kokko, A. (1994). 'Technology, Market Characteristics, and Spillovers', *Journal of Development Economics,* **43**: 279-93.

Kokko, A., R. Tansini, and M. Zejan (1996). 'Local Technological Capability and Productivity Spillovers from FDI in the Uruguayan Manufacturing Sector, *Journal of Development Studies*, **32**: 602-11.

Kokko, A., M. Zejan, and R. Tansini (2001). 'Trade Regimes and Spillover Effects of FDI: Evidence from Uruguay', *Weltwirtschaftliches Archiv,* **137** (1), 124-49.

Lin, P. and K. Saggi (2005). 'Multinational Firms and Backward Linkages: A Critical Survey and a Simple Model', in T. Moran, E. M. Graham, M. Blomström (eds.), *Does Foreign Direct Investment Promote Development?,* Institute for International Economics, Washington D.C.

Lipsey, R. (2001). 'Foreign Direct Investment and the Operations of Multinational Firms: Concepts, History and Data', in H. James (ed.), *Handbook of International Trade*, Basil Blackwell, Cambridge.

Markusen, J. R. and A. J. Venables (1999). 'Foreign Direct Investment as a Catalyst for Industrial Development', *European Economic Review*, **43** (2): 335-56.

Martin, J. and J. M. Page (1983). 'The Impact of Subsidies on X-Efficiency in LDC Industry: Theory and an Empirical Test', *Review of Economics and Statistics,* **65**, 608-17.

Menon, J. (1998). 'Total Factor Productivity Growth in Foreign and Domestic Firms in Malaysian Manufacturing', *Journal of Asian Economics***,** **9**: 251-80.

Moran, T. H. (2001). *Parental Supervision: The New Paradigm for Foreign Direct Investment and Development*, Institute for International Economics, Washington D.C.

Moultan, B. R. (1990). 'An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units', *Review of Economics and Statistics,* **72**(2) May: 334-8.

Oguchi, N., N. A. M. Amdzah, Z. Bakar, R. Z. Abidin and M. Shafii (2002), 'Productivity of Foreign and Domestic Firms in Malaysian Manufacturing Industry', *Asian Economic Journal,* **16**: 215-28.

Porter, M. E. (1990). *The Competitive Advantage of Nations,* Macmillan Press, London.

Pursell, G. (2001). 'Australia's Experience with Local Content Program in the Auto Industry', *Policy Research Working Paper*, No.WPS2625, World Bank, Washington D.C.

Ramstetter, E. D. (2003). 'Foreign Multinationals in Thailand after the Crisis: the Challenge of Measuring and Interpreting Recent Trends', in M. Toida and J. Uemura (eds.), *Projects for Asian Industrializing Region 2003,* Institute of Developing Economies, Chiba: 83-170.

Ramstetter, E. D. (2006). 'Are Productivity Differentials Important in Thai Manufacturing', in E. D. Ramstetter and F. Sjöholm (eds.) *Multinational Corporations in Indonesia and Thailand,* Palgrave McMillan, New York.

Roberts, M. K. and J.R. Tybout (1996). *Industrial Evolution in Developing Countries: Micro Patterns of Turnover, Productivity and Market Structure*, Oxford University Press, New York.

Rodriguez-Clare, A. (1996). 'Multinationals, Linkages and Economic Development', *American Economic Review*, **86** (4): 852-73.

Rodrik, D. (1991). 'Closing the Technology Gap: Does Trade Liberalization Really Help?', in G. Helleiner (ed.), *Trade Policy, Industrialization and Development: New Perspectives*, Clarendon Press, Oxford.

Scharfstein, D. (1988). 'Product-Market Competition and Managerial Slack', *Rand Journal of Economics,* **19** (spring): 147-55.

Schoors, K. and B. van der Tol (2001). 'The Productivity Effect of Foreign Ownership on Domestic Firms in Hungary', paper presented at the International Atlantic Economic Conference in Philadelphia.

Schumpeter, J. A. (1942). *Capitalism, Socialism, and Democracy*, Harper and Row, New York.

Sjohölm, F. (1999). 'Technology Gap, Competition and Spillovers from Direct Foreign Investment: Evidence from Establishment Data', *Journal of Development Studies,* **36**(1): 53-73.

Studwell, J. (2007). *Asian Godfather: Money and Power in Hong Kong and South East Asia*, Profile Books

Symeonidis, G. (1996). 'Innovation, Firm Size, and Market Structure: Schumpeterian Hypotheses and Some New Themes', *OECD Economic Studies*, **27**: 35-70.

Tamburlertchai, S., and E. D. Ramstetter (1991). 'Foreign Firms in Promoted Industries and Structural Change in Thailand', in E. D. Ramstetter (ed.), *Direct Foreign Investment in Asia's Developing Economies and Structural Change in the Asia-Pacific region*, Westview Press: USA.

Vaupel, J. W. and J. P Curhan (1969), *The Making of Multinational Enterprise*, Boston Division of Research, Graduate School of Business Administration, Harvard University.

Wagner, J. (2007). 'Exports and Productivity: A Survey of the Evidence from Firm Level Data', *World Economy*, **30**: 60-82.

Wilkins, M. (1970). *The Emergence of Multinational Enterprise: American Business Abroad from the Colonial Era to 1914*, Harvard University Press, Cambridge.

Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data,* MIT Press, Cambridge MA.