VERTICAL AND HORIZONTAL FDI TECHNOLOGY SPILLOVERS IN THAI MANUFACTURING: DOES MEASUREMENT MATTER?

BY

MR. PATTARAKORN TANTRATANANUWAT

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ECONOMICS (INTERNATIONAL PROGRAM) FACULTY OF ECONOMICS THAMMASAT UNIVERSITY ACADEMIC YEAR 2015

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ABSTRACT

This thesis examines the technology spillover from FDI to indigenous firms, using the information derived from the industrial census of Thailand in 2012, the most up-to-date and reliable source of data presently available. While this study takes both horizontal and vertical FDI spillover into account following previous studies, alternative measures of backward and forward linkages are used to examine the robustness of empirical results. The key finding is that measuring only direct linkages tends to result in overestimation of spillovers. Moreover, this finding also supports the results of previous studies in that horizontal FDI spillover is negatively influenced by the restrictiveness of trade policy regimes. The more the restrictive a trade policy, the less horizontal spillover a host country could expect. Two policy implications can be drawn from this thesis. Firstly, while vertical FDI spillovers exist, their magnitude is sensitive to how linkages are measured. This finding may raise awareness in policy circles of avoiding overemphasizing vertical FDI spillovers, which result in imposing policy-induced linkages. Secondly, liberalizing foreign direct investment policy must go hand-in-hand with trade policy reform to maximize FDI horizontal spillovers.

Keywords: FDI Technology Spillovers, Trade Policy, Thai Manufacturing, Linkages.

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Mr. Pattarakorn Tantratananuwat

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LIST OF ABBREVIATIONS

Symbols/Abbreviations	Terms
AD	Anno Domini
BE	Buddhist Era
BOI	The Board of Investment of Thailand
BOT	The Bank of Thailand
CR4	4-Firm Concentration Ratio
CR5	5-Firm Concentration Ratio
EP	Export Promotion (Trade Regime)
ERP	Effective Rate of Protection
FIML	Full-information Maximum Likelihood
FDI	Foreign Direct Investment
HHI	Herfindahl-Hirschman Index
HS	Harmonized System Code
IMF	International Monetary Fund
IO Table	Input-Output Table
IP	Intellectual Property
IS	Import substitution (Trade Regime)
ISIC	The International Standard Industrial Classification of All Economic Activities
IV	Instrument Variable
LDI Matrix	Leontief Domestic Inverse Matrix
M&A	Mergers and Acquisitions
MNC	Multinational Corporation
MNE	Multinational Enterprise
NESDB	Office of the National Economic and Social Development Board of Thailand

NSO	National Statistical Office of Thailand
WTO	World Trade Organization
OECD	Organization of Economic Co-operation and Development
OFCF	Other Form of Capital Flow
OLS	Ordinary Least Squares
R&D	Research and Development
TRIMs	Trade-related Investment Measures
UNCTAD	United Nations Conference on Trade and Development
2SLS	Two-Stage Least Squares
3SLS	Three-Stage Least Squares

CHAPTER 1
INTRODUCTION

1.1 Statement of the problem

FDI is uniformly welcomed by many developing host countries, as such capital inflow is able to generate notable positive effects on the economic development of such nations. In theory, the presence of foreign direct investment (FDI) is able to engender desirable outcomes for the host country, both directly and indirectly. In the former case, FDI is able to provide additional capital funds and mitigate any financial constraints. In the latter, FDI has the potential to positively affect the technological capabilities of indigenous firms, a concept widely known as technology spillover. Nowadays, direct effects have become less important as a consequence of the increasingly integrated international global capital market. Hence, FDI technology spillovers, indirect effects, represent the principal desired effect that host countries are able to expect (Kohpaiboon, 2006a).

Interestingly, empirical studies suggest that technology spillover may be found in only a limited range of countries, leading ongoing research efforts to be directed at identifying the factors influencing FDI spillovers. In theory, there are numerous channels in which the advanced technology associated with FDI could benefit indigenous firms. This could take the form of both intra- and inter-industry spillovers, known as horizontal and vertical spillovers, respectively. A number of studies have argued that vertical spillovers are more likely to take place as opposed to horizontal ones. This is because foreign affiliates may have an incentive to prevent knowledge leakage to their local competitors. By contrast, there would be more mutual benefit between foreign affiliates and local suppliers when the former transfers knowledge to the latter, i.e. a backward linkage effect. Moreover, local firms could be more productive from using intermediate output produced by multinational suppliers as their input, i.e. a forward linkage effect.

Nonetheless, there are two main shortcomings in the existing literatures. First, how linkages should be measured remains an open question. All of the related studies (e.g. Javorcik, 2004), with the exception of Kohpaiboon & Jongwanich (2013),

focus on direct linkages between foreign affiliates and local suppliers. Interestingly, studies using the direct measure found empirical evidence of inter-industries FDI spillovers. However, evidence of vertical spillovers was not found in Kohpaiboon & Jongwanich (2013), which employed measures capturing both direct and indirect (inter-sectoral) linkages. There is no prior theoretical support indicating why vertical spillovers are transmitted only through direct linkages. Hence, it is worth systematically examining whether any measurement of linkages is sensitive to the presence of vertical spillovers.

Second, the empirical findings of studies examining vertical spillovers tend to be subject to another major shortcoming. That is, horizontal FDI in these studies was treated as only one among various other controlling variables. In fact, in a number of empirical studies, horizontal spillover from FDI was seen to vary, depending on conditions in investment-receiving (host) countries, such as local firms' absorptive capability and trade policy regime[1]. Interestingly, Kohpaiboon and Jongwanich (2013) argued that ignoring such conditions could lead to overestimating the effects of vertical spillovers. Even though the findings of Kohpaiboon and Jongwanich (2013) are not perfectly comparable to other studies due to differences in the linkage measures used, the statistical significance of vertical spillover found depends on how horizontal spillover is treated. Therefore, it would be interesting to re-visit whether the statistical significance of vertical spillover is sensitive to how linkages are measured, as well as how horizontal spillover is treated.

While these are two important considerations in empirically examining the presence of FDI spillovers, they have not been examined systematically in previous studies. Against this backdrop, this thesis aims to investigate the presence of FDI technology spillovers, using the latest Industrial Census of Thailand compiled in 2012. In the empirical model, the productivity equation of locally-owned plants in the manufacturing sector is employed. Horizontal FDI spillover is introduced in the empirical model. Together with its determinants (i.e. trade policy regimes), which were

[1]See Görg & Greenaway (2004); Kohpaiboon (2006b); Crespo & Fontoura (2007); Hayakawa et al. (2008); and Kohpaiboon & Jongwanich (2013).

highlighted in the previous studies. In addition, both direct and indirect linkages are alternatively used to examine the robustness of the results.

1.2 Objectives

1. To review policy towards foreign direct investment, as well as trend and patterns concerning FDI inflows in Thailand.
2. To examine the horizontal and vertical spillovers of FDI within Thai manufacturing.
3. To provide policy recommendations to harness any gains acquired from FDI spillovers.

1.3 Scope of the study

This thesis emphasizes the presence of FDI in the manufacturing sector in the new millennium (i.e. from 2000 to the present). Where policy towards direct foreign investment is concerned, this thesis focuses on trade and investment policies, as they play a crucial role in influencing the presence of FDI spillovers. Other policies concerning such factors as macroeconomic stability, infrastructure development, and human capital development will be discussed when relevant. In the thesis, FDI inflows instead of outflows are employed. In view of the fact that it is different to other forms of capital flows, any consideration of FDI must treat inflows and outflows differently as they have divergent implications on economic development. While FDI outflows have become increasingly important in developing countries like Thailand, this ground is not covered in this thesis. In fact, it deserves comprehensive analysis on its own, which is far beyond the scope of this current paper.

CHAPTER 2
REVIEW OF LITERATURE

This chapter aims to present a literature review concerning research into FDI and technology spillovers. Previous studies are organized in order to provide an analytical framework in order to better understand the presence of FDI spillovers. The organization is as follows; Section 2.1 discusses the nature of FDI as opposed to other forms of capital flows. Channels in which foreign technology is able to be transmitted to local firms is outlined in Section 2.2; while in Section 2.3, factors conditioning FDI spillovers are presented. The last section provides insight into empirical studies of FDI spillovers.

2.1 Foreign direct investment versus other form of capital flow

Foreign direct investment (FDI) is often referred to as the investment made to acquire a lasting interest in, or significant degree of influence on, the management of an enterprise operating outside of the home nation of the investor body. In other words, FDI is regarded as the existence of long-term relationships between direct investors and invested enterprises, according to IMF and OECD definitions. Similar to other forms of capital flow (OFCF), FDI provides capital funds to host countries, which will further reduce the cost of capital and in turn motivate domestic production (Sjoholm, 1997; and Blomstrom et al., 2000). In contrast, the main difference between FDI and OFCF is that while the latter contributes only capital, the former usually transfers both capital and technology to host countries. In particular, the entry of foreign affiliates is typically associated with some amount of technological investment emanating from the parent company. That is because MNEs need to offset potential disadvantages in competition with local firms. For instance, local firms may possess relatively superior knowledge in terms of the availability of factor inputs, business practices and/or consumer preferences prevalent within their markets. Under these circumstances, the advanced technology brought from MNE headquarters has the potential to help foreign affiliates be able to survive in a new market, or even successfully compete with indigenous firms.

Recently, existing studies have tended to emphasize the direct impact of FDI, that is, the impact of additional capital funds provided by the involvement of FDI as mentioned above. Nonetheless, the direct impact of FDI is becoming less important to some host countries as a result of integrated international capital markets and the possibility of borrowing funds from within host country capital markets (Kohpaiboon, 2006a). Hence, a number of studies have placed an emphasis on indirect impacts, that is, impacts on a local firms' productivity or efficiency improvements made as a consequence of the presence of foreign affiliates. This is often regarded as FDI technology spillover (Blomstrom & Kokko, 1998). Specifically, local firms can observe, learn, and adapt the superior technology associated with foreign firms to enhance their own technological capabilities (Wang & Blomstrom, 1992). That is because the technology which accompanies foreign firms has certain public favorable qualities, which cannot be fully internalized. Thus, the localization of foreign firms has the potential to generate positive externality in the form of technological benefits disseminated to local firms.

2.2 Channels of FDI technology spillovers

While the efficiency of indigenous firms is able to be improved through FDI technology spillovers, there are various channels in which foreign technological innovations may be adopted by local enterprises. As identified by FDI spillover studies, there are at least three channels in which FDI spillovers are able to impact local firms, namely Demonstration-Competition Effects, Labor Mobility and Linkage Effects.

The presence of MNEs induces Demonstration Effects. In many cases, foreign affiliates tend to come up with superior technology, operation process and knowledge. Local firms might not be aware of certain technologies or advanced knowledge until they become available in the domestic economy (Kohpaiboon, 2006a). For instance, once a new technological innovation is introduced into a domestic market, adopting that technology may be ongoing debate within the local firm, i.e. whether it is worth investing in or not. Nonetheless, when the technology has been successfully used by foreign companies, the local firm will be encouraged to imitate a particular technology, which helps improve their productivity (Crespo & Fontoura, 2004).

Nonetheless, foreign firms tend to make significant efforts to avoid any leakage of knowledge which may potentially strengthen their local competitors. Under these circumstances, the magnitude of any technological benefit which local firms may gain depends on the effectiveness of MNCs in protecting their knowledge, the degree of product sophistication, and the ability of local firms to incorporate the potential knowledge into their production and management processes (Pfeiffer et al., 2014).

On the other hand, the presence of foreign affiliates can exert pressure on local firms, i.e. Competition Effects. The competition in the domestic market generated by foreign affiliates acts as an incentive for indigenous firms to enhance their technical capabilities, or attempt to resolve their allocation inefficiencies. This is because it allows local firm to be able to compete with foreign firms, or even successfully survive. For example, in the short term, local firms may strategically respond to higher intensity of competition generated by foreign affiliates by proactively improving their efficiency or reducing the cost. Then, in the longer term, local firms seek new technology or innovations, which allow them to sustainably upgrade their existing production (Kohpaiboon, 2006a). In contrast, the efficiency of the local firms might be harmed by the higher competition generated by foreign affiliates. In other words, the presence of foreign affiliates may lead to a contraction of the market share of local firms by stealing their customers, resulting in a decrease in their productivity (Kim, 2014). In sum, the net effect of competition depends on the ability of local firms to compete with MNCs and the effectiveness of foreign affiliates to consolidate their market share (Kosava, 2010). Interestingly, as pointed by Atiken and Harrison (1999), a negative relationship between the existence of foreign firms and the productivity of local firms may be found in the short and medium terms. After that, in the long run, when the weakest local firms have left the market, the relationship may be reversed. Importantly, both demonstration and competition effects are likely to occur simultaneously. Hence, these two effects are often regarded in the empirical literatures, as constituting a single channel of spillover, accordingly.

MNEs often play a more active role than local firms in training and educating their local labor force (see Lindsey, 1986; Djankov & Hoekman, 2000; and Sousa, 2001). Foreign firms usually instigate training programs for the local labor force at most levels of employment, from manufacturing operatives to technically advanced

professionals and senior managers. The types of training range from simple training courses and seminars to more formal schooling and overseas education, depending on the skill needed. For instance, based on the evidence of the Czech Republic, foreign affiliates spent 4.6 times more than local firms on training their employees (Filer et al., 1995). The various skills gained while working in foreign firms may subsequently spill over to local markets, either when workers are recruited by local firms, or go to establish their own local businesses, and use the knowledge gained from their previous employment in foreign affiliates. This is often regarded as Labor Mobility (Blomstrom & Kokko, 1998). However, foreign affiliates often offer the local labor force wage premiums in order to prevent the high worker turnover, which could benefit their local competitors (Javorcik, 2013). On the other hand, significant labor mobility does not necessarily generate only positive impacts for local firms. In fact, the presence of foreign affiliates may also negatively affect local firms by recruiting their talented employees (Blalock & Gertler, 2008).

Indigenous firms are potentially able to become more productive through contracts with their multinational suppliers and customers, i.e. Linkage Effects. The former is referred to as backward linkage, while the latter is regarded as forward linkage. Backward linkage effects are created when local firms become suppliers for multinational firms. In general, foreign affiliates often demand better and/or more diverse immediate outputs (Winkler, 2013). Under these circumstances, local firms need to enhance their productivity and efficiency, while enjoying returns to scale (i.e. demand effect). Meanwhile, in some cases, MNEs have to directly assist local suppliers to enhance their technological capabilities, i.e. an assistance effect (Paus & Gallagher, 2008). For example, foreign customers might share their production techniques, product design and technology acquisition. Moreover, MNEs might offer personal training, advance payments, leasing of machinery, provision of inputs and/or quality assurance, or even share in the organization of product lines (Javorcik & Spatareanu, 2008). While the demand and assistance effects are intentionally provided by multinational organizations, unintentional FDI spillovers through backward linkages could also exist. In particular, such a scenario could take place, where there is technology leakage to supplying firms in the same sector, i.e. a diffusion effect (Winkler, 2013). On the other hand, forward linkage effects could exist when local

firms use intermediate outputs produced by foreign firms in upstream industries as their inputs. Local firms may become more productive through gaining access to new, reliable, higher quality and/or less costly intermediate products, i.e. availability and quality effects (Javorcik & Spatareanu, 2008). In consequence, the total linkage effect constitutes the sum of backward and forward linkages, which can be seen as the growth of industries induced by establishing MNE affiliates in other industries (Kohpaiboon & Jongwanich, 2013).

2.3 Factors influencing FDI technology spillovers

As discussed in the first chapter, several studies implicitly assume that FDI spillovers are identical across all industries, i.e. ignoring the determinants of FDI spillovers. Doing so may not be in line with the results of a number of studies pointing out the heterogeneity of FDI spillovers (e.g. Crespo & Fontoura, 2007; and Kohpaiboon & Jongwanich). In other words, economic analysis under this assumption could result in biased estimates, as a result of omitting variable problems. Furthermore, according to Irsova & Havranek (2013), who collected more than a thousand estimates of horizontal spillovers in their meta-analysis, intra-industry spillovers are on average zero, whereas their sign and magnitude depends on heterogeneity in the host country. Hence, this implies that heterogeneity of FDI spillovers needs to be recognized in order to exploit technological benefits, especially through horizontal spillovers. To do that, several studies have tried to identify what kinds of heterogeneity in either foreign affiliates, indigenous firms or host-country policies represent crucial considerations. Consequently, while it is likely that no factor conditioning vertical spillovers exists, a number of studies have identified two factors conditioning horizontal spillovers, namely absorptive capability and trade policy regimes.

An *Absorptive Capability* is often referred to in terms of the technological gap between foreign affiliates and local firms (see Kokko, 1994; Blomstrom & Sjoholm, 1999; and Sjoholm, 1999). Early theoretical papers emphasized the speed of adoption of new technologies, i.e. FDI spillovers depend on the technological distance between the host and home countries of foreign affiliates. Researchers argued that the wider the technology gap, the higher the potential for positive spillovers (Findlay,

1978). Subsequently, views on the nature of technology gaps have changed considerably, while the literature still focuses on the role of technological distance. Nonetheless, they perceive the technology gap between multinational and local firms as an indicator of the absorptive capability of local firms. That is, the ability to internalize knowledge created by the others and adapt such knowledge to fit their own specific application, processes and routines (Narula & Marcin, 2003).

The relationship between technology gaps and FDI spillover is theoretically non-linear. On the one hand, the larger the gap, the lower the human capital and technological know-how required for benefits to accrue through the presence of foreign affiliates, the lower the potential for spillover benefits (Girma & Gorg, 2005). This is because local firms possessing a large gap are far behind the best practices and technical competency needed to catch up. The magnitude of FDI spillovers will increase with smaller technological gaps, as it increases the opportunities for increased efficiency via the imitation and adoption of foreign technological innovations (Crespo & Fontoura, 2007). On the other hand, when the technological gap is small, foreign affiliates will transmit limited technological gains to local firms (Kokko, 1994). This is owing to the fact that firms with smaller gaps often lack the incentive to alter existing practices. Moreover, these firms may have already invested in low-hanging fruit technologies, which are low cost and yield high returns, thereby it is more complicated to further improve their capacity (Blalock & Gertler, 2009). Therefore, it is maintained that local firms should have a moderate technological gap vis-à-vis foreign affiliates in order to maximize the gains available through the advanced technology associated with MNEs.

On the other hand, research into the impact of *Trade Policy Regimes* on FDI technology spillovers was pioneered by Bhagwati (1978)[1]. In particular, he hypothesized that gains through FDI are far less or may even be characterized as negative, under restricted trade regimes (i.e. IS regimes), than under liberal trade regimes (i.e. EP regimes). This conditional gain is often regarded as the Bhagwati hypothesis. In consequence, FDI under restrict trade regimes usually flow to an industry with high trade restrictions in order to supply their output in a highly protected

[1]And were further developed by Bhagwati (1985, 1994); Brecher & Diaz-Alejandro (1977); and Breecher and Findlay (1983).

domestic market. Although the foreign affiliate's production technology is less advanced than comparable technology used in its home country, it is often relatively capital- and skill-intensive compared to a local firm's technology. Under such circumstances, it is more complicated for local firms to assimilate the required advanced technology. In some cases, local firms may have an incentive to avoid competition by establishing production in other industries, and exploit the benefit of economic rents induced by the regime. Thus, in this situation, it is unlikely that foreign technology will spill over to local firms.

In contrast, under liberal trade regimes, FDI inflows are attracted to industries in which the host country has a comparative advantage, e.g. relatively lower labor costs or the availability of raw materials. Meanwhile, local firms in such industries often have a greater potential to catch up with foreign firms and achieve the desired productivity improvements. Hence, it is more likely that liberal trade policies will generate more FDI spillovers from FDI involvement to local firm.[2] Nonetheless, there is empirical evidence pointing to the negative impact of FDI spillover through trade liberalization in middle income countries (see Nobakht & Madani, 2014).

2.4 Empirical studies of FDI technology spillovers

Nowadays, the empirical literature tends to examine FDI spillovers in terms of horizontal and vertical spillovers, instead of the channels discussed above. On the one hand, horizontal spillovers often refer to intra-industry spillovers, including both demonstration-competition effects and labor mobility within an industry. However, in many cases, the data related to the working experiences of owners and the workforce of local firms is not available, thereby only demonstration-competition effects within an industry are practically referred to as horizontal spillover. On the other hand, FDI spillovers across industries are often regarded as vertical spillovers. Therefore, the inter-industry demonstration effect and labor mobility, as well as any linkage effect, are captured in this context. Similarly, inter-industry labor mobility is unable to be

[2] For more details, see Kokko et al., 2001; Kohpaiboon 2006b; and Kohpaiboon & Jongwanich, 2013

examined as an intra-industry factor. Meanwhile, it is complicated to compute inter-industry demonstration-competition effects in practice. Under this circumstance, the vertical spillover is normally examined only through linkage effects. Hence, most studies examine horizontal and vertical spillovers by investigating intra-industry demonstration-competition effects and linkage effects, respectively.

The empirical studies of FDI spillovers may be broken down generally into three categories, as discussed in Jefferson & Ouyang (2014). The first involves case-study research, which can offer detailed descriptions of cases that may clearly illustrate general issues. However, case studies often employ only qualitative analysis, which might preclude the insights derived from quantitative analysis. Second, industry-level studies, pioneered by Caves (1974), usually reveal a positive correlation between FDI inflows and local firm productivity. Nonetheless, it is likely that a positive relationship is generated by highly productive industries attracting multinational corporations, or the presence of FDI driving away weak firms. Industry-level studies are susceptible to endogeneity and the spurious inference of the causality of critical firm effects, accordingly. The third category within FDI spillover research constitutes firm-level data. In particular, it is able to maintain quantitative insights, and directly examines the relationship between existing local firms and any FDI presence. Consequently, firm-level data is preferable and employed in a number of studies.

Regarding firm-level studies, line of enquiry concerns proving whether the involvement of MNEs leads to the improvement of local firms' productivity. To do that, analysis usually starts by establishing an econometric equation, particularly concerning a local firms' production function with controlling variables being employed. Local firms' productivity will be assigned as a dependent variable, while local firms' production inputs (i.e. labor and capital), and controlling variables (i.e. firm- and industry-specific factors) employed as independent variables. Importantly, proxies for horizontal and vertical spillovers are included as controlling variables. In many cases, a proxy for horizontal spillover is any foreign presence in each industry, e.g. the output share of foreign affiliates. On the other hand, vertical spillovers consist of backward and forward linkages, as mentioned earlier. Proxies for backward and forward linkages comprise the magnitude of relationships between local suppliers-foreign customers and foreign suppliers-local customers, respectively. In other words, the proxy for backward

linkages represents the share of produced intermediate output in each industry, which has been purchased by foreign firms, while the proxy for forward linkages concerns the share of purchased intermediate output in each industry, which has been produced by foreign firms.

Once the variables are ready to be examined, a number of econometric models may be further chosen, mostly dependent on the characteristics of data. In practice, an existence of FDI spillovers is empirically proved when the proxy for the FDI spillovers is revealed to be statistically significant. So far, there have been a number of empirical studies examining horizontal and vertical spillovers simultaneously, as illustrated in following table.

Table 2.1

Summary of empirical studies examining horizontal and vertical spillovers

Empirical literature	Country	Study period	Measures of linkage[γ]	Horizontal*	Vertical**
Javorcik (2004)	Lithuania	1996-2000	D	0	B+,F0
Bwalya (2006)	Zambia	1993-1995	D	0	B+,F-none
Javorcik & Spatareanu (2008)[δ]	Romania	1998-2000	D	0	B+,F-none
Kugler (2006)	Colombia	1974-1998	D	0	B+,F0
Blalock & Gertler (2008)	Indonesia	1988&1996	D	0	B+,F-none
Marcin (2008)	Poland	1996-2003	D	+	B+,F0
Lin et al. (2009)	China	1998&2005	D	0	B+,F+
Managi & Bwalya (2010)[Ω]	Kenya, Tanzania, Zimbabwe	1993-1995	D	+	B+,F-none
Barrios et al. (2011)	Ireland	1983-1998	D	0	B+,F-none
Du et al. (2012)	China	1998-2007	D	0	B+,F+
Xu & Sheng (2012)	China	2000-2003	D	+	B+,F+
Kohpaiboon & Jongwanich (2013)	Thailand	2001-2003	D&IND	0	B0[Ψ],F0

Source: The author's compilation.

Note: *0 denotes statistic insignificant or weak, + denotes positive statistic significant

**B+ denotes positive statistic significant on backward linkage, B0 denotes statistic insignificant on backward linkage. F+ denotes positive statistic significant on forward linkage. F0 denotes statistic insignificant on forward linkage. F-none denotes the study which does not examine forward linkage.

[γ] D denotes the measures of linkage capturing only direct linkages, D&IND denotes the measures of linkage capturing both direct and indirect linkages.

[δ] The results derived from the measures including foreign shares at 10-99 per cent.

[Ω] The evidence of FDI spillovers was found only in Kenya and Zimbabwe.

[Ψ] Significant positive backward linkage is found when omitting the determinants of horizontal spillovers.

Eventually, all studies, with the exception of Kohpaiboon & Jongwanich (2013), revealed evidence of vertical spillovers, particularly through backward linkages. In contrast, the existence of horizontal spillovers was rarely found. Nonetheless, while all studies employ identical measure concerning horizontal spillovers, measures of vertical spillovers are employed differently, i.e. consensus on how vertical spillovers should be measured has been reached. In particular, all studies

discovering the evidence of vertical spillovers employ the measure of Javorcik (2004), which captures only direct linkages. However, Kohpaiboon & Jongwanich (2013) which represents the only work unable to find any evidence of vertical spillovers, employed a distinct measure capturing both direct and indirect linkages. Hence, measures of vertical spillover might be sensitive to the presence of technological benefits.

Furthermore, most studies implicitly assume that FDI spillovers will automatically be transmitted to local firms, when MNEs have become established, i.e. the factors of FDI spillovers are omitted, which may result in biased estimates. For example, Kohpaiboon & Jongwanich (2013) experimentally examine the existence and factors inherent within FDI spillovers. They found no evidence of vertical spillover, as mentioned above, when their empirical model included factors concerning FDI spillovers, i.e. the assumption of heterogenous FDI spillovers. Nonetheless, very importantly, evidence of backward linkage is found, when they omit the factors, i.e. the assumption of FDI spillovers. Therefore, the existence of vertical spillovers in earlier empirical analyses might also constitute biased measures as a result of omitting the variable problem.

CHAPTER 3
FOREIGN DIRECT INVESTMENT IN THAILAND

This chapter aims to present an overview of foreign direct investment in Thailand. In the first section, the policy environment in Thailand is discussed. In particular, foreign direct investment and trade policies are contemplated. The second section reviews trends and patterns within foreign direct investment in Thailand. In this section, flows and the distribution and the presence of foreign direct investment are discussed. Furthermore, the relationship between FDI and trade policy; as well as FDI and labor productivity is further discussed.

3.1 Policy environment in Thailand

3.1.1 Foreign direct investment policy in Thailand

In general FDI in Thailand is governed by the Foreign Business Act B.E. 2542 (A.D. 1999) and Investment Promotion Act B.E. 2544 (A.D. 2001). A foreigner is defined by the first act as a natural person, who is not by nationality Thai, or a juristic person under one of following conditions. First, a juristic person established under foreign law. Second, half or more of an operations' capital is owned by foreigners, even if the firm is incorporated under Thai law. Third, half or more of the value of total capital has been invested by foreigners, even if more than half of the capital is owned by Thai nationals. The last requirement is imposed to act as a bar on the use of Thai nationals as nominees.

The first act classifies businesses into three main categories, in which each category refers to differently imposed foreign restrictions. Specifically, businesses listed in the first category are strictly prohibited to foreigners due to special reasons, unless there is an exception under special laws or treaties[1]. In general, the first category includes the mass media, rice and animal husbandry and other resource-based businesses. The foreign equity participation of any enterprise engaged in businesses

[1]For example, American have the same right as Thais with respect to the ownership and operation of businesses in Thailand in some sectors.

detailed in the first list, must be lower than half of its registered capital. Regarding the second category, the list includes businesses related to national safety or security; or affecting arts and culture, traditions, folk handicrafts or natural resources and the environment. As with the first listing, the foreign equity participation of firms must be lower than half of its registered capital. However, there is an exception for some foreign firms which are granted permission to operate by a government minister with the approval of the Thai cabinet. Finally, the third category is relatively less strict in that particularly foreign firms are able to become involved in businesses within this list in cases where permission is granted by the Director-General with the approval of the a governmental committee. The third list includes businesses in which Thai nationals are unable to compete with foreigners

On the other hand, a policy measure explicitly aiming to attract FDI was first launched legally in 1960. In particular, the Industrial Promotion Act of 1960 established an organization, which later became the Board of Investment (BOI) and started offering tax incentives. Later, the Investment Promotion Act enacted in 1977 not only continued to provide a tax holiday to MNEs, but also additionally offered a 50 per cent reduction in import duties on machinery. More recently, an area-based incentive was introduced in the Investment Promotion Act revised in 1993, so as to improve income distribution and reduce economic disparities. For example, the BOI promoted industrial decentralization with an additional incentive (e.g. a longer term of tax holiday and reduced import duties) to investment projects located outside of Zone 1 (i.e. the Bangkok metropolitan district).

According to an announcement of the Board of Investment No.2/B.E.2557 (A.D. 2014), the BOI has rotated to grant activity-based and merit-based incentives, hoping that these will enhance the nation's competitiveness and help achieve sustainable growth. Regarding activity-based incentives, the board classifies two groups[2] of incentives based on the importance of particular activities, i.e. Group A and Group B. In general, Group A involves activities using high technology and complicated production processes, whereas activities in Group B employ relatively lower technological input and simpler production processes. More specifically, Group

[2]See full list in Appendix.

A, which is further divided into four sub-groups, consists of activities receiving corporate income tax incentives, machinery and raw materials import duty incentives and other non-tax incentives. On the other hand, activities included in Group B, which is further divided into two sub-groups, receive only machinery and raw material import duty incentives and other non-tax incentives. More specifically, incentives granted based on their importance are explicitly shown in the following table.

Table 3.1

BOI activity-based incentives

	Incentive	**Group A**				**Group B**	
		A1	**A2**	**A3**	**A4**	**B1**	**B2**
1.	Corporate income tax exemption	8-year	8-year*	5-year*	3-year*	*No*	*No*
2.	Exemption of import duty on machinery	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*
3.	Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year, which can be extended as deemed it by the board	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
4.	Other non-tax incentives	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Source: The Board of Investment.

Note: Yes denotes the incentive applicable for each group. *No* denotes the incentive is excluded for the group. *denotes corporate income tax exemption accounting for 100 per cent of investment (excluding cost of land and working capital).

Furthermore, the board also offers additional incentives based on specific merits of individual projects in order to attract and stimulate more investment and expenditure on activities benefiting the country or industry. Nonetheless, the total period of corporate income tax exemption shall not exceed eight years, although additional incentives according to projects of individual merit have been approved. There are three merit-based incentives, namely merits on competitiveness enhancement, decentralization and industrial area development.

Projects granted approval based on merit concerning competitiveness enhancement, include investment and expenditure in R&D regarding technology and innovation, donations, IP acquisition or licensing fees for commercializing technology developed, advanced technology training, development of local suppliers, and product

and package design. Enterprises will be granted one, two, and three additional years of tax holiday, if qualified investment or expenditure is not less than one, two or 3 per cent of the project's total revenue of the first three years combined respectively, or not less than 200, 400, and 600 million baht respectively, whichever constitutes the lesser amount. Moreover, the cap on additional corporate income tax exemption accounts for 200 per cent of the investment and expenditure specified in R&D projects and 100 per cent in the remainder.

The second merit concerns decentralization wherein additional incentives are granted for projects located in investment promotion zones. Projects being approved will receive three additional years of corporate income tax exemption, double deduction for transportation, electricity and water costs for ten years from the date of the first revenue derived from the promoted activity, and deduction from net profit of 25 percent of the project's infrastructure installation or construction costs, in addition to normal depreciation. Such deduction can be made from the net profits of one or several years within ten years from the date of the first revenue derived from the promoted activity. As merit-based suggests, area-based incentives still exist on the decentralization factor. However, its priority is delegated into additional incentives. Finally, regarding the third merit category, a one year additional corporate income tax incentive will be granted to projects located within industrial estates or promoted industrial zones, which are approved by the board.

3.1.2 Trade policy in Thailand

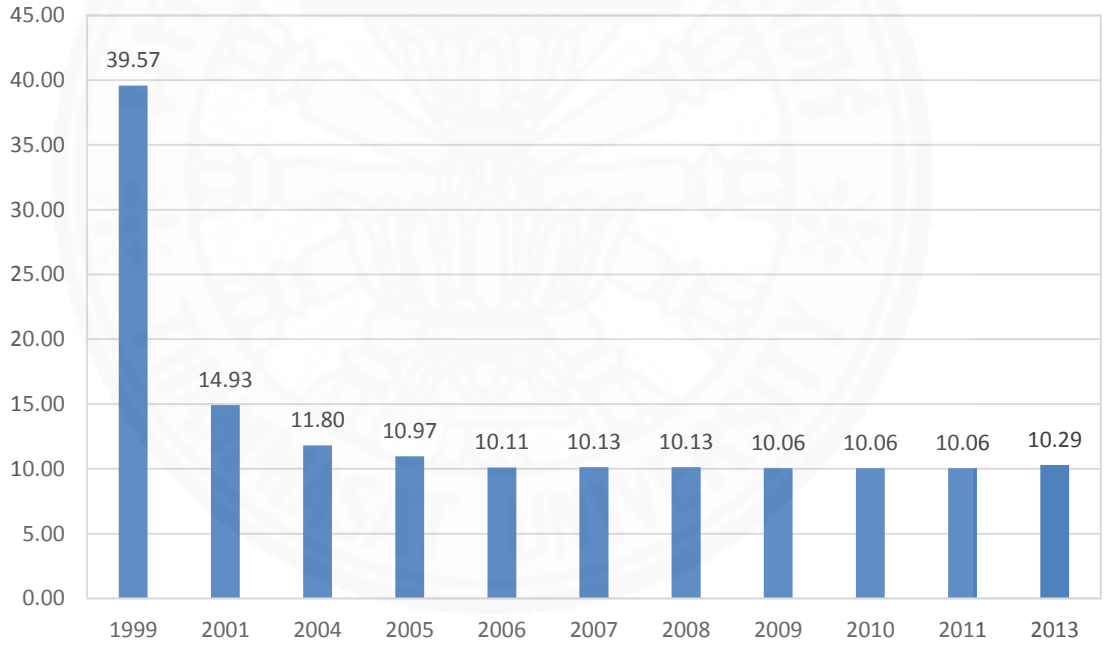
The composition of FDI has shifted from domestic-oriented production to export-oriented production mostly due to the liberalization of trade policy regimes. Thai policy makers implemented the first national economic development plan in 1961, which was based on the import substitution (IS) regime, in order to promote industrialization. To do so, tariffs were the major instrument used to influence the country's development path. In 1974 an escalation tariff structure was eventually imposed so as to promote domestic industries. Specifically, there was a rise in the tariff rates from raw materials to finished products. For example, the range of effective rates of protection (ERP) in the Thai manufacturing sector stood between -20.92 and 236.42 percent in 1971 (Akrasanee, 1975). Subsequently, ERP was increased from -21.44 to

1693.41 percent in 1982 (Mongkolsamai et al., 1985). The distortionary tariff structure remained high until the late 1980s, although the government announced the implementation of a new development strategy concerning an export promotion (EP) regime in 1974.

Significant tariff reduction was first started in 1988, and its continued influence was particularly due to the comprehensive packages of tariff reform implemented in 1995 and 1997. As a result, ERP declined considerably from -57.75 to 60.41 percent (Jongwanich & Kohpaiboon, 2007). More precisely, average tariffs after 1999, shown in Figure 3.1, provide evidence of more obvious reductions.

Figure 3.1

Average tariff rates in Thai non-agricultural sectors



Source: The World Trade Organization.

Note: The average tariff is computed using simple non-weighted averages. See full data in Appendix.

Consequently, the average tariff rate declined markedly from around 40 per cent to 15 percent during 1999-2001, i.e. the average rate decreased by more than 60 per cent. After that, between 2001 and 2005 the average tariff rate continued to shrink and reached a rate of around 11 per cent. Importantly, the average rate has remained at around ten per cent since 2006 through until the present day.

Ranking industries according to variances in tariff rates, the top ten most liberalized industries are shown in Table 3.2. The tariff rates of industries related to fabrics, textiles, leather and furniture have been dramatically reduced. For example, Knitted or Crocheted Fabrics (HS60) tariff was 100 per cent in 1999. However, it stood at only five per cent in 2013.

Table 3.2

Tariffs of industries with dramatically reduced rates

HS	Description	1999	2001	2004	2005	2006	2007	2008	2009	2010	2011	2013
56	Knitted or Crocheted Fabrics	100.00	20.00	12.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
62	Articles of Apparel and Clothing Accessories, Not Knitted or Crocheted	100.00	46.94	30.31	30.31	30.31	29.61	29.61	29.61	29.61	30.71	29.27
61	Articles of Apparel and Clothing Accessories, Knitted or Crocheted	100.00	30.00	30.00	30.00	30.00	29.93	29.93	29.93	29.93	29.93	29.93
64	Footwear, Gaiters and the Like; Parts Articles	90.58	26.92	26.92	26.92	26.92	26.03	26.03	26.03	26.03	26.28	26.73
65	Headgear and Parts	77.50	25.00	25.00	25.00	25.00	21.48	21.48	21.48	21.48	21.48	22.00
94	Furniture; Bedding, Mattresses, Mattress Supports, Cushions and Similar Stuffed Furnishings; Lamps and Lighting Fittings	71.76	20.00	18.11	18.11	18.11	18.21	18.21	18.21	18.21	18.21	18.21
63	Other Made Up Textile Articles; Sets; Worn Clothing and Worn Textile Articles; Rags	79.06	29.06	28.91	28.91	28.91	25.98	25.98	25.98	25.98	25.98	26.12
03	Fish and Crustaceans, Molluscs and Other Aquatic Invertebrates	60.00	7.87	8.19	8.19	8.19	8.22	8.22	8.22	8.04	8.04	8.13
42	Articles of Leather; Saddlery and Harness; Travel Goods, Handbags and Similar Containers; Articles Of Animal Gut	75.91	29.09	27.27	27.27	27.27	27.00	27.00	27.00	27.00	27.25	27.50

Source: The World Trade Organization.

Note: Shown industries are ranked based on their variance of tariff rates over 1999-2013.

The trade policy in each industry could also be measured by the effective rate of protection (*ERP*), obtained from Jongwanich & Kohpaiboon (2007). Specifically, *ERP* is measured as follows,

$$ERP_j = \frac{t_j - \sum_{i=1}^{n} a_{ij} t_i}{1 - \sum_{i=1}^{n} a_{ij}} \quad (1)$$

where

t_j = Nominal tariff rate on output j,

t_i = Nominal tariff rate on output i,

$\sum_{i=1}^{n} a_{ij}$ = The sum of the shares of intermediate inputs (1,…,n) in the output value of product j.

The above equation suggests that the higher the nominal tariff and sum of the shares of intermediate inputs in the output value, the higher the *ERP*. In contrast, the higher the nominal tariff on intermediate inputs, the lower the *ERP*. Hence, the higher the ERP, the more the protection through policy makers exists. Consequently, the top-seven industries which recorded the highest and lowest ERP are chosen to be explicitly illustrated in Table 3.3. *ERP* is averaged out at 0.02 with a maximum of nearly 0.61 in Structural and Metal Products (ISIC2811) and a minimum of -0.58 in Tanning and Dressing of Leather (ISIC1911). Note that, 39 out of 111 industries have negative values regarding *ERP*.

Table 3.3

Effective rate of protection (*ERP*) in Thai manufacturing sectors

ISIC	Industry	*ERP*
Selected industries being top-seven highest ERP		
2811	Structural Metal Products	0.60
2893	Cutlery, Hand Tools and General Hardware	0.51
2913	Bearings, Gears, and Driving Elements	0.44
3420	Automobile Bodies, Trailers, and Semi-Trailers	0.44
3599	Other Transport Equipment n.e.c.	0.42
2022	Builders' Carpentry, and Joinery	0.38
2021	Veneer Sheets, Plywood, Particle Board, etc.	0.38
Selected industries being top-seven lowest ERP		
2023	Wooden Containers	-0.18
1554	Soft Drink: Mineral Waters	-0.18
1533	Prepared Animal Feeds	-0.19
3591	Manufacture of Motor Cycles	-0.21
1512	Processing of Preserving of Fish	-0.38
1514	Vegetable and Animal Oils, and Fats	-0.38
1911	Tanning and Dressing of Leather	-0.58

Source: Jongwanich & Kohpaiboon (2007).

Note: See full list in the Appendix.

3.2 Trends and patterns of foreign direct investment in Thailand

3.2.1 Foreign direct investment flows in Thailand

In Thailand the trends and patterns in FDI flows changed dramatically after the Asian financial crisis in 1997. In particular, FDI net flows in 1997 had risen more than 60 per cent compared with 1996. This was mostly due to sharp exchange rate depreciation, lower property prices and more company assets being offered for sale in the wake of economic turmoil (UNCTAD, 1998). Therefore, this study starts by illustrating the trends and patterns in FDI since the 1997 crisis. To do that, data provided by the Bank of Thailand (BOT)[3] , representing the most reliable FDI data available so

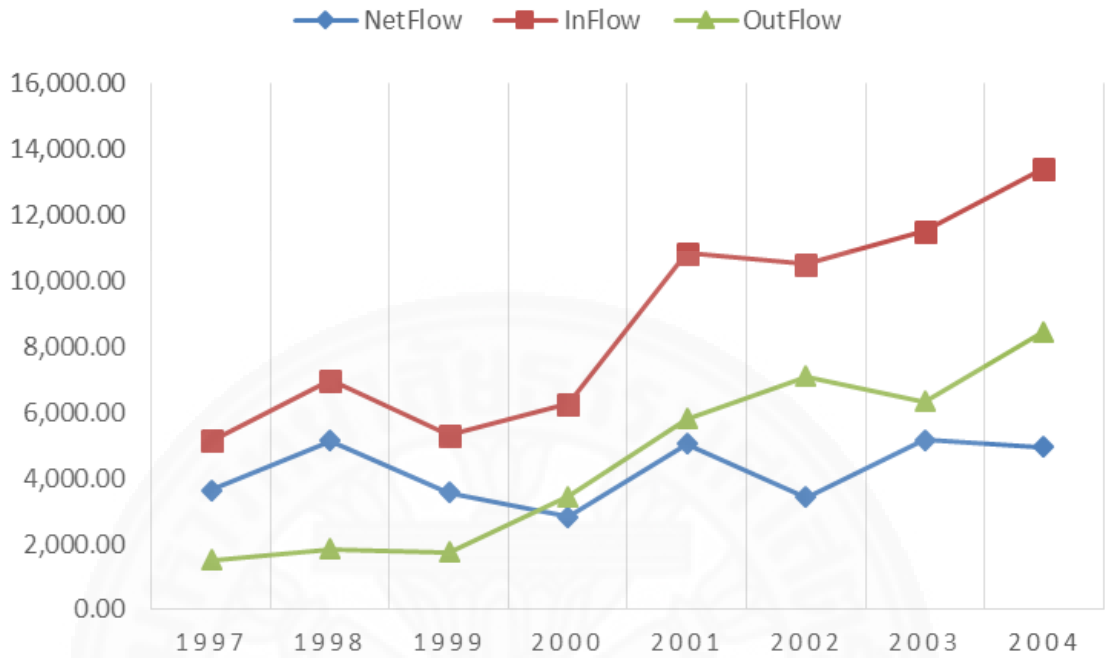
[3]Specifically, the BOT gathers data on the activities of direct investors, including investing in equity capital, lending to affiliates, reinvested earnings, debt securities and trade credit among affiliates. The BOT follows consensus defined by the IMF and OECD, particularly direct investors, are defined as one owning 10 per cent or more of voting shares in an enterprise or the equivalent for an unincorporated enterprise.

far, is employed. Nonetheless, a continuous series of data covering FDI flows from 1997 to the present is unavailable. Data for only two periods, 1997 - 2004 and 2005 – 2014 can be accessed at the present time. Moreover, these two series of data are classified differently. For example, the FDI flow series over 1997 - 2004 excludes non-bank activities, whereas the new series has included such measures. Under these circumstances, an analysis of total FDI flows in this section has to be separated into two periods of investigation.

Between the years 1997 and 2000, the highest FDI net flow and inflow occurred in 1998. As a result of the financial crisis off 1997, currency depreciation attracted foreign direct investment and induced debt-to-equity conversion (Jantarangs, 2004). In particular, there was a dramatic increase in mergers and acquisitions (M&A), since foreign firms took over Thai firms facing severe debt and liquidity problems (Puapan, 2014). Moreover, parent companies had to increase their affiliates' capital share due to the floating exchange rate policy as well as the credit crunch. Nonetheless, capital outflows rose sharply in the year 2000, which led to the lowest FDI net flow benchmark in the first data series. This was due to a combination of equity-to-debt conversion, buying-back through local firms and paybacks to funds buying assets from the Financial Sector Restructuring Authority. Later, FDI inflow started increasing again in 2001, mostly through equity investments, which halted the downturn in FDI net flow.

Figure 3.2

FDI flows in Thailand over 1997 - 2004



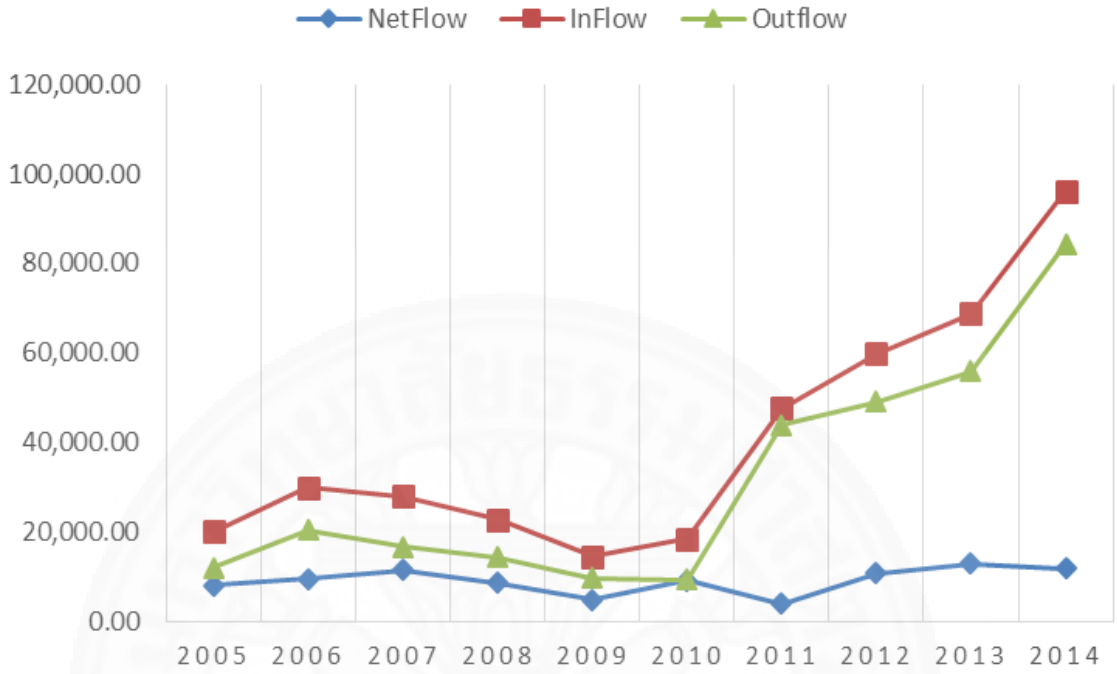
Source: The Bank of Thailand.

Note: The unit in the vertical axis represent millions of US dollars. Conversions to US dollar equivalents are based on monthly New York closing average exchange rates.

As mentioned above, FDI flows in the series 2005 - 2014 are considerably higher than the past series, since FDI flows relating to bank activities have been included in the new measurements. In the period between 2005 and 2010 flows were relatively more stable than experienced during the period 2011 – 2014. The subprime crisis from 2007 to 2010 led to a temporary decline in FDI inflows before they started to increase again in 2010. Interestingly, while Thailand experienced serious flooding in 2011, both FDI inflows and outflows rose dramatically and temporarily increased marking a new trend. Under such circumstances, FDI net flow dropped to its lowest level. However, the FDI net flow since 2012 has remained on the same path as the period from 2005 to 2010 due to a slower rise in FDI outflows. This is largely because Japanese direct investors have returned to heavily investing in the Thai manufacturing sector, after generating a negative net flow in 2011.

Figure 3.3

FDI flows in Thailand over 2005 - 2014



Source: The Bank of Thailand.

Note: The unit in the vertical axis represent millions of US dollars. Conversions to US dollar equivalents are based on monthly New York closing average exchange rates.

The distribution of FDI net flows within the Thai manufacturing sector is shown in Table 3.4. There are eight industries chosen to be illustrated explicitly. That is because the FDI net flow shares of these industries account for more than 80 per cent of total net flows in the Thai manufacturing sector since 2005 with only one exception being the year 2008. Motor Vehicles, Trailers and Semi-Trailers received around one-third of FDI net flows over 2005-2006. However, its share has started to decline since 2007 and was unable to earn a share of more than 30 per cent until the 2010. Coke and Refined Petroleum Products accounted for one quarter of the share in 2007, albeit it normally earned small shares or even negative net flows over other years. Similarly, Electrical Equipment, and Chemicals and Chemical Products gained the highest share of FDI inflows in 2008 and 2009, respectively, although they experienced small, or even negative, net flows throughout the other years. Subsequently, Motor Vehicles, Trailers and Semi-Trailers returned to record the largest share of net flows in 2010.

More recently, Computers, Electronics and Optical Products gained the highest shares in 2011 and 2012. It is of particular note that its share in the latter year was double that of the previous year. Interestingly, while the Thai manufacturing sector suffered from serious flooding in 2011, Machinery and Equipment n.e.c. and Motor Vehicles, Trailers and Semi-Trailers recorded their highest share and lowest share since the year 2005, respectively. Subsequently, Motor Vehicles, Trailers and Semi-Trailers overcame the natural disaster and maintained the highest-share position again continuing on until now.

Table 3.4

Shares of main destination of FDI net flows in Thai manufacturing

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Food Products	0.02	0.02	0.04	0.03	0.06	0.02	0.09	-0.03	0.02	0.06
Beverages	-0.03	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.01	0.03
Paper and Paper Products	0.00	-0.01	0.00	0.08	0.01	0.01	0.07	0.00	0.02	0.03
Coke and Refined Petroleum Products	-0.02	0.07	**0.28**	-0.09	0.08	0.00	0.05	0.03	0.06	0.02
Chemicals and Chemical Products	0.14	0.04	-0.03	0.13	**0.21**	0.19	0.09	0.12	0.05	0.06
Basic Pharmaceutical Products and Pharmaceutical Preparations	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02
Rubber and Plastics Products	0.13	0.10	0.07	0.08	0.13	0.07	0.10	0.09	0.06	0.07
Computer, Electronic and Optical Products	0.09	0.15	0.11	0.07	0.01	0.21	**0.16**	**0.31**	0.21	0.12
Electrical Equipment	0.20	0.18	0.08	**0.27**	0.12	-0.02	0.06	0.09	0.06	0.14
Machinery and Equipment n.e.c.	0.02	0.03	0.03	0.02	0.08	0.01	0.14	0.02	0.07	0.08
Motor Vehicles, Trailers and Semi-trailers	**0.33**	**0.30**	0.24	0.19	0.16	**0.30**	0.13	0.28	**0.34**	**0.21**
Furniture	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Others	0.11	0.11	0.16	0.22	0.12	0.19	0.09	0.08	0.10	0.16

Source: The Bank of Thailand.

Note: The shares are computed from the FDI net flows of each manufacturing to total FDI net flows of Thai manufacturing. The bold values indicate the highest share in each year.

The distribution of the main sources of FDI net flows in Thailand is illustrated in Table 3.5. Japanese investors represented the greatest source of direct investment in seven of the ten years since 2005. More precisely, they never invested less than 25 per cent of total FDI net flow in Thailand, with the exception of 2011. A

negative net flow of Japanese direct investment was generated when Thailand was severely hurt by the catastrophic flooding. Singapore and the United State also constitute important sources of direct investment, particularly the former being the largest source in 2006 and 2011, while the latter occupied that position in 2012. Nonetheless, during the Subprime crisis between the years 2007 and 2009, the share of American direct investment declined dramatically. Moreover, the British Virgin Islands and the Cayman Islands accounted for 22 per cent of investment in 2009 and 25 per cent in 2011, respectively, whereas they did not register as main sources in other years. Interestingly, the role of Chinese direct investment is becoming increasingly more important. That is due to the fact that their direct investment share represented only 0.1 per cent in 2005, but had eventually reached 9 per cent in 2014.

Table 3.5

Shares of main sources of FDI net flows in Thailand

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Japan	**0.38**	0.25	**0.30**	**0.37**	**0.28**	**0.37**	-0.55	0.29	**0.62**	**0.34**
United States	0.09	0.01	0.12	0.02	-0.10	0.11	0.06	**0.31**	0.11	0.13
Hong Kong	0.00	0.02	0.00	0.12	-0.01	-0.01	0.11	0.05	0.02	0.10
China	0.00	0.00	0.01	0.00	0.01	0.08	0.01	0.05	0.06	0.09
Netherlands	-0.01	0.10	0.03	0.05	0.12	0.05	0.10	0.06	-0.17	0.08
Singapore	0.18	**0.30**	0.23	0.09	0.15	0.10	**0.41**	-0.11	0.02	0.06
Germany	0.04	0.04	0.01	-0.03	0.01	0.01	0.18	0.04	0.01	0.02
British Virgin Islands	0.07	-0.07	0.02	-0.00	0.22	0.01	0.07	0.01	-0.01	0.02
Cayman Islands	-0.02	0.02	0.05	0.13	0.05	0.03	0.25	-0.06	0.01	-0.01
Others	0.28	0.33	0.22	0.25	0.28	0.25	0.36	0.36	0.32	0.17

Source: The Bank of Thailand.

Note: The shares are computed from the FDI net flows of each manufacturing group to the total FDI net flows of the Thai manufacturing sector as a whole. Bold type values indicate the highest share in each year.

The presence of foreign direct investment (i.e. foreign firms) in each industry could also be measured by *FOR*, which is computed using the output shares of foreign affiliates, i.e. firms with foreign shares exceeding 10 per cent. Output and foreign shares are based on the industrial census in the year 2012. As shown in Table 3.6, there are eight industries out of 111 which have a foreign presence exceeding 70

percent. In contrast, there are six industries which constitute only Thai firms, i.e. industries without any foreign presence. The average *FOR* is 22.09 per cent with a maximum of 90.16 percent in Repair and Maintenance of Machines, Computers and Computer Peripheral Devices (ISIC7250), and Minimum of 0 per cent in Malt Liquors and Malt (ISIC1553), Publishing of Books and Other Publications (ISIC2211), Other Publishing (ISIC2219), Reproduction of Recorded Media (ISIC2230), Cutting, Shaping and Fishing of Stone (ISIC2296) and Other Transport Equipment (ISIC3599).

Table 3.6

Foreign presence (*FOR*) in the Thai manufacturing sectors

ISIC	Industry	*FOR*
Selected Industries having foreign presence exceed 70 per cent		
7250	Repair and Maintenance of Office Machines, Computers, and Computer Peripheral Devices	0.90
3591	Manufacture of Motor Cycles	0.88
2921	Agricultural and Forestry Machinery	0.83
2911	Engines and Turbines (not for transport equip.)	0.80
2913	Bearings, Gears, and Driving Elements	0.78
2926	Machinery for Textile and Apparel Production	0.76
3150	Manufacture of Electric Lamps and Lighting Equipment	0.72
3140	Accumulators, Primary Cells, and Batteries	0.71
Selected Industries having no foreign presence		
1553	Malt Liquors and Malt	0
2211	Publishing of Books and Other Publications	0
2219	Other Publishing	0
2230	Reproduction of Recorded Media	0
2696	Cutting, Shaping, and Finishing of Stone	0
3599	Other Transport Equipment n.e.c.	0

Source: Author's compilation. See full data in Appendix.

Note: Foreign presence is computed from the output shares of foreign firms in which foreign-owned share exceeds 10 per cent.

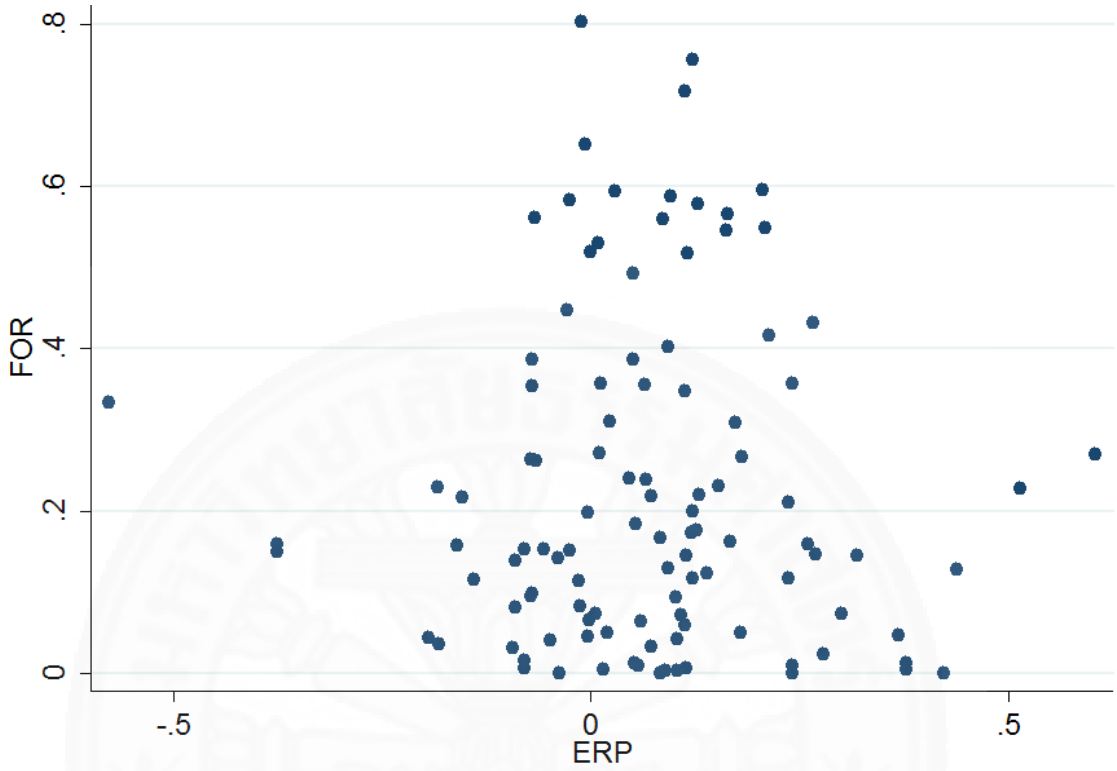
3.2.2 Foreign direct investment and trade policy in Thailand

This section aims to illustrate the relationship between trade policy and foreign presence across industries in the Thai manufacturing sector, disaggregated into four-digit ISIC classification. The trade policy is proxied by the effective rate of protection (*ERP*) obtained from Jongwanich & Kohpaiboon (2007), as mentioned above. The higher the *ERP*, the more restrictive the trade policy regime. Econometric

and statistical analyses are employed to reveal the relationship between trade policy and foreign presence in Thai manufacturing. The calculated foreign presence (*FOR*) is plotted together with the proxy for trade policy (*ERP*). Nonetheless, as the data used is cross-sectional in nature, the analysis might be distorted by outliers. Under this circumstance, the Cook's distance tool is employed in order to identify outliers, which are further deleted from the model. Consequently, the scatter plot in Figure 3.4 indicates insignificantly negative relationships between foreign presence and trade policy. The Spearman correlation is -0.03 without any statistical significance. Hence, there is no clear relationship between *FOR* and *ERP* in the Thai manufacturing sector in light of both the statistical and econometric analyses. In other words, this finding points out that trade policy may no longer determine foreign presence, which is different from the recent prevailing structure within Thai manufacturing. For example, in the late 1970s, FDI was predominantly extant in import-substitution industries (i.e. those involving high trade protection regimes), such as textiles, automobiles and chemicals. Subsequently, FDI started to rotate to industries under export-oriented policies (i.e. liberal trade regimes), such as clothing, footwear and toys.

Figure 3.4

Correlations between *FOR* and *ERP*



Source: Author's compilation. See full data in Appendix.

Note: The statistical correlation between *FOR* and *ERP* is not different from zero, based on the simple ordinary least square estimation in which *FOR* and *ERP* are the dependent variable and independent variable, respectively.

$$FOR = 0.22 - 0.05ERP$$

(10.69)*** (-0.41)

(t-stat in parenthesis)

3.2.3 Foreign direct investment and labor productivity in Thailand

This section aims to re-examine the preposition that FDI inflows in Southeast Asia, including Thailand, predominantly belong to efficiency-seeking categories (Hill & Athukorala, 1998). The nature of an efficiency-seeking category is revealed by illustrating the relationship between any foreign presence and an industry's labor productivity. The foreign presence (*FOR*) is measured by the approach used in the previous section. Industry labor productivity (*LP*)[4] is measured from the sum of a firm's value added per worker (*VA/L*) weighted by each firm's value added (*VA*), where

[4]See full data in Appendix.

VA is defined as the difference between gross output and raw material net of changes in inventories. Both variables are based on the industrial census comprising the year 2012.

Table 3.7

Industry labor productivity (*LP*) in the Thai manufacturing sectors

ISIC	Industry	*LP*
Selected industries having labor productivity exceed 10 million baht		
3420	Automobile Bodies, Trailers, and Semi-trailers	119,589,940
2694	Cement, Lime, and Plaster	105,173,011
2924	Machinery for Mining and Construction	21,046,628
1554	Soft Drink: Mineral waters	16,050,560
2610	Glass and Glass Products	15,884,742
3210	Electronic Valves, Tubes, etc.	14,926,150
1600	Tobacco Products	11,411,429
2320	Refined Petroleum Products	11,272,947
2430	Man-made Fibers	10,479,769
3410	Manufacture of Motor Vehicles	10,218,759
2519	Other Rubber Products	10,005,355
Selected industries having labor productivity below 0.5 million baht		
3693	Sports Goods	488,198
2219	Other Publishing	401,867
3599	Other Transport Equipment n.e.c.	352,047
3692	Musical Instruments	254,684

Source: Author's compilation. See full data in Appendix.

Note: Labor Productivity is computed in Thai Baht.

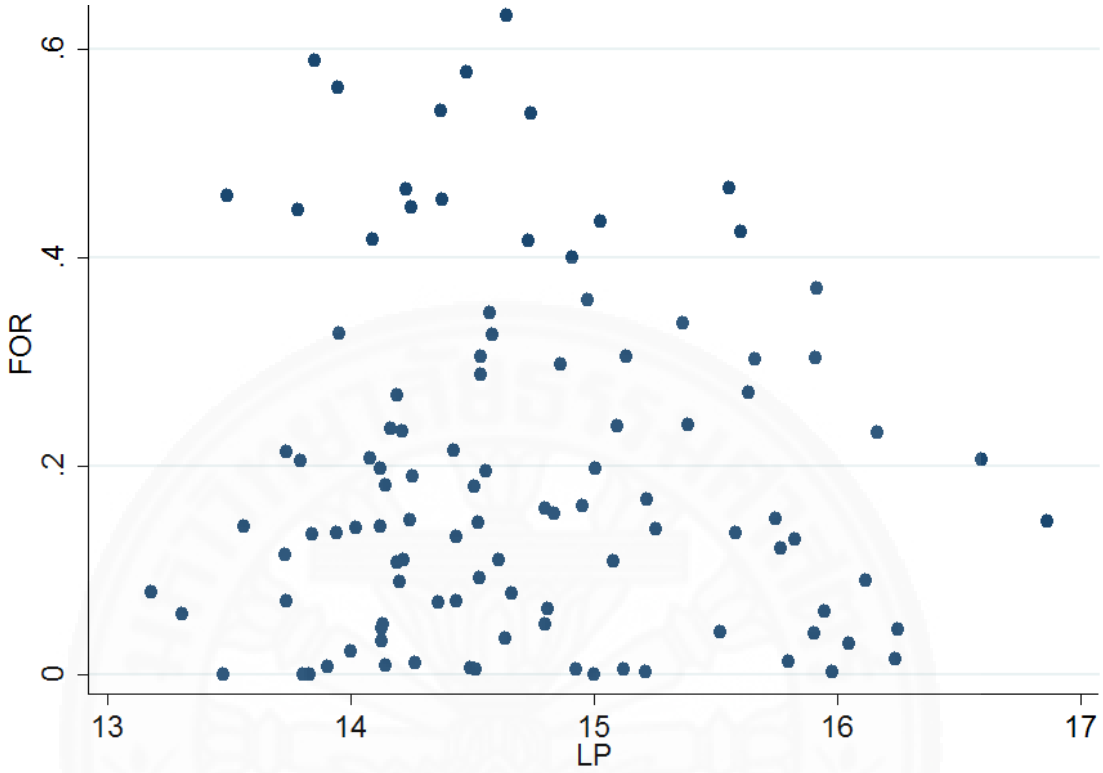
While an overview of *FOR* is reported in the previous section, industries which have a labor productivity exceeding 10 million baht or below 0.5 million baht are selected to be shown in Table 8. *LP* is averaged out at 5.50 million Thai Baht with a maximum of 119.60 million Thai Baht recorded in Automobile Bodies, Trailers and Semi-Trailers (ISIC3420), and a minimum of 0.25 million Thai Baht seen with Musical Instruments (ISIC3692). Interestingly, when primarily comparing the relationship between foreign presence and labor productivity based on selected industries, Other Publishing (ISIC2219), which constitutes one category of lowest labor productivity within Thai manufacturing has no foreign presence.

As in the previous section, econometric and statistical methods are employed in order to examine the relationship between foreign presence and labor

productivity. The scatter plot in Figure 3.5 indicates insignificantly positive relationships between foreign presence and labor productivity. The spearman correlation is 0.0013 without statistical significance. This finding seems to be in contradiction to Hill & Athukorala (1998), who argued that FDI in Southeast Asia represents an efficiency-seeking category. Nonetheless, it is hard to believe that the insignificance, found in this and previous sections is unequivocally correct. That is because the employed data represent plant-level information taken during the serious flooding of 2011. Hence, the data might not reflect the firm's operations under normal situation, which could result in misleading conclusions concerning actual patterns within the Thai manufacturing sector.

Figure 3.5

Correlations between *FOR* and *LP*



Source: Author's compilation. See full data in Appendix

Note: The statistical relationship between *FOR* and *LP* is not different from zero, based on the simple ordinary least square estimation in which *FOR* and *ERP* are the dependent variable and independent variable, respectively. *FOR* is converted into a logarithmic form as ln(1+*FOR*), whereas *LP* represents the logarithmic transformation of its value.

$$FOR = 0.38 - 0.01LP$$

(1.26) (-0.61)

(t-stat in parenthesis)

CHAPTER 4
EMPIRICAL ANALYSIS

4.1 The model

This thesis follows the standard practice within the related literature, wherein the empirical model is derived largely from the production function of locally-owned enterprises. There are two forms of the production function often used, i.e. the Cobb-Douglas form and the Trans-log functional form. Nonetheless, the former is often criticized in that there are certain restrictions imposed within the form, such as the unity of elasticity of substitution and the log-linear relationship between inputs and outputs. In this thesis, the latter is employed to examine whether the imposed restrictions in the former are supported by data as presented in Equation 1.

$$lnY_{ij} = \beta_0 + \beta_1 lnK_{ij} + \beta_2 lnL_{ij} + \beta_3 lnK_{ij} lnL_{ij} + \beta_4 (lnL_{ij})^2 + \beta_5 (lnK_{ij})^2 + \beta_6 X_{ij} \quad (2)$$

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

L_{ij} = labor of local plant *i* of industry *j*

K_{ij} = capital of local plant *i* of industry *j*

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

Equation 1 represents the production function of local firms. The left-hand-side variable comprises the value added of local firms, while the right-hand-side variables include physical capital and labor with their squared and interaction terms as suggested by the trans-log function. Controlling variables (X_{ij}) include both firm- and industry-specific factors.

Regarding the firm-specific factors, the first controlling variable is the plants' market orient nature (MKT_{ij}). As argued in several studies[1], the international market is able to exert firm heterogeneity in productivity. That is, exporting firms are

[1]See Wagner (2007); De Loecker (2007); Greenaway & Kneller (2008); Muûls & Pisu (2009); Cassama et al. (2010); Wagner (2012); and Kasahara & Lapham (2013).

relatively more productive than the remainder. Nevertheless, there is an ongoing debate regarding the casual effect of exports on productivity. Specifically, a productivity advantage could potentially be generated by either boosting productivity before exporting (self-selection), or experiencing productivity gains during exporting (learning from exporting). In all cases, the expected coefficient corresponding to MKT_{ij} is theoretically positive, accordingly.

Engaging in international trade not only improves the productivity of exporting firms, but also the efficiency of firms importing intermediates for producing their final goods, as argued in a number of studies[2]. Firms may become more productive by importing intermediate products from overseas. That is because imported goods may be of superior quality and/or may not be available in the domestic market. Hence, the expected coefficient corresponding to IMP_{ij} is theoretically positive.

The last firm-specific variable comprises the firm's quality of labor (QL_{ij}). The variable QL_{ij} represents the ratio of supervisory and management workers to total number of employees within an organization. That is because supervisory and management workers are often regarded as constituting skilled labor. Skilled employees are potentially not only able to help the firm to operate more efficiently, but also better contribute to the formulation of sound strategic directions. Therefore, the higher the labor quality, the more the firm's capacity is bolstered. As a result, the expected sign of the corresponding coefficient is positive, accordingly.

Regarding industry-specific factors, producer concentration (CON_j) is often used by policy makers to signal the intensity of product market competition, and to justify any action in preventing the spread of possibly anti-competitive behaviors (Kohpaiboon & Jongwanich, 2013). Nonetheless, the data on the effects of producer concentration is inconclusive. On the one hand, perfect competition is not necessarily favorable for productivity improvement. That is because productivity-enhancing activities involve large fixed and sunk costs, associated with a large degree of risk and uncertainty. Consequently, *ex post* market power is needed as an incentive to invest in such activities. In other words, the required market power is not in itself a sufficient

[2]e.g. Bernard et al. (2007); Anderson et al. (2008); and Kasahara & Lapham (2013).

condition for committing to these activities (Symeonidis, 1996; and Ahn, 2002). These activities are costly, so that a certain degree of market competition is needed to induce a firm to accelerate the adoption of new technology (Porter, 1990; and Aghion et al, 1999). In contrast, productivity improvement may be diminished by a high level of producer concentration (CON_j). Therefore, the coefficient corresponding to CON_j is theoretically expected to be either positive or negative.

With respect to the variable relating to FDI spillovers, the extent of foreign presence in an industry j (FOR_j) is introduced to examine intra-industry spillovers. Horizontal spillovers could either positively affect indigenous firms through demonstration effects or negatively impact local firms' productivity through competition effects, i.e. a market-stealing effect. Hence, the coefficient corresponding to FOR_j is theoretically expected to be either positive or negative.

As discussed, trade policy regimes could potentially condition technological gains through horizontal spillovers, i.e. the assumption of heterogeneous FDI spillovers. The role of trade policy as conditional gains of FDI spillovers is often regarded as the Bhagwati hypothesis. All existing studies[3] were unable to reject the Bhagwati hypothesis. In light of these circumstances, it is likely that local firms under liberal trade policies will be more productive than the remainder. Hence, it is theoretically expected that the more the restricted the trade policy regime, the higher the gains expected through FDI spillovers.

Vertical FDI spillovers through backward linkage ($BACK_j$) have been commonly found in a number of empirical studies, as mentioned in the second chapter. Multinational firms tend to demand a better quality and higher volume of intermediates, or are even willing to assist their suppliers in some cases. This potentially encourages local suppliers to enhance their capacity to meet their foreign customers' demands. On the other hand, FDI spillovers through forward linkage ($FORW_j$) may arise when local firms use intermediates produced by foreign suppliers in their production process. Local firms may become more productive through gaining access to new, reliable, higher

[3]Kokko et al. (2001) studies the case of Uruguay. Kohpaiboon (2006b) and Kohpaiboon & Jongwanich (2013) study the case of Thailand.

quality and/or less costly intermediate products. Therefore, positive signs of both $BACK_j$ and $FORW_j$ are theoretically expected.

All in all, the empirical model, in this thesis, is specified with theoretically expected signs given in parenthesis as:

$$lnY_{ij} = \gamma_0 + \gamma_1 lnK_{ij} + \gamma_2 lnL_{ij} + \gamma_3 lnK_{ij} lnL_{ij} + \gamma_4 (lnL_{ij})^2 + \gamma_5 (lnK_{ij})^2 + \gamma_6 MKT_{ij} + \gamma_7 IMP_{ij} + \gamma_8 QL_{ij} + \gamma_9 CON_j + \gamma_{10} FOR_j + \gamma_{11} FOR_j TP_j + \gamma_{13} BACK_j + \gamma_{14} FORW_j + \mu_{ij} \quad (3)$$

where

lnY_{ij} = Value added of local plant *i* in industry *j*,

lnK_{ij} = Fixed asset of local plant *i* in industry *j*,

lnL_{ij} = Number of workers of local plant *i* in industry *j*,

MKT_{ij} = Market orientation of local plant *i* in industry *j* measured by the firm's export-to-sales ratio (+),

IMP_{ij} = Imported intermediate ratio of local plant *i* in industry j (+),

QL_{ij} = Quality of labor of local plant *i* in industry *j* measured by the ratio of non-production workers to total employment (+),

CON_j = Producer concentration of industry *j* proxied by CR4 (+),

FOR_j = Foreign presence in industry *j* measured by output share of foreign plants to total sales, i.e. presence of horizontal spillovers (+/-),

$FOR_j * TP_j$ = FDI technology spillover gain conditioned by trade policy regime, i.e. Bhagwati's hypothesis (-),

$BACK_j$ = Backward linkages spillovers through foreign presence to industry alternatively proxied by $BACK\_std_j$ and $BACK\_alt_j$ (+),

$FORW_j$ = Forward linkages spillovers of foreign presence to industry alternatively proxied by $FORW\_std_j$ and $FORW\_alt_j$ (+),

$MSIZE_j$ = Market size of the industry *j* measured by the sum of gross output and (net) import,

TP_j = Trade policy regime in industry *j* proxied by ERP

μ_{ij} = A stochastic error term representing the other influences omitted in the model.

4.2 Data sources and variable measurements

The most appropriate data set suiting the purpose of this study would be long-panel data concerning the establishment in Thai manufacturing. Unfortunately, such a particular data set is not available in Thailand. So far, there have been only three industrial censuses[4], which are cross-sectional in nature. In exploiting these three censuses it is not feasible to formulate a panel data set as the identification numbers (ID No.) used in each census are assigned differently, i.e. a given ID No. in two different censuses does not necessarily refer to the same firm. Under these circumstances, the Industrial Census gathered by the National Statistical Office of Thailand (NSO), Ministry of Information and Communication Technology in 2012[5], was eventually deemed the most suitable data source to be used in this study.

The census used comprises 98,842 observations (i.e. number of plants). The census was first cleaned up by deleting self-employed (i.e. zero record of paid worker) and micro firms (i.e. less than or equal to ten paid workers). In doing this 71,387 observations were eliminated, thereby the remaining observations total 27,095. As revealed in several literatures[6], there are many duplicate samples in which at least two observations report the same value in terms of most variables. The criterion in this study is that a variable is treated as a duplicated sample (and will count as only one sample), if samples report identical values concerning seven key variables. The seven key variables include total paid-workers, female paid-workers, initial fixed assets, ending fixed assets, registered capital, sale values and input values. According to this criterion, 4,418 samples were removed. The remaining observations comprise 22,677.

Subsequently, observations reporting unrealistic values of key variables were eliminated. These included negative value added, low value added (i.e. less than

[4]The industrial census in the year 1996, 2006 and 2012.

[5]The census actually contains the firm data in the year 2011.

[6]They are Ramstetter (2004), Kohpaiboon (2006b) and Kohpaiboon & Jongwanich (2013).

10,000 Thai Baht) and low fixed assets (i.e. less than 10,000 Thai Baht). Finally, eight industries which serve niches in the domestic market[7], in the service sector[8] and explicitly preserved for local enterprises[9], were excluded. All in all, 19,531 observations thus remained.

Value added (Y_{ij}) is defined as the difference between gross output and raw material net of changes in inventories that can be obtained in the census. L_{ij} and K_{ij} are measured by the number of workers and the value of fixed assets in the initial period, respectively. MKT_{ij} and IMP_{ij} are measured by the plant's export-sale ratio and the plant's imported intermediate ratio, respectively. Furthermore, QL_{ij} is measured the ratio of non-productive workers to total employees. All of the above factors (i.e. L_{ij}, K_{ij}, MKT_{ij}, IMP_{ij} and QL_{ij}) are reported in the census.

In the Thai context, empirical studies point to the same relationship between market concentration and firms' productivity, regardless of how the market concentration is proxied.[10] Hence, CON_j is proxied by CR4, which is obtained from Kohpaiboon & Ramstetter (2008) in which the concentration is measured at the more aggregated level. In other words, most industries are measured at the four-digit measurement, while the remainder are measured using the three-digit ISIC classification. The data is treated this way in order to avoid the potential drawback in which two substitute products would be categorized into different industry.

TP_j is proxied by ERP, which is derived from Jongwanich & Kohpaiboon (2007). Their estimates are based on the data from 2003, which reflect the protection structure in the period 1997 to 2003. Since there was no major change in tariffs during this period, this data is appropriate for this study (see Figure 3.1). In addition, the used ERP series represents the weighted average of import-competing and export-oriented ERP. The latter refers to ERP estimates for exporters who are eligible for various tariff

[7]e.g. processing of nuclear fuel, manufacture of weapons and ammunition.

[8]e.g. building and repairing of ships, manufacture of aircraft and spacecraft, and recycling.

[9]e.g. manufacture of ovens, furnaces and furnace burners, manufacture of coke oven products.

[10]CR4, CR5, HHI are employed by Kohpaiboon (2006b); Kohpaiboon & Jongwanich (2013); and Srithanpong (2014)

rebate programs. Since ERP is based on the input-output (IO) industrial classifications, official concordance is needed to convert them into four-digit ISIC. In a case that there is not one-to-one matching in the concordance, a weighted average is applied, using value added as a weight (see Kohpaiboon 2006b)

FOR_j is constructed using the Industrial Census 2012, with all plants which have share of stakeholders greater than ten per cent being considered as foreign instead of local plants. This cutting point (i.e. ten per cent) is in line with the benchmark widely used by globally organizations (i.e. IMF and OECD)

The ideal dataset for measuring $BACK_j$ and $FORW_j$ comprises detailed information of inter-enterprises relationship between local and foreign enterprises, i.e. how much the former sells to, or buys from, the latter. However, this choice is impracticable as a result of unavailable data. Hence, the inter-industry relationship to measure$BACK_j$ and $FORW_j$ is based on Thailand's input-output table of 2010, which represents the most up-to-date and reliable IO table, conducted by Office of National Economic and Social Development Board, Office of the Prime Minister. The IO table consists of information concerning 180 economic activities. The same procedure, applied for ERP, is used to convert input-output (IO) industrial classifications to four-digit ISIC.

In earlier studies, foreign presence is measured by either capital shares, employment or output. In this study, FOR_j is measured by the share of an industry's output produced by foreign affiliates. This is due to two reasons. First, measuring by capital shares may lead to underestimating foreign presence, as a result of the foreign ownership restrictions in Thailand. Second, most foreign affiliates tend to be more capital intensive than local firms, thereby measuring by employment share is likely to underestimate the foreign presence. Thus, FOR_j is measured using the following equation:

$$FOR_j = \frac{\left[\sum_{i\ for\ all\ i \epsilon j} ForeignFirm_i * Y_i\right]}{\sum_{i\ for\ all\ i \epsilon j} Y_i} \quad (4)$$

where $ForeignFirm_i$ is a dummy variable equal to one, if the firm is a foreign affiliate (i.e. their foreign shareholding is greater than ten per cent) and zero otherwise.

There are two alternative methods for testing the Bhagwati hypothesis. First, Kokko et al. (2001) uses the year 1973, where Uruguay embarked on trade liberalization reform, as a benchmark in classifying FDI under restricted and liberal trade policies. However, using a base year is problematic. This is because there were some industries which continued to remain under heavy protection, in the years after implementing the reform program (Favaro & Spiller, 1991). Consequently, this study follows the second method used in Kohpaiboon (2006b) and Kohpaiboon & Jongwanich (2013). In particular, both studies employ an interaction term between foreign presence (FOR_j) and trade protection. (TP_j).

Widespread consensus on how linkages should be measured has not been reached in the relevant literature, as mentioned earlier. Currently, there are two measures commonly used in the empirical studies. That is, the measures of Javorcik (2004), versus the measures of Kohpaiboon & Jongwanich (2013). In specifics, the first measures capture only direct linkages, whereas the second capture both direct and indirect linkages. Interestingly, while empirical models using the former often emphasize the role of vertical spillovers, those using the latter have been unable to yield any evidence of inter-industry FDI spillovers[11]. As a result, this thesis proposes to systematically examine vertical spillovers, i.e. both measures are simultaneously used.

The measures of Javorcik (2004), namely standard measures, are proxies for vertical spillovers. On the one hand, $BACK\_std_j$ is intended to capture the extent of potential contact between domestic suppliers and multinational customers, i.e. a proxy for backward linkage effects:

$$BACK\_std_j = \sum_{k\ if\ k \neq j} \alpha_{jk} FOR_k \tag{5}$$

where α_{jk} is the proportion of sector *j*'s intermediate output supplied to sector *k*. The proportion includes only the intermediate product supplied within Thai manufacturing, i.e. the products supplied for final demand and imported intermediates are excluded.

[11]See Kohpaiboon & Jongwanich (2013)

On the other hand, $FORW\_std_j$ captures the activities in which intermediate output produced by multinational firms is supplied to local customers, i.e. a proxy for forward linkage effects:

$$FORW\_std_j = \sum_{m\ if\ m \neq j} \sigma_{jm}\, FOR_m \tag{6}$$

where σ_{jm} is the proportion of intermediate output produced by sector *m*, which is purchased by sector *j*. As with the previous measure, this proportion includes only the intermediate products purchased within the Thai manufacturing sector. Importantly, as the equations (5) and equation (6) illustrate, both α_{jk} and σ_{jm} capture only the direct linkages between indigenous suppliers and multinational customers, and vice versa.

The measures of Kohpaiboon & Jongwanich (2013), namely alternative measures, are initially applied following an identical process as with the previous measure. This measure aims to detail the linkages between foreign affiliates and local firms. $BACK\_alt_j$ is alternatively measured by:

$$BACK\_alt_j = \sum_{k\ if\ k \neq j} \delta_{jk} FOR_k \tag{7}$$

Meanwhile, $FORW\_alt_j$ is alternatively measured by:

$$FORW\_alt_j = \sum_{m\ if\ m \neq j} \varphi_{jm} FOR_m \tag{8}$$

Very importantly, both δ_{jk} and φ_{mj} are different from α_{jk} and σ_{jm}, respectively. In particular, they are derived according to the Leontief inter-industry accounting framework. Firstly, an input-output table is conducted in the form of equation (9), i.e. the import content of each transaction is separately identified and allocated to an import matrix:

$$X = A^d X + Y^d + E \tag{9}$$

where X is the column vector of total gross output, $A^d = \left[a_{ij}^d\right]_n$ in which $a_{ij}^d = X_{ij}/X_j$ is domestic input-output coefficient matrix, Y^d is the column vector of domestic demand on domestically produced goods, and E is the column vector of export demand on domestically produced goods. In the next step, equation (9) is solved for X as equation (10):

$$X = (1 - A^d)^{-1}[Y^d + E] \tag{10}$$

where $(1 - A^d)^{-1}$ is the Leontief domestic inverse (LDI) matrix. Finally, δ_{jk} is an element in a row vector *j* of the matrix, which indicates the amount of industry *j*'s output demanded by an additional unit of industry *k*'s output produced, i.e. the derived demand for industry *j*'s output from industry *k*'s output produced. On the other hand, φ_{mj} is an element in a column vector *j* in the LDI matrix, which indicates demand for industry *m*'s output to be used as inputs for producing a unit of industry *j*'s output. Importantly, δ_{jk} and φ_{mj} capture both direct and indirect (inter-sectoral) repercussions. As discussed, the higher $BACK\_alt_j$ and $FORW\_alt_j$, the more likely the benefits accrued through vertical spillovers.

As is the nature of cross-sectional data, it is likely that outliers could impact on and mislead the estimated parameters, thereby careful treatment of outliers is needed. In order to eliminate possible problems, Cook's distance is used to identify suspected outliers (see Cook, 1977). The observations derived, which are suspected as identifying outliers according to Cook's distance, are further deleted. Table 4.1 and Table 4.2 provide a statistical summary of all the variables discussed above and their correlation matrix.

Table 4.1

Statistical summary of the key variables

	Unit	Mean	S.D.	Min	Max
Y_{ij}	(ln) Thai Baht	15.73	2.28	9.26	23.38
L_{ij}	(ln) Thai Baht	3.63	1.08	2.40	9.61
K_{ij}	(ln) Thai Baht	15.72	2.21	9.43	26.32
MKT_{ij}	(ln) Export ratio	0.04	0.13	0.00	0.70
IMP_{ij}	(ln) Import ratio	0.03	0.12	0.00	0.70
CON_j	(ln) proportional	0.37	0.06	0.28	0.53
QL_{ij}	(ln) proportional	0.06	0.11	0.00	0.69
FOR_j	(ln) proportional	0.16	0.12	0.00	0.63
$BACK\_std_j$	(ln) proportional	0.11	0.08	0.00	0.31
$FORW\_std_j$	(ln) proportional	0.11	0.07	0.00	0.27
$BACK\_alt_j$	(ln) proportional	0.28	0.35	0.00	1.45
$FORW\_alt_j$	(ln) proportional	0.23	0.11	0.04	0.52
QL_j	(ln) proportional	0.09	0.04	0.00	0.30
$MSIZE_j$	(ln) Thai Baht	24.63	1.16	18.09	27.16
TP_j	(ln) proportional	0.03	0.17	-0.86	0.47
$BACKM\_std_j$	(ln) proportional	0.35	0.20	0.00	0.68
$FORWM\_std_j$	(ln) proportional	0.45	0.18	0.04	0.66
$BACKM\_alt_j$	(ln) proportional	0.66	0.62	0.00	2.52
$FORWM\_alt_j$	(ln) proportional	0.81	0.19	0.30	1.15

Source: The author's estimation based on the data sources described.

Note: [a]Mean = Simple average; S.D. = Standard deviation; Min = Minimum; Max = Maximum;

[b]Estimates of Y_{ij}, K_{ij} and L_{ij} are the logarithmic transformations of their values. The other variables are converted into logarithmic forms as ln(1+x) where x is the variable.

Table 4.2

Correlation matrix of the key variables

	Y_{ij}	L_{ij}	K_{ij}	MKT_{ij}	IMP_{ij}	CON_j	QL_{ij}	FOR_j	$BACK\_std_j$	$FORW\_std_j$	$BACK\_alt_j$	$FORW\_alt_j$	QL_j	$MSIZE_j$	TP_j	$BACKM\_std_j$	$FORWM\_std_j$	$BACKM\_alt_j$	$FORWM\_alt_j$
Y_{ij}	1.00																		
L_{ij}	0.66	1.00																	
K_{ij}	0.81	0.60	1.00																
MKT_{ij}	0.27	0.33	0.23	1.00															
IMP_{ij}	0.22	0.21	0.19	0.32	1.00														
CON_j	0.05	0.00	0.08	0.00	0.01	1.00													
QL_{ij}	0.30	0.15	0.24	0.09	0.13	0.04	1.00												
FOR_j	0.10	0.08	0.04	0.02	0.09	-0.15	0.04	1.00											
$BACK\_std_j$	0.01	0.00	-0.02	-0.03	0.03	-0.31	0.03	0.19	1.00										
$FORW\_std_j$	-0.02	-0.02	-0.06	-0.04	0.04	-0.16	0.00	0.25	0.12	1.00									
$BACK\_alt_j$	0.07	0.01	0.05	-0.06	0.03	-0.18	0.06	0.23	0.66	-0.06	1.00								
$FORW\_alt_j$	0.10	0.02	0.04	-0.04	0.06	-0.07	0.05	0.45	0.11	0.84	0.13	1.00							
QL_j	0.23	0.05	0.23	-0.01	0.07	0.33	0.14	0.07	-0.18	-0.06	0.02	0.03	1.00						
$MSIZE_j$	0.16	0.11	0.14	0.03	-0.01	-0.15	0.03	0.09	-0.17	-0.13	0.01	-0.07	0.08	1.00					
TP_j	0.01	-0.02	0.00	-0.01	0.03	0.07	0.04	0.07	0.08	0.26	0.05	0.31	0.00	-0.32	1.00				
$BACKM\_std_j$	-0.11	-0.04	-0.10	-0.03	-0.02	-0.33	-0.01	-0.04	0.83	-0.09	0.51	-0.20	-0.29	-0.14	-0.03	1.00			
$FORWM\_std_j$	-0.11	-0.04	-0.14	-0.07	0.00	-0.14	-0.02	-0.01	0.21	0.74	-0.15	0.41	-0.04	-0.16	0.18	0.06	1.00		
$BACKM\_alt_j$	0.06	0.01	0.04	-0.06	0.03	-0.17	0.06	0.14	0.66	-0.12	0.97	0.04	0.01	0.02	0.05	0.60	-0.18	1.00	
$FORWM\_alt_j$	0.04	0.01	-0.01	-0.07	0.04	-0.14	0.04	0.32	0.23	0.85	0.10	0.85	0.02	-0.04	0.22	-0.06	0.74	0.03	1.00

Source: The author's estimations based on the data sources described.

4.3 Econometric procedure

The equations are initially estimated using the ordinary least square (OLS) method. The lack of bias and consistency of OLS estimates rest on the assumption that explanatory variables are uncorrelated with the stochastic disturbance terms. This assumption becomes invalid for any individual equation in a system of equations whenever at least one of the explanatory variables of that equation is jointly-determined; so making the use of OLS inappropriate. In this study, FOR_j is suspected as an endogenous variable, as it is likely that there is simultaneous relationship between FOR_j and Y_{ij}. As a result, a suspected simultaneity problem not only impacts on the coefficient corresponding to FOR_j, but also FOR_jTP_j, $BACK_j$, and $FORW_j$. That is because these variables are measured by incorporating the foreign presence (FOR_j).

The alternative estimators, devised to be used in this situation, fall into two main categories, i.e. system methods and single-equation methods. The system methods, which comprise both three stage least squares (3SLS) and full-information maximum likelihood (FIML) are more widely employed, and are superior to the single-equation methods in terms of the efficiency of estimates derived. However, when using 3SLS or FIML, all equations in the system must be properly specified. Since these methods utilize information on the interconnection among all the equations in the system, what is happening elsewhere in the system will be transmitted throughout the whole system, which is liable to cause both bias and distortion. Moreover, based on a Monte Carlo experiment of a finite sample, 2SLS has emerged as a favorable compromise choice among the available alternatives. The 2SLS measurement, generally performing well in terms of both bias and mean-squared error, shows a relatively higher degree of stability and is not greatly affected by specifications (Intriligator et al. 1996: p.389). Moreover, 2SLS and 3SLS estimates are equivalent asymptotically (Wooldridge 2002: p.199). Hence, 2SLS is chosen for solving the suspected simultaneity problem.

2SLS involves applying OLS in two stages. The first stage comprises regressing each of the explanatory endogenous variables on all the pre-determined variables. In the second stage, the fitted values of the explanatory endogenous variables, obtained from the first regression, are used in place of their observed values to estimate

the structural form coefficients. This two-stage procedure avoids the simple one-stage least square bias and inconsistency in the estimates by eliminating from the explanatory endogenous variables that part of the variation which is due to the disturbance.

4.4 Econometric results

The regression results, relating to the determinants of the local firms' productivity, are reported in Table 4.3. The columns (1) – (2) and (3) – (4) represent OLS and 2SLS estimates, respectively. Following one of the main purposes of this study, the different measures of vertical spillovers are systematically examined. So that, $BACK_j$ and $FORW_j$, based on the standard measure introduced by Javorcik (2004), i.e. measures capturing only direct linkages are proxied in the columns (1) and (3). In contrast, the alternative measures introduced by Kohpaiboon & Jongwanich (2013), i.e. the measures capturing both direct and indirect linkages, are proxied in the columns (2) and (4). Nonetheless, as pointed out in the FDI literature, there is a possibility of a simultaneity problem. In particular, the positive coefficient corresponding to FOR_j may be a result of the characteristic of foreign firms tending to be located in highly productive sectors, instead of any existence of FDI spillovers. To guard against the possibility of the simultaneity problem, the empirical model expressed in the columns (1) and (2) is re-estimated using 2SLS. The set of instrument variables, which were guided by the theory of FDI determinants, includes market size, quality of labor, intensity of inter-industry trade and trade policy regime[15]. The 2LS estimation results are reported in columns (3) and (4).

[15] See variable measurement and data sources of instrument variables in the Appendix.

Table 4.3

Regression results

	OLS		**2SLS**	
	Std. Measures	Alt. Measures	Std. Measures	Alt. Measure
	1	2	3	4
Firm Specific				
Intercept	-3.16 (-9.54)***	-2.97 (-9.06)***	-3.21 (-9.66)***	-3.02 (-9.19)***
lnL_{ij}	0.62 (7.97)***	0.64 (8.22)***	0.62 (7.87)***	0.64 (8.24)***
lnK_{ij}	1.45 (31.46)***	1.43 (31.32)***	1.46 (30.94)***	1.42 (30.88)***
$lnL_{ij}lnK_{ij}$	0.01 (1.29)	0.01 (1.36)	0.01 (1.21)	0.01 (1.14)
$(lnL_{ij})^2$	-0.02 (-1.88)*	-0.02 (-2.09)**	-0.01 (-1.75)*	-0.02 (-1.90)*
$(lnK_{ij})^2$	-0.03 (-14.86)***	-0.03 (-14.83)***	-0.03 (-14.71)***	-0.03 (-14.47)***
MKT_{ij}	0.48 (6.71)***	0.52 (7.38)***	0.46 (6.45)***	0.52 (7.35)***
IMP_{ij}	0.36 (4.63)***	0.34 (4.32)***	0.34 (4.31)***	0.30 (3.74)***
QL_{ij}	2.04 (25.15)***	1.98 (24.60)***	2.04 (25.06)***	1.98 (24.49)***
Industry Specific				
CON_j	1.07 (7.14)***	0.95 (6.81)***	1.06 (6.44)***	1.16 (8.06)***
FOR_j	0.63 (8.00)***	0.27 (3.34)***	1.43 (8.33)***	1.16 (5.60)***
$BACK\_std_j$	0.67 (5.92)***		0.62 (4.74)***	
$FORW\_std_j$	0.63 (4.59)***		-0.47 (-2.65)***	
$BACK\_alt_j$		0.23 (8.67)***		0.27 (9.37)***
$FORW\_alt_j$		0.78 (8.91)***		0.30 (2.37)**

Table 4.3 (Continue)

Regression results

	OLS		2SLS	
	Std. Measures	Alt. Measures	Std. Measures	Alt. Measure
	1	2	3	4
FOR_jTP_j	0.41 (-1.53)	-0.73 (-2.74)***	-0.74 (-2.52)**	-0.92 (-3.08)***
Statistical Details				
#Observation	18,496	18,403	18,496	18,403
F-stat	2,572.26***		2,615.46***	
Wald chi-sq		53,575.80***		54,611.29***
R-squared	0.74	0.74	0.74	0.74
Geary	-19.28 (p=0.00)	-20.28 (p=0.00)	-18.91 (p=0.00)	-19.64 (p=0.00)
White	269.27 (p=0.00)	266.63 (p=0.00)	266.47 (p=0.00)	257.52 (p=0.00)
RESET	173.77 (p=0.00)	124.96 (p=0.00)	150.20 (p=0.00)	179.08 (p=0.00)
Overid		399.08 (p=0.00)		340.13 (p=0.00)

Source: The author's estimation based on the data sources and variable measurements described in the previous chapter.

Note: OLS = Ordinary Least Square and 2SLS = Two-Stage Least Square. Std. Measures are the tools capturing only direct linkages, while Alt. Measures represent the measures capturing both direct and indirect linkages. Numbers in parenthesis are t-statistics and z-statistics for OLS and 2SLS constructed from robust standard error, respectively. ***, ** and * indicate the level of statistical significance at 1, 5 and 10 per cent levels, respectively. Geary = Geary Non-Normality LM Runs Test; White = White Test for heteroscedasticity (F-distribution); RESET = Ramsey RESET Test functional form misspecification (F-distribution and Chi-squared distribution for OLS and 2SLS, respectively); Overid = Overidentification Test (Chi-squared distribution).

As Table 4.3 illustrates, all the regressed equations pass the overall statistical significance at the one per cent level. This outcome indicates that the empirical models used in this study work significantly well for examining FDI

spillovers. Furthermore, this study employs the Hausman test[16], which suggests that 2SLS performs better than OLS. Therefore, the following discussion will be based on utilization of 2SLS.

The coefficients corresponding to firm-specific factors are statistically significant and reach the theoretical expected sign. Most coefficients corresponding to the labor squared, as well as the capital squared, are statistically significant, suggesting that the trans-log functional form fits the data better as opposed to the Cobb-Douglas measure.

The sign of coefficient corresponding to MKT_{ij} and IMP_{ij} turns out to be significantly positive. Exporting firms and firms using imported intermediates are likely to exhibit a higher level of productivity than other firms. This finding is in line with the key finding in the firm heterogeneity literature in which international trade performs as a channel through which advanced technology can be transmitted to firms. In general, exporting firms are facing more intense competition than domestic-oriented operations. This acts as a conducive catalyst for firms to enhance their productivity in order to survive. Advanced technology could be embodied into imported intermediates so that firms importing such intermediates would be able to benefit from it. This would potentially positively affect firms' productivity.

The coefficients corresponding to QL_{ij} is significantly positive. Firms hiring skilled workers (measured by the number of non-production workers to total workers) have higher productivity than the remainder. A number of non-production workers hired by firms might reflect the adoption of modern management practices, such as keisen and just-in-time inventory system. This could affect productivity significantly.

With regard to industry-specific factors[17], coefficients corresponding to CON_j turn out to be significantly positive. That is, the higher the industry's market

[16] The hypothesis used in the Hausman Test, H0: OLS performs as well as 2SLS and H1: 2SLS performs better than OLS. Both models (employing standard and alternative measures) reject H0 with a statistical significance at the 1 per cent level.

[17]It is likely that there are industry-specific characteristics, which may significantly impact on a firm's productivity. To guard against the possibility of biased estimates, industry binary dummies based on ISIC four-digit classifications are introduced in the model. For example, IND1543 is a binary dummy variable, which is

concentration, the higher the firm's productivity. This finding is consistent with the empirical evidence derived from the Thai manufacturing sector found in previous studies.[18]

The finding is consistent with previous studies reporting that FDI spillovers vary across industries. Horizontal FDI spillovers depends on the nature of trade policy. The significantly negative coefficient corresponding with FOR_jTP_j suggests that the more restrictive the trade policy (an increase in ERP), the less the horizontal FDI spillover from which indigenous firms would potentially benefit. Although this study found a significantly positive impacts through intra-industry FDI spillovers[19] (i.e. horizontal FDI spillovers), the involvement of foreign firms could generate negative FDI spillovers towards local plants in the industry with high ERP. This intuition concerning negative spillovers would be in line with the so-called market stealing effect coined by Aitken and Harrison (1996). In particular, while foreign firms have to be associated with advanced technology and have the potential to generate positive spillovers, the restrictiveness of trade policy induces all firms (both indigenous and foreign) to compete with each other for limited domestic markets. The advanced technology associated with foreign affiliates potentially places them in an advantageous position as opposed to indigenous firms. As a consequence, the latter could lose their market share and this may result in higher average costs and lower productivity.

Evidence of absorptive capability was not found in this thesis. In practice, the interaction term between foreign presence and ratio of non-productive workers is employed as a proxy for absorptive capability (Kohpaiboon & Jongwanich, 2013). Nonetheless, non-productive workers in the census include unskilled workers, such as cleaners and security guards. Under this circumstance, the ratio of skilled workers tends

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equal to one, if a plant is a member of the industry of ISIC1543 and zero otherwise. There are eight industry binary-dummies, which reveal statistical significance and are added in the model, including ISIC1543, ISIC1554, ISIC1711, ISIC1722, ISIC2421, ISIC2424, ISIC2710 and ISIC3699.

[18]See Kohpaiboon (2006b); Kohpaiboon & Jongwanich (2013); and Srithanpong (2014).

[19]Sensitivity analysis of horizontal spillovers has been conducted. In particular, foreign presence (FOR_j) is alternatively measured by foreign capital share and employment share. In consequence, the results are in line with the above outcome derived from output share.

to be overestimated. As a result, the thesis is likely to be unable to find sufficient evidence due to this reason.

There are indications of positive spillover through backward linkages in Thai manufacturing, indicated by the statistical significance of the coefficient corresponding to backward linkage variables. This outcome occurs regardless of how the backward linkage is measured. The positive spillover through backward linkage seems sensible as a number of empirical studies suggest that there were a number of industries experiencing increasing backward linkages and the increasing linkage occurs naturally (i.e. Kohpaiboon and Jongwanich, 2010; and Kohpaiboon 2006). Policy-induced linkages are less likely within Thai manufacturing since the new millennium partly due to the establishment of the World Trade Organization and prohibition concerning using local content requirement through the conclusion of the Trade Related-Investment Measures (TRIMs) agreement. When the linkage occurs naturally as a consequence of mutual benefits among firms, this tends to reflect productivity enhancing activities.

Interestingly, the magnitude of the coefficient tends to be much higher when only the direct linkage is measured (i.e. the coefficient corresponding to $BACK\_std_j$ is much greater than $BACK\_alt_j$). In theory, measures of the industrial linkage would be more comprehensive when covering both direct and indirect linkages. When foreign firms demand quality intermediates from local suppliers, these suppliers need to further search for qualified inputs and raw materials from other potential suppliers. Under this circumstance, measures capturing only the direct backward linkage are likely to understate the total effect of the backward linkage, so that the corresponding coefficient tends to be overestimated. In other words, the model is likely to suffer from a biased estimation problem, since the indirect backward linkage is omitted within the model when using the standard measure. On the other hand, as shown in Table 4.1, the value of the backward linkage, which is measured alternatively, is much higher than its counterpart. As a result, it is also likely that the lower magnitude of coefficient corresponding to the alternative measure is derived from a relatively higher value.

Finally, the coefficient corresponding to $FORW\_std_j$ is revealed to be negative and statistically significant. This result seems counter-intuitive. Similar to

backward linkage, it is unlikely for negative spillover to be observed through forward linkages. In other words, multinational firms may not be willing to hurt their local customers. Nonetheless, when both direct and indirect forward linkages are included (i.e. employing the alternative measures), the coefficient turns out to be positive, whereas it is not significantly different from zero at the conventional statistical significant level, i.e. at five per cent. Therefore, the empirical evidence affirms that the standard measures may not be able to estimate the total impact of inter-industry FDI spillovers. Similar to the backward linkage scenario, employing the standard measure may lead to the omitted variable problem as the indirect forward linkage is not included in the empirical model.

CHAPTER 5
CONCLUSIONS AND POLICY INFERENCES

5.1 Conclusions

This thesis examines FDI spillovers in the Thai manufacturing sector using the 2012 industrial census as a data source. A cross-sectional econometric analysis of the plant productivity determinants of indigenous firms is undertaken. The thesis contributes to the existing literature in two ways. First, vertical spillovers are systematically examined, particularly both measures capturing only direct linkages (i.e. the standard measures) and measures capturing both direct and indirect linkages (i.e. the alternative measures) are employed. Second, the paper more efficiently incorporates horizontal FDI spillover by allowing it to vary across industries.

The key finding is that evidence of horizontal spillovers is found in some industries depending on the nature of the prevailing trade policy regime. In other words, advanced technologies associated with foreign affiliates are likely to spill over to local plants operating in the same industry (i.e. horizontal spillovers), when the trade policy provides a neutral incentive. In contrast, such technological gains could negatively affect indigenous firms' productivity in the industry under restricted trade policy regimes, as all firms are competing with each other for the limited local market. The more liberal the trade policy regime, the higher the gains accrued through horizontal spillovers.

Where vertical spillovers are concerned, only the backward linkage channel is found to reveal any statistically positive significance. This occurs regardless of measure employed. However, how backward linkage is measured matters and influences the magnitude of vertical spillover. The estimated magnitude tends to be grossly overestimated when only the direct measure is used. In practice, it is very unlikely that direct linkage are separated from indirect. The thesis fails to find the statistical significance of forward linkage. Interestingly, the result based on the direct measure seems to be counter-intuitive.

Another important finding is that export-oriented plants and firms using imported intermediates have higher productivity than firms operating otherwise. This finding supports the role of liberal trade policy regimes supporting plants' productivity improvement processes.

5.2 Policy inferences

Two policy inferences can be drawn from this study. First, the results strongly plead the case for trade policy liberalization. More liberal regimes would be likely to result in productivity improvement. Trade policy liberalization would not only facilitate the horizontal technology spillover of FDI, but also allow firms to be engaged in international trade. This could be either involved with exporting finished goods, importing intermediates or both. Second, the results shed light on the problem of how to measure linkages prevailing in the FDI spillover literature. Both direct and indirect linkages should be taken into consideration in examining how vertical spillovers reach a reasonable spillover magnitude. Accuracy in estimating the magnitude of linkages matters for policymakers in developing countries, who tend to be in favor of maximizing the amount of linkages created by foreign firms. Overestimating the amount of linkages could result in the mistreatment of foreign direct investors, especially by imposing policy-induced linkages. Such treatment eventually could be counter-productive. In fact, it is far beyond the realm of the policy domain to favor horizontal spillover over vertical, or vice versa. All kinds of spillover are beneficial for the developmental process from a host country perspective.

5.3 Limitations

Conducting this study necessitated employing and judiciously treating cross-sectional data due to the unavailability of long-panel data. In general, cross-sectional data tends to provide more significant information on the impact of FDI spillovers than other types of dataset (see Havranek & Irsova, 2011). As discussed, studies on FDI spillover are often criticized with respect to the possibility of the existence of simultaneity problems. Although this thesis employs the 2SLS measure in

an attempt to mitigate the problem, it may not be able to completely eliminate simultaneity issues. As a result, the use of long-panel data is strongly recommended when reliable longitudinal dataset is available. It is likely that the panel data would better mitigate the problems outlined than cross-sectional data.

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APPENDICES

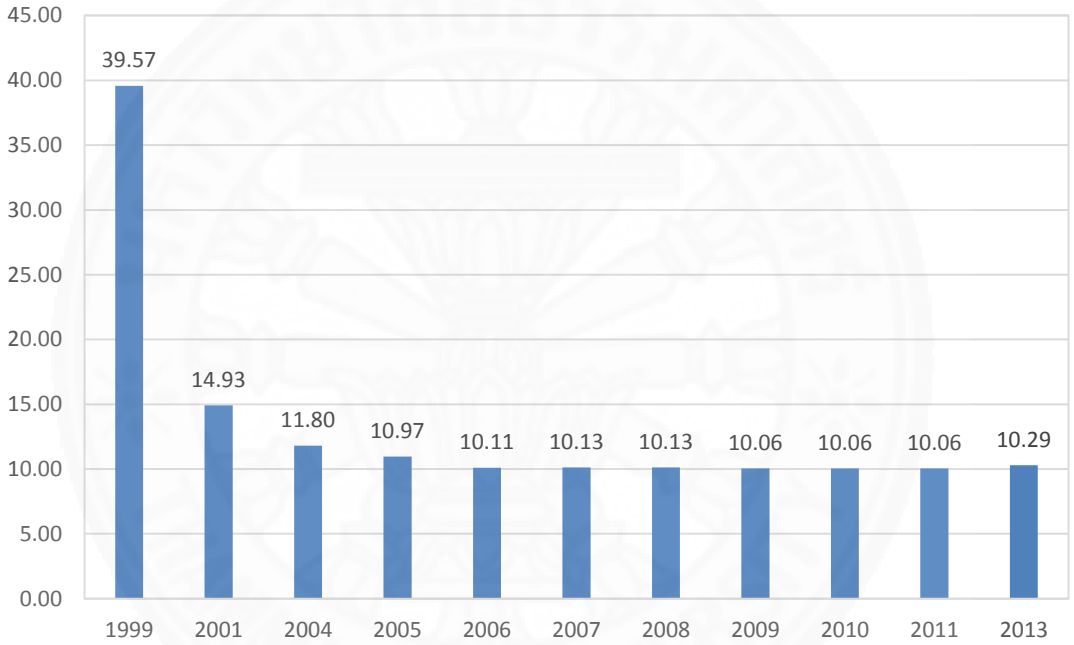
APPENDIX A

Tariff Rates in Thai Non-Agricultural Sectors

Significant tariff reduction was started in 1988, particularly due to comprehensive packages of tariff reform implemented in 1995 and 1997.

Figure Appendix C.1

Average tariff rate in Thai non-agricultural sectors



Source: The World Trade Organization.

Note: The average tariff is computed using simple non-weighted average. See full data below.

In consequent, the average tariff rate was considerably declined from around 40 per cent to 15 percent during 1999-2001, i.e. the average rate decreased more than 60 per cent. After that, between the periods 2001-2005, the average tariff rate continued to shrink and reach a rate of around 11 per cent. Importantly, the average rate has remained around 10 per cent since the year 2006 until the present period. The full data is shown in the below tables:

Table Appendix A.1

Historical tariff rates in Thai non-agricultural sectors

HS	Description	1999	2001	2004	2005	2006	2007	2008	2009	2010	2011	2013
03	FISH AND CRUSTACEANS, MOLLUSCS AND OTHER AQUATIC INVERTEBRATES	60.00%	7.87%	8.19%	8.19%	8.19%	8.22%	8.22%	8.22%	8.04%	8.04%	8.13%
25	SALT; SULPHUR; EARTHS AND STONE; PLASTERING MATERIALS, LIME AND CEMENT	18.97%	7.17%	2.84%	2.44%	1.42%	1.98%	1.98%	1.98%	1.98%	1.87%	2.14%
26	ORES, SLAG AND ASH	8.94%	1.00%	1.00%	1.00%	0.68%	0.59%	0.59%	0.59%	0.59%	0.59%	0.57%
27	MINERAL FUELS, MINERAL OILS AND PRODUCTS OF THEIR DISTILLATION; BITUMINOUS SUBSTANCES; MINERAL WAXES	22.96%	1.81%	1.00%	1.00%	0.57%	1.93%	1.93%	1.93%	1.93%	1.93%	2.19%
28	INORGANIC CHEMICALS; ORGANIC OR INORGANIC COMPOUNDS OF PRECIOUS METALS, OF RARE- EARTH METALS, OF RADIOACTIVE ELEMENTS OR OF ISOTOPES	29.19%	1.25%	1.61%	1.61%	0.51%	0.49%	0.49%	0.46%	0.46%	0.44%	0.44%
30	PHARMACEUTICAL PRODUCTS	25.55%	7.90%	8.19%	8.19%	8.19%	7.93%	7.93%	7.93%	7.90%	7.92%	8.29%
31	FERTILISERS	28.85%	5.19%	4.81%	4.81%	4.81%	4.78%	4.78%	4.78%	4.78%	4.78%	4.78%
32	TANNING OR DYEING EXTRACTS; TANNINS AND THEIR DERIVATIVES; DYES, PIGMENTS AND OTHER COLOURING MATTER; PAINTS AND VARNISHES; PUTTY AND OTHER MASTICS; INKS	27.56%	10.58%	6.16%	6.16%	6.05%	5.77%	5.77%	5.18%	5.18%	4.73%	4.73%
34	SOAP, ORGANIC SURFACE- ACTIVE AGENTS, WASHING PREPARATIONS, LUBRICATING PREPARATIONS, ARTIFICIAL WAXES, PREPARED WAXES, POLISHING OR SCOURING PREPARATIONS, CANDLES AND SIMILAR ARTICLES, MODELLING PASTES, "DENTAL WAXES" AND DENTAL PREPARATIONS WITH A BASIS OF PLASTER	38.75%	11.83%	7.33%	7.33%	7.33%	7.45%	7.45%	7.45%	7.45%	7.45%	7.88%
36	EXPLOSIVES; PYROTECHNIC PRODUCTS; MATCHES; PYROPHORIC ALLOYS; CERTAIN COMBUSTIBLE PREPARATIONS	51.43%	20.00%	18.57%	18.57%	18.57%	18.75%	18.75%	18.75%	18.75%	18.75%	18.75%
37	PHOTOGRAPHIC OR CINEMATOGRAPHIC GOODS	37.64%	18.44%	18.20%	18.20%	3.23%	1.63%	1.63%	1.63%	1.63%	1.32%	1.25%
39	PLASTICS AND ARTICLES THEREOF	0.00%	0.00%	0.00%	0.00%	0.00%	7.21%	7.21%	7.19%	7.19%	7.19%	7.69%
40	RUBBER AND ARTICLES THEREOF	42.91%	22.46%	13.91%	6.96%	6.27%	7.98%	7.98%	7.98%	7.98%	7.98%	8.30%

Source: The World Trade Organization.

Table Appendix A.1 (Continue)

Historical tariff rates in Thai non-agricultural sectors

HS	Description	1999	2001	2004	2005	2006	2007	2008	2009	2010	2011	2013
42	ARTICLES OF LEATHER; SADDLERY AND HARNESS; TRAVEL GOODS, HANDBAGS AND SIMILAR CONTAINERS; ARTICLES OF ANIMAL GUT (OTHER THAN SILK- WORM GUT)	75.91%	29.09%	27.27%	27.27%	27.27%	27.00%	27.00%	27.00%	27.00%	27.25%	27.50%
44	WOOD AND ARTICLES OF WOOD; WOOD CHARCOAL	35.56%	12.47%	10.11%	6.57%	6.57%	6.88%	6.88%	6.88%	6.88%	6.88%	6.77%
45	CORK AND ARTICLES OF CORK	30.71%	11.00%	8.86%	6.71%	6.71%	6.71%	6.71%	6.71%	6.71%	6.71%	6.71%
46	MANUFACTURES OF STRAW, OF ESPARTO OR OF OTHER PLAITING MATERIALS; BASKETWARE AND WICKERWORK	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%
47	PULP OF WOOD OR OF OTHER FIBROUS CELLULOSIC MATERIAL; RECOVERED (WASTE AND SCRAP) PAPER AND PAPERBOARD	10.00%	3.20%	1.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
48	PAPER AND PAPERBOARD; ARTICLES OF PAPER PULP, OF PAPER OR OF PAPERBOARD	26.25%	12.00%	9.00%	6.00%	1.03%	5.72%	5.72%	6.01%	6.01%	6.01%	5.99%
49	PRINTED BOOKS, NEWSPAPERS, PICTURES AND OTHER PRODUCTS OF THE PRINTING INDUSTRY; MANUSCRIPTS, TYPESCRIPTS AND PLANS	9.71%	6.43%	5.54%	4.64%	1.56%	2.76%	2.76%	2.76%	2.76%	2.76%	2.74%
54	MAN- MADE FILAMENTS	30.00%	10.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
55	MAN- MADE STAPLE FIBRES	35.96%	10.00%	4.83%	4.57%	4.57%	4.59%	4.59%	4.59%	4.59%	4.59%	4.59%
56	WADDING, FELT AND NONWOVENS; SPECIAL YARNS; TWINE, CORDAGE, ROPES AND CABLES AND ARTICLES THEREOF	40.00%	17.50%	11.38%	6.21%	6.21%	6.30%	6.30%	6.30%	6.30%	6.30%	5.77%
58	SPECIAL WOVEN FABRICS; TUFTED TEXTILE FABRICS; LACE; TAPESTRIES; TRIMMINGS; EMBROIDERY	48.00%	20.00%	14.50%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%	9.00%
59	IMPREGNATED, COATED, COVERED OR LAMINATED TEXTILE FABRICS; TEXTILE ARTICLES OF A KIND SUITABLE FOR INDUSTRIAL USE	38.40%	15.28%	12.38%	10.29%	10.29%	10.29%	10.29%	10.29%	10.29%	10.29%	10.29%
60	KNITTED OR CROCHETED FABRICS	100.00%	20.00%	12.50%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
61	ARTICLES OF APPAREL AND CLOTHING ACCESSORIES, KNITTED OR CROCHETED	100.00%	30.00%	30.00%	30.00%	30.00%	29.93%	29.93%	29.93%	29.93%	29.93%	29.93%
62	ARTICLES OF APPAREL AND CLOTHING ACCESSORIES, NOT KNITTED OR CROCHETED	100.00%	46.94%	30.31%	30.31%	30.31%	29.61%	29.61%	29.61%	29.61%	30.71%	29.27%

Source: The World Trade Organization.

Table Appendix A.1 (Continue)

Historical tariff rates in Thai non-agricultural sectors

HS	Description	1999	2001	2004	2005	2006	2007	2008	2009	2010	2011	2013
63	OTHER MADE UP TEXTILE ARTICLES; SETS; WORN CLOTHING AND WORN TEXTILE ARTICLES; RAGS	79.06%	29.06%	28.91%	28.91%	28.91%	25.98%	25.98%	25.98%	25.98%	25.98%	26.12%
64	FOOTWEAR, GAITERS AND THE LIKE; PARTS OF SUCH ARTICLES	90.58%	26.92%	26.92%	26.92%	26.92%	26.03%	26.03%	26.03%	26.03%	26.28%	26.73%
65	HEADGEAR AND PARTS THEREOF	77.50%	25.00%	25.00%	25.00%	25.00%	21.48%	21.48%	21.48%	21.48%	21.48%	22.00%
66	UMBRELLAS, SUN UMBRELLAS, WALKING- STICKS, SEAT-STICKS, WHIPS, RIDING- CROPS AND PARTS THEREOF	55.00%	15.00%	15.00%	15.00%	15.00%	20.83%	20.83%	20.83%	20.83%	20.83%	23.33%
67	PREPARED FEATHERS AND DOWN AND ARTICLES MADE OF FEATHERS OR OF DOWN; ARTIFICIAL FLOWERS; ARTICLES OF HUMAN HAIR	50.00%	27.50%	26.88%	26.88%	26.88%	26.88%	26.88%	23.75%	23.75%	23.75%	23.75%
68	ARTICLES OF STONE, PLASTER, CEMENT, ASBESTOS, MICA OR SIMILAR MATERIALS	37.95%	15.51%	8.46%	8.46%	8.31%	7.95%	7.95%	7.75%	7.75%	7.75%	7.79%
69	CERAMIC PRODUCTS	36.56%	17.19%	8.75%	8.75%	8.44%	18.02%	18.02%	17.67%	17.67%	16.90%	16.67%
70	GLASS AND GLASSWARE	39.02%	14.28%	7.98%	7.05%	6.00%	9.73%	9.73%	9.71%	9.71%	9.74%	9.47%
71	NATURAL OR CULTURED PEARLS, PRECIOUS OR SEMI-PRECIOUS STONES, PRECIOUS METALS, METALS CLAD WITH PRECIOUS METAL, AND ARTICLES THEREOF; IMITATION JEWELLERY; COIN	33.62%	5.42%	5.32%	5.32%	5.53%	4.87%	4.87%	4.87%	4.87%	4.87%	4.94%
72	IRON AND STEEL	14.02%	8.39%	5.58%	4.45%	3.82%	3.01%	3.01%	3.02%	3.02%	3.01%	3.32%
73	ARTICLES OF IRON OR STEEL	34.36%	17.90%	13.42%	11.56%	11.42%	10.32%	10.32%	10.32%	10.36%	10.36%	10.35%
74	COPPER AND ARTICLES THEREOF	20.24%	10.91%	6.28%	6.28%	2.63%	2.58%	2.58%	2.58%	2.58%	2.58%	2.23%
75	NICKEL AND ARTICLES THEREOF	19.90%	9.82%	6.06%	6.06%	1.29%	1.06%	1.06%	1.06%	1.06%	1.06%	1.47%
76	ALUMINIUM AND ARTICLES THEREOF	30.79%	13.59%	9.93%	9.33%	9.16%	7.77%	7.77%	7.57%	7.71%	7.71%	7.53%
78	LEAD AND ARTICLES THEREOF	19.25%	10.50%	5.70%	4.50%	1.00%	0.63%	0.63%	0.63%	0.63%	0.63%	0.83%
79	ZINC AND ARTICLES THEREOF	23.42%	9.25%	6.73%	5.45%	4.58%	3.11%	3.11%	2.74%	2.74%	2.74%	2.67%
80	TIN AND ARTICLES THEREOF	19.60%	9.17%	5.54%	5.21%	1.25%	0.80%	0.80%	0.80%	0.80%	0.80%	0.67%
81	OTHER BASE METALS; CERMETS; ARTICLES THEREOF	23.82%	11.18%	3.24%	2.53%	0.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
82	TOOLS, IMPLEMENTS, CUTLERY, SPOONS AND FORKS, OF BASE METAL; PARTS THEREOF OF BASE METAL	31.29%	20.76%	16.36%	16.36%	15.15%	15.15%	15.15%	15.00%	15.00%	15.00%	14.84%
83	MISCELLANEOUS ARTICLES OF BASE METAL	41.41%	20.94%	15.00%	15.00%	13.44%	12.26%	12.26%	12.83%	12.83%	12.83%	13.22%

Source: The World Trade Organization.

Table Appendix A.1 (Continue)

Historical tariff rates in Thai non-agricultural sectors

HS	Description	1999	2001	2004	2005	2006	2007	2008	2009	2010	2011	2013
84	NUCLEAR REACTORS, BOILERS, MACHINERY AND MECHANICAL APPLIANCES; PARTS THEREOF	32.68%	8.05%	5.46%	4.52%	4.29%	3.72%	3.73%	3.73%	3.72%	3.75%	3.94%
85	ELECTRICAL MACHINERY AND EQUIPMENT AND PARTS THEREOF; SOUND RECORDERS AND REPRODUCERS, TELEVISION IMAGE AND SOUND RECORDERS AND REPRODUCERS, AND PARTS AND ACCESSORIES OF SUCH ARTICLES	42.31%	14.13%	11.58%	9.39%	9.31%	7.68%	7.68%	7.66%	7.65%	7.77%	8.32%
86	RAILWAY OR TRAMWAY LOCOMOTIVES, ROLLING- STOCK AND PARTS THEREOF; RAILWAY OR TRAMWAY TRACK FIXTURES AND FITTINGS AND PARTS THEREOF; MECHANICAL (INCLUDING ELECTRO- MECHANICAL) TRAFFIC SIGNALLING EQUIPMENT OF ALL KINDS	5.52%	2.77%	2.56%	2.77%	2.77%	2.74%	2.74%	2.74%	2.74%	2.74%	2.85%
87	VEHICLES OTHER THAN RAILWAY OR TRAMWAY ROLLING-STOCK,AND PARTS AND ACCESSORIES THEREOF	60.33%	40.92%	34.08%	32.11%	32.11%	31.70%	31.70%	31.70%	31.70%	31.70%	32.22%
88	AIRCRAFT, SPACECRAFT, AND PARTS THEREOF	5.00%	3.13%	3.25%	3.25%	3.25%	3.13%	3.13%	3.13%	3.10%	3.13%	3.13%
89	SHIPS, BOATS AND FLOATING STRUCTURES	33.24%	16.82%	5.61%	5.61%	5.61%	3.79%	3.79%	3.79%	3.79%	3.79%	4.41%
90	OPTICAL, PHOTOGRAPHIC, CINEMATOGRAPHIC, MEASURING, CHECKING, PRECISION, MEDICAL OR SURGICAL INSTRUMENTS AND APPARATUS; PARTS AND ACCESSORIES THEREOF	32.82%	5.44%	4.11%	4.11%	3.84%	3.74%	3.74%	3.74%	3.74%	3.83%	3.73%
91	CLOCKS AND WATCHES AND PARTS THEREOF	44.73%	11.09%	8.40%	8.40%	8.40%	8.43%	8.43%	8.43%	8.43%	8.43%	8.47%
92	MUSICAL INSTRUMENTS; PARTS AND ACCESSORIES OF SUCH ARTICLES	41.30%	10.87%	10.87%	10.87%	10.87%	11.18%	11.18%	11.18%	11.18%	11.18%	11.18%
93	ARMS AND AMMUNITION; PARTS AND ACCESSORIES THEREOF	37.65%	28.24%	24.29%	24.29%	24.29%	24.00%	24.00%	24.00%	24.00%	24.00%	25.00%

Source: The World Trade Organization.

Table Appendix A.1 (Continue)

Historical tariff rates in Thai non-agricultural sectors

HS	Description	1999	2001	2004	2005	2006	2007	2008	2009	2010	2011	2013
94	FURNITURE; BEDDING, MATTRESSES, MATTRESS SUPPORTS, CUSHIONS AND SIMILAR STUFFED FURNISHINGS; LAMPS AND LIGHTING FITTINGS, NOT ELSEWHERE SPECIFIED OR INCLUDED; ILLUMINATED SIGNS, ILLUMINATED NAME-PLATES AND THE LIKE; PREFABRICATED BUILDINGS	71.76%	20.00%	18.11%	18.11%	18.11%	18.21%	18.21%	18.21%	18.21%	18.21%	18.21%
95	TOYS, GAMES AND SPORTS REQUISITES; PARTS AND ACCESSORIES THEREOF	41.83%	15.49%	15.60%	15.60%	15.60%	13.81%	13.81%	13.81%	13.81%	13.81%	13.81%
96	MISCELLANEOUS MANUFACTURED ARTICLES	49.57%	15.98%	14.24%	14.24%	14.24%	13.70%	13.70%	13.70%	13.70%	13.70%	14.06%
97	WORKS OF ART, COLLECTORS' PIECES AND ANTIQUES	34.29%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	17.14%

Source: The World Trade Organization.

APPENDIX B

Measured Values of Key Variables of Thai Manufacturing

Table Appendix B.1

The measured values of the industry's key variables of Thai manufacturing

ISIC	Industry	*LP*	*ERP*	*FOR*	*BACK_std*	*BACK_alt*	*FORW_std*	*FORW_alt*
1511	Processing/preserving of meat	1.50	-0.07	0.26	0.08	0.36	0.03	0.11
1512	Processing/preserving of fish	1.50	-0.38	0.16	0.02	0.02	0.04	0.15
1513	Processing/preserving of fruit & vegetables	5.90	0.27	0.15	0.05	0.01	0.05	0.15
1514	Vegetable and animal oils and fats	4.20	-0.38	0.15	0.07	0.09	0.01	0.14
1520	Dairy products	1.50	0.10	0.09	0.02	0.03	0.05	0.13
1531	Grain mill products	9.30	-0.09	0.03	0.02	0.13	0.00	0.07
1532	Starches and starch products	8.10	-0.05	0.04	0.10	0.16	0.02	0.09
1533	Prepared animal feeds	5.50	-0.19	0.04	0.00	0.17	0.07	0.17
1541	Bakery products	3.50	-0.14	0.12	0.02	0.00	0.07	0.15
1542	Sugar	2.00	-0.08	0.01	0.12	0.20	0.03	0.10
1543	Cocoa, chocolate and sugar confectionery	1.90	-0.04	0.14	0.05	0.04	0.05	0.14
1544	Macaroni, noodles & similar products	0.78	-0.08	0.15	0.00	0.00	0.06	0.14
1549	Other food products n.e.c.	7.50	-0.09	0.14	0.05	0.04	0.05	0.14
1551	Distilling, rectifying & blending of spirits	3.70	0.01	0.00	0.00	0.01	0.07	0.09
1552	Wines	0.97	-0.07	0.56	0.00	0.01	0.07	0.09
1553	Malt liquors and malt	3.30	-0.04	0.00	0.00	0.01	0.15	0.17
1554	Soft drinks; mineral waters	16.00	-0.18	0.23	0.00	0.01	0.15	0.28
1600	Tobacco products	11.00	0.00	0.04	0.00	0.00	0.06	0.04
1711	Textile fibre preparation; textile weaving	1.40	-0.06	0.15	0.15	0.48	0.13	0.20
1712	Finishing of textiles	2.00	-0.16	0.16	0.16	0.02	0.18	0.29
1721	Made-up textile articles, except apparel	0.92	0.01	0.07	0.10	0.05	0.19	0.30
1722	Carpets and rugs	0.73	-0.02	0.58	0.04	0.00	0.17	0.27
1723	Cordage, rope, twine and netting	1.40	0.07	0.03	0.01	0.01	0.09	0.18
1729	Other textiles n.e.c.	6.00	0.01	0.53	0.15	0.31	0.17	0.25
1730	Knitted and crocheted fabrics and articles	2.70	0.02	0.05	0.06	0.07	0.20	0.32
1810	Wearing apparel, except fur apparel	1.50	-0.01	0.11	0.06	0.07	0.21	0.33
1820	Dressing & dyeing of fur; processing of fur	N/A	N/A	N/A	0.36	0.18	0.21	0.26
1911	Tanning and dressing of leather	2.00	-0.58	0.33	0.36	0.18	0.21	0.26
1912	Luggage, handbags, etc.; saddlery & harness	1.30	0.00	0.52	0.03	0.02	0.23	0.31
1920	Footwear	1.00	0.11	0.14	0.24	0.06	0.14	0.23
2010	Sawmilling and planing of wood	1.20	0.28	0.02	0.12	0.25	0.04	0.14
2021	Veneer sheets, plywood, particle board, etc.	3.00	0.38	0.00	0.12	0.25	0.04	0.14
2022	Builders' carpentry and joinery	1.60	0.38	0.01	0.12	0.25	0.04	0.14
2023	Wooden containers	2.30	-0.18	0.04	0.19	0.13	0.07	0.16
2029	Other wood products; articles of cork/straw	1.10	0.32	0.15	0.19	0.13	0.07	0.16
2101	Pulp, paper and paperboard	7.30	0.05	0.01	0.07	0.69	0.06	0.16
2102	Corrugated paper and paperboard	1.70	0.11	0.07	0.21	0.21	0.06	0.19
2109	Other articles of paper and paperboard	3.30	0.13	0.22	0.18	0.23	0.11	0.22

Source: ERP is from Jongwanich & Kohpaiboon (2007), while the others are measured by the author, based on the industrial census 2012 and IO Table 2010.

Note: The unit of *LP* is million THB per worker per year, while the unit of the others is ratio.

Table Appendix B.1 (Continue)

The measured values of the industry's key variables of Thai manufacturing

ISIC	Industry	*LP*	*ERP*	*FOR*	*BACK_std*	*BACK_alt*	*FORW_std*	*FORW_alt*
2211	Publishing of books and other publications	0.71	0.24	0.00	0.16	0.25	0.15	0.24
2212	Publishing of newspapers, journals, etc.	1.10	0.24	0.01	0.16	0.25	0.15	0.24
2213	Publishing of recorded media	N/A	N/A	N/A	0.16	0.25	0.15	0.24
2219	Other publishing	N/A	0.24	0.00	0.16	0.25	0.15	0.24
2221	Printing	1.40	0.18	0.05	0.16	0.25	0.15	0.24
2222	Service activities related to printing	0.53	-0.01	0.08	0.16	0.25	0.15	0.24
2230	Reproduction of recorded media	0.99	0.24	0.00	N/A	N/A	N/A	N/A
2310	Coke oven products	N/A	N/A	N/A	0.09	0.52	0.01	0.05
2320	Refined petroleum products	11.00	-0.08	0.02	0.07	2.25	0.01	0.11
2330	Processing of nuclear fuel	1.50	0.03	0.59	N/A	N/A	N/A	N/A
2411	Basic chemicals, except fertilizers	7.10	0.09	0.13	0.21	2.96	0.04	0.14
2412	Fertilizers and nitrogen compounds	4.10	0.09	0.00	0.16	2.37	0.05	0.15
2413	Plastics in primary forms; synthetic rubber	4.70	0.09	0.40	0.14	2.30	0.03	0.11
2421	Pesticides and other agro-chemical products	6.90	0.17	0.16	0.00	0.30	0.08	0.21
2422	Paints, varnishes, printing ink and mastics	2.10	0.21	0.42	0.25	0.62	0.10	0.18
2423	Pharmaceuticals, medicinal chemicals, etc.	1.20	-0.03	0.15	0.01	0.05	0.12	0.23
2424	Soap, cleaning & cosmetic preparations	8.20	-0.03	0.45	0.13	0.35	0.14	0.24
2429	Other chemical products n.e.c.	4.80	0.01	0.27	0.14	0.62	0.05	0.10
2430	Man-made fibres	10.00	-0.07	0.26	0.19	0.59	0.08	0.16
2511	Rubber tyres and tubes	2.10	-0.15	0.22	0.25	0.08	0.11	0.21
2519	Other rubber products	10.00	-0.07	0.09	0.18	0.26	0.03	0.09
2520	Plastic products	2.80	0.08	0.17	0.24	0.86	0.10	0.21
2610	Glass and glass products	N/A	0.09	0.56	0.21	0.29	0.11	0.23
2691	Pottery, china and earthenware	0.92	0.14	0.12	0.04	0.02	0.10	0.21
2692	Refractory ceramic products	2.20	0.12	0.12	0.04	0.04	0.06	0.18
2693	Struct.non-refractory clay; ceramic products	2.00	0.11	0.01	0.00	0.01	0.06	0.19
2694	Cement, lime and plaster	N/A	0.10	0.04	0.01	0.07	0.01	0.10
2695	Articles of concrete, cement and plaster	8.70	0.10	0.00	0.00	0.02	0.14	0.31
2696	Cutting, shaping & finishing of stone	1.00	0.08	0.00	0.03	0.04	0.12	0.27
2699	Other non-metallic mineral products n.e.c.	2.30	-0.09	0.08	0.13	0.09	0.05	0.15
2710	Basic iron and steel	8.10	0.06	0.36	0.30	3.24	0.12	0.40
2720	Basic precious and non-ferrous metals	6.20	0.02	0.31	0.37	2.05	0.02	0.09
2731	Casting of iron and steel	6.30	-0.07	0.35	0.30	3.24	0.12	0.40
2732	Casting of non-ferrous metals	2.70	0.12	0.17	0.30	3.24	0.12	0.40
2811	Structural metal products	3.60	0.60	0.27	0.02	0.01	0.30	0.56
2812	Tanks, reservoirs and containers of metal	1.40	0.37	0.05	0.20	0.85	0.22	0.55
2813	Steam generators	1.90	0.30	0.07	0.17	0.85	0.17	0.50
2891	Metal forging/pressing/stamping/roll-forming	2.10	-0.07	0.39	0.36	2.70	0.11	0.34
2892	Treatment & coating of metals	2.00	-0.07	0.10	0.27	0.85	0.31	0.63
2893	Cutlery, hand tools and general hardware	0.98	0.51	0.23	0.12	0.16	0.29	0.50
2899	Other fabricated metal products n.e.c.	2.10	0.01	0.36	0.27	0.85	0.31	0.63
2911	Engines & turbines (not for transport equip.)	1.00	-0.01	0.80	0.33	0.43	0.16	0.51
2912	Pumps, compressors, taps and valves	1.80	0.05	0.24	0.03	0.38	0.17	0.65
2913	Bearings, gears, gearing & driving elements	1.90	0.44	0.78	0.05	0.21	0.23	0.61

Source: ERP is from Jongwanich & Kohpaiboon (2007), while the others are measured by the author, based on the industrial census 2012 and IO Table 2010.

Note: The unit of *LP* is million THB per worker per year, while the unit of the others is ratio.

Table Appendix B.1 (Continue)

The measured values of the industry's key variables of Thai manufacturing

ISIC	Industry	*LP*	*ERP*	*FOR*	*BACK_std*	*BACK_alt*	*FORW_std*	*FORW_alt*
2914	Ovens, furnaces and furnace burners	N/A	N/A	N/A	0.17	0.69	0.17	0.44
2915	Lifting and handling equipment	3.20	0.27	0.43	0.17	0.85	0.17	0.50
2919	Other general-purpose machinery	3.40	0.16	0.55	0.03	0.47	0.16	0.67
2921	Agricultural and forestry machinery	N/A	0.26	0.83	0.00	0.02	0.19	0.56
2922	Machine tools	1.40	0.07	0.22	0.24	0.28	0.14	0.55
2923	Machinery for metallurgy	1.50	0.24	0.12	0.17	0.85	0.17	0.50
2924	Machinery for mining & construction	21.00	0.26	0.16	0.17	0.85	0.17	0.50
2925	Food/beverage/tobacco processing machinery	8.40	0.06	0.06	0.17	0.85	0.17	0.50
2926	Machinery for textile, apparel and leather	1.10	0.12	0.76	0.03	0.47	0.16	0.67
2927	Weapons and ammunition	N/A	N/A	N/A	0.21	0.46	0.15	0.25
2929	Other special purpose machinery	1.40	0.12	0.20	0.20	0.85	0.22	0.55
2930	Domestic appliances n.e.c.	5.70	0.21	0.59	0.04	0.45	0.17	0.68
3000	Office, accounting and computing machinery	3.10	0.13	0.18	0.02	0.42	0.16	0.68
3110	Electric motors, generators and transformers	1.70	0.13	0.58	0.29	0.35	0.14	0.58
3120	Electricity distribution & control apparatus	1.30	0.15	0.23	0.16	0.49	0.14	0.38
3130	Insulated wire and cable	1.60	0.24	0.21	0.26	0.14	0.27	0.38
3140	Accumulators, primary cells and batteries	2.50	-0.15	0.71	0.30	0.07	0.19	0.35
3150	Lighting equipment and electric lamps	1.70	0.11	0.72	0.16	0.49	0.14	0.38
3190	Other electrical equipment n.e.c.	1.50	0.17	0.31	0.16	0.49	0.14	0.38
3210	Electronic valves, tubes, etc.	N/A	0.10	0.59	0.18	1.51	0.04	0.31
3220	TV/radio transmitters; line comm. apparatus	0.60	0.11	0.06	0.18	1.51	0.04	0.31
3230	TV and radio receivers and associated goods	2.90	0.11	0.35	0.18	1.51	0.04	0.31
3311	Medical, surgical and orthopaedic equipment	3.00	0.05	0.49	0.07	0.11	0.07	0.38
3312	Measuring/testing/navigating appliances, etc.	2.50	0.11	0.52	0.07	0.11	0.07	0.38
3313	Industrial process control equipment	1.20	0.05	0.39	0.19	0.22	0.18	0.28
3320	Optical instruments & photographic equipment	1.50	0.16	0.57	0.04	0.02	0.21	0.33
3330	Watches and clocks	2.70	0.00	0.07	0.06	0.01	0.17	0.35
3410	Motor vehicles	N/A	0.36	0.67	0.03	0.12	0.21	0.60
3420	Automobile bodies, trailers & semi-trailers	N/A	0.44	0.13	0.01	0.10	0.21	0.60
3430	Parts/accessories for automobiles	3.70	0.24	0.36	0.01	0.10	0.21	0.60
3511	Building and repairing of ships	N/A	N/A	N/A	0.00	0.01	0.28	0.52
3512	Building/repairing of pleasure/sport. boats	1.40	0.06	0.01	0.00	0.01	0.28	0.52
3591	Motorcycles	2.30	-0.21	0.88	0.00	0.00	0.24	0.62
3592	Bicycles and invalid carriages	N/A	N/A	N/A	0.00	0.00	0.24	0.62
3599	Other transport equipment n.e.c.	N/A	0.42	0.00	0.19	0.22	0.18	0.28
3610	Furniture	2.00	0.00	0.20	0.16	0.02	0.14	0.20
3691	Jewellery and related articles	1.40	0.18	0.27	0.00	0.02	0.12	0.30
3692	Musical instruments	N/A	0.21	0.55	0.05	0.01	0.17	0.29
3693	Sports goods	N/A	-0.01	0.65	0.05	0.01	0.17	0.29
3694	Games and toys	0.92	0.07	0.24	0.19	0.22	0.18	0.28
3699	Other manufacturing n.e.c.	4.10	0.05	0.18	0.19	0.22	0.18	0.28
7220	Research and experimental development on social sciences and humanities	N/A	N/A	0.26	N/A	N/A	N/A	N/A
7240	Database activities	N/A	N/A	0.22	0.09	1.38	0.07	0.19
7250	Maintenance and repair of office, accounting and computing machinery	N/A	N/A	0.90	0.16	0.09	0.37	0.87
9000	Creative, arts and entertainment activities	N/A	N/A	0.00	0.11	0.06	0.14	0.13

Source: ERP is from Jongwanich & Kohpaiboon (2007), while the others are measured by the author, based on the industrial census 2012 and IO Table 2010.

Note: The unit of *LP* is million THB per worker per year, while the unit of the others is ratio.

APPENDIX C

Reduced-form Equation and Instrument Variables

The literature examining the presence of FDI spillovers is often criticized in view of the possibility of simultaneity problem interference. In particular, the positive relationship between foreign presence and firms' productivity (i.e. FOR_j and Y_{ij}) might reflect the fact that foreign affiliates prefer to invest in highly productive industries, rather than representing the presence of FDI technology spillovers (Haddad & Harrison, 1993; and Atiken & Harrison, 1999). As a result, a suspected simultaneity problem not only impacts on the coefficient corresponding to FOR_j, but also FOR_jTP_j, $BACK_j$, and $FORW_j$. This is because the last three variables are measured by incorporating the foreign presence variable (FOR_j). In this study, the possibility of simultaneity bias is mitigated by replacing suspected endogenous variables (i.e. FOR_j, FOR_jTP_j, $BACK_j$ and $FORW_j$) with instrumental variables (IV). Thus, instruments for reduced-form equation are needed to support exploration. There are four factors which have been widely used in previous empirical studies on FDI determinants. Specifically, FOR_j is a function of market size, tariff barrier, labor quality and the intensity of inter-industry trade.

Since one of the objectives of FDI in developing countries is to encourage the reaping of benefit from the domestic market, market size ($MSIZE_j$) often determines foreign presence (Sahoo, 2006). Thus, it is likely that an industry with a larger market size would be able to attract more FDI, because of enhanced business opportunities (Wang & Swain, 1995; and Moore, 1993). Consequently, $MSIZE_j$ represents the first independent variable in the reduced-form equation employed.

As argued by Lim (2001), the presence of FDI may be determined by the prevailing trade policy regime. In particular, horizontal FDI, which is undertaken in order to promote trade berries (i.e. tariff-hopping), may decline with tariff reduction. In contrast, vertical FDI may increase with the reduction of tariffs, since vertical FDI often requires a substantial flow of intermediate inputs across a country. Moreover, non-tariff-hopping horizontal FDI may be stimulated to the extent that trade liberalization

could lead to a better business climate, as well as more optimistic expectations of improved long-term economic growth prospects and increasing market size. Consequently, TP_j is included as the independent variable in the reduced-form equation. Furthermore, it is likely that the statistical relationship between FOR_j and TP_j is not linear. As a result, the model would more accurately explain the foreign presence by incorporating the squared term of TP_j. Hence, both TP_j and TP_j^2 are added in the model.

Nonetheless, either $MSIZE_j$ or TP_j alone might not be significant in attracting FDI, especially in a small open economy like Thailand (Kohpaiboon, 2006b). It is more appropriate to add an interaction term ($MSIZE_jTP_j$) to capture the impact of both factors. Specifically, at a given level of tariff barrier, a larger market could potentially enhance the stimulating impact of tariff protection on any foreign presence. In Thailand market size might not be large enough to attract a MNE to locate its affiliate and substitute international trade for investment. That is, the impact of market size on FDI determinants depends positively on tariff barriers.

Furthermore, when multinational firms expand their affiliations in a small economy, they not only consider market size, but also the intensity of inter-industry trade. In particular, foreign affiliates have to ensure that there are plenty of suppliers in upstream industries producing the intermediates needed in their production processes. On the other hand, they also need to make sure that there are sufficient corporate customers in downstream industries demanding their output. As a result, such multinational firms also have to take the attractiveness of upstream and downstream industries into consideration. Therefore, the interaction terms between market size and intensity of inter-industry trade (i.e. $MSIZE_jBACKM_j$ and $MSIZE_jFORWM_j$) are needed in the reduced-form equation. Similarly, the intensity of inter-industry trade is able to be be ascertained by either the measures of Javorcik (2004) or the measures of Kohpaiboon & Jongwanich (2013). The first measure is able to capture the intensity of the directly inter-industry trade only, while the second is able to include the intensities of both direct and indirect inter-industry trade.

Regarding the first tool, standard measures represent the proxies for inter-industry trade. On the one hand, $BACKM\_std_j$ is intended to capture the intensity of

the directly inter-industry trades between industry j and suppliers in upstream industries:

$$BACKM\_std_j = \sum_{m\ if\ m \neq j} \sigma_{jm} \tag{11}$$

where σ_{jm} is the proportion of intermediate output produced by sector *m*, which are purchased by sector *j*, i.e. the same proportion as of the equation (5).

On the other hand, $FORWM\_std_j$ captures the intensity of the directly inter-industry trade in which intermediate output produced by a particular industry *j* supplied to other downstream industries:

$$FORWM\_std_j = \sum_{k\ if\ k \neq j} \alpha_{jk} \tag{12}$$

where α_{jk} is the proportion of sector *j*'s intermediate output supplied to sector *k*, i.e. the same proportion as of the equation (6).

The intensity of inter-industry trade could be alternatively measured by applying a Leontief domestic inverse (LDI) matrix, i.e. equations (9) and (10). This measurement is able to capture both the intensities of the direct and indirect inter-industry trade. On the one hand, $BACKM\_alt_j$ aims to capture the intensity of both the direct and indirect inter-industry trade between industry *j* and suppliers in upstream industries:

$$BACKM\_alt_j = \sum_{m\ if\ m \neq j} \varphi_{jm} \tag{13}$$

where φ_{mj} is an element in a column vector *j* in the LDI matrix, $(1 - A^d)^{-1}$ in the equation (7), which indicates demand for industry *m*'s output to be used as input for producing a unit of industry *j*'s output

On the other hand, $FORWM\_alt_j$ aims to capture the intensities of both the direct and indirect inter-industry trade between industry *j* and corporate customers in downstream industries:

$$FORWM\_alt_j = \sum_{k\ if\ k \neq j} \delta_{jk} \tag{14}$$

where δ_{jk} is an element in a row vector *j* of the LDI matrix, $(1 - A^d)^{-1}$ in equation (8), which indicates the amount of industry *j*'s output demanded by an additional unit of industry *k*'s output produced, i.e. the derived demand for industry *j*'s output from industry *k*'s output produced

Several studies within the FDI determinant literature hypothesize that the quality of labor will encourage efficiency-seeking FDI inflows, particularly in cases of MNEs locating their affiliates in order to access not only cheaper and better quality raw material, but also less costly labor with the prerequisite high quality standards necessary to enhance productivity. Hence, this study also incorporates such a hypothesis by incorporating labor quality (QL_j) into the reduced-form equation. Additionally, similar to the structural equation, there are industry-specific characteristics, which could determine the degree of foreign presence within a domestic economy. To do that, this study has conducted a regression model of foreign presence and introduced a industry binary-dummy based on the ISIC four-digit classification. As a consequence, this study defines and incorporates two industry binary-dummies (i.e. ISIC2921 and ISIC3591) into the reduced-form equation. All in all, the reduced-form equation is specified as:

$$\left|FOR_j, FOR_jTP_j, BACK_j, FORW_j\right| = \pi_0 + \pi_1 MSIZE_j + \pi_2 TP_j + \pi_3 TP_j^2 + \pi_4 MSIZE_j TP_j + \pi_5 MSIZE_j BACKM_j + \pi_6 MSIZE_j FORWM_j + \pi_7 QL_j + INDR_j + \nu_j$$

where

$MSIZE_j$ = Market size of the industry *j* measured by the sum of gross output and (net) imports,

TP_j = Trade policy regime in industry *j* proxied by ERP

$BACKM_j$ = The intensity of inter-industry trade between industry *j* and suppliers in upstream industries, alternatively proxied by $BACKM\_std_j$ and $BACKM\_alt_j$

$FORWM_j$ = The intensity of inter-industry trade between industry j and customers in downstream industries, alternatively proxied by $FORWM\_std_j$ and $FORWM\_alt_j$

QL_j = Labor quality of the industry j proxied by the ratio of supervisory and management workers to total industry management,

$INDR_j$ = The set of industry binary-dummies of ISIC2921 and ISIC3591 incorporated into the reduced-form equation,

v_j = A stochastic error term representing the other influences omitted in the reduced-form equation.

BIOGRAPHY

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Publications

Tantratananuwat, P. (2015). Vertical and Horizontal FDI Technology Spillovers in Thai Manufacturing: Does Measurement Matter? *The WEI International Academic Conference Proceedings June 8 – 10, 2015 in Harvard University, USA, 128 – 153.*

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July 2015 – December 2015:
Business Analyst (Outsourced)
Sasin Management Consulting

May 2014 – June 2015:
Case Team Assistant
Bain & Company

April 2014 – May 2014:
Research Assistant
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Awards

September 2013 - February 2014:
Young Financial Star Competition 2013
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- 1st prize: Muang Thai Insurance Star
- 1st prize: TFEX Derivative Star Team