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Joining the supply chain: A firm-level perspective from Southeast Asia

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Joining the Supply Chain: A Firm-Level Perspective from Southeast Asia

Ganeshan Wignaraja

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INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS

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Abstract

This paper undertakes a comparative, firm-level analysis of joining the supply chain in five Southeast Asian economies to improve our understanding of fragmentation of manufacturing across borders. The research maps supply chains and conducts firm-level econometric analysis on 5,900 enterprises. The findings suggests that firm size (reflecting economies of scale to overcome entry costs) matters for joining supply chains with large firms playing the dominant role in Southeast Asian economies. Meanwhile, small and medium enterprises (SMEs) make a small contribution to supply chain activity relatively to the sectors employment or GDP contribution in South East Asian economies. However, firm size is not the whole story. Efficiency – particularly investment in building technological capabilities and skills – and access to commercial bank credit also influence joining supply chains. The paper suggests that governments can facilitate SMEs joining supply chains through a market-oriented strategy for SMEs, modern physical infrastructure, streamlined bureaucratic procedures and good quality business support services.

JEL Classification: *F1, F2, F21, F23, F43, L25, and O31*

Keywords: *Global supply chains, firm-level analysis, firm size, SMEs, technological capabilities, access to finance, policy and business environment, South East Asia*

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Opinions and recommendations in the paper are exclusively of the author(s) and not of any other individual or institution including ICRIER

Joining the Supply Chain:
A Firm-Level Perspective from Southeast Asia

Ganeshan Wignaraja*

1. Introduction

Global production networks and supply chains (hereafter, supply chains) have transformed Asia in recent decades (Baldwin 2013). Joining supply chains has been a fast-track route for some Asian economies to industrialize and achieve unprecedented prosperity. Adopting outward-oriented policy reforms have facilitated entry into supply chains. Rising inequality is a problem in Asia and greater participation of small and medium-sized enterprises (SMEs) in supply chains supports more inclusive growth (Lim and Kimura 2010). Increasing attention has focused on measuring the magnitude of supply chain trade through trade in parts and components and trade in value added (e.g., Ng and Yeats 2003; Athukorala 2011; Koopman et al. 2010; and WTO and IDE-JETRO 2011). However, little micro-level work exists on supply chains in Asia.[1] The behavior of large firms and SMEs in supply chains in Asia thus largely remains a mystery.

This paper studies the supply chain from the unique micro-level perspective of the firm. It undertakes a comparative and firm-level analysis of factors influencing joining supply chains in Southeast Asian economies. The research aims to improve our understanding of the micro-level behavior of firms in supply chains and contribute to the handful of empirical studies on Asia. The main focus of the research is a firm-level econometric investigation of why some firms have been better able to join supply chains than others. This investigation draws on recent literature emphasizing the notion of heterogeneity of firms and highlights key enterprise characteristics (e.g., firm size, technological capabilities, skills, and access to finance) underlying success. The research also maps supply chains in Southeast Asian economies by firm size at the national and enterprise levels and explores the role of the business environment in shaping enterprise behavior.

The absence of cross-country firm-level data was previously a binding constraint on micro-level research on supply chains in Asia. This research benefitted from access to a large cross-sectional enterprise dataset from the World Bank. It covers 5,900 firms in five economically important outward-oriented Southeast Asian economies (Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam).

The paper is organized as follows. Section 2 reviews the literature and formulates hypotheses for empirical testing. Section 3 sets out the empirical methodology. Section 4 maps supply chains by firm size. Section 5 presents econometric results. Section 6 explores the role of the

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policy and business environment. Section 7 concludes. The enterprise dataset is described in Appendix 1.

2. Literature Review

An established body of trade, industrial organization, and technology literature points to the overwhelming importance of firm-specific factors, on which competitive advantages are built. As background to this research of the role of firms in supply chains, key aspects of the theoretical and empirical literature are discussed here.

2.1 Theory

Several strands of literature can explain trade and supply chain activity of firms, which is the focus of this paper. The so-called fragmentation of production approach—found in seminal work by Jones and Kierzkowski (1990) and Arndt and Kierzkowski (2001)—has become the standard framework for international economists to study supply chains. It shows how increasing returns and the advantages of specialization of factors within firms encouraged the location of different stages of manufacturing production across geographical space connected by service links. Products traded between firms in different countries are components rather than final goods. Papers by Kimura and Ando (2005) and Baldwin (2013) are among those that develop conceptual explanations as to why fragmentation trade occurs. Meanwhile, Low (2013) points out that the role of services in production and trade has been understated and that this has become a greater problem with the growth of supply chains.

Competing methods have been used to quantify the magnitude of fragmentation trade. One uses national trade data obtained from the United Nations trade data reporting system to identify trade in parts and components (e.g., Ng and Yeats 2003; Athukorala 2011) which are used as a proxy for supply chain trade. It shows that East Asia's trade is increasingly made up of parts and components trade, which suggests that global supply chains are growing in importance in Asia. Within East Asia, the People's Republic of China (PRC) has been the major driving force but Southeast Asian economies have grown faster than the regional average.[2] More industrially developed economies such as Malaysia and Thailand are more prominent in supply chain trade than other Southeast Asian economies. Another more innovative method—relying on input–output tables to trace value added in production networks—suggests that value added seems a more accurate means of capturing supply chain activity in Asia than trade data (e.g., Koopman et al. 2010; and WTO and IDE-JETRO 2011). Both methods are widely used to chart trends in supply chain trade, but their findings require careful interpretation. However, neither method highlights factors affecting firms joining supply chains. Case studies show that micro-level factors matter in supply chains. In particular, case studies suggest that large multinational corporations, which use the region as an international production base, drive the process of production fragmentation (Kuroiwa and Heng 2008; Kuroiwa 2009).

Other theoretical approaches have focused on the role of firms in international trade. The neo-Heckscher–Ohlin model and Vernon's concept of the product cycle provided the early rationale for studies highlighting the importance of firm-specific advantages (i.e., differences in skills, technologies, and tastes) in the operation of industry-level determinants of comparative advantage (e.g., Lall 1986; Wilmore 1992; and Wakelin 1998). More recently, the "new new" trade theory of Melitz (2003) and Helpman, Melitz, and Yeaple (2004) emphasized firm heterogeneity in international trade (i.e., that firms are considered different in terms of efficiency and fixed and variable costs when involved in trade). Accordingly, only a few highly efficient firms are able to export and invest overseas as they are able to make sufficient profit to cover the large trade costs required for overseas operations.
The technological capability and national innovation systems approach reveals a different channel through which firm behavior affects export performance. Focusing on innovation and learning processes in developing countries, studies emphasize the acquisition of technological capabilities as a major source of export advantage at the firm level (Bell and Pavitt 1993; Lall 1992; Wignaraja 2002; Iammarino, Padilla-Perez, and von Tunzelmann 2008). The underlying evolutionary theory of technical change emphasizes that difficult firm-specific processes and complex interactions with institutions are needed to absorb imported technologies efficiently (Nelson and Winter 1992).

Combining the fragmentation of production approach with firm-level approaches to international trade provides additional insights for supply chains. Technology and know-how are key enablers of supply chains. Furthermore, firm heterogeneity (or firm-specific advantages) is important to explaining successful entry into supply chains. In essence, the self-selection hypothesis applies whereby better firms are more able to join supply chains than other firms. Firm size is an important aspect of being a better firm but not the whole story. Implicit in most of the above theories is the notion that SMEs are at a disadvantage in participation in supply chains compared with large firms. SMEs face, to a higher extent than large firms, resource constraints (in terms of finance, information, management capacity, and technological capability).[3] In addition, SMEs suffer disproportionately from external barriers such as market imperfections and regulations. Accordingly, the probability of SMEs joining supply chains (as direct exporters or indirect exporters) is lower than that of large firms. Thus, justification exists for public policies to support the entry of SMEs in supply chains and exports. In the main, such support should be geared toward an enabling environment that opens access to markets, reduces bureaucratic impediments against SMEs, and provides appropriate SME institutional support services (e.g., technological, marketing, and financial support).

2.2 Empirical Studies and Hypotheses

There is a growing econometric literature on the relationship between firm size and exports at the enterprise level (see, e.g., Kumar and Siddharthan 1994; Zhao and Li 1997; Wignaraja 2002 and 2012; Hollenstein 2005; and Srinivasan and Archana 2011). There have also been econometric studies of SMEs and exports (e.g., Lefebvre and Lefebvre 2001). A very few recent econometric studies have begun to explicitly look at the link between firm size and

supply chains (e.g.,Harvie 2010; Harvie, Narjoko, and Oum 2010; Kyophilavong 2010; Tranh, Narjoko and Oum 2010; and Rasiah, Rosli, and Sanjivee 2010). The notion of firm heterogeneity receives broad support from empirical work. Several studies report that the characteristics of firms vary widely within industries and across countries. Firms that are involved in exports or supply chains are larger, more efficient, and have higher levels of skills than other firms.

However, this empirical literature has some limitations. First, scant coverage of countries and sectors was attempted. Typically, studies have looked at a single country and a specific sector within manufacturing (e.g., electronics) rather than multiple countries and multiple sectors.[4] Second, with the exception of van Dijk (2002), most work uses small samples of less than 1,000 firms. It is thus difficult to generalize their findings. Third, two studies deal exclusively with SMEs in supply chains,[5] but no studies compare the characteristics of large exporters with SME exporters or SME exporters with indirect SME exporters.

Our study attempts to remedy these gaps in the empirical literature. It covers five Southeast Asian economies (Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam) and a wide range of industrial sectors. Second, the dataset used here is large, comprising 5,900 manufacturing enterprises (including 70% SMEs), which were randomly selected using a comprehensive questionnaire (see Appendix 1). Third, the analysis is based on two alternative econometric models: one for all firms in supply chains (direct and indirect exporters) and one for sustained exporters only. Each model was estimated separately for all manufacturing firms and SMEs.

Relevant studies will be mentioned below to formulate hypotheses for empirical testing in this study.

Firm size. Most studies are based on the conventional assumption that large firms are more competitive than SMEs in international markets (see Zhao and Li 1997; van Dijk 2002; and Srinivasan and Archana 2011). A positive relationship between size and exports has thus been reported. Similar arguments can be made about participation in supply chains through direct and indirect exporting. Owing to scale economies, larger firms may have lower average and marginal costs, which would increase the probability of participation in supply chains. Furthermore, large firms have more resources to meet the fixed costs of entry into supply chains (e.g., information, marketing, and technology expenses). A few studies, however, report no relationship or a negative one. This conflicting result can be partly attributed to the nonlinear nature of this relationship (Kumar and Siddharthan 1994; Lefebvre and Lefebvre 2001). It may be that economies of scale and fixed costs are significant in the early stages of joining production networks but less relevant in the longer term. For instance, SMEs may join together in industrial clusters and collectively overcome the disadvantage of firm size. Alternatively, some SMEs might concentrate on niche markets and emerge as leading enterprises with branded products.

As a result of the above discussion, the following hypothesis is proposed: *Hypothesis 1—firm size is expected to have a positive effect on participation in supply chains up to a given threshold, but may not matter later on*.

Technological capabilities. Empirical studies indicate that firm-level technological capabilities contribute to export performance (Zhao and Li 1997; Hobday 2001; Rasiah 2004; Wignaraja 2002, 2011, and 2012). Building technological capabilities in developing country firms, particularly SMEs, is not just a simple function of years of production experience. Rather, it requires conscious investments in creating skills and information to operate imported technology efficiently. Such investments involve a spectrum of technological activities, such as technology search, quality management, engineering, and research and development (R&D) activities (Kumar and Siddharthan 1994; Lefebvre and Lefebvre 2001). Importing technology through foreign licenses is an important mechanism for transfer of new technologies and internal capability building. Furthermore, foreign buyers and subcontractors view internal quality standards (e.g., International Organization for Standardization [ISO] certification) as increasingly compulsory for enterprises to qualify as potential suppliers. Developing new products (or modifying existing products) and taking out patents to protect intellectual property rights also facilitate export competitiveness at the firm level.

These considerations suggest: *Hypothesis 2—firms that have acquired high levels of technological capabilities are more likely to succeed in supply chains*.

Human capital. Within a given activity, a higher level of human capital contributes to a firm's export performance. Higher levels of human capital are generally linked with development of more effective business strategies and more rapid technological learning that can provide a competitive edge at the enterprise level (van Dijk 2002; Dueñas-Caparas 2006). Enterprises with a stock of high-quality human capital are expected to be more likely to perform well in supply chains as this is essential for forging close supplier relationships with large exporters, effective technology transfer, and efficient production of orders (Harvie, Narjoko, and Oum 2010). Although human capital at all levels is important, workers' education and that of the chief executive officer (CEO) and his or her experience are particularly significant for participation in supply chains. A literate workforce made up of high school graduates is more productive and adaptive to new technology than one that is not. Furthermore, a CEO with a college degree or vocational training as well as work experience may have a better business attitude (i.e., in terms of risk taking or willingness to implement new business ideas). In SMEs, with few high school-educated workers, much of the firm's human capital may be reflected in the quality of the CEO's education and experience.

Accordingly, the following could be said: *Hypothesis 3—higher levels of human capital, in terms of secondary level educated workers or well-educated and experienced CEOs, are positively correlated with joining supply chains.*

Age. A learning by doing effect may be at work. The older the firm, the more accumulated experience in production and tacit knowledge, which is likely to facilitate participation in

supply chains. Alternatively, a technology lock in effect may apply whereby mature firms may become complacent with an overreliance on accumulated experience and set in past ways. Meanwhile, younger firms may be at an advantage in joining supply chains for two reasons. First, younger enterprises may use relatively modern technology, which increases productivity and product quality (van Dijk 2002). Second, they may be more proactive in learning about business and technological opportunities in supply chains. For instance, younger firms may be more nimble in seeking out new sources of information and external knowledge, such as market information from buyers of output or technical know-how from equipment suppliers. Younger firms may be more flexible in combining external and internal information to realize opportunities in supply chains.

Bearing in mind these different possibilities, the following hypothesis is put forward: *Hypothesis 4—firm age needs to be controlled for when looking for relationships between factors affecting firm-level participation in supply chains*.

Foreign ownership. A joint venture with a foreign partner (or 100% foreign equity) facilitates participation in supply chains, as it enables firms to reap the ownership advantages of parent companies (Wilmore 1992; Nguyen and Nishijima 2009; Srinivasan and Archana 2011). First, access to the superior marketing connections and know-how of parent companies enables direct and indirect exporting. Second, access to parent companies' accumulated learning experience of export production as well as access to sophisticated technologies and management experience improves technical efficiency. The transfer of such ownership-specific advantages depends on whether the foreign firm has a controlling interest in the domestic venture. A controlling interest typically can occur with minority foreign equity in a project rather than total foreign equity. In most of the previous literature on firm-level exporting and participation in supply chains, it has been consistently observed that foreign ownership matters.

These arguments lead to the following proposition: *Hypothesis 5—foreign ownership is positively related to participation in supply chains because it provides access to superior marketing, technology, and management expertise*.

Access to credit. Access to credit for working capital and investment is typically a binding constraint on the involvement of firms in supply chains (Harvie, Narjoko, and Oum 2010). Capital markets in developing countries are highly segmented into a formal bank sector and informal sources due to various market imperfections associated with underdevelopment. Credit from commercial banks is usually cheaper than finance from informal credit sources but requires substantial information about balance sheets and collateral. Many firms (including SMEs) find it difficult to provide the requisite financial information and collateral and instead rely on internally generated funds or more expensive informal sources. This puts them at a cost disadvantage compared to well-organized firms with an established record with commercial banks.

The following hypothesis emerges: *Hypothesis 6—enterprises with access to bank credit are more likely to join supply chains than other firms*.

3. Empirical Methodology

In order to examine the firm-level characteristics shaping all manufacturing firms' and SMEs' joining supply chains, the following general equation is estimated:

$$\boldsymbol{Y} = \beta \boldsymbol{X} + \boldsymbol{\varepsilon}, \qquad (1)$$

where $\boldsymbol{Y}$ is the vector denoting joining supply chains at the firm level, $\boldsymbol{X}$ is the matrix of explanatory variables, β is the matrix of coefficients, and $\boldsymbol{\varepsilon}$ is the matrix of error terms.

Joining supply chains is captured by a binary variable reflecting different activities by firms in such networks, particularly SMEs. The probit model in two alternative forms was used here. In the first, the dependent variable takes a value of 1 if a firm undertakes any form of activity in a supply chain (i.e., as an exporter, an indirect exporter, or some combination of the two) and 0 for a wholly domestic market-oriented firm. In the second, the dependent variable is 1 if the firm's primary mission is to export (defined as more than total sales being exported globally) and 0 otherwise.

The first captures all involvement of firms in supply chains regardless of the intensity of exporting or indirect exporting behavior (subcontracting or input supply) of a given firm. While this definition is inclusive, it encompasses a range of participation in supply chains from occasional and limited involvement of firms to more sustained involvement. Accordingly, the second was formulated to represent a more focused mission of sustained involvement in supply chains through exports. It is interesting to examine whether the determinants are the same for both models. Our approach refines previous work which did not distinguish between different activities undertaken by SMEs in production networks.[6]

The hypotheses were described in section 2. The explanatory variables in $\boldsymbol{X}$ in equation (1) are described in the following and Table 1 includes a summary.

Table 1: Description of Variables

Variable	Description
Independent	
Size	No. of permanent workers
Size squared	Square of the no. of permanent workers
SME	Firm has less than 100 employees (1–99)
Foreign license	1 if firm uses technology licensed from foreign-owned company (excluding software); 0 otherwise
ISO	1 if firm has a form of internationally-agreed certification (e.g., ISO 9000, ISO 9002); 0 otherwise
Patent	1 if firm has registered a patent; 0 otherwise
Age	No. of years in operation
Workers HS	1 if average production worker has HS education; 0 otherwise
GM primary	1 if GM/CEO's highest level of education is primary school; 0 otherwise
GM secondary	1 if GM/CEO's highest level of education is HS; 0 otherwise
GM vocational	1 if GM/CEO's highest level of education is vocational; 0 otherwise
GM college	1 if GM/CEO's highest level of education is college; 0 otherwise
GM experience	No. of years of work experience of the GM/CEO
Foreign ownership	1 if firm has foreign ownership; 0 otherwise
Access to credit	1 if firm has credit line/loan from financial institution; 0 otherwise
Indonesia	1 if firm is located in Indonesia; 0 otherwise
Malaysia	1 if firm is located in Malaysia; 0 otherwise
Philippines	1 if firm is located in the Philippines; 0 otherwise
Thailand	1 if firm is located in Thailand, 0 otherwise
Viet Nam	1 if firm is located in Viet Nam; 0 otherwise
Dependent	
1. All firms in supply chains	1 if more than 0% of sales are exported (directly or indirectly); 0 otherwise
2. Sustained exporter	1 if more than 40% of sales are directly exported; 0 otherwise

CEO = chief executive officer, GM = general manager, HS = high school, ISO = International Organization for Standardization, SMEs= small and medium-sized enterprises,

Firm size is represented by the number of employees. This is commonly used in empirical work as other measures such as value added or output are more susceptible to variations in macroeconomic conditions. To provide additional insights, a size-squared variable was also added to some of the models.

Technological capabilities are represented by several variables: (i) a dummy variable which is 1 if a firm has a technology license; (ii) a dummy variable which is 1 if a firm has a form of internationally agreed quality certification (e.g., ISO 9000 or 9002); and (iii) a dummy variable which is 1 if a firm has registered a patent. The three chosen variables were the only technology variables included in the dataset for Indonesia the Philippines, , and Viet Nam. Accordingly, these were included individually in the regressions and a composite technology index could not be constructed.[7]

Age is represented by the number of years in operation of the firm. This is more accurate than number of years since establishment as there can be a lag between the legal incorporation of a firm and the start-up of plant operations.

Human capital is proxied by the following variables:[8] (i) a dummy variable which is 1 if the average production worker has high school education; (ii) four dummy variables to capture different levels of educational attainment of the CEO from primary schooling to college education; and (iii) the number of years of work experience of the CEO. In line with the hypothesis on human capital, these variables attempt to capture the average quality of education of workers and the CEO. In addition, the CEO's experience is included.

Foreign ownership is captured by a dummy variable which takes a value of 1 if the firm has any foreign equity. The standard measure—share of foreign equity—seems to suffer from some noise and may be correlated with number of employees.

Access to credit is proxied by a dummy variable which is 1 if a firm has a credit line or loan from a formal financial institution.

In addition, four country dummy variables were included to capture country-specific effects of the five Southeast Asian economies.

4. Mapping Supply Chains by Firm Size

4.1 Insights from National Data and Problems

Research on firm size in Southeast Asian economies is scarce and sometimes contentious. A major problem facing such research is the dearth of data at the sectoral level and the use of different definitions of SMEs (e.g., turnover, employment, assets, etc.). Appendix 2 shows the definitions of SMEs in Southeast Asia and other economies. In Thailand and Viet Nam, SMEs are defined by broad economic sectors and assets or employees. Malaysia defines SMEs by broad economic sectors and turnover or employees. Indonesia uses only assets or turnover, while the Philippines relies only on assets. A further problem is that assets or turnover are expressed in national currencies and the firm size thresholds are not comparable when converted into US dollars. These problems make it difficult to reliably compare the role of SMEs across Southeast Asian economies over time. As a crude approximation, studies (e.g., Harvie and Lee 2002; Tambunan 2009; Lim and Kimura 2010) have typically used national SME definitions to compute the share of SMEs in employment, gross domestic product (GDP), and exports in Southeast Asian economies for the most recent year. The balance shares of economic aggregates are attributed to large firms. The SME shares of exports can be used as an indication of the sector's involvement in supply chains.

Following this approach, Table 2 provides most recent estimates of economic activity by firm size for the five Southeast Asian economies in this study and for other selected economies

(the PRC, Germany, the Republic of Korea, Japan and the US). Several interesting findings emerge.

First, on average, SMEs account for the majority of national employment in Southeast Asian economies (74.4%) and a notable share of GDP (40.8%). Meanwhile, large firms account for the remainder (25.6% of employment and 59.2% of GDP). Inter-country variations are visible in these figures. Indonesia seems an outlier in Southeast Asia with SMEs accounting for as much as 97.2% of employment and 57.8% of GDP. The figures for the Southeast Asian economies are generally in line with international trends. SMEs make up the majority of employment and about half of GDP in the comparator economies. The US has a much lower SME share of employment than other comparator economies.

Second, SMEs in Southeast Asian economies make relatively little contribution to exports relative to the sector's size or employment contribution. On average, SMEs account for only 20.9% of exports compared to 79.1% for large firms. A comparison with an earlier study by Harvie and Lee (2002) suggests that the figure for SME exports in Southeast Asian economies may have modestly risen over time.[9] It thus appears that SMEs in Southeast Asia play a limited role in supply chains as direct exporters. It is possible, however, that SME export shares in Southeast Asian economies may be understated if indirect exports through subcontracting or input supply are included (Tambunan 2009). Data gaps, however, make it hard to estimate the indirect contribution of SMEs to national exports.

Third, Thailand seems an outlier among the five Southeast Asian economies with a relatively high share of its exports (29.5%) originating from SMEs. The other Southeast Asian economies have notably lower SME export shares. In Indonesia, the figure is particularly low (15.8%).

Fourth, SMEs in more industrialized East Asian economies and other developed economies are more involved in supply chains as direct exporters than in Southeast Asian economies. The data show that as much as 68% of the PRC's exports, 53.8% of Japan's exports, and 30.9% of the Republic of Korea's exports come from SMEs. It seems that room exists for the advancement of SMEs in Southeast Asian economies' exports through supply chains.

National-level data, however, suffer from some important drawbacks from the perspective of this study on enterprise behavior in supply chains. As discussed earlier, no standard definition of firm size exists for national data collection in Southeast Asian economies, which makes cross-country comparisons problematic. Furthermore, national sources on Southeast Asian economies lack data on indirect SME exports (for small firms as input suppliers or subcontractors) and explanatory variables for micro-level econometric analysis of supply chains or exports. To remedy these problems with national data sources, our study was based on information from multi-country, multi-firm surveys collected by the World Bank's Enterprise Surveys. Appendix 1 describes the cross-section dataset of 5,900 enterprises in the five Southeast Asian economies, which was collected in the late-2000s. The absence of cross-country firm-level data has been up to now a binding constraint on such research.

Table 2: Contribution of Large Firms and Small and Medium-Sized Enterprises in Economic Activity, most recent estimates (national data, %)

	Large firms			SMEs			Year[a]	Definition of SMEs
	Share of total employment	Contribution to GDP	Share of total exports	Share of total employment	Contribution to GDP	Share of total exports		
Southeast Asian economies								
Malaysia	41.1	68.1	81.0	58.9	31.9	19.0	Emp 2008, GDP 2010, Exp 2005	Based on industry, number of employees, and turnover
Thailand	22.1	61.3	70.5	77.9	38.7	29.5	2011	Based on industry, number of employees, and total assets
Philippines	39.0	64.3	80.0	61.0	35.7	20.0	Emp/GDP 2011, Exp 2001	Based on total assets
Indonesia	2.8	42.2	84.2	97.2	57.8	15.8	2010	Based on total assets and turnover
Viet Nam	23.0	60.0	80.0	77.0	40.0	20.0	Emp/GDP 2011, Exp 2009	Based on industry, number of employees, and total assets
Average	**25.6**	**59.2**	**79.1**	**74.4**	**40.8**	**20.9**		
Comparator economies								
People's Republic of China	20.0	41.5	32.0	80.0j	58.5	68.0	2009	Based on industry, number of employees, total assets, and turnover
Republic of Korea	12.5	50.6	69.1	87.5	49.4	30.9	Emp/GDP 2011, Exp 2008	Based on industry, number of employees, capital, and turnover
Japan	29.8	50.0	46.2	70.2	50.0	53.8	2009	Based on industry, number of employees, and capital
Germany	21.0	46.2	44.1	79.0	53.8	55.9	Emp/GDP 2010, Exp 2009	Based on the number of employees, turnover, and assets
United States	50.6	54.0[b]	66.3	49.4	46.0[b]	33.7	Emp/Exp 2010, GDP 2008	Based on number of employees

GDP = gross domestic product, SMEs = small and medium-sized enterprises.
[a] Emp: Share of total employment, GDP: Contribution to GDP, Exp: Share of total exports.
[b] percent of private nonfarm GDP in 2008.
Sources:
Malaysia – ASEAN SME Data and Statistics, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
Thailand – ASEAN SME Data and Statistics, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
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4.2 *Findings on Firm Size in Supply Chains*

Table 3 provides data on aspects of the sample firms' overall participation in supply chains for each Southeast Asian economy sample and across the five countries. These include the number of firms in supply chains (i.e., both direct and indirect exporters), large firms in supply chains as a percentage of all large firms, and SMEs in supply chains as a percentage of all SMEs. Table 3 also provides data on export behavior by firm size, including the percentage of exports from large firms and SMEs in total export value as well as the share of the top 25% of SME exporters in terms of export value.

Table 3: Role of Large Firmsa and SMEsb in Supply Chains (firm survey data)

		All Sample Countries	Malaysia	Thailand	Philippines	Indonesia	Viet Nam
(1)	Number of firms in supply chains[c]	2,203	646	619	352	206	380
(2)	Supply chain firms as a percentage of all firms, %	37.3	59.7	59.3	26.9	14.5	36.4
(3)	Large firms in supply chains as a percentage of all large firms, %	72.1	82.4	91.1	51.1	52.0	64.6
(4)	SMEs in supply chains as a percentage of all SMEs, %	22.0	46.2	29.6	20.1	6.3	21.4
(5)	Share of large firms in total exports, %	77.0	71.9	65.3	66.6	90.7	83.2
(6)	Share of SMEs in total exports, %	23.0	28.1	34.7	33.4	9.3	16.8
(7)	Share of top 25% SME exporters in terms of export value, %	85.8	69.9	85.0	78.9	96.3	76.2
(8)	Share of SMEs that are 100% exporters[d]	18.2	14.1	16.4	27.2	15.0	19.2

SMEs = small and medium-sized enterprises.
Notes:

[a] Large firms are defined as firms with 100 or more employees.
[b] SMEs are defined as firms with 1–99 employees.
[c] Number of firms in supply chain includes direct and indirect exporters.
[d] SMEs that don't serve the domestic market.

Source: Author's calculations based on World Bank Enterprise Surveys.

The following can be observed:

- A minority of the sample firms (37.3% of the total) are in supply chains. More developed Southeast Asian economies such as Malaysia and Thailand have particularly high representation in supply chains (nearly 60% of their firms participate). Viet Nam (36.4%) follows. The Philippines (26.9%) and Indonesia (14.5%) have relatively low participation in supply chains.

- Large firms are the major players in supply chains with 72.1% of all large firms participating. Most of the large firms in Malaysia and Thailand are involved in supply chains and over half the large firms in the remaining three countries.

- SMEs are minor players in supply chains as only 22.0% of all SMEs participate. SME participation rates vary considerably across Southeast Asian economies. As much as 46.2% of all SMEs in Malaysia and 29.6% of all SMEs in Thailand are involved in supply chains. In Viet Nam, the figure is 21.4% and in the Philippines 20.1%. Indonesia seems an outlier with only 6.3% of all SMEs involved in supply chains.

- A small fraction of SMEs in supply chains are 100% global exporters. The vast majority of such SMEs engage in either a mix of global exports and indirect exporting, or purely indirect exports. Accordingly, only 18.2% of SMEs in supply chains in all the countries are 100% global exporters. The figures by country are: Malaysia (14.1%), Thailand (16.4%), Philippines (27.2%), Indonesia (15.0%), and Viet Nam (19.2%).

- Large firms (77%) make a larger contribution to exports in all countries compared with SMEs (23%). The country-level pattern of SME export shares is broadly reflective of the picture of SME participation in supply chains. Malaysia (28.1%) and Thailand (34.7%) are among the leaders in terms of SME export shares. The Philippines, unexpectedly, has a similarly high SME export share (33.4%), which may partly reflect the high proportion of SME numbers in the country sample. Viet Nam's SME export share is 16.8%, while Indonesia's is 9.3%.

- SME exports are highly concentrated in a relatively few firms in the Southeast Asian economies: The top 25% of SMEs account for 85.8% of SME exports in all countries. Concentration in the top 25% SME exporters is highest in Indonesia (96.3%). This is followed by Thailand (85.0%), the Philippines (78.9%), Viet Nam (76.2%), and Malaysia (69.9%).

5. Econometric Results

This section examines factors influencing the engagement of firms in supply chains in the five Southeast Asian economies. A probit model was used to estimate equation (1) specified in Section 3 using the two alternative dependent variables but with the same set of

determinants. The results of the probit regressions are shown in Table 4. Column 1 shows the results of the model for all manufacturing firms in supply chains, while the results of sustained exporters are in column 2. The results for SMEs are in columns 3 and 4.

Following diagnostic testing, we first consider the results for all manufacturing firms and then for SMEs. As shown by a higher R^2, the "all manufacturing firms in supply chains" model better fits the outcome data than the "sustained exporters" model. Many of the firm-specific variables are significant, as hypothesized. The coefficient of firm size is positive and significant, as expected, in both models. Adding a size-squared variable in the all manufacturing firms model was useful in clarifying the size effect. The coefficient on size-squared is negative and significant, implying a nonlinear relationship. Thus, it seems that economies of scale and fixed costs are important in the early stages of joining production networks, but less relevant over time as SMEs become important players in their own niche markets or form industrial clusters.

The coefficient on internationally agreed quality certification is positive and significant in both models. Having an internationally agreed quality certificate (like ISO) increases the probability of a firm joining a supply chain. Foreign licenses and registered patents are also significant with the correct sign in the all manufacturing firms model. Accordingly, firms that have acquired higher levels of technological capabilities are more likely to succeed in supply chains.[10] This requires firms to undertake conscious investments in skills and information to operate imported technologies rather than simply learning by doing. Capability building involves a range of technological activities, including actively acquiring new technologies through foreign licenses, implementing international quality standards, and developing new products supported by patent protection.

The firm age variable is negative and significant in both models, thereby contradicting the hypothesized positive sign. While age may be a proxy for many influences, this result suggests that younger firms are likely to be more nimble in learning new market and technological information and more flexible in combining internal and external knowledge in an efficient manner. Both of these traits are likely to facilitate younger firms joining production networks.

Table 4: Probit Estimates

Binary variable: 1 if part of a production network; 0 otherwise

	All manufacturing firms		SMEs only	
	All firms in supply chain	**Sustained exporter**	**All firms in supply chain**	**Sustained exporter**
	All	All	All	All
	[1]	[2]	[3]	[4]
Firm size	0.002***	0.001***	0.012***	0.010***
	(0.000)	(0.000)	(-0.001)	(-0.001)
Firm size squared	-0.000***	-0.000***		
	(0.000)	(0.000)		
Firm uses foreign licenses	0.169***	0.027	0.196***	0.093
	(-0.055)	(-0.061)	(-0.073)	(-0.087)
Firm is ISO-certified	0.403***	0.100*	0.311***	0.144*
	(-0.049)	(-0.053)	(-0.071)	(-0.084)
Firm has registered patents	0.331***	0.063	0.218***	0.055
	(-0.056)	(-0.062)	(-0.073)	(-0.090)
Firm age	-0.004*	-0.009***	-0.004*	-0.011***
	(-0.002)	(-0.002)	(-0.003)	(-0.003)
Workers have HS education	0.181***	0.053	0.255***	0.162**
	(-0.045)	(-0.050)	(-0.059)	(-0.071)
GM has primary education	0.167	0.131	0.329	0.07
	(-0.285)	(-0.365)	(-0.415)	(-0.499)
GM has secondary education	0.372	0.256	0.482	0.086
	(-0.273)	(-0.351)	(-0.404)	(-0.487)
GM has vocational degree	0.516*	0.387	0.538	0.156
	(-0.276)	(-0.354)	(-0.407)	(-0.491)
GM has college degree	0.595**	0.564	0.515	0.159
	(-0.272)	(-0.349)	(-0.403)	(-0.484)
GM's experience	0.003	0.005**	0.003	0.007**
	(-0.002)	(-0.002)	(-0.003)	(-0.003)
Foreign ownership	0.566***	0.533***	0.547***	0.500***
	(-0.050)	(-0.053)	(-0.071)	(-0.081)
Access to credit	0.141***	0.045	0.094*	-0.005
	(-0.042)	(-0.046)	(-0.054)	(-0.066)
Malaysia	0.634***	0.452***	0.841***	0.526***
	(-0.068)	(-0.070)	(-0.094)	(-0.107)
Indonesia	-0.399***	-0.391***	-0.13	-0.322**
	(-0.082)	(-0.091)	(-0.117)	(-0.143)
Philippines	-0.201**	-0.166*	0.260**	0.143
	(-0.080)	(-0.085)	(-0.110)	(-0.126)
Viet Nam	0.156*	-0.099	0.425***	0.06
	(-0.080)	(-0.087)	(-0.112)	(-0.133)
Pseudo-R-squared	0.267	0.178	0.205	0.146
N	5,641	5,641	3,903	3,903

GM = general manger, HS = high school, ISO = International Organization for Standardization, PN = production network, SMEs = small and medium-sized enterprises.

* p<0.1, ** p<0.05, *** p<0.01

Notes:

Robust standard errors in parentheses.

Thailand was used as reference.

All firms in PN: 1 if more than 0% of sales are exported (directly or indirectly); 0 otherwise.

Sustained exporter: 1 if more than 40 % of sales are directly exported; 0 otherwise.

Source: Author's calculations based on World Bank Enterprise Surveys.

The coefficient on workers' high school education is positive and significant in the all manufacturing firms model. Having a high school-educated workforce increases the probability of a firm joining a supply chain. Furthermore, the CEO having a college degree or vocational degree is positive and significant in the all manufacturing firms model. Meanwhile, the CEO's experience is positive and significant in the sustained exporters model. These results suggest that higher levels of human capital, particularly literate secondary-level educated workers, college and vocational educated CEOs, and experienced CEOs, increase the probability of a manufacturing firm joining a supply chain.

The foreign ownership variable has a positive and significant effect on the probability of joining supply chains in both models. Access to the superior marketing connections and know-how of parent companies enables direct and indirect exporting by firms. Furthermore, access to parent companies' accumulated learning experience of export production as well as access to sophisticated technologies and management experience improves technical efficiency in firms.

Access to commercial bank credit is positive and significant in the all manufacturing firms model. This suggests that, in the presence of capital market imperfections, well-organized firms with collateral and an established record with commercial banks are more likely to join production networks.

The significance of the coefficients on the country dummies suggests that some differences exist between the Southeast Asian countries. Indonesia, Malaysia, and the Philippines are significant in both models. Viet Nam is significant in the all manufacturing firms model.

The two all manufacturing firms models provide a somewhat better fit than the two SME models (compare the R^2 in columns 1 and 2 with columns 3 and 4). The all SMEs model (column 3) is a better fit to the outcome data than the sustained SME exporters model (column 4). Interestingly, several variables (firm size, international quality certification, firm age, workers high school education and foreign ownership) turn out as significant with the correct sign in both SME models. Hence, the key determinants of firm-level participation in supply chains are remarkably stable across the four models, suggesting that the pattern for all manufacturing firms broadly holds for SMEs.

There are also some differences between the all-manufacturing-firms models (columns 1 and 2) and the SME models (columns 3 and 4). The size-squared variable was not significant in either SME model. In addition, the CEO's characteristics are less pronounced in the SME models, with only CEO's experience being significant in the sustained-SME-exporters model. Finally, country characteristics matter but differ somewhat between the different models.

It is interesting to examine some predicted probabilities of the size variable holding all other variables at their means.[11] In the all-SMEs model (column 3) the probability of an SME participating in a supply chain for a firm with 1 to 25 workers is 10%, compared to 35% for one that has 75 to 100 workers. Having an internationally agreed quality certificate (like ISO)

increases the probability of an SME joining a supply chain from 16% to 25% in the all-SMEs model 3. Having a high school-educated workforce increases the probability of an SME joining a production network from 14% to 21% in the all-SMEs model 3.

6. Exploring the Policy and Business Environment

6.1 Incentive and Supply-Side Policies

The overall business environment in Southeast Asian economies is an important influence on firms joining supply chains. A myriad of reform policies, factor markets, and targeted policies are involved. These range from trade policies and customs regulations to business start-up regulations, export promotion initiatives, special financing schemes, and technology support measures.[12] It is hard to portray the overall business environment in Southeast Asian economies and disentangle the different effects on firms. One practical method is to use available data on enterprise perceptions to examine the supportive nature of the business environment facing SMEs in their quest to participate in supply chains. SME-level analysis of the business environment is useful to formulate policy implications for SMEs, which are less present in supply chains or exports than large firms in Southeast Asian economies.

Table 5 lists the main obstacles identified by the SMEs in conducting business in the Southeast Asian economies using information from the World Bank's Enterprise Surveys. These are grouped under three headings: incentive framework, supply-side factors, and other. The discussion that follows highlights SMEs' views of major obstacles facing them for all five Southeast Asian economies and for individual economies. The data for Thailand should be interpreted with caution as the survey was conducted in the late-2000s during a period of political turbulence and uncertainty.

Table 5: Main Obstacles to Conducting Business, SMEs (% of all SMEs)

	All Sample Countries	Malaysia	Thailand	Philippines	Indonesia	Viet Nam
Incentives						
Tax rates	31.9	31.1	54.8	42.9	14.3	16.5
Tax administration	26.7	24.0	49.6	34.2	13.3	12.4
Customs and trade regulations	20.0	20.1	41.0	18.0	12.5	8.7
Business licensing and permits	16.7	16.4	25.4	22.1	16.5	2.8
Political instability/economic uncertainty	34.7	28.8	84.0	28.9	29.5	2.3
Supply-Side Factors						
Transport	23.8	11.3	33.6	26.5	23.2	24.2
Electricity	29.6	17.9	42.4	30.6	30.2	26.7
Telecommunication	10.4	9.3	24.5	7.6	6.6	3.8
Access to finance/credit	34.6	22.1	44.3	28.5	38.6	39.4
Inadequately educated labor force	28.0	24.1	60.2	16.8	15.4	23.7
Labor regulations	17.4	17.2	35.2	15.5	11.3	8.0
Access to land	16.0	11.1	11.7	9.6	19.2	28.3
Other						
Crime, theft, and disorder	24.5	25.3	53.7	16.5	21.4	5.8
Corruption	30.1	20.6	59.7	37.4	23.4	9.5
Practices of competitors in the informal sector	38.6	20.7	55.9	44.5	36.6	35.3
Source: Author's calculations based on World Bank Enterprise Surveys.						

Contrary to expectations, the leading obstacle facing SMEs in all Southeast Asian economies falls under the heading of "other" and relates to the practices of competitors in the informal sector. Cited by 38.6% of all SMEs in Southeast Asian economies, such practices refer to a variety of negative activities including smuggling of goods and inputs, price fixing and other anticompetitive practices, and poaching of skilled workers. A high degree of trust among firms is increasingly regarded by multinational corporations as a critical ingredient for developing market-led production networks. Among other things, high levels of trust encourage positive collective behavior among firms (e.g., sharing of sensitive information, pooling of technical knowledge, and joint production and marketing activities), which is critical in technologically intense, efficient production networks. However, the data are suggestive of a general trust deficit among SMEs in Southeast Asian economies which impedes the development of production networks with greater SME involvement. Interestingly, Malaysian SMEs (20.7%) seem to view the practices of competitors much less

seriously than those of the other Southeast Asian economies, suggesting that higher levels of trust exist among its enterprises.

A variety of supply-side factors are viewed as an obstacle by SMEs. The usual constraint in most studies of SMEs—access to finance (34.6%)—follows closely as the second most important obstacle in Southeast Asian economies. This issue seems least severe in Malaysia (22.1%) and most severe in Viet Nam (39.4%) and Indonesia (38.6%). Both the high cost of borrowing and the availability of financing from commercial banks fall under this heading. Inter-country differences in access to finance partly reflect the influence of monetary policies and the development of capital markets. A lack of financing is a deterrent to some firms investing in new equipment, technologies, and marketing methods which are needed to participate in production networks.

Bottlenecks pertaining to physical infrastructure and worker skills also show up as impediments to SMEs joining production networks in Southeast Asian economies. Electricity costs (and some fluctuations in supply) were cited by 29.6% of SMEs in all Southeast Asian economies and the quality of transport systems (roads, rail, and ports) by another 23.8%. High electricity costs and the quality of transport systems appear to be less of a problem in energy-producing economies (e.g., Malaysia and Indonesia) than in the three energy-importing economies. Relative infrastructure gaps in energy-importing Southeast Asian economies was reflected in poorer connectivity and higher trade costs compared with energy-producing economies.

An inadequately educated labor force was mentioned as a problem by 28.0% of SMEs in all Southeast Asian economies, but Thailand, Malaysia, and Viet Nam report higher figures than the other economies. This pattern may reflect skill shortages and rising wage costs in part associated with moves in the direction of full employment. Amidst a tightening labor market, labor regulations were perceived to be more of a problem for SMEs in Malaysia and Thailand than in the other Southeast Asian economies.

In contrast, access to land is generally not seen as an obstacle, with only 16% of SMEs in all Southeast Asian economies highlighting this issue. Within this overall picture, however, SMEs in Viet Nam (28.3%) may have some concerns in relation to access to land.

On the policy and incentive front, regulatory issues at the border seem to be of limited concern. For instance, only 20.0% of SMEs in all Southeast Asian economies cited customs and trade regulations as a concern. This may reflect the fact that tariffs are quite low in Southeast Asian economies and that customs administrations have been improved due to decades of gradual trade reforms. Thailand may be somewhat of an outlier, and the issue may relate to customs administration rather than trade regulations per se. Thus, customs and trade regulations generally do not seem to be an important impediment to SMEs participating in production networks.

There are mixed views about some behind-the-border regulatory issues. Business licensing and permits are not a widespread problem in Southeast Asian economies, with only 16.7% of firms pointing to this issue. Meanwhile, tax policy issues do matter. In this vein, high corporate tax rates were cited by 31.9% of SMEs and gaps in tax administration by 26.7%. Tax policy issues directly affect enterprise profitability and the incentive to participate in production networks. These issues appear to be of particular concern in the Philippines and Thailand and, to a lesser extent, in Malaysia.

According to 34.7% of SMEs in all Southeast Asian economies, economic uncertainty is also a notable impediment. However, a closer look at the data indicates that this figure is partly attributed to Thailand (84%) being an outlier for an unusually long period of domestic political turbulence. With the exception of Viet Nam (2.3%), some concerns about economic uncertainty were also expressed in the other Association of Southeast Asian Nations (ASEAN) economies.

Finally, corruption was mentioned by 30.1% of SMEs in all Southeast Asian economies and crime, theft, and disorder by 24.5%, indicating that these are significant issues for SMEs.

6.2 Business Support Services

Thus far, the availability of enterprise-level data on the five Southeast Asian economies has limited further exploration of supply-side factors influencing SME participation in supply chains. The important area of business services markets and business service providers for SMEs has not been discussed. Fortunately, some data for Malaysia and Thailand only on SMEs' ranking of the affordability and quality of business services in the country could be obtained from the World Bank's Enterprise Surveys. These are provided in Table 6 for six kinds of business services.

Table 6: Small and Medium-Sized Enterprises' Perception of Business Support Services

Quality of business services available in their country (1 = very poor; 4 = very good)				
	Malaysia		**Thailand**	
	Affordable	**Quality score**	**Affordable**	**Quality score**
Business services available in the country – quality (average)	69.4%	3.2	42.6%	2.8
Engineering and design	57.4%	3.1	15.4%	2.8
Management and marketing	69.8%	3.1	8.4%	2.6
Accounting	81.9%	3.3	84.2%	3.0
Legal services	69.3%	3.1	35.1%	2.8
Insurance	78.6%	3.2	81.2%	3.0
Information technology services	59.4%	3.1	31.2%	2.8
Source: Author's calculations based on World Bank Enterprise Surveys.				

The following are the main findings:

- On average, Malaysia seems to have more affordable and higher-quality business services than Thailand. Thus, 69.4% of SMEs in Malaysia said that business services were affordable, compared with only 42.6% in Thailand. Likewise, the quality of business services in Malaysia was scored as 3.2 and in Thailand as 2.8 (where 4 is very good).
- Looking at individual services, there is little variation in the good quality of individual business services in Malaysia. Technology services (engineering and design as well as information technology services), however, are somewhat less affordable compared with other services.
- Meanwhile, Thailand shows notable variation in terms of affordability and quality of business services. Strikingly, engineering and design (15.4%), management and marketing (8.4%), and information technology services (31.2%) are considered less affordable than other business services. In terms of service quality, marketing and management services (with a score of 2.6) are rated lower than other business services.

7. Conclusions

This paper conducted a comparative, firm-level analysis of joining the supply chain in five Southeast Asian economies to improve our understanding of fragmentation of manufacturing across borders in Asia. It mapped supply chains by firm size at the national and firm levels, undertook econometric analysis of factors influencing supply chain participation, and discussed enterprises' perceptions of the influence of the business environment. This difficult and painstaking research was facilitated by access to a large and comprehensive dataset of manufacturing enterprises from the World Bank.

Analysis of national data indicates that SMEs play an important role in economic activity in Southeast Asia. Not only are SMEs the major source of employment in Southeast Asian economies, but they also contribute notably to GDP. Large firms are a minor source of employment and significant contributor to GDP. However, SMEs in Southeast Asian economies make relatively little contribution to exports relative to the sectors employment or GDP contribution. Furthermore, even more industrially developed Southeast Asian economies (e.g., Thailand and Malaysia) lag behind the SME export shares of advanced East Asian economies such as the PRC, Japan and the Republic of Korea. Accordingly, national export data hint at the underperformance of SMEs in supply chains relative to large firms in Southeast Asia and SMEs in advanced East Asian economies.

Complementary and more detailed insights show up in the analysis of firm-level data (which include both direct and indirect exporters). A minority of firms in Southeast Asian economies are involved in supply chains through exports, input supply, and subcontracting. More developed economies (such as Thailand and Malaysia) have a higher share of their firms in supply chains than other Southeast Asian economies. Turning to firm size, the dominance of

large firms in supply chains and the minor role of SMEs is confirmed by firm-level data. SME participation varies across Southeast Asia with Malaysia and Thailand having a higher proportion of their SMEs in supply chains than in other economies. SME exports are highly concentrated in relatively few firms in the Southeast Asian economies—the top 25% of SMEs account for the bulk of SME exports in Southeast Asia.

The results of the micro-econometric analysis, conducted separately on all manufacturing firms and on SMEs in Southeast Asian economies, underscore the notion of firm heterogeneity in supply chains. The findings indicate that some firms are better at joining supply chains than others and that these differences are linked to various factors. Firm size shows up as an important influence on the probability of joining supply chains but exhibits a nonlinear form. It seems that economies of scale and fixed costs are significant in the early stages of joining production networks but less relevant in the longer term. SMEs may form clusters or embark on niche market strategies to overcome the disadvantages of firm size.

However, econometric analysis further suggests that firm size is not the whole story. Efficiency, particularly investment in technological capabilities and skills, and access to commercial banks also affect the probability of supply chain participation. The controls on firm age and ownership are also revealing. Unexpectedly, the econometric results further indicate that younger firms are likely to be more nimble in joining supply chains than older firms as they more easily use information and knowledge. In addition, foreign ownership facilitates participation in supply chains through access to marketing and technological know-how.

The exploration of SME perceptions of the business environment provides additional policy insights. A trust deficit seems to hamper the requisite intra-firm cooperation needed for effective SME participation in supply chains. Supply-side factors—such as lack of access to finance, high electricity costs, variable quality of transport systems, and inadequately educated workers—are an additional hindrance to SMEs. On the policy and incentive side, behind-the-border issues like high corporate tax rates as well as economic uncertainty also play their part. Finally, the limited evidence from Malaysia and Thailand suggests that the affordability and quality of business support services are an issue.

Some limitations in the methodology employed in this study may be addressed in future research. First, several factors that may also affect the participation of firms in supply chains (e.g., trade policies, domestic regulations, infrastructure, and business support services) were considered in the descriptive part but not in the econometric exercise. Attempting to include such factors in future econometric work may provide additional insights. Second, the supply chains functions estimated are static as only cross-section data were available from the World Bank surveys. Panel data analysis would be invaluable to highlight changes over time when the requisite data are available. Third, the research was unable to examine the issue of foreign direct investment by large firms and SMEs in Southeast Asia due to data gaps. Fourth, as larger enterprise samples become available in the future, it would be useful to explore

whether the characteristics of joining the supply chain of one industry sub sector differs from that of another. Thus, the findings need to be interpreted with caution.

Three policy implications may be drawn from the research. First, policy and incentive reforms are necessary but not sufficient to promote the participation of firms in supply chains. The myriad of supply-side obstacles and other issues identified by firms in Southeast Asia suggests that transparent and comprehensive national policies (which integrates supply side and incentive interventions) are crucial to support the participation of firms in supply chains. Specific policies to support SMEs (e.g., to form industrial clusters) could be useful, but further research is required on what works as there is a risk of government failure. Second, private sector representatives such as business associations should be involved in formulating policies for supply chains in Southeast Asia as they have firsthand knowledge and experience of rapidly evolving supply chains. Third, to facilitate effective policy development for supply chains, national statistics need to take better account of trends in supply chains and firm size. Noteworthy initiatives include using a consistent definition of firm size across countries to enable better mapping of exports by firm size, attempting to incorporate the contribution of indirect exports into gross export data, and, ultimately, measuring value-added trade.

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Notes

[1] The very few micro-level studies of supply chains in Asia include Harvie, Narjoko, and Oum (2010); Kyophilavong (2010); Rasiah, Rosli, and Sanjivee (2010); and Lim and Kimura (2010). See also some papers in Kuroiwa and Heng (2008) and Kuroiwa (2009).

[2] Athukorala (2011) presents data on world trade based on network trade or supply chain trade. His data show that Southeast Asian economies, with the exception of Singapore, have increased their world share of network trade between 1992–1993 and 2006–2007. Thus, Malaysia's world share of network trade increased from 1.8% to 2.6%, Thailand's from 0.8% to 1.6%, the Philippines' from 0.4% to 1.2%, Indonesia's from 0.1% to 0.5%, and Viet Nam's from 0.0% to 0.1%.

[3] For further discussion of resource constraints and external barriers faced by SMEs as well as appropriate policy interventions, see Levy, Berry, and Nugent (1999); Hallberg (2000); Wignaraja (2002); Fischer and Reuber (2003); and Tambunan (2009).

[4] There are a few multi-country, multi-sector studies (Harvie, Narjoko, and Oum 2010; Wignaraja 2011) and one multi-country single sector study (Rasiah 2004).

[5] See Harvie, Narjoko, and Oum (2010); and Rasiah, Rosli, and Sanjivee (2010).

[6] For instance, Harvie, Narjoko, and Oum (2010) simply define SME participation in supply chains according to whether it is a supplier, importer of intermediate goods, or exporter of some of its products.

[7] Technological capabilities are hard to measure and empirical work has either used aspects of technological activity (e.g., quality certification, patents, etc.) or a composite index of technological capability made up of many different technical functions performed by enterprises to assimilate imported technologies.

[8] Most unfortunately, data were not available from the World Bank Enterprise Surveys on the share of engineers and technicians in employment to more accurately capture technical-level skills at the firm level.

[9] Unfortunately, time series data on exports by firm size are not readily available from national sources. Methodological difficulties notwithstanding, a rough indication may be obtained by comparing the the share of SME exports (largely for the late-2000s) in Table 2 with the estimate by Harvie and Lee (2002) for the late-1990s. This crude comparison suggests that the percentage of SME exports in Southeast Asian economies rose from 14.3% to 20.9% between the late-1990s and the late-2000s.

[10] Wignaraja, Kruger, and Tuazon (2013) further explore this insight for a sample of Malaysian and Thai firms using a technology index (consisting of eight technical functions) based on the taxonomy of technological capabilities developed by Lall (1992). The results show that participation in production networks and supply chains is positively correlated with technology upgrading at the firm level.

[11] The same assumption is made for all the probabilities given in the text. A complete set of results on predicted probabilities is available on request.

[12] It is recognized that the developing industrial clusters involving SMEs and large firms are also an important means to promote SME entry into production networks. However, a lack of data on this aspect meant that clustering and cluster promotion could not be examined in this paper (see Fischer and Reuber 2003).

Appendix 1: Enterprise Data and Sample Characteristics

The dataset and sampling methodology used in this study are briefly described here. Our firm-level study on five Southeast Asian economies was based on cross-section data collected in the late 2000s from the World Bank's Enterprise Surveys dataset. The World Bank surveys are conducted at infrequent intervals in the given countries—the data for Malaysia and Thailand were gathered in 2007 and those for the other three economies in 2009. This is the only relatively detailed and recent firm-level dataset currently available for Southeast Asian economies. The data are not publicly available, but it is possible to apply to the World Bank for access for research purposes.

Stratified random sampling with replacement was the sampling methodology used by the World Bank Enterprise Surveys.[1] This means that all population units are grouped within a homogenous group and simple random samples are selected within each group. This method allows computing estimates for each of the strata with a specific level of precision, while population estimates can also be estimated by properly weighting individual observations. The strata for Enterprise Surveys are firm size, business sector, and geographic region within a country. In most developing countries, small and medium-sized enterprises (SMEs) form the bulk of the enterprises. Large firms are oversampled in the firm surveys as they tend to be engines of job creation.

Face-to-face interviews using a common questionnaire were conducted with business owners and senior managers of firms. The surveys provide cross-section firm-level information on direct and indirect exports, employment, ownership, human capital, technology, access to credit, and aspects of the policy regime. Table A1 provides a snapshot of the enterprise dataset for the five Association of Southeast Asian Nations (ASEAN) economies according to firm size, ownership, and sector. The dataset largely consists of a total of 5,900 manufacturing firms with reasonable samples of over 1,000 firms for each ASEAN country.

[1] For details of the sampling methodology in the World Bank surveys, see www.enterprisesurveys.org/methodology.

Table A1: Sample Characteristics

	All firms	Malaysia	Thailand	Philippines	Indonesia	Viet Nam
Number of firms	5,900	1,082	1,043	1,310	1,422	1,043
By sector, % of distribution						
Garment	11.4	8.2	15.2	10.8	11.6	11.2
Textile	7.6	3.5	12.8	0.2	12.5	9.6
Machinery and equipment	3.6	8.5	8.0	0.2	0.5	2.7
Electronics/electrical appliances	2.3	8.9	8.7	9.6	0.4	1.8
Rubber and plastic	15.0	25.3	24.7	13.4	10.5	3.0
By size, % of distribution						
SMEs	69.3	62.7	51.6	78.2	82.1	65.3
Large	30.7	37.3	48.4	21.8	17.9	34.7
By ownership, % of distribution						
Foreign	25.5	30.5	59.9	23.3	6.8	14.0
Domestic	74.5	69.5	40.1	76.7	93.2	86.0

SMEs = small and medium-sized enterprises.
Source: Author's calculations based on World Bank Enterprise Surveys.

Following the standard Organisation for Economic Co-operation and Development (OECD) definition, large firms are defined in our study as enterprises with more than 100 employees and SMEs those with fewer than 100 employees.[2] Large firms constitute 30.7% of the total sample and the remaining 69.3% consists of SMEs. The figure for SMEs as a percentage of total number of firms varies by country: Malaysia (62.7%), Thailand (51.6%), the Philippines (78.2%), Indonesia (82.1%), and Viet Nam (65.3%). About a quarter of the total sample has some proportion of foreign equity. The share of firms with foreign equity as a percentage of total number of firms is highest in Thailand and Malaysia and lowest in Indonesia.

[2] See Organisation for Economic Co-operation and Development (OECD). 1997. *Globalisation and Small and Medium Enterprises*. Vol. 1 Synthesis Report. Paris: OECD.

Appendix 2: Definition of Small and Medium-Sized Enterprises across Various ASEAN Member States and Other Countries

Economy	Category of industry	Criteria/country's official definition	Source
Thailand	Manufacturing industry	≤ 200 employees or assets ≤ 200 million baht	ASEAN SME Data and Statistics, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
	Wholesale industry	≤ 200 employees or assets ≤100 million baht	
	Retailing industry	≤ 150 employees or assets ≤ 60 million baht	
	Service industry	≤ 200 employees or assets ≤ 200 million baht	
Viet Nam	Agriculture, forestry, and fishing	≤ 300 employees or assets ≤ 100 billion dong	ASEAN SME Data and Statistic, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
	Industry and construction	≤ 300 employees or assets ≤ 100 billion dong	
	Commerce and services	≤ 100 employees or assets ≤ 50 billion dong	
Indonesia		Assets ≤ 10 billion rupiah or sales per annum ≤ 50 billion rupiah	ASEAN SME Data and Statistics, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
Malaysia	Manufacturing	Turnover ≤ 25 million ringgit or full-time employees ≤ 150	ASEAN SME Data and Statistics, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
	Services	Sales turnover ≤ 5 million ringgit or full-time employees ≤ 50	
Philippines		Total assets less than 100 million pesos	ASEAN SME Data and Statistics, available at http://www.asean.org/communities/asean-economic-community/category/data-and-statistics
United States		≤ 500 employees	United States Small Business Administration, available at http://www.sba.gov/
Japan	Manufacturing and others	≤ 300 employees and capital ≤ or equal to 300 million yen	Ministry of Economy, Trade and Industry, available at http://www.chusho.meti.go.jp/sme_english/outline/04/20131007.pdf
	Wholesale	≤ 100 employees or assets ≤ 100 million yen	
	Services	≤ 100 employees or assets ≤ 100 million yen	
	Retail	≤ 50 employees or assets ≤ 50 million yen	
Germany (European Commission definition)		≤ 250 employees, turnover ≤ 50 million euros, or balance sheet total ≤ 43 million euros	European Commission, available at http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/sme-definition/index_en.htm
Republic of Korea	Manufacturing	≤ 300 employees, capital or sales ≤ 8 billion won	Small and Medium Business Administration, available at http://eng.smba.go.kr/eng/index.do
	Mining, construction, and transportation	≤ 300 employees, capital or sales ≤ 3 billion won	
	Publication, information and communication; administrative and support service activities; human health, and social work activities; professional scientific and technical activities	≤ 300 employees, capital or sales ≤ 30 billion won	
	Agricultural, forestry, and fishery; electricity, gas, steam, and waterworks business; wholesale and retail trade; accommodation; food services activities; financial and insurance activities; arts, entertainment, and recreation	≤ 300 employees, capital or sales ≤ 20 billion won	
	Sewerage, waste management, and remediation activities; education; repair and other services	≤ 300 employees, capital or sales ≤ 10 billion won	
	Real estate, rental, and leasing activities	≤ 300 employees, capital or sales ≤ 5 billion won	
People's Republic of China	Industry	≤ 300 employees, total assets ≤ 40 million yuan, or business sales ≤ 30 million yuan	Economic Research Institute for ASEAN and East Asia, available at http://www.eria.org/SME%20Development%20in%20China_A%20Policy%20Perspective%20on%20SME%20Industrial%20Clustering.pdf
	Construction	≤ 600 employees, total assets ≤ 40 million yuan, or business sales ≤ 30 million yuan	
	Wholesale	≤ 100 employees, or business sales ≤ 30 million yuan	
	Retail	≤ 100 employees, or business sales ≤ 10 million yuan	
	Transport	≤ 500 employees, or business sales ≤ 30 million yuan	
	Post	≤ 400 employees, or business sales ≤ 30 million yuan	
	Hotel and restaurant	≤ 400 employees, or business sales ≤ 30 million yuan	

ASEAN = Association of Southeast Asian Nations, SMEs = small and medium-sized enterprises.

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