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Spatial Architecture of the Production Networks in Southeast Asia*

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Abstract: The main purpose of this paper is to provide empirical evidence on the inter-firm production networks in Southeast Asian developing economies. Using firm-level data obtained from a questionnaire survey of manufacturing firms in Indonesia, the Philippines, Thailand, and Vietnam in 2008, this paper presents the regional distribution of main customers and suppliers and their geographical proximity. Firm-level capabilities and transaction costs associated with specific inter-firm relationships would influence the distances between customers and suppliers. Ordered logistic estimations are carried out to examine factors affecting the spatial architecture of the production networks in the region.

Keywords: Linkages, Spatial architecture, Southeast and East Asia, Transaction cost, Value chain

JEL Classification: L14, L23, R12

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1. Introduction

The process of industrial development in Southeast Asia has unique characteristics. First, agglomeration forces have been the engine of industrial growth. Dynamic agglomeration has been observed mainly around capital cities and in surrounding regions. The governments in the region have made efforts to improve business environments, including the development of soft and hard infrastructures and the introduction of various investment incentives. Zoning strategies such as industrial parks (IP), industrial zones (IZ), export processing zones (EPZ) and special economic zones (SEZ) have been one of the successful policy interventions established by the governments, with the aims of satisfying the minimum conditions indispensable to industrial development with limited resources, and attracting MNCs, their suppliers and related industries. Such successful industrial development policies have been researchers' interests. Rasiah (2008) and Kuchiki and Tsuji (2008, 2009) conceptualize Asian development models, emphasizing the importance of business environments, in particular macroeconomic, political and social stabilities and basic hard and soft infrastructure, in the initial stage of industrial development. Ariff (2008), Tsuji and Ueki (2008) and Tsuji *et al*. (2008) identify factors that have promoted agglomerations by applying econometric techniques to unique firm-level datasets collected through questionnaire surveys organized in Bangkok and four countries in Southeast Asia respectively. Secondly, the agglomerations in Southeast and East Asia have occurred in the progress of deepening de-facto economic integration in the region. Even though agglomerations in this region are in competitive relationships, they are not isolated. Rather than being enclaves, they are interconnected very closely through

international production and logistics networks to co-evolve. Emerged industrial agglomerations consist of different types of production and logistics networks in space (Tsuji *et al*., 2007; Markusen, 1996). The interdependence of the agglomerations in Southeast and East Asia increased intra-regional trades, particularly of machinery goods and their parts and components (Ando and Kimura 2009; Kimura 2006, 2008).

Why and how (1) agglomerations and (2) production and logistics networks are configured have been interesting for researchers and practitioners. Spatial economics and the new economic geography view spatial configuration of economic activities as the outcome of a complex interaction between agglomeration forces and dispersion forces. These forces arise from transport costs, scale economies at the firm level or the local externalities among neighboring firms. Resulting agglomerations could be composed of a single industry, multi industries, a full set of production processes or related industries, which depend on the types of sources of agglomeration economies, or the favorable economic environment created by greater concentrations. Such differences in the types of agglomeration affect the patterns of international trade (Fujita *et al*., 1999; Fujita *et al*., 2010; Fujita and Mori, 2005; Fujita and Thisse, 1996).

The fragmentation model in international trade economics provides another explanation of the development of Southeast and East Asian production and distribution networks. The fragmentation model originates the idea of using services to fragment a vertically integrated production nexus into separate production blocks and possibly locate them in appropriate places with different location advantages (Jones and Kierzkowski, 2005). The fragmentation is rationalized when a production process is divisible into production blocks, and total production costs decrease by making use of location advantages and economies of scale even after paying distance-dependent

"service link costs" of connecting geographically separated production blocks. Ando and Kimura (2009) and Kimura (2006, 2008) apply the model to illustrate the framework of the two-dimensional fragmentation with a typical case of the production/distribution networks in Southeast and East Asia where the formation of agglomeration is observed together with fragmentation.

Production and logistics networks, or linkages among people and firms, are of increasing importance for academics and policy makers because linkages are recognized as an important channel of ''externalities" or "spillovers". Information and knowledge transferred through a linkage can spill over to people and firms who are directly and indirectly interconnected through the linkage, and interact mediated by the market (pecuniary externalities) and non-market mechanisms (technological externalities) (Fujita and Thisse, 2002). In the literature of innovation, universities and research institutes are recognized as a major source of knowledge spillovers. But developing countries tend to have weak science, technology and educational infrastructure and research and development (R&D) capabilities. Thus, Southeast Asian countries would depend more on production linkages to upgrade industrial structures and stimulate innovative activities.

At the same time, geographical proximities to sources of information, knowledge and technologies are a matter of concern for developing countries that lack domestic sources and depend heavily on foreign direct investments (FDIs). If proximities to partner or rival firms facilitate direct physical contacts with them and promote transfers and the diffusion of information and knowledge, a weak industrial foundation becomes a significant constraint for developing countries wishing to upgrade industrial activities. On the other hand, it is also reasonable to expect that information transfers would be

less dependent on physical distances than movements of goods and people, so that firms in developing countries could take advantage of information, knowledge and technologies created in faraway developed countries or the home countries of multinational companies (MNCs). Thus, understanding the spatial configurations of production linkages and determinants of the spatial structure of linkages is crucially important for developing countries wishing to strengthen their industrial foundations and enhance their capabilities for innovation. However, these have not been sufficiently explored by theoretical and empirical studies, especially in the context of Southeast and East Asian production networks.

The objectives of this paper are to present the spatial architecture of the production networks in Southeast Asia and examine empirical analyses of the factors affecting the distance from firms to their suppliers and customers, using firm-level data obtained from an original questionnaire survey on manufacturing firms. This paper intentionally uses the term “architecture” to express the spatial structure, considering that the macro structure of the production networks is a result of a series of firm-level strategic decision-makings on the selection of partner firms.

This paper is organized as follows. The second section partially reviews the literature. In the third section, hypotheses and a model are developed. The fourth section explains data and variables used for regressions. The fifth section maps out the customer-supplier relations derived from the questionnaire survey conducted in four ASEAN countries. Estimation results are provided in the sixth section. The seventh section summarizes and discusses the empirical findings.

2. Spatial Architecture of the Production Networks

A linkage has largely organizational and geographical characteristics. The organizational form of the linkage appears as a result of an aggregation of firm-level decisions regarding which inputs should be produced in-house, and which should be procured from spot markets (based on arm's-length relationships with independent suppliers outside the firm), or through contractual arrangements for outsourcing, and so forth. In addition, both a customer and supplier in a single linkage behave, and make strategic decisions that interact in a complex way. Furthermore, a linkage is associated with other linkages in which the customer or supplier is involved. Thus, the governance of a value chain is also a matter of importance. Geographical extension of the linkage, specifically whether the linkage is locally completed or global, rather than location choice of a factory, has been the subject of attention, especially from policy-oriented researchers. As the issues are various and interrelated and have a dynamic nature, researchers have applied various theories and empirical approaches, including contract theory, the global value chains (GVC) approach, international trade economics, transportation economics, etc.

The transaction-cost approach, and concepts of incomplete contract and monitoring cost, and the boundary of the firm, provide theoretical foundations for considering the spatial architecture even though these focus on organizational characteristics of inter-firm relationships. Under these approaches, the boundary of the firm is determined to minimize transaction costs. When the cost of monitoring suppliers' rent seeking behaviors is low, firms can choose outsourcing rather than vertical integration (intra-firm transactions).

Williamson (1979) is one of the pioneering works centering on transaction costs to discuss cost-effective transaction governance structures, where spot market, contract-based and internal transactions are main alternatives in a business context. He proposes that three critical dimensions for characterizing transactions are (1) uncertainty, (2) frequency of exchange, and (3) the degree to which transaction-specific investments (in physical and human capital) are incurred. The implications of his paper include that transaction-specific governance is observed in the location of a specialized plant where plant-proximity benefits are attributed to transportation, inventory and related flow-process economies. Asanuma (1989) investigates manufacturer-supplier relationships in the Japanese automobile and electrical machinery industries, applying Williamson's transaction-cost economics and new institutional economics. He shows that longstanding relationships between a core manufacturer of the final product and its suppliers are more densely distributed where customized parts are transacted another noteworthy observation is the fact that interactions with the core firm at the moments of manufacturing, development, delivery and price negotiation enable suppliers to accumulate learning. They can thus improve their capabilities for not only assuring quality and punctual delivery of the parts, but also reducing manufacturing costs during the manufacturing stage and satisfying the specifications of parts or manufacturing processes issued by the core firm. On the other hand, such interactions make the capabilities of suppliers visible to the core firm, which continuously updates ratings on the suppliers.

International trade economics has incorporated the concept of incomplete contract to explain the international procurement of intermediates through outsourcing, within the firm or through FDI, and the boundary of the firm. Under this research approach,

Antràs (2003) explains why capital-intensive goods are transacted within the boundaries of MNCs, while labor-intensive goods are traded on the basis of arm's length market relationships. Antràs (2005) illustrates how incomplete contracts limit the international fragmentation of the production process. He develops a North-South trade model in which the incompleteness of international contracts leads to product cycles. Specifically, goods are initially manufactured in the North where products are developed, then the manufacture shifts to the South within the boundaries of the firm through FDI, and finally through outsourcing to independent firms in the South (Spencer, 2005). Nunn (2005) examines whether a country's contracting environments would affect relation-specific investments and exports.

GVC and its analogous approaches (Gereffi *et al*., 2005; Humphrey and Schmitz, 2000) gives other explanations for the use of outsourcing, recognizing that firms benefit from inter-firm relationships, bearing expenses for coordination and monitoring to handle difficulties related to transaction and contractual costs. Repeated transactions, trust, reputation, and social norms and sanctions reduce the risk of opportunism. Thus, spatial proximity to suppliers is one of the ways available for buyers to regulate the relationships. Buyer firms' capabilities and learning are additional factors that necessitate outsourcing. A firm cannot produce an input in-house to achieve scale economies if it does not require the input frequently. The firm also needs to learn the production process or enhance production capabilities, but it is time-consuming. Thus firms need to depend on external resources.

The GVC approach also focuses on the governance of value chains and categorizes them largely into market, network, and hierarchy. Such value chain governance patterns are determined mainly by (1) the complexity of transactions, (2) the ability to

codify information, and (3) the capabilities of suppliers to meet the requirements of the transaction. When the complexity of transactions is high but the ability to codify product specifications and the capabilities of supplier are low, the value chain tends to be hierarchical and "buyer-driven." In the buyer-driven chains, lead firms, who are mostly multinational large retailers, marketers, and branded manufacturers provide suppliers in developing countries with specifications and monitor their performance, so that an asymmetric power balance between firms emerges. In the case of the garment industry, manufacturers are highly dependent on middlemen (Knutsen, 2004).

Codifications are technically important factors for decreasing transaction costs. Modular production networks are advanced transaction forms based on standardized protocols to exchange codified knowledge on a global scale. In the networks, tacit activities are spatially clustered in particular locations, whereas the sources of modular components are geographically dispersed (Sturgeon, 2003).

The codifications become simpler if product and process standards are adopted. However, transactions can be complex, especially for local firm if just-in-time (JIT) delivery and other modern management systems are applied. The capabilities of local suppliers are always matters of concern for MNCs' factories in developing countries planning local procurements. Differences in market demands and technical requirements between domestic and international markets produce gaps between the technological capabilities of firms in developing countries and the technological requirements of MNCs. In reality, it is very difficult for local firms to meet MNCs' high requirements for quality, cost and delivery (QCD), so that local firms tend to have only weak linkages with MNCs (Machikita, *et al*., 2008).

In line with the GVC approach, Gereffi (1999) identifies the central roles of large,

mostly multinational, oligopolistic firms in coordinating production networks in "producer-driven" commodity chains such as automobiles and computers. Profits in producer-driven chains derive from scale, volume, and technological advances. This type of the power balance in producer-driven chains may influence the distances between customers and suppliers. Kuchiki and Tsuji (2008) consider suppliers' degree of dependence on the anchor firm and the unbalanced power between them as a factor promoting agglomeration. In their framework, FDI by an anchor firm in developing countries creates local markets for potential local suppliers in the countries. On the other hand, the anchor firm can request existing suppliers in its home country to enter into foreign production. These may evoke waves of domestic and overseas investments in the neighborhood of the anchor firm's factory by suppliers as verified by Ariff (2008), Tsuji *et al.* (2008) and Tsuji and Ueki (2008).

These approaches to customer-supplier relationships, above all those applying transaction-cost, contract theories and institutional economics, have not placed geographical space and the spatial architecture of the linkages as central issues. Transportation costs are the most fundamental element to be considered when spatial distributions of economic activities are characterized. Firms choose transportation modes and related services to minimize transportation costs and ultimately enhance the competitiveness of products in the international market. In some instances, firms arrange production plans in accordance with transportation schedules. Especially, vessel schedules are significantly relevant to import procurements and export production in less developed countries where regular, high-frequency liner services are not available. To leading firms that govern whole value chains, matters of concern are not limited to their own transportation costs. Transportation costs across the whole

value chain influence their competitiveness. As presented by Banomyong (2005), the cost associated with the physical transfer of the goods is an essential element of the transportation costs. Nevertheless, this cost factor does not explain the whole transportation cost. Transportation cost management along a supply chain takes into account a number of elements including time (transit time and time reliability), safety of goods, risk, and security, which can be considered as transaction costs that affect the governance of transactions.

Kimura and Ando (2005) introduce transaction costs in the original fragmentation model to make a distinction between intra-firm and inter-firm/arm's-length transactions. They propose the concept of two-dimensional fragmentation. In their model, one of the dimensions corresponds to the original fragmentation theory, where the service link cost depends on the geographical distance (Jones and Kierzkowski, 2005). The other dimension represents the service link cost dependent on controllability of Williamson's transaction cost. Based on the two-dimensional fragmentation, Kimura (2009) proposes the concept of relating the spatial structure of production and distribution networks with appropriate transaction types, and technological and managerial conditions. He argues that on the axis of geographical distance, when network set-up costs are lower or service link costs including transportation costs are higher, shorter-distance transactions would be better. In contrast, when differences in location advantages between two production places or when plant-level economies of scale are significantly large, longer-distance transactions would be economical.

On the other hand, on the controllability axis, focus is placed on the relationship between transaction costs and geographical distance. If trust between customers and suppliers or credibility of partner firms is low, or unbalanced power exists between them,

the shorter-distance arm's-length transactions could be preferred. Additionally, if the architecture of the inter-firm interface is a modular interface, transactions can be made over a long distance. However the integrated interface prefers shorter-distance transactions.

3. Hypothesis and Model

The literature review provides a number of firm-level elements potentially affecting the spatial architecture of the production and logistics networks. Nevertheless, one may stress three elements to be considered: (1) customers' technological and managerial capabilities for production, logistics and innovation; (2) suppliers' technological and managerial capabilities for production, logistics and innovation; and (3) transaction and coordination costs. Among the three, the former two focus on individual firm capabilities and determine the power balance between customers and suppliers. On the other hand, the third element is related to inter-firm interactions and depends on a relationship of mutual trust between the parties and institutions and other factors that affect interrelations between them. These elements can be embodied by various variables in empirical analyses, interact in a complex manner, and be variable through historical interaction processes between partners. Thus, empirical studies of the effect of one element on the spatial architecture may have mixed results. The element could shape short and long distances in space between customer and supplier. Based on the literature reviews above, in particular Kimura (2009), the following testable hypotheses are suggested.

Hypothesis 1: More capable suppliers can tolerate longer separation distances from their partners, while more capable customers can encourage their suppliers to be located at a shorter distance away**.**

As for the customers'/suppliers' capabilities, there are two types of technological and managerial capabilities to be considered: production and innovation.[1] Proficiency in production management affects production costs, definitely the capability of bearing transportation cost, and hence the price competitiveness of goods. Thus, firms with poor production management, particularly producing and selling standardized products on the arm's length transaction basis, tend to be located in the neighborhood of their main customers. Flexibility is also a competency required to respond to contingent events and unexpected changes in market conditions. Hence, firms with better organizational arrangements and management of market information can decrease not only production and transportation costs but also inventory and financial costs, and may consequently be located far from partners.

Capabilities of innovation management do not necessarily denote research and development (R&D) centers possessed by firms. What really matters is whether firms can make use of resources available internally and externally to introduce new products and processes, enhance quality of products, decrease costs or improve deliveries. In buyer or producer-driven chains, interactions with lead firms provide suppliers with opportunities for learning and improving capabilities. Such learning and capabilities

[1] The capability of logistics management is also important. Logistics managements become increasingly complex even within a single firm, and may not be limited to the transportation of goods. Business strategies involve other operations related to logistics such as inventory managements and risk control. In addition, to make whole in-house processes efficient, intra-firm coordination among production, procurement, inventory and logistic planning is needed. Firms are required to enhance information management skills and respond flexibly to contingent events and unexpected changes in market conditions. Hence, logistics management is becoming difficult for a single manufacturing firm, so that more manufacturing firms depend on logistics services providers.

accumulated through the interactions enable lead firms to transfer knowledge and technologies, and relocate productions of technology or knowledge-intensive products to developing countries. Thus, local suppliers' learning abilities are also significantly relevant to the distance between customers and suppliers. Industrial districts lacking suppliers with learning capacities may need to depend on imported materials and parts.

Hypothesis 2: Firms creating well harmonized inter-firm coordination mechanisms jointly with their partners can keep longer distances between them, and vice versa, on the assumption that transaction and coordination costs in space depend on the distances between related parties.

This is associated with management and other mechanisms for transaction and coordination costs. Of importance for firms in a customer-supplier relationship is the governance of the value chain, or how to decrease transaction and coordination costs. There are largely two aspects that can influence the costs: (1) the aspect of credibility, such as relationship of trust, reputation of partners, social norms, relation-specific institutions and (2) knowledge stickiness and technical aspects such as standardization and codification of transaction specification.

In the case of the credibility aspect, capital ties are typical means by which to control transaction and coordination costs and risks arising from outsourcing. In the customer-supplier relationship, repeat transactions enable firms to accumulate more accurate information on the capabilities of their partner firms and foster mutual trust, consequently reducing the risk of opportunism and monitoring costs.[2,3] Exchange of

[2] Incentives for opportunistic behavior can be reduced further by imposing enforceable penalty mechanisms and social sanctions that are complementary with repeat transactions. On the other hand, these trust-based relationships develop the closed and exclusive nature of transactions.

personnel and face-to-face communication are the most human and effective ways of sharing information and building up and deepening trusting relationships. In the case of the technical aspect, standardization and codification can decrease the complexity of information and knowledge transfer, transaction-specific investments and costs for coordination and monitoring.

Advanced managerial approaches embrace factors that can increase transaction, coordination or monitoring costs, and devices to suppress such costs, so that they seem to have both positive and negative impacts on the distances between customers and suppliers. Thus whether a managerial approach has a positive or negative impact should be verified empirically. One of the examples is product customization. Production of customized products normally necessitates relation-specific investments and frequent interactions in the design, development and manufacturing stages. These activities create substantial cost burdens. Therefore, longstanding relationships between a leading firm and their suppliers of customized parts tend to be distributed densely. On the other hand, the frequent interactions necessary for customization may foster trust relationships, and computerization and standardization of product design and production processes may decrease the necessity for frequent face-to-face interactions between them.

Machikita, *et al.* (2008) provides empirical evidence. They verify that local firms tend to interact with other local firms, rather than MNCs. Therefore, social networks would be one of the important determinants of linkages among local firms that have common social norms and historical mutual dependence.

[3] Firm-level reputation is also a notable factor that interconnects independent firms, while it seems to have both positive and negative impacts on the distances between customers and suppliers. Transactions with reputable firms enable their partners to decrease monitoring costs and risks of contingent events, and ease long-distance transactions (Kimura, 2009). Similarly trust-royalty is a coordination mode to help the movement of tacit knowledge embodied in humans (Rasiah, 2008). Contrarily, location choice of an anchor firm could effect decisions by not only its supplier firms but also their rivals and unrelated firms (Ariff, 2008; Kuchiki and Tsuji, 2008, 2009; Tsuji, *et. al.*, 2008; Tsuji and Ueki, 2008).

Hypothesis 3: Local firms from less-developed countries and SMEs are less capable, and less experienced in longstanding transactions with MNCs, consequently their customers and suppliers tend to be locals and located at a shorter distance, or they have no other alternative than to import materials and parts from abroad.

This hypothesis is a derivation of hypotheses 1 and 2, based on the assumption that local firms, small and medium-size enterprise (SMEs), and firms located in less-developed countries in general tend to be less capable of production, logistics and innovation managements than MNCs or joint ventures (JVs) from abroad or firms located in developed countries.

In sum, to examine the hypotheses, the distance between customer and supplier can be explained by the capacities of customer and supplier and transaction protocols introduced by them. This paper presents empirical evidences in Southeast and East Asia derived from original data obtained from the questionnaire survey. Due to constraints of availability of the data for respondents' partners, estimations in this paper focus on variables for respondents' capabilities and transaction manners. This paper uses the following ordered logit estimations:

$$Logit\ (d_{is}) = \alpha + \beta_1 CAP_i + \beta_2 TRAN_{is} + \beta_3 x_i + u_i.$$

The dependent variable (d_{is}) is the distance from a respondent firm (i) to its main supplier (s). The independent variables are capacities of the respondent (i) (CAP_i), transaction manners ($TRAN_{is}$), and other control variables for the respondent firm (i) (x_i) correspondingly. The error term (u_i) follows logistic distribution. The distance from the respondent firm (i) to its main customer (c) is also modeled as the same function (d_{ic}). It is predicted from the hypotheses that the coefficients on capabilities of the

respondent (β_1) would be positive, while the coefficient on a transaction manner (β_2) would be positive if the manner would decrease transaction costs and negative if it would increase them.

4. Data and Variables

4.1. Data

This paper uses the dataset created from the ERIA 2008 Survey on Production and Logistics Networks (SPLN) for manufacturing firms in four countries in Southeast Asia, Indonesia, the Philippines, Thailand, and Vietnam (Kitti, 2009). The objective of the survey was to collect firm-level data on production and logistics networks for investigation of the impacts of agglomeration and economic integration on innovative activities by firms in Southeast Asia. Therefore, the sample population is restricted to the selected manufacturing districts in each country (JABODETABEK area, i.e., Jakarta, Bogor, Depok, Tangerang, and Bekasi for Indonesia, CALABARZON area, i.e., Cavite, Laguna, Batangas, Rizal, and Quezon for the Philippines, Greater Bangkok area for Thailand, and the Hanoi area for Vietnam).

An original questionnaire was developed exclusively for the survey. In the process of designing the questionnaire, the OECD's Oslo Manual, which is an international standard for collecting innovation data, and questionnaires for the Community Innovation Survey (CIS) conducted by the European Union were referenced. Thus, the ERIA 2008 SPLN follows partly standard methodologies internationally endorsed. On the other hand, the originality of the ERIA 2008 SPLN comes from detailed questions

on respondents' attributes and customer-supplier relationships with their main customers and suppliers. Although the ERIA 2008 SPLN focuses on pinpointing sources of agglomeration effects and technology transfers facilitated by economic integration in Southeast and East Asia, the questionnaire includes questions on the attributes of respondents' relationships with main customers and suppliers and physical and time distances to them. Thus, the data allow us to analyze factors affecting the distance between respondents and their main customers/suppliers.

The questionnaire was distributed in December 2008 and January 2009. As shown in Table 1, a total of 605 firms agreed to participate in the survey: (1) 150 firms in Indonesia (24.8% of the whole sample); (2) 204 firms in the Philippines (33.7%); (3) 113 firms in Thailand (18.7%); and (4) 138 firms in Vietnam (22.8%). By nationality of the firms, 373 firms (61.7%) are locals, thus the remaining are MNCs or JVs. If the firms are categorized by the number of full-time employees, SMEs that employ less than 200 personnel account for 66.1% of the whole sample (400 firms). It can be said that the dataset includes a relatively high number of local firms and SMEs. These characteristics of this dataset provide an advantage in the analyses in this paper, because researchers have had difficulties in accessing information on such firms.

Table 1. Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Distance between the respondent to the supplier	545	6.310	3.330	1	10
Distance between the respondent to the customer	584	5.800	3.304	1	10
SME (200 or less employees)	605	0.661	0.474	0	1
Local firm (100% local capital)	605	0.617	0.487	0	1
Indonesia	605	0.248	0.432	0	1
Philippines	605	0.337	0.473	0	1
Vietnam	605	0.228	0.420	0	1
Production of final products	605	0.712	0.453	0	1
Usage of air cargo for distribution with the supplier	605	0.094	0.292	0	1
Usage of air cargo for distribution with the customer	605	0.078	0.268	0	1
Production department	605	0.618	0.486	0	1
R&D department	605	0.339	0.474	0	1
Sales department/agent	605	0.448	0.498	0	1
Organizational change	605	0.597	0.491	0	1
Adoption of an international standard	605	0.531	0.499	0	1
Capital tie-up with the supplier	605	0.112	0.316	0	1
Capital tie-up with the customer	605	0.107	0.310	0	1
Transaction of customized products with the supplier	605	0.554	0.498	0	1
Transaction of customized products with the customer	605	0.638	0.481	0	1
JIT delivery with the supplier	605	0.362	0.481	0	1
JIT delivery with the customer	605	0.451	0.498	0	1
Acceptance of engineer from the supplier	605	0.273	0.446	0	1
Acceptance of engineer from the customer	605	0.339	0.474	0	1
Dispatch of engineer to the supplier	605	0.170	0.376	0	1
Dispatch of engineer to the customer	605	0.215	0.411	0	1

Source: ERIA 2008 SPLN.

4.2. Dependent and Independent Variables

The ERIA SPLN collects information on distances between respondents and their main suppliers/customers. In the questionnaire, the distances are categorized into 10 ranges: (1) 0-10 km; (2) 11-25 km; (3) 26-50 km; (4) 51-100 km; (5) 101-200 km; (6) 201-300; (7) 301-400; (8) 401-500 km; (9) 501-1,000 km; and (10) 1,001 km or more. Respondents are requested to choose one of them. Such categorical data on the distances between customers and suppliers is used as dependent variable.

All independent variables are binary or dummy variables. In relation to the first

hypothesis, a firm can be recognized as being technologically capable if the firm attaches importance to internal sources of information and new technologies. Therefore the firm that obtains information from its own (1) *production department* would have better production-related capabilities, thus co ded 1 else 0. In the same manner, binary variables (2) *R&D department* and (3) *sales department/agent* are defined as equaling 1 if the respondent consider these departments as important sources of information and new technologies respectively. Additionally defined is a binary variable (4) *organizational change*, which takes 1 if the firm introduced in 2006-2008 internal activities to respond to changes in the market. Innovative activities related to organizational arrangements are of increasing importance as they are needed to meet demands from customers flexibly, decrease transaction costs with suppliers and acquire business opportunities without fail.

In order to test Hypothesis 2, mainly two types of the binary variables related to transaction costs are adopted. One is credibility of the respondent firm and the other is technical arrangements. Both of the two would decrease transaction costs. Among the first category, the variable (5) *capital tie-up* equals 1 if the respondent has a capital tie-up with the main customer or supplier. It is predicted that transaction costs between firms with capital tie-ups would be lower. Therefore they could be located in far distant places. If the firm deals in (6) *customized products*, and implements a (7) *JIT delivery system*, the corresponding dummy variables are coded 1. The variables (8) *engineer acceptance*, and (9) *engineer dispatch* equal 1 if the firm accepts engineers from their main customer/supplier, and dispatches engineers to their main customer/supplier respectively. These transactions would necessitate frequent communications between the parties, thus would enhance trust relationships between

customers and suppliers and result in decreasing transaction costs. On the other hand, production of customized products and JIT delivery require complex management systems, so they could increase transaction costs. Engineer dispatch or acceptance would be needed if business partners lack credibility with each other. In sum, the effects of customized product, JIT, engineer acceptance, and engineer dispatch on the distance between customers and suppliers would be mixed, and are to be tested by regressions. Related to technical arrangements, the variable (10) *International standard* is coded 1 if the firm adopted an international standard in 2006-2008.

The dummy variables for testing Hypothesis 3 are (11) *SME* and (12) *local*. SMEs are defined as firms that employ 200 or fewer personnel. In a similar way, the respondent firms are categorized as local if they are owned 100% by local capital. The effect of SME status on the distance to main suppliers would be mixed and is to be tested statistically. SMEs would not be able to bear higher transaction costs so they would prefer domestic suppliers. On the other hand, they need to import raw materials and parts unavailable locally. In contrast, large firms, typically MNCs, could request suppliers to locate in their neighborhoods (Ariff, 2008; Kuchiki and Tsuji, 2008, 2009; Tsuji *et al*., 2008; Tsuji and Ueki 2008). Finally, these key independent variables and their predicted signs are summarized in Table 2.

Table 2. List of Key Independent Variables by Hypothesis

Hypothesis	Variable	Indicator	Expected sign	
			Supplier	Customer
Hypothesis 1	Production capability	(1) Production department	+	+
	Innovation capability	(2) R&D department	+	+
		(3) Sales department/agent	+	+
		(4) Organizational change	+	+
Hypothesis 2	Transaction costs	(5) Capital tie-up	+	+
		(6) Customized product	+/-	+/-
		(7) JIT delivery	+/-	+/-
		(8) Acceptance of engineer	+/-	+/-
		(9) Dispatch of engineer	+/-	+/-
		(10) International standard	+	+
Hypothesis 3	Size of firm	(11) SME (200 or less employees)	+/-	-
	Nationality of firm	(12) Local firm (100% local capital)	-	-

In addition to these key independent variables, three groups of control variables are included in the model. The first are dummy variables for *Indonesia*, the *Philippines* and *Vietnam* where the respondents are located. Thailand is therefore the reference country. This dummy variable is needed in order to consider differences between these countries in physical and institutional infrastructure, and other country and regional-specific elements. Secondly, the respondent firms are coded 1 if they carry out *production of final products*. This variable would be relevant particularly to the distance to those customers which are wholesalers, retailers, trading companies and others closely connected with final consumers. The third variable *Air* equals 1 if the respondent firms usually utilize airfreight as the mode of transportation with their main customers or suppliers. The spatial architectures of such firms would be distinct because they pay much higher transportation costs to overcome all impediments arising from distance. Summary statistics of dependent and independent variables are listed in Table 1.

5. Customer-supplier Relationships in Space

This section summarizes facts of the main markets and sources of input found from descriptive statistics.

5.1. Regional Distribution of the Main Markets and Sources of Inputs

In the questionnaire survey, firms were asked about their three most important markets and sources of raw materials and suppliers respectively. Table 3 presents the geographical characteristics of the procurement-distribution network in Southeast Asia, showing the locations of the most important source of inputs for 584 respondent firms, as well as the most important markets for 602 respondent firms in the manufacturing sector.

The upper half of Table 3 explains the geographical distribution of the main source of inputs. As shown in the column for the whole sample, 34.1% of the respondents procure their inputs in the same agglomeration where they are located. If the firms selling mostly in other regions in the country are considered, 56.3% of the firms recognize the domestic market as the largest. What is noteworthy is that East Asia (China, Japan, South Korea, and Taiwan) is the second most important supply region, followed by domestic areas other than the place where the respondents are located. Although the percentage for ASEAN (6.5%) is unexpectedly small, as the percentage for Europe and the United States (U.S.) is only 3.9%, the firms in the four countries are able to procure almost all of their necessary inputs in Southeast and East Asia. The similar geographical distribution is maintained even after disaggregating the sample into two subgroups according to the number of full-time employees. But the dependence of

large firms on East Asia and Europe and the U.S. is significantly higher than that of SMEs. In contrast, SMEs acquire inputs mainly from domestic suppliers. The same differences observed between large firms and SMEs are more distinct between MNCs/JVs and local firms. Some 58.6% of the MNCs/JVs specified East Asia as the most important source, while 47.9% of the local firms specified the same agglomeration. More sharp contrasts are detected between the survey countries. Firms in JABODETABEK, Indonesia, purchase inputs mostly from the largest agglomeration in the capital and its surrounding areas. As with Indonesian firms, domestic procurements are significantly important for Thai firms. But not only the greater Bangkok area but also other industrial districts in the country are major sources of inputs, reflecting geographically widespread manufacturing activities and heavy accumulation of suppliers in Thailand. The Philippines has different characteristics from the previous two countries. Inputs come from outside CALABARZON, mainly from East Asia. Other ASEAN countries are also essential. The industrial district in Hanoi, on the other hand, is less developed. The agglomeration in the capital region is a recent phenomenon. Thus the country overwhelmingly depends on inputs imported from East Asian countries, compared to the other three countries.

In the same way as the main sources of inputs, the geographical distribution of the main markets can also be observed. As shown in the column for the whole sample in the lower half of Table 3, 47.5% of the respondents sell their products in the region where they are located. Adding 19.9% of them selling mostly in other regions in the same country, a total of 67.4% of the firms place the most importance on their domestic markets. East Asia and Europe and the U.S. follow the domestic markets. The importance of ASEAN is unexpectedly minor. Large firms and SMEs show a similar

geographical distribution to that observed for the whole sample. The main difference between large firms and SMEs are that large firms have better access to the European and U.S. markets, and SMEs are highly dependent on the industrial districts where they operate. On the other hand, many differences are found between MNCs/JVs and local firms, and between countries. Particularly, East Asia and Europe and the U.S. are significantly important as export markets for MNCs or JVs. Some 37.5% and 19.8% of them specified East Asia, and Europe and the U.S. as their most important markets respectively, while the figures for local firms are 2.4% and 8.9% correspondingly. By survey country, firms in Indonesia are the most dependent on their domestic markets, whereas Vietnam is the most export-oriented, especially targeting the markets in East Asia. Although the Philippines is also export-oriented, unlike Vietnam, Europe and the U.S. are more important than East Asia. Thai firms are distinct from firms in other countries in the importance of the ASEAN market to them. This is the largest market for 6.3% of the Thai respondents.

In the discussion so far, the markets and input sources are discussed separately. Nevertheless, they are associated procurement and distribution networks. From this point of view, it can be said that firms located in the four agglomerations surveyed use inputs procured locally and imported mainly from East Asia, and distribute products derived from them to their domestic markets, East Asia, Europe and the U.S. In turn, there are characteristics of the procurement-distribution networks that are different between MNCs/JVs and local firms, between large firms and SMEs, and between countries.

MNCs or JVs are based on the production network between ASEAN and East Asia. They procure inputs from East Asia and in the same agglomeration and sell products in

their domestic markets or as exports to East Asia. On the other hand, manufacturing activities by local firms are almost entirely in their home countries, although East Asia and ASEAN are somewhat important as sources of inputs and Europe and the U.S. as export markets. Firm size also affects the geographical distribution. Large firms have similarities to SMEs in the geographical distributions of their main sources of inputs. In contrast, there are differences between them in their main markets. Large firms focus on exports to Europe and the U.S., while SMEs concentrate on domestic sales.

Regional characteristics of the spatial architecture result from such firm-level differences. Regional-level data provide more diversified production networks. Production networks of the firms in JABODETABEK, Indonesia are almost entirely in their home countries. This partially reflects characteristics of the respondents in Indonesia. About 70% of them have less than 200 full-time employees and about 80% of them are local. Firms in CALABARZON, the Philippines export to East Asia, Europe and the U.S., based on their procurement networks within Asia. Compared to other countries, ASEAN is important for firms located in the Greater Bangkok area, Thailand. The geographical architecture of Hanoi's production network reflects the international division of labor in Asia. The capital region in Vietnam focuses on processing imported intermediates from East Asia to export to East Asia. It can be said that this country is in the early stage of industrial development.

Table 3. Main Markets and Sources of Inputs by Nationality, Firm Size and Survey Country (%)

		Whole	Nationality		Size		Country			
			MNC/JV	Local	Large	SME	Indonesia	Philippines	Thailand	Vietnam
Source	Same agglomeration	34.1	12.3	47.9	26.4	38.1	70.7	16.7	42.6	12.0
	Other domestic areas	22.3	11.5	29.1	18.4	24.3	20.4	24.0	35.2	10.4
	ASEAN	6.5	7.9	5.6	5.0	7.3	0.7	11.8	3.7	7.2
	East Asia	31.0	58.6	13.4	38.8	26.9	4.8	38.2	12.0	66.4
	Europe and the U.S.	3.9	6.6	2.2	7.5	2.1	2.0	5.9	5.6	1.6
	Others	2.2	3.1	1.7	4.0	1.3	1.4	3.4	0.9	2.4
Market	Same agglomeration	47.5	20.3	64.6	34.5	54.1	79.3	25.5	58.6	36.5
	Other domestic areas	19.9	16.4	22.2	18.7	20.6	13.3	30.9	20.7	10.2
	ASEAN	2.2	3.4	1.4	1.5	2.5	0.7	1.0	6.3	2.2
	East Asia	15.9	37.5	2.4	17.7	15.0	0.7	16.7	3.6	41.6
	Europe and the U.S.	13.1	19.8	8.9	25.1	7.0	5.3	24.0	10.8	7.3
	Others	1.3	2.6	0.5	2.5	0.8	0.7	2.0	0.0	2.2

Note: The numbers of observations are 584 for the main source and 602 for the main market.

Source: ERIA 2008 SPLN.

5.2. Geographical Proximity to the Main Customer and Supplier

Table 4 present geographical distributions of main customers and suppliers for respondent firms, measured by geographical distances. In general, the distribution of the distances reflects the geographical distribution of the main market shown in Table 3. As described above, the distances in Table 4 are dependent variables utilized for the estimations conducted in the next section.

The figures in the columns for the whole sample show that half of the main suppliers and customers are located within 200 kilometers (km), and more than 30% of the respondents are closely associated with firms at least 1,000 km away from their locations, in other words in foreign countries. Compared to the customer geography, the suppliers are dispersed. Therefore, firms tend to gather materials and parts from

distant suppliers, and sell products to neighboring customers. There are sharp differences between MNC/JV and local firms. While their main suppliers still tend to be concentrated in space, key customers and suppliers from abroad make up more than 60% of the former sub-group's counterparts. In contrast, the figure for local firms is less than 20%. The country or regional characteristics are summarized bellow.

Customer-supplier networks of the firms in JABODRTABEK are geographically concentrated. Some 80% of their main customers are located within 200 km. However, their supplier networks are more dispersed. The percentages for the suppliers located between 201and 400 km away are sizeable. As in Table 3, this partially reflects the fact that the respondents were mostly local SMEs. In contrast to Indonesia, firms in CALABARZON are much more internationalized. Nevertheless, their domestic suppliers and customers tend not to be far away. If their partner firms within 1,000 km of the respondents are considered, about 80% of them are situated within 100 km of the respondent firms. Thai firms in the Greater Bangkok area are less dependent on foreign partners, and have partners within 201-500 km. Probably, better road infrastructure and the large agglomeration in Thailand enable the firms surrounding the capital region to maintain contact with remote manufacturers. The agglomeration in Hanoi initially rose from the industrial development initiatives implemented in the area along the national road No.5 between Hanoi and Hai Phong. Therefore, the industrial activities in the region spread over approximately 100 km, depending on imported materials and parts mostly landed at the Hai Phong Port. The spatial architecture of Hanoi's production network thus reflects the historical process of its development and the international division of labor in Southeast and East Asia.

Table 4. Distance to the Main Supplier by Nationality, Firm Size and Survey Country (Cumulative %)

		Whole	Nationality		Size		Country			
			MNC/JV	Local	Large	SMEs	Indonesia	Philippines	Thailand	Vietnam
Supplier	0-10 km	6.6	8.1	5.6	8.5	5.6	7.9	10.8	5.3	0.7
	11-25 km	15.6	12.2	18.0	15.4	15.7	21.4	20.5	13.7	4.5
	26-50 km	26.1	15.8	33.1	21.3	28.6	36.4	30.1	27.4	9.0
	51-100 km	40.0	21.2	52.9	28.7	45.9	54.3	41.5	45.3	19.4
	101-200 km	49.9	28.4	64.7	41.5	54.3	67.1	46.6	63.2	26.9
	201-300 km	53.2	29.7	69.3	43.1	58.5	74.3	48.3	65.3	29.1
	301-400 km	56.7	30.2	74.9	44.7	63.0	80.7	50.6	67.4	32.1
	401-500 km	58.5	30.6	77.7	46.8	64.7	83.6	51.1	70.5	33.6
	501-1,000 km	62.4	34.2	81.7	49.5	69.2	86.4	52.8	73.7	41.8
	1,001 km or more	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Customer	0-10 km	6.7	5.7	7.3	6.1	7.0	7.3	8.0	7.3	3.6
	11-25 km	17.5	10.6	21.8	13.1	19.7	23.4	21.0	11.9	10.9
	26-50 km	29.8	18.5	37.0	21.2	34.2	36.5	33.5	25.7	21.0
	51-100 km	48.8	26.4	63.0	34.8	56.0	62.8	46.0	50.5	37.7
	101-200 km	59.8	32.6	77.0	43.9	67.9	79.6	54.0	65.1	44.2
	201-300 km	62.3	34.4	80.1	44.9	71.2	83.9	55.0	68.8	46.4
	301-400 km	63.7	35.2	81.8	47.0	72.3	84.7	55.5	74.3	46.4
	401-500 km	65.1	36.1	83.5	48.5	73.6	86.9	56.0	77.1	47.1
	501-1,000 km	66.4	37.0	85.2	49.5	75.1	87.6	57.0	78.9	49.3
	1,001 km or more	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: The numbers of observations are 584 for the main customer and 545 for the main supplier.

Source: ERIA 2008 SPLN.

6. Estimation Results

Based on the model and dependent and independent variables explained above, two models for (1) distances from the respondents to their suppliers and (2) distances to their customers are estimated. In order to avoid multicollinearity when three hypotheses are

tested, regression functions of distances on the variables for dealing with Hypothesis 3 and control variables are estimated at first, and then one of the other variables is embedded into the functions alternately. The estimation results are summarized below.

6.1. Distance to the Main Supplier

Table 5 presents regression results for the distance to main suppliers. The coefficients for Vietnam, production of the final products and transportation by airfreight are consistently positive and significant at the 1% level. These imply that first the main suppliers of firms in Hanoi are located closer than is the case for firms located in Bangkok and that firms producing final products or using airfreight tend to procure raw materials and parts from faraway suppliers. The coefficients for Indonesia are constantly negative but significant only at the 10% level in the columns (3), (7), and (9), showing that suppliers of firms in JABODETABEK, Indonesia are relatively concentrated in a confined space compared to Bangkok.

Hypothesis 3 is supported by the coefficients on local firms that are significant at 1% level in all columns. The coefficients on SMEs are not significant and their signs vary with independent variables. It can be concluded that local firms would have insufficient capability to access remote suppliers, resulting in them procuring necessary inputs from neighboring suppliers.

Hypothesis 1 is confirmed by the coefficients on sales department/agent and organization change that are significant at 10% and 5% levels in the columns (4) and (5) respectively. This result suggests that buyer-side capabilities in responding to changes in market demands and other business conditions are important for developing distant suppliers, rather than capabilities in production control and R&D.

Hypothesis 2 is supported by coefficients on customized products, acceptance of engineers, and international standards in the columns (7), (9), and (11) that are positively significant at 5%, 1%, and 5% levels respectively. The coefficient on capital tie-up is negative although it is not significant. But this result is contrary to the expectation in Table 2. The coefficient on international standards is positive. This result suggests that the adoption of standardized managerial processes would decrease transaction or coordination costs. The signs of other variables related to transaction costs should be tested as denoted in Table 2. The positively significant coefficient on customized products would be inconsistent with case studies based on the transaction cost approach, especially of automotive sectors where relation-specific investments are often required. This empirical result would be partially affected by the current international division of labor, where advanced countries in Southeast and East Asia such as Japan, Korea, Singapore, and Taiwan provide less developed countries in ASEAN with capital and technology-intensive materials and parts. On the other hand, parts of the transaction cost associated with mass production of customized products could be reduced by introducing standardized managerial arrangements, for example, information and communication technology-based systems such as computer-aided design and manufacturing (CAD/CAM). Similar factors would underlie the positive coefficient on acceptance of engineers. The supplier of the respondent has sufficient capabilities, thus can keep a distance from the respondent firm. On the other hand, by accepting an engineer from their main supplier, the firm could decrease transaction costs and overcome the stickiness of tacit knowledge that impede knowledge sharing and transfer.[4]

[4] The Dummy variable of *customized-product & engineer-acceptance from the supplier* is defined.

Table 5. Regression Results for the Main Supplier

Dependent Variable:	Ordered logit										
Distance to the main supplier	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Control variables											
Indonesia	-0.349	-0.252	-0.417*	-0.204	-0.134	-0.352	-0.443*	-0.257	-0.397*	-0.366	-0.225
	(0.227)	(0.239)	(0.252)	(0.238)	(0.250)	(0.228)	(0.231)	(0.251)	(0.226)	(0.231)	(0.235)
Philippines	-0.362	-0.209	-0.449	-0.120	-0.221	-0.362	-0.279	-0.314	-0.412	-0.397	-0.222
	(0.262)	(0.295)	(0.297)	(0.294)	(0.274)	(0.263)	(0.265)	(0.268)	(0.264)	(0.268)	(0.273)
Vietnam	0.915***	0.899***	0.819***	1.139***	1.019***	0.913***	0.732***	0.883***	0.668**	0.905***	0.978***
	(0.254)	(0.253)	(0.299)	(0.278)	(0.262)	(0.253)	(0.263)	(0.260)	(0.263)	(0.257)	(0.258)
Production of final products	0.626***	0.618***	0.628***	0.610***	0.632***	0.620***	0.650***	0.626***	0.679***	0.651***	0.621***
	(0.194)	(0.193)	(0.193)	(0.192)	(0.194)	(0.196)	(0.197)	(0.193)	(0.199)	(0.199)	(0.191)
Air	4.296***	4.302***	4.304***	4.303***	4.280***	4.310***	4.309***	4.282***	4.327***	4.298***	4.316***
	(0.778)	(0.778)	(0.780)	(0.776)	(0.773)	(0.783)	(0.776)	(0.776)	(0.765)	(0.782)	(0.772)
Independent variables: Hypothesis 3											
SME	-0.0149	-0.00552	-0.0229	0.0383	0.0450	-0.0220	0.0167	-0.0275	0.0366	0.00108	0.0839
	(0.204)	(0.204)	(0.205)	(0.208)	(0.210)	(0.204)	(0.207)	(0.203)	(0.209)	(0.205)	(0.212)
Local	-1.316***	-1.313***	-1.313***	-1.338***	-1.240***	-1.317***	-1.311***	-1.320***	-1.071***	-1.302***	-1.214***
	(0.224)	(0.224)	(0.225)	(0.225)	(0.228)	(0.224)	(0.223)	(0.224)	(0.237)	(0.227)	(0.233)
Independent variables: Hypothesis 1											
Production department		0.236									
		(0.213)									
R&D department			-0.124								
			(0.204)								
Sales department/sales agent				0.337*							
				(0.190)							
Organizational change					0.406**						
					(0.188)						
Independent variables: Hypothesis 2											
Capital tie-up						-0.120					
						(0.327)					
Customized product							0.475**				
							(0.195)				
JIT delivery								-0.173			
								(0.212)			
Acceptance of engineer									0.863***		
									(0.251)		
Dispatch of engineer										0.201	
										(0.283)	
International standard											0.389**
											(0.190)
Observations	545	545	545	545	545	545	545	545	545	545	545

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

The variable equals 1 if the respondent accepts an engineer from a supplier that supplies a customized product, otherwise 0. Although the results are not listed in Table 5, the coefficient on the dummy variable is positively significant at the 1% level. This suggests that technically capable suppliers dispatch their engineers to distant customers.

6.2. Distance to the Main Customer

In the same manner as Table 5, Table 6 provides regression results for the distance to main customers. The coefficients on production of the final products and transportation by airfreight are consistently positive and significant at the 1% level. Although the coefficient on Vietnam became insignificant, most of the coefficients on Indonesia and the Philippines are negatively significant at the 5% or lower level. This indicates that firms in these semi-developed ASEAN countries are not reaching remote customers compared with firms in Thailand.

Hypothesis 3 for the customer is supported by the coefficients on local firms, which are significant at the 1% level in all columns. In addition, the coefficients on SMEs in the columns (1), (6), (8), and (10) are significant at the 10% level, backing up the hypothesis. It can be said that local firms and SMEs would have insufficient capability to reach remote customers, resulting in them selling their products to neighboring customers.

Hypothesis 1 is verified by the coefficients on production department, sales department/agent and organization changes that are significant at the 10%, 10%, and 5% levels in the columns (1), (4) and (5) respectively. This result suggests that supplier-side flexibilities in response to changes in market demands and other business conditions are important for reaching distant customers, rather than R&D capabilities. Additionally, unlike the case on the supplier side, better production management is crucial in maintaining business with customers in remote areas.

The variables related to Hypothesis 2 are insignificant, except for international standards and dispatch of engineers to the main customer, which are significant at the 10% level as shown in the columns (10) and (11) of Table 6. It can be said that the

adoption of standardized managerial process would decrease transaction or coordination costs. On the other hand, the coefficient on dispatch of engineers is negative, which is contrary to the estimation result for the main customer in column (11) of Table 5. This might suggest that geographical proximity, with face-to-face communication, would be significantly important for decreasing transaction costs or sharing and transferring tacit knowledge.[5] Or perhaps the buyer-side is so influential that suppliers have no other choice than locating their production bases near customers (Ariff, 2008; Kuchiki and Tsuji, 2008, 2009; Tsuji *et al*., 2008; Tsuji and Ueki 2008).

[5] In the same manner as described in footnote 4, the dummy variable of *customized-product & engineer-acceptance from the customer* is defined. Although the estimation result is not listed in the Tables 6, the coefficient on the dummy variable is positively significant at the 5% level.

Table 6. Regression Results for the Main Customer

Dependent Variable:	Ordered logit										
Distance to the main Customer	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Control variables											
Indonesia	-0.546**	-0.389	-0.528**	-0.419*	-0.267	-0.555**	-0.586***	-0.487**	-0.560**	-0.530**	-0.455**
	(0.222)	(0.241)	(0.254)	(0.235)	(0.250)	(0.224)	(0.224)	(0.229)	(0.221)	(0.224)	(0.227)
Philippines	-0.663***	-0.431	-0.642**	-0.460*	-0.487*	-0.661***	-0.639***	-0.631***	-0.711***	-0.610**	-0.562**
	(0.243)	(0.273)	(0.273)	(0.269)	(0.257)	(0.243)	(0.246)	(0.242)	(0.248)	(0.243)	(0.252)
Vietnam	0.169	0.141	0.193	0.367	0.304	0.168	0.0822	0.122	-0.00894	0.204	0.219
	(0.240)	(0.240)	(0.285)	(0.267)	(0.248)	(0.239)	(0.252)	(0.251)	(0.275)	(0.238)	(0.243)
Production of final products	0.585***	0.579***	0.585***	0.577***	0.596***	0.580***	0.599***	0.584***	0.602***	0.552***	0.588***
	(0.188)	(0.188)	(0.188)	(0.188)	(0.186)	(0.188)	(0.189)	(0.188)	(0.190)	(0.190)	(0.188)
Air	37.19***	37.20***	37.19***	40.21***	35.19***	35.22***	38.20***	38.21***	38.20***	37.23***	35.18***
	(0.254)	(0.254)	(0.254)	(0.257)	(0.256)	(0.253)	(0.253)	(0.255)	(0.255)	(0.255)	(0.258)
Independent variables: Hypothesis 3											
SME	-0.318*	-0.313	-0.315	-0.270	-0.263	-0.327*	-0.295	-0.324*	-0.311	-0.357*	-0.251
	(0.192)	(0.193)	(0.192)	(0.197)	(0.194)	(0.192)	(0.195)	(0.190)	(0.193)	(0.193)	(0.193)
Local	-1.464***	-1.464***	-1.466***	-1.481***	-1.378***	-1.459***	-1.457***	-1.469***	-1.394***	-1.477***	-1.367***
	(0.214)	(0.214)	(0.215)	(0.215)	(0.217)	(0.214)	(0.215)	(0.215)	(0.220)	(0.213)	(0.222)
Independent variables: Hypothesis 1											
Production department		0.375*									
		(0.204)									
R&D department			0.0311								
			(0.205)								
Sales department/sales agent				0.303*							
				(0.182)							
Organizational change					0.477**						
					(0.185)						
Independent variables: Hypothesis 2											
Capital tie-up						-0.207					
						(0.266)					
Customized product							0.210				
							(0.182)				
JIT delivery								-0.148			
								(0.182)			
Acceptance of engineer									0.313		
									(0.213)		
Dispatch of engineer										-0.369*	
										(0.223)	
International standard											0.313*
											(0.171)
Observations	584	584	584	584	584	584	584	584	584	584	584

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

7. Summary and Discussion

This paper develops a regression model, considering implications from economics and case studies on agglomeration, as well as transaction-cost and value chain approaches, which have been applied to analyses of inter-firm relationships. The dataset developed by the questionnaire survey conducted in the major agglomerations in Indonesia, the Philippines, Thailand, and Vietnam allow us to outline the present production networks in Southeast and East Asia, at first based on the summary statistics. Then on the assumption that firm-level capabilities and transaction costs associated with specific inter-firm relationships would influence distances between customers and suppliers, ordered logistic estimations are carried out to examine factors affecting the spatial architecture of the production networks in the region. Although there are some data limitations, in particular insufficient data on respondents' partners, firm-level data allow us to derive detailed empirical findings summarized as follows.

There are three main important findings from analyses based on the descriptive statistics. First domestic sources of inputs and domestic markets are important especially for local firms, whereas MNCs/JVs are more dependent on inputs from East Asia and markets in East Asia and developed countries in other regions. The second key finding is that SMEs tend to sell more products in their neighborhood, while they depend on not only domestic suppliers but also suppliers in East Asia. Thirdly, it can be said from the first and second findings that firms located in the major agglomerations in the four ASEAN countries would be closely linked with firms located in East Asia. In other words, it seems that there is room for developing further complementary relationships within the ASEAN region.

Econometric analyses provide four additional rigorous findings. The fourth finding in this paper is related to factors common to the linkages between the respondents and their main suppliers and those between respondent firms and their main customers. The fundamental capabilities necessary for reaching distant suppliers and customers would be: (1) in-house managerial organization for handling information obtained from marketing and sales activities; (2) flexibility to changes in demands and other market conditions; and (3) adoption of international standards. On the other hand, there is an element exclusively relevant to the relationship with customers as follows: firms would be able to reach remote customers by having better production management. This is the fifth finding.

The econometric methods enable us to test to see whether a factor is significantly related to the dependent variable or not, and whether the correlation is positive or negative. This methodological advantage is useful when inter-firm collaborative activities could either increase or decrease transaction costs. The sixth finding is related to production of customized products. Firms conducting business in customized products tend to reach remote suppliers and customers. Thus, specialization in specific products would promote inter-agglomeration transactions. The seventh finding places emphasis on facilitation of engineer mobility that would promote the development of closer linkages with business partners. In particular, acceptance of engineers would help firms in developing countries overcome obstacles impeding knowledge sharing and transfer.

Economic integration in Southeast and East Asia is expected to create one of the world largest business spaces. It will provide firms with greater business opportunities in the region. The original dataset used in this paper maps out the situation where both

local firms and SMEs take advantage of so-called de-facto economic integration and recent de-jure integration between Southeast and East Asia. Nonetheless, there is considerable room for developing closer ties between both the regions and ASEAN countries. Further efforts toward deeper economic integration will promote freer competition and factor mobility. this would encourage firms to be innovative and specialized in specific business activities with comparative advantages. Appropriate institutions and policy supports for enhancing firms' capabilities and promoting common technical and managerial standards will reinforce the effects of economic integration. Therefore sound economic integration policy would consequently extend and strengthen intra-ASEAN and ASEAN-East Asia customer-supplier linkages.

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