ERIA-DP-2009-02

ERIA Discussion Paper Series

The Spatial Structure of Production/Distribution Networks and Its Implication for Technology Transfers and Spillovers*

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March 2009

Abstract: This paper argues that a variety of firm specificity supported by sophisticated inter-firm relationships is essential for understanding the mechanics and spatial structure of international production/distribution networks in East Asia. By mapping the two-dimensional fragmentation framework (Kimura and Ando (2005)) into geographical space, the paper proposes the concept of four layers of transactions in production/distribution networks: (i) local, (ii) sub-regional, (iii) regional, and (iv) the world. The concept effectively bridges geographical extensions of production/ distribution networks and the nature of transactions in terms of intra-firm vs. arm's-length as well as technological/managerial conditions. In addition, the paper discusses the implications of such geographical structure of production/distribution networks for technology transfers/spillovers from multinationals to local firms and claims its importance in new development strategies.

***Keywords*:** Fragmentation, new economic geography, firm heterogeneity, multinational enterprises, and technology spillovers.

* This paper is written for the FY2008 IDE-JETRO Project "Economic Integration and Vertical Specialization in East Asia: Does Vertical Specialization Play a Role in Dissolving the Border?" led by Daisuke Hiratsuka.

1. Firm Heterogeneity, the Spatial Structure of Networks, and Technology Spillovers

Multinational firms (MNEs) play a primary role in the formation of international production/distribution networks. Typically, one firm or a small number of MNEs either upstream or downstream of a value chain deliberately design, operate, and manage a network of production and distribution with production-process-wise international division of labor. In this process, MNEs exploit various opportunities to establish relations with other firms, including those in less developed countries (LDCs). The firm-specific nature and characteristics are thus naturally influenced in the process of network formation. As a result, there is a wide variety of production/distribution networks, even in the same industry or in the same product line. Firm heterogeneity is an essential basis of international production/distribution networks.

The sophisticated combination of intra-firm and arm's-length (inter-firm) transactions in production/distribution networks links with the recent proliferation of various business models. Until the 1980s, the most admired companies were giant multinationals, such as IBM, with intra-firm total integration of value chains from upstream to downstream. However, this type of giant total integration model has been critically reviewed since the 1990s. Currently, firms are trying to enhance their productivity and profitability by concentrating their resources on their core competences and outsourcing other tasks to other firms.[1] The formation of international production/distribution networks in East Asia has advanced together with the innovative construction of inter-firm relationships.

International trade theory has struggled to incorporate firm-specific aspects in formal theoretical models. Neither a perfect competition setting in traditional comparative advantage models nor a horizontal product differentiation model in new international trade theory captures the richness in the variety of corporate firms; the demand for model tractability necessarily over-simplifies firm-specific characteristics. The "new" new international trade theory led by a group of young scholars, including Mark Melitz and Pol Antras, makes a breakthrough by explicitly introducing firm

[1] Berger (2005) provides an excellent argument on recent changes in corporate strategies.

heterogeneity in the general equilibrium setting.[2] However, the base setting of their models is still too simplistic to analyze the current East Asian economy; firms with high productivity simply become bigger and internalize more activities such as export activities and foreign operations through foreign direct investment (FDI). A crucial missing element is inter-firm relationships. The leading firms today are able to concentrate on their own competences because they can outsource some activities to other firms. Some firms rather concentrate on work outsourced by other firms. "The bigger, the better" no longer holds true because sophisticated inter-firm relationships have been developed.

This paper claims that rich firm heterogeneity supported by sophisticated inter-firm relationships is an essential element in understanding the mechanics and spatial structure of international production/distribution networks in East Asia. Geographical distance is a crucial factor in the choice of transaction. When a firm needs close communication with (or close monitoring over) a counterpart, a short distance transaction is chosen, and vice versa. The mechanics of production/distribution networks generate four layers of transactions in the case of machinery industries in East Asia. With various information obtained from field work as well as some statistical data, this paper explores the relationship between various types of transactions and the spatial structure of international production/distribution networks.

In addition, the development of production/distribution networks certainly alters the mechanism of technology transfers and spillovers between MNEs and local firms. In the era of globalization, it does not make sense to foster local firms for all sorts of activities; some activities may naturally be taken care of by MNEs. However, policymakers in LDCs naturally still wish to nurture some local firms and entrepreneurs, and so a possible mechanism of technology transfers and spillovers in international production/distribution networks is important.

The fragmentation theory suggests that although value added slices may initially be thin, technology itself can move to LDCs much more easily than before. Multinational enterprises (MNEs) have a certain degree of freedom in how to cut out production blocks and how to establish technological links among them. Furthermore, the

[2] See in particular Melitz (2003), Bernard, Eaton, and Kortum (2003), Helpman, Melitz, and Yeaple (2004), and Antras and Helpman (2004).

formation of industrial agglomeration based on active vertical linkages among firms generates a number of opportunities for technology transfers and spillovers from MNEs to local firms/entrepreneurs and accelerates local human capital accumulation. In a competitive economic environment open to international competition, some MNEs have a strong incentive to facilitate technological transfers to local firms/entrepreneurs. Although the implication of the augmented fragmentation theory for technology transfers and spillovers has not yet been fully discussed, this paper provides a preliminary analysis on the connection between technological transfers/spillovers and the augmented fragmentation theory and tries to establish links with the literature on empirical technology spillovers.

The paper is organized as follows: the next section provides an overview of a wide variety of outsourcing in East Asia, with reference to the framework of two-dimensional fragmentation. The third section proposes the concept of four layers of transactions in production/distribution networks. The fourth section discusses factors that affect the choice of layers in transactions with the framework of two-dimensional fragmentation. The fifth section examines the relationship between the spatial structure of production/distribution networks and technology transfers/spillovers from multinationals to local firms. The sixth section discusses the implication of the nature of production/distribution networks for new development strategies, particularly on technology transfers and spillovers. The last section concludes the paper.

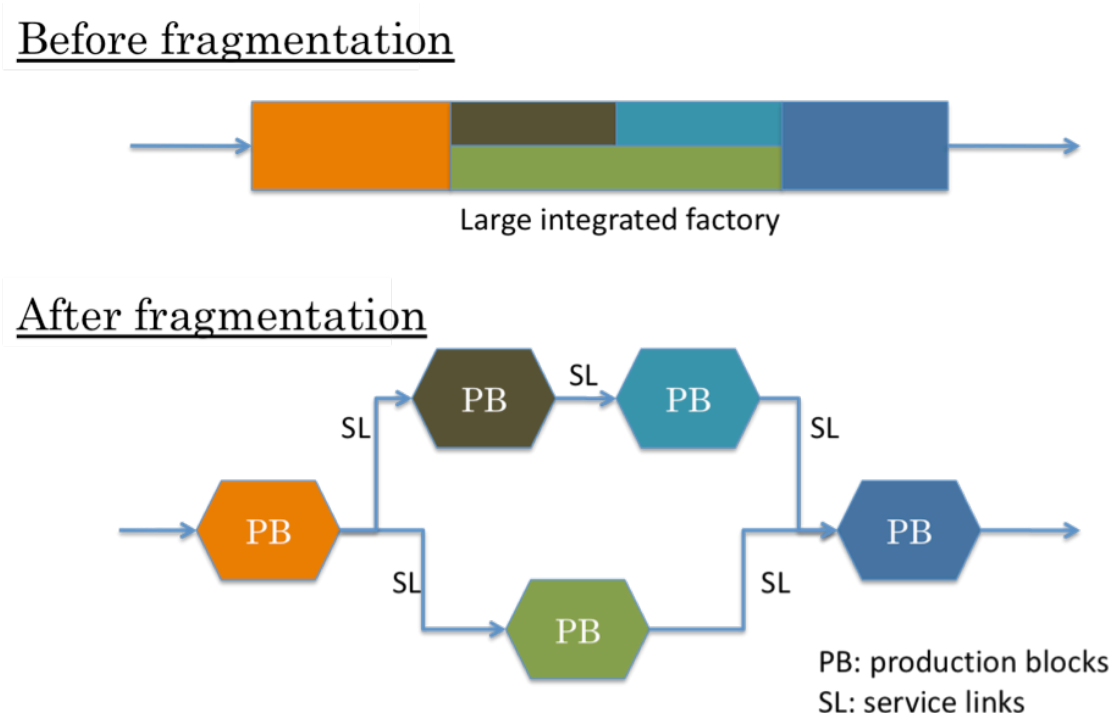
2. The Formation of Production/Distribution Networks in East Asia

Although international production/distribution networks in East Asia began forming from the beginning of the 1990s, Jones and Kierzkowski (1990) made an early start in developing the theory of fragmentation. The theory pointed out fundamental differences between industry-wise division of labor and production-process-wise division of labor or between finished-products trade and intermediate-goods trade, particularly in the flexibility of a firm's decision-making in cutting out production blocks and the existence of service link costs.

Figure 1 illustrates the original idea of fragmentation. Suppose that a large factory

initially exists in the electronics industry that takes care of all upstream and downstream production processes. Such a factory is capital and human capital intensive as a whole and thus is likely to be located in a developed country. However, a closer look at the factory may find a variety of production processes. Some processes are human-capital intensive and require close monitoring by researchers and technicians. On the other hand, some are purely labor-intensive, and a mass of unskilled labor may suffice. Alternately, some processes need 24-hour operations to accelerate capital depreciation. Hence, if we can fragment production processes into several production blocks and locate them in appropriate places with different location advantages, total production costs may be reduced. This is fragmentation.

Figure 1. The Original Idea of Fragmentation: An Illustration



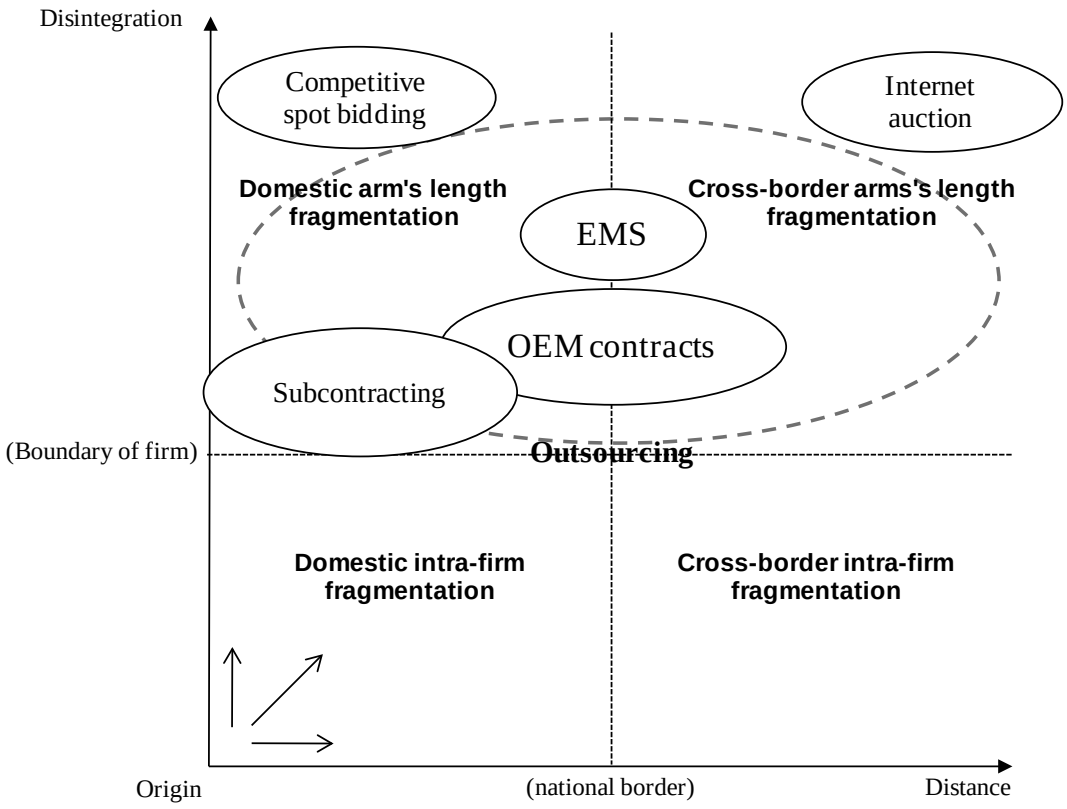
Source: Author.

Fragmentation of production processes makes sense when: (i) the saving in production costs *per se* in production blocks is large; and (ii) incurred service link costs to connect remotely located production blocks are small. Firms can cut out production blocks so as to exploit differences in location advantages in remote areas. On the other hand, service link costs, including not only transport costs but also various coordination

costs, should not be too high. Transactions between production blocks tend to be relation-specific rather than those in spot markets.

Kimura and Ando (2005) propose an expanded version of the framework called two-dimensional fragmentation. Figure 2 illustrates the basic concept. The horizontal axis depicts fragmentation along the axis of geographical distance, which is the traditional fragmentation, while the vertical axis represents fragmentation along the axis of disintegration or uncontrollability. The sophisticated nature of international production/distribution networks arises from a complicated combination of two kinds of fragmentation.

Figure 2. Two-dimensional Fragmentation: An Illustration



Source: Kimura and Ando (2005).

An important aspect of two-dimensional fragmentation is the spatial implication of disintegration-type fragmentation. Service link costs in arm's-length transactions, in

other words “transaction cost” in Oliver Williamson’s sense, are highly sensitive to geographical distance. Geographical proximity reduces search costs for new business partners, monitoring costs for quality and delivery timing, and trouble-shooting costs when an unexpected event occurs. The intimacy between disintegration-type fragmentation and geographical proximity is one of the major sources of agglomeration forces. In East Asia, fragmentation and agglomeration have proceeded together.

Although it is very difficult to comprehend intra-firm and arm’s-length transactions in official statistics, the data of foreign affiliates of Japanese firms collected by METI (*Kaiji Chosa*) provide useful information. By-destination sales and by-origin purchases of affiliates of Japanese firms in East Asia, particularly in machinery industries, present a clear-cut pattern of intra-firm and arm’s-length transactions. Transactions with Japan are predominantly intra-firm while those in the host country’s market are mostly arm’s-length. Transactions with other East Asia countries fall in between (Ando and Kimura (2008)). This is important evidence that confirm the intimacy between disintegration-type fragmentation and geographical proximity.

We observe a wide variety of disintegration-type fragmentation in production/distribution networks. East Asia has a number of prototypes for arm’s-length transactions. The *Shitauke* system in Japan, subcontracting in Taiwan, and Hong Kong – Guangdong operations are examples of these. Some of the arm’s-length transactions in East Asia are a direct extension of these prototypes in the international setting. Furthermore, the abundance of opportunities for exploiting differences in location advantages and firm-specific assets in East Asia results in the proliferation of outsourcing. Examples include original equipment manufacturers (OEM), original design manufacturers (ODM), electronics manufacturing services (EMS), and foundries. The designers or managers of networks are also varied, not necessarily downstream assemblers; vendor-managed inventory (VMI) services are examples in which logistic companies play a crucial role.

The recent technological and managerial innovation in corporate management is clearly supporting the proliferation of various business models in East Asia. As mentioned above, the evolution of business models, particularly in the computer industry, from vertically-integrated giants to firms concentrating on core competences is

one of the crucial changes in the mindset of corporate managers. Another significant trend is the development of a lean production method, a just-in-time system, value (supply) chain management, and cash flow management. Furthermore, the deepening of the product architecture argument, namely modular versus integral, is also crucial to the development of various business models.

The next task for research is to investigate the spatial structure of production/distribution networks.

3. Four-layer Spatial Structure

Currently, machinery industries are dominant players in East Asian networking, both in quantity and quality. Because machines typically consist of a large number of parts and components, fragmentation with delicate coordination is naturally pursued. Short product life cycles result in active R&D and frequent reshuffling of value chains. Machinery industries therefore present the most sophisticated form of production networking in the globalizing world, and so we can derive important economic logic that is largely applicable to other industries.

An assembly plant in the machinery industry uses a large number of parts and components, and the procurement of parts and components and the sales of products are typically stratified into four layers in terms of gate-to-gate lead time and the frequency of delivery (Table 1). For convenience, let us call these "the first layer (local)," "the second layer (sub-regional)," "the third layer (regional)," and "the fourth layer (world)."

Table 1. Four Layers of Transactions in Production/Distribution Networks

	1st layer (local)	2nd layer (sub-regional)	3rd layer (regional)	4th layer (world)
Lead time	Less than 2.5 hours	1 to 7 days	1 to 2 weeks	2 weeks to 2 months
Frequency	Once or more in a day	Once or more in a week	Once a week	Once a week
Transport mode	Trucks	Trucks/ships/ airplanes	Ships	Ships
Trip length	Less than 100km	Less than 1,500km	Less than 6,000km	Longer

Source: Author.

The first layer covers transactions with a gate-to-gate lead time of less than 2.5 hours and a delivery frequency of once or more per day. Most of these transactions are handled by trucks and are predominantly arm's-length. The geographical area of these transactions corresponds to what we call "industrial agglomeration" in which a tight just-in-time system with frequent deliveries and monitoring is operated. Transactions with business partners that are new, small, and that are not entirely trusted are conducted mostly within this geographical boundary. Here, an integral interface is possible, and penetration by local firms/entrepreneurs into production networks as well as technological transfers/spillovers may occur. Congestion effects in the form of wage hikes, increases in land prices, traffic jams, and others also occur in such geographical areas.

Examples of geographical areas where first-layer transactions occur with dense vertical links include the Bangkok-Eastern Seaboard area in Thailand, Selangor and Penang in Malaysia, and the Pearl River Delta and the backyard of Shanghai in China. Figure 3 is a map of the Bangkok-Eastern Seaboard area in Thailand with major industrial estates. A circle with a 100-km diameter, centered in east Bangkok, covers most of the industrial estates in this area. This is exactly the geographical area in which Toyota sets up a tight just-in-time system for more than 80% of parts and components; Toyota plants only hold less-than-two-hour inventories for most parts and components. The Pearl River Delta is almost the same geographical size and so this type of agglomeration may develop. The distance of 100 km corresponds to Tokyo-Takasaki, Tokyo-Mishima, Nagoya-Iwata, Osaka-Suzuka, and Osaka-Akoh; thus, a circle with a 100-km diameter roughly covers the greater Tokyo, Nagoya, and Osaka areas, respectively.

The second layer includes transactions with a lead time of 1 to 7 days and a delivery frequency of once or more per week. Transport modes vary; these can be trucks, ships, or airplanes. For intra-firm transactions, the second layer covers transactions between plants held by the same multinationals. For arm's-length transactions, parts and components with a modular interface comprise a large portion; trade in computer modules and transactions with EMS firms are typical examples. Some transactions have an integral-type interface; in these cases, parts and components producers often have a

sound reputation and negotiating power so they do not follow a downstream firm's request for relocation. In addition, plant-level economies of scale are sometimes crucial in this type of transactions.

Figure 3. The Bangkok-Eastern Seaboard Area and Industrial Estates

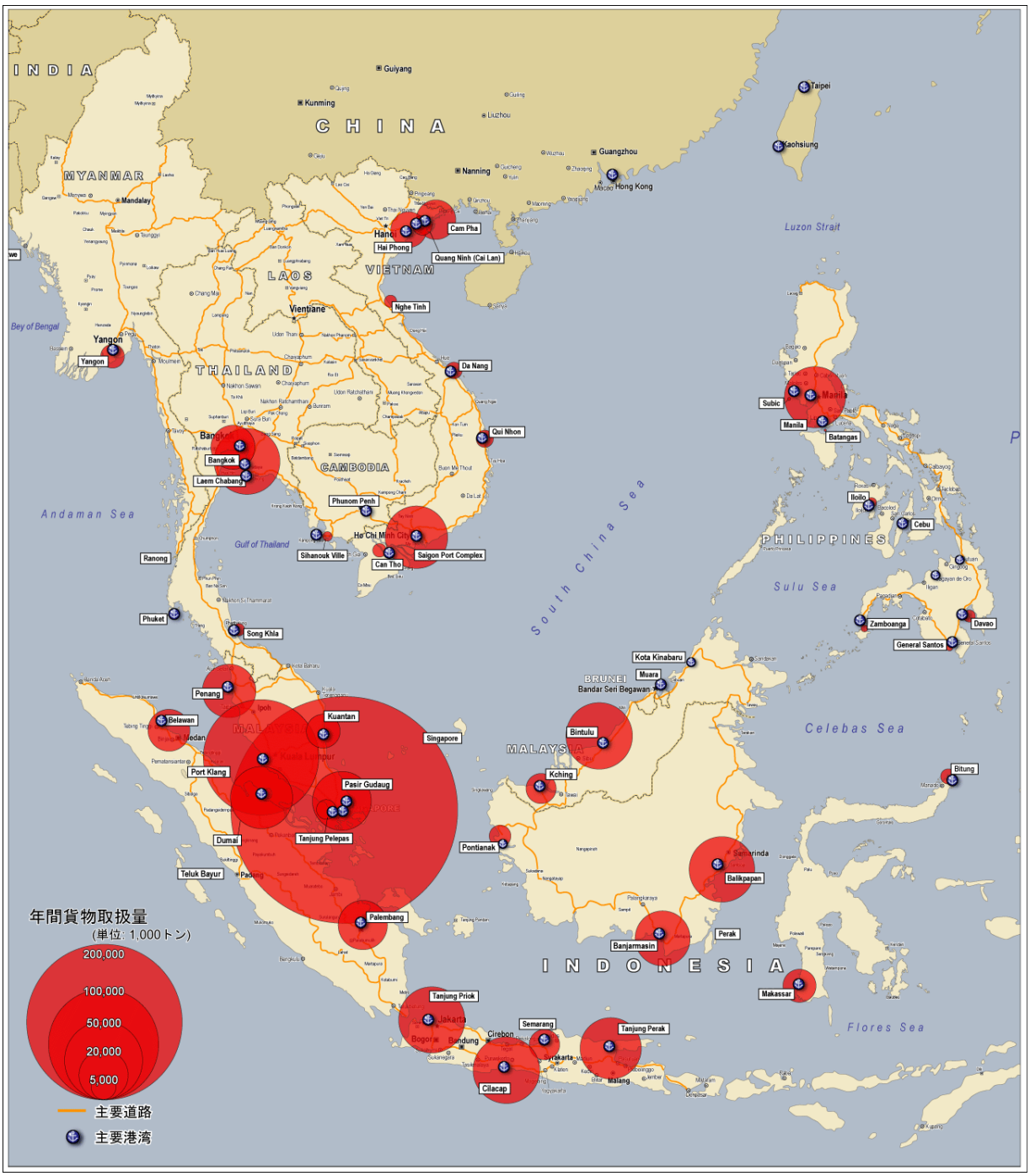
Source: Board of Investment, Thailand. The circle is added by the author.

An example of a geographical area in which second-layer transactions are conducted is the North-South corridor between Bangkok and Singapore. The distance between these two cities is roughly 1,500 km, which is equivalent to the length of Honshu Island in Japan. This is the longest distance for second-layer transactions. Figure 4 presents daily traffic on highways in the ASEAN region, and the arrow denotes a distance of 1,500 km. The traffic connection between Singapore and Malaysia is known to be dense, with multiple bridges and high-grade highways. In addition, cross-border operations between Thailand and Malaysia are developing gradually, accompanied by an improvement in customs clearance at the border and the mutual acceptance of trucks without re-loading. Figure 5 depicts the locations of major ports and their annual cargo handling in the ASEAN region. We can conceive that a large portion of second-layer transactions are transactions among industrial agglomerations. Figure 6 shows the frequency of regular air flights between ASEAN airports. Again, the importance of the North-South corridor between Bangkok and Singapore is confirmed. Air transportation represents a large share of cross-border trade in electronic parts and components, which have high values per weight or volume. With the improvement of customs clearance, a within-24-hour just-in-time system becomes possible among three countries by air. It is also important that businessmen can make a round trip within a day along this North-South corridor.

Figure 4. Daily Traffic of the ASEAN Highways

Source: JETRO (2007). The arrow is added by the author.

Figure 5. Major Ports and Their Cargo Handling in ASEAN



Source: JETRO (2007).

Figure 6. Frequency of Air Traffic in ASEAN

Source: JETRO (2007).

If we draw a circle with a 1,500 km diameter, it covers the core of the entire Southeast Asia or the flat region of mainland China. However, second-layer transactions are not yet observed everywhere. The second-layer transactions can extend to a distance of 1,500 km only when industrial agglomerations have grown at both ends simultaneously with the development of transport infrastructure, logistic industries, and trade facilitation.

The third layer includes transactions with a lead time of 1 to 2 weeks and a typical delivery frequency of once per week. The corresponding geographical area covers the entire East Asia region; transactions between Japan and China/ASEAN fall into this category. Actually, the size of North America is about the same, and Europe is slightly smaller than East Asia. Because transactions are allowed to have some flexibility in their delivery timing, marine transportation is a major mode. Air transportation is used additionally in urgent situations. Intra-firm transactions between parent firms and affiliates are included in this layer. This is the geographical area in which the regionalization of economies has developed.

The fourth layer includes transactions covering the entire world. The lead time is typically 2 weeks to 2 months, and the frequency of delivery is, say, once per week. The predominant transport mode is marine transportation with containers along regular shipping routes. Although air transportation is sometimes used, the proportion is relatively small. For machinery producers located in East Asia, markets outside East Asia are still important, although market shares are gradually decreasing due to the development of the East Asian market itself (Ando and Kimura (2008)).

4. Factors Affecting the Choice of Transaction Layers

By returning to the framework of two-dimensional fragmentation, we can list major factors that affect which transaction layers are chosen as in Table 2.

As for the economic logic in fragmentation along the distance axis, there are three kinds of costs to be considered: (i) network set-up costs or relocation costs; (ii) service link costs; and (iii) location advantages to save production costs *per se*. When network set-up costs or relocation costs are low, shorter distance transactions are better, and vice versa. When service link costs including transport costs are high, shorter distance transactions are preferred, and vice versa. When differences in location advantages are significant, long-distance transactions are permitted and vice versa. When plant-level economies of scale are salient, long-distance transactions may be warranted.

Table 2. Factors Affecting Transaction Choices

	1st layer (local)	2nd layer (sub-regional)	3rd layer (regional)	4th layer (world)
Re: fragmentation along the distance axis				
Network set-up cost / relocation cost	small ◄	———	► large	
Service link cost (esp. transport cost (cost, lead time, quality))	large ◄	———	———	► small
Location advantages (esp. production conditions, economies of scale)	small ◄	———	► large	
Re: fragmentation along the disintegration axis				
Intimacy of inter-firm relationship				
Intra-firm vs. arm's-length (capital holdings)	arm's-length ◄	———	———	► intra-firm
Credibility	weak ◄	———	► strong	
Power balance	unbalanced ◄	———	► balanced	
Architecture of inter-firm interface				
Modular vs. integral	integral ◄	———	► modular	

Source: Author.

As for fragmentation along the disintegration axis, the relationship between transaction costs and geographical proximity is crucial. If the intimacy or trust between business partners is high, the geographical distance in transactions can be long, and vice versa. Therefore, arm's-length transactions are predominant in the first layer while intra-firm transactions occupy a large share in the third layer. For arm's-length transactions, when credibility is weak (strong), the first layer (second layer) is chosen. When the power balance between upstream and downstream firms is unbalanced, the first layer is chosen. When the power of upstream and downstream firms is balanced, the second layer can be selected. In addition, the architecture of the inter-firm interface is important. When a modular interface is selected, transactions can be in the second layer or third layer. On the other hand, when the interface is totally integrated, the first layer is predominantly chosen.

The list of factors in Table 2 is useful for understanding differences in the spatial structure of production networking across industries and product lines. Production networks for personal computers consist of the first layer for production-supporting services, the second layer for modules, and the third and fourth layers for distribution. HDD assembly spans the first and second layers. The automobile industry primarily utilizes the first layer while some parts with economies of scale such as spark plugs are in the second layer. Production networks with an OEM/ODM contract or EMS firms are in the first and second layers. By assessing the weights of these factors, we can lucidly explain the choice of transaction layers.

The application of this framework to industries other than machinery industries would require some cautious empirical work because the technological and managerial setting could be different. For example, outsourcing in software development between the US and India may present a different spatial structure of production networks. However, fundamental factors that determine the spatial structure of production networks seem to share common factors across industries.

5. The Link with Technology Transfers and Spillovers

International production/distribution networks provide various opportunities for MNEs and local firms in developing countries to compete and cooperate with each other. Such interactions between MNEs and local firms are much more varied and intense than in a world with a relatively simple industry-wise North-South division of labor. This in turn implies that the nature of technology transfers and spillovers has certainly evolved in the enhanced economic dynamism.

What would be the implication of production fragmentation for technology transfers and spillovers? In comparison with the relocation of whole operations to LDCs, an MNE has a degree of freedom in how to cut out production blocks, which generates much larger flexibility in the location pattern. This means that an MNE can relocate some activities to LDCs with much smaller commitments than in the case of the relocation of entire activities. The consequence is that some production processes in industries, the relocation of which has not even been considered in the past, actually move to LDCs with technology. From the viewpoint of hosting LDCs, weaker policy intervention such as the improvement of special economic zones and logistics services would be necessary to induce such FDI than in the case of the relocation of the entire industry in the form of import-substituting FDI.

The physical movement of technology and managerial know-how to LDCs would provide more opportunities for local firms or entrepreneurs to enjoy technology transfers or spillovers. However, a possible difficulty comes from thin slices of value chains. Particularly at the early stage of development, fragmented production blocks do not typically engage in transactions with neighboring firms, which limits the linkage

channel of technology transfers/spillovers. In addition, technology absorptive capacity is one of the crucial determinants for what sort of production processes will be located in LDCs, whether vertical linkage is developed, and whether technological spillovers occur. LDCs at the initial stage of industrialization typically suffer from low technology absorptive capacity.

Once LDCs reach the stage of formulating industrial agglomeration, the perspective of technology transfers and spillovers is drastically improved. In industrial agglomeration, vertical division of labor by means of arm's length transactions is actively conducted. Initially, such transactions tend to be among upstream and downstream MNEs. However, under severe competitive pressure, MNEs start seeking local firms to procure parts and components at cheaper prices. Some MNEs may even be keen to transfer technologies to local firms/entrepreneurs in order to obtain a supply of parts and components at satisfactory prices, quality, and delivery timing. Technology absorptive capacity of local firms and entrepreneurs again becomes an important determinant of the extent of technology transfers and spillovers. A key difference from the traditional import substitution strategy with heavy trade protection is competitive pressure from international markets, which provide efficiency in the operation of MNEs.

The spatial structure of production networks provides an important geographical consideration regarding technology transfers and spillovers. At least in the case of machinery industries with major just-in-time systems, arm's length transactions almost always occur in geographical proximity. When a novice local firm enters international production networks, this most often occurs as a first layer transaction. This geographical extension is also equal in size to one industrial agglomeration. It coincides with the geographical extent in which human resources can travel daily. Cross-border arm's length transactions by local firms, i.e., transactions in the second or third layer, are rare except in cases where the firm already establishes a strong reputation.

In industries other than machinery, some adjustments are necessary. In the garment industry, for example, the speed and frequency of transactions are typically slower than in the machinery industry, and thus longer-distance transactions between MNEs and local firms may be possible. In the software industry, the geographical

distance in transactions may be less important, although credibility remains important. In both cases, technological links with MNEs are crucial to the quality of work.

6. New Development Strategies and Technology Transfers/Spillovers

The formation of international production/distribution networks in East Asia induces fundamental revision of development strategies for LDCs. New development strategies claim that participation in international production/distribution networks is the key to accelerating economic development in an era of globalization.[3]

The concept of four layers of transactions has a profound policy implication. In the context of East Asia, developing countries at the early phase of economic development try to participate in international production networks by hosting production blocks pushed out of congested industrial agglomeration in the neighborhood. During this phase, transactions by invited production blocks occur mostly in the second layer. On the other hand, developing countries that have reached a higher phase of economic development should try to formulate efficient industrial agglomeration; in this phase, transactions in the first layer become important. Alternatively, in the context of developing economies outside East Asia, long-distance transactions such as those in the third layer become important. Required policies as well as demand for hard and soft infrastructure are certainly different, depending on what types of transactions are expected.

The development of international production/distribution networks in East Asia also presents a new perspective on technology transfers and spillovers. Hosting FDI generates both positive and negative effects on local firms and entrepreneurs. Negative effects stem from enhanced competition in local markets of products and labor where technological dominance by MNEs may adversely affect the performance of local firms. On the other hand, positive effects derive from easier access to technology and managerial know-how for local firms and entrepreneurs. Technology transfers or

[3] Kimura (2004) discusses the decline in traditional development strategies and the emergence of new thinking in East Asia. Kimura (2008a, b) strengthens the argument by connecting policy discussion with the extended fragmentation theory and the spatial structure of production/distribution networks.

spillovers may occur in the form of imitation or reverse technology, spin-off of engineers, and most notably vertical links to upstream/downstream MNEs.

A traditional development strategy utilizing import-substituting FDI intends to establish vertical links between local firms and MNEs and explore the possibility of technological upgrading of local firms and entrepreneurs. Such attempts often fail because the size of the local market is small and compensating incentives for MNEs such as import restrictions degrade the competitive environment. Under discretionary incentive schemes, MNEs typically have a weak incentive to make technology transfers to local firms and entrepreneurs.

Another development strategy that utilizes export-oriented FDI does not provide a notable outcome in technology transfers and spillovers insofar as the activities of MNEs are geographically segregated in narrow export processing zones (EPZs). MNEs in EPZs are exposed to international competition and pursue maximum efficiency. However, value-added slices that MNEs bring in are often very thin and limited to purely labor-intensive activities, and the enclave nature of EPZs becomes a serious obstacle to technology transfers and spillovers.

International production/distribution networks, particularly at the stage of development observed in East Asia today, present a new possibility for technology transfers and spillovers. East Asia proves that the sophistication of production fragmentation can achieve the formation of industrial agglomeration in which active technology spillovers may occur. In an internationally competitive environment, some MNEs are quite willing to transfer technologies. This is a new way of pursuing technology transfers and spillovers.

One problem is that not all countries can immediately attain such a stage of development. In order to participate in international production/distribution networks, a country must host the first wave of production blocks invested by MNEs. At this stage, the operation tends to be thin in value added, perhaps even thinner than in the case of traditional EPZ operations, and local vertical links are not yet established. This means that significant technology transfers or spillovers may not be expected for a while if the technology absorptive capacity is not well developed. Policymakers in LDCs must be patient until they are hosting a critical mass of FDI, rather than hastily

introducing performance requirements for technology transfers. Once the seed of industrial agglomeration has been planted, local firms and entrepreneurs will have ample opportunities for penetrating into production networks, which will eventually accelerate technology transfers and spillovers.

Although these arguments require further theoretical elaboration and empirical support, they seem to be largely consistent with the literature on technology spillovers. The literature in particular suggests that vertical, input-output linkages between local firms and MNEs are the most powerful channel to accelerate technology transfers and spillovers.[4]

7. Concluding Remarks

This paper explores the spatial structure of production/distribution networks in East Asia by introducing the concept of four layers of transactions. By further expanding the framework of two-dimensional fragmentation theory, a much clearer picture of spatial designs for production/distribution networks is revealed.

This paper also presents preliminary thoughts on the implication of international production/distribution networks for technology transfers and spillovers. It seems obvious that well-developed production/distribution networks with industrial agglomeration generate massive technology transfers and spillovers. East Asia is presenting a novel development strategy in which fragmentation and agglomeration forces are effectively utilized. Further empirical studies using micro/panel data are expected to confirm our intuition.

[4] For literature on microdata-based empirical studies on the impact of globalization, including technology spillovers, see Hayakawa, Kimura, and Machikita (2008).

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