

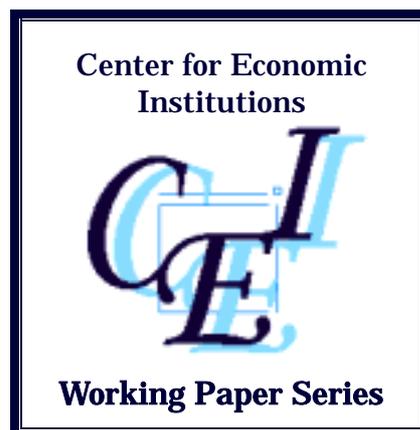
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*“The mechanics of production networks in
Southeast Asia:
the fragmentation theory approach”*

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Summary

Southeast Asia is truly a unique area in that it deeply gets involved with sophisticated international production networks extended to the whole East Asia. This chapter provides an overview on the current status of economic analysis on this issue, placing its emphasis on the newly developed fragmentation theory approach. The two-dimensional fragmentation model is introduced and employed for disentangling the mechanics of production networks as well as the spatial structure of networking in East Asia. Profound policy implication for further activating production networks and economic development in Southeast Asia and other less developed countries is also discussed.

1. What happens in international trade and industrial location?

At this point in time, Southeast Asia is truly a unique area in that it deeply gets involved with sophisticated international production networks extended to the whole East Asia.¹² The formation of international production networks in East Asia has created an unprecedented pattern of trade and industrial location across countries with different income levels and development stages. In the process of forming production networks, the perception of hosting foreign direct investment (FDI) has totally been renewed, and strategies for industrial promotion have also been critically reviewed. It is now extremely important to analyze the nature and characteristics of international production networks in East Asia and discuss their policy implication for less developed countries (LDCs) such as Southeast Asian countries. This chapter provides an overview on the current status of economic analysis on this issue, placing its emphasis on the newly developed fragmentation theory approach.

Until the 1980s, Southeast Asian countries followed a typical North-South

¹ In this paper, “Southeast Asia” stands for ASEAN member countries, and “East Asia” indicates ASEAN+3 (and sometimes with Chinese-Taipei).

² Kimura (2006) presents “eighteen facts” on international production/distribution networks as well as offering a list of further references.

trade pattern; they exported natural-resource-based products and labor-intensive manufactured goods to developed countries while importing a whole range of capital-intensive/human-capital-intensive manufactured goods. Trade with neighboring countries at similar income level was basically inactive. Such a trade pattern was well explained by the traditional trade theory based on comparative advantage such as the Ricardian and Heckscher-Ohlin models in which international trade occurred due to differences in technologies and/or factor endowments among countries. A majority portion of FDI was in import-substituting-type industries with highly distortive trade protection and a long list of performance requirements, and export-oriented FDI was confined to export-processing zones from which the domestic economy was cautiously insulated.

Trade and FDI patterns in Southeast Asia have drastically changed since the beginning of the 1990s. The North-South trade pattern has steadily subsided, and massive intra-industry trade, particularly in general and electric machineries, has gradually dominated trade in East Asia. The intra-industry trade is actually vertical, in contrast with horizontal intra-industry trade in Europe. The vertical product

differentiation model, however, does not seem to explain a large portion of East Asia's intra-industry trade. Rather, we observe the explosive development of dense transactions in parts and components among East Asian countries accompanied with production-process-wise division of labor.³ Export-oriented or network-forming-type FDI has occupied the center stage, replacing for import-substituting-type FDI.

Figure 1 presents shares of machinery exports/imports in total exports/imports in selected countries in the world. Each bar indicates both machinery trade in total and machinery parts & components trade in 2005. Countries are in order from the left-hand side according to the shares of parts & components exports. "Machinery" here includes general machinery, electric machinery, transport equipment, and precision machinery (HS 84-92), which cover major industries extending production networks.⁴

== Figure 1 ==

³ See Ando (2006).

⁴ Such production networks are observed in various industries such as chemical industry, textiles and garment, software industry, and others. However, machinery industries are by far the most important industry in magnitude at this point in time.

The positioning of major Southeast Asian countries in the figure tells the whole story. The Philippines, Singapore, Malaysia, and Thailand are all on the left-hand side of the figure and actively export and import machinery goods, in particular machinery parts & components. As a counterpart, Northeast Asian countries, namely Japan and Korea, are also conducting massive back-and-forth transactions in these goods. China is about in the middle but is quickly moving leftwards. Indonesia and other Southeast Asian countries (not shown in the figure) are still on the right-hand side, which indicates that these countries do not yet fully participate in production networks as of 2005. However, these countries recently present some signs to integrate their economies into the Asian dynamism.

The contrast with other parts of the world is notable. In Latin America, only Mexico and Costa Rica work on production sharing with the US while other countries do not establish such networks yet. Central and Eastern European countries such as Hungary, Czech Republic, Poland, and Slovakia have similar relationship with Western European countries, but networks are still relatively simple back-and-forth outsourcing. The advancement of production networks in East Asia clearly leads the world.

Facing such important phenomena, analyzing the mechanism of international production networks in East Asia is truly an important research agenda. Why did we observe such a sudden development of sophisticated production-process-wise division of labor? What made East Asia special? What was and will be the role of multinational enterprises (MNEs) in forming and operating production networks? What would be the implication for the economic development of LDCs such as Southeast Asian countries? These issues are important not only for academicians but also for policy makers in LDCs.

The fragmentation theory is a newly developed line of research in international trade theory. The prototype theoretical formation is provided by Sanyal and Jones (1982) in the context of trade in middle products, and Jones and Kierzkowski (1990) provide path-breaking application of the idea for international production sharing so as to establish the concept of “fragmentation.” Arndt and Kierzkowski (2001), Cheng and Kierzkowski (2001), Deardorff (2001), and others contribute to enhancing the applicability of the concept of fragmentation in both theoretical and empirical analysis. The concept of fragmentation is particularly important in

understanding the nature and characteristics of international production networks in East Asia, and Kimura and Ando (2005) develop the framework of two-dimensional fragmentation, which we apply in this chapter.

The chapter plan is as follows: the next section explains the concept of two-dimensional fragmentation and discusses how far it can be useful in understanding the mechanics of production networks. The third section applies the concept for East Asia and examines the spatial structure of production networks with special reference to the positioning of Southeast Asia. The fourth section presents the connection with policy agenda in Southeast Asian countries. The last section concludes.

2. The mechanics of production networks

The international trade theory has a tradition of aggregating individual firms' behavior up to the industry/macro level and constructing a general equilibrium framework for rigorous welfare analysis. According to this strict criterion, the fragmentation theory is still at its infant stage. It however proves its powerful applicability to the analysis on firms' decision making and the mechanics of

production-process-wise division of labor.

(1) The original concept of fragmentation

The original source of imagination for the concept of fragmentation was the US-Mexico production sharing. Figure 2 illustrates a typical border operation between the US and Mexico. A US firm prepares necessary parts & components and sends them to its own production plant located in Maquila in the Mexican territory.⁵ After the assembly process using inexpensive labor is completed in Mexico, the products are sent back to the US and served for the US market. Such operation is mostly intra-firm production sharing in the form of simple back-and-forth, closed-loop fragmentation. Local production links inside Maquila are very thin in general.⁶

== Figure 2 ==

⁵ Maquila is a special industrial zone in Mexico, specifically designed for the US-Mexico border operation.

⁶ Yi (2003)'s indicators for international production sharing is actually based on such a simple pattern and thus are not properly applicable to the East Asia's situation.

Figure 3 illustrates the original idea of fragmentation, presenting its key concepts, production blocks and services links. Suppose that a firm in electronics industry originally has a huge factory in a developed country that takes care of the whole production processes from upstream to downstream. The traditional theory predicts that a capital and/or human capital industry such as electronics should be located in a developed country abundant in physical/human capital. If we carefully look at the factory, however, we may find various types of production processes. If the firm can separate production processes and locate them in appropriate places, the total production cost may be saved. For example, capital- or human-capital-intensive processes would continue to be located in developed countries while labor-intensive ones would be moved to LDCs. Or, paradoxically, extremely capital-intensive processes might be located in LDCs because it would need to accelerate capital depreciation by 24-hour operation. This is “fragmentation.” There are two elements that make fragmentation possible. First, there must be production cost saving in fragmented production blocks; the firm must take advantage of differences in location advantages between the original position and a new position. Second, the cost of

service links that connect remotely located production blocks, i.e., the cost of transportation, telecommunication, and various types of coordination, must not be too high. The feasibility of fragmentation, therefore, heavily depends on the nature of technologies in the industry and economic environment.

== Figure 3 ==

(2) The two-dimensional fragmentation

The production networks in East Asia, however, are much more sophisticated. Figure 4 is an example. It contains a complicated combination of intra-firm and arm's-length (inter-firm) transactions whereas the original idea of fragmentation implicitly assumes intra-firm fragmentation. It does not necessarily consist of a simple closed-loop link, but a much more complicated, open-ended network is often observed. We can also observe the formation of agglomeration together with fragmentation even though forces of fragmentation and agglomeration may seem to go in the opposite directions. Transactions among less developed countries (LDCs) such as trade in parts

& components between Malaysia and the Philippines also start to grow, which cannot perhaps be explained by differences in location advantages.

== Figure 4 ==

To entangle the mechanics of such production networks in East Asia, the framework of two-dimensional fragmentation (Kimura and Ando (2005)) is extremely useful. Figure 5 is a schematic presentation of the concept. The horizontal axis denotes geographical distance, and fragmentation in this direction from the origin is a traditional one. In this type of fragmentation, a firm takes advantages of differences in location advantages while service link cost due to geographical distance must be borne. The mechanics of such fragmentation are particularly effective in cross-border fragmentation between a developed and developing countries. On the other hand, the vertical axis is newly introduced in order to represent disintegration or outsourcing to other unrelated firms. In this type of fragmentation, differences in firms' technologies and managerial know-how are utilized for production cost saving while service link cost

or “transaction cost” in arm’s-length (inter-firm) transactions must be borne. Various forms of outsourcing observed in East Asia including subcontracting, OEM (original equipment manufacturing) contract, EMS (electronics manufacturing services) firms, internet auctions, and others are interpreted as fragmentation of this type.

== Figure 5 ==

In case of East Asia, countries are at diversified income levels as well as different development stages, which generate large differences in location advantages such as differences in wage levels for various types of human resources, services of industrial estates, tax incentives, and others. To make fragmentation possible, however, fairly low service link cost must be offered in addition to favorable investment climate. In East Asia, transactions in machinery parts & components notably become quicker, cheaper, and more reliable in the 1990a and after so that new types of dense supply networks are actively developed. On the other hand, in the disintegration-type fragmentation, the saving of production cost *per se* is due to differences in firm-specific

assets, such as technology and managerial know-how, between two firms. Service link cost in this context includes various kinds of transaction cost due to losing controllability. The existence of various types of potential business partners as well as flexible and accountable business environment is the key for the disintegration-type fragmentation in East Asia.

(3) Further application of fragmentation theory

Further thought of fragmentation theory provides convincing explanation on the sophisticated nature of production networks in East Asia. First, we observe fragmentation and agglomeration at the same time in East Asia. Of course, at an individual firm level, fragmentation and agglomeration are forces heading for directions opposite to each other. However, fragmentation at the firm level and agglomeration at the industry or macro level can go together. The fragmentation theory suggests a couple of economic logics for such phenomena. The one comes from the existence of economies of scale, particularly in service links in the distance-type fragmentation. If a city or an industrial estate offers substantially low service link cost, it may attract

production blocks of many companies. The other is due to the close relationship between geographical proximity and service link cost (transaction cost) in the disintegration-type fragmentation. The latter, in particular, generates forces of forming efficient vertical links among unrelated firms in agglomeration. This actually provides chances for local firms to penetrate into networks.

Second, a MNE setting up an international production network tries to design, operate, and control the whole value chain unless a part of the value chain can be taken care of by efficient spot markets. It is thus natural that a large portion of transactions in production networks is “relation-specific,” if not totally intra-firm, rather than spot-market-type transactions. One of the important consequences is that a firm can have room for discretion in how to cut out production blocks in designing production networks. Compared with relocating a whole operation from one place to the other, fragmentation can be much more flexible in utilizing various components of location advantages. From the viewpoint of recipients of FDI, even if it were difficult to immediately provide perfect business environment, FDI would come in with some pinpointed improvement of investment climate at some specific place. Wise

government policy is vital here.

Third, the recent development of “horizontal” transactions among developing countries can also be neatly explained by introducing fixed relocation cost. In contrast with the US-Mexico Nexus and the WE-CEE Corridor, East Asia has started conducting extensive transactions among developing countries including Southeast Asian countries and China. The fragmentation theory may seem only to explain transactions between countries with different location advantages; i.e., countries at different income levels. However, once fragmented production blocks are located in multiple places just like we observe in Southeast Asia and China, “horizontal” transactions emerge.

The key tradeoffs for explaining such phenomena include “relocation cost vs. service link cost” and “positive vs. negative agglomeration effects.” “Relocation cost vs. service link cost” means that a location close to the client saves service link cost while the relocation also costs; if the latter factor is larger, a firm does not relocate the plant and keep paying service link cost in distance-type fragmentation. “Positive vs. negative agglomeration effects” mean that agglomeration saves transaction cost in disintegration-type fragmentation while congestion effects degrade location advantages.

Thus, vendors may want to keep some distance from their clients. Through these mechanisms, once fragmentation develops beyond some critical point, forces of “horizontal” transactions start working. The mechanism shares some aspects of intra-industry trade among developed countries based on horizontal product differentiation. It is, however, somewhat different in that we observe trade primarily in intermediate goods with vertical links, rather than finished products, and among developing, rather than developed, countries.

3. The spatial structure of production networks in East Asia

Because official statistics such as international trade statistics and FDI-related data is not intended to investigate the nature of production networks, it is very difficult to draw the overall structure of production networks with rigorous econometric analysis. However, having the two-dimensional fragmentation theory as a prior, we can capture the current spatial structure of production networks in East Asia. The following three points are what we have learned from empirical observations so far.

(1) Findings from the gravity equation exercises

One way to investigate the property of production networks in East Asia is to check the implication of geographical distance in gravity equation exercises. The gravity equation is a popular empirical tool to analyze bilateral trade flows among countries. It basically regresses values of bilateral trade flows on the economic size of exporting and importing countries, geographical distance between the countries, and other control variables. The recent studies by the author and his coauthors find interesting properties of production networks in East Asia vis-à-vis benchmark trade patterns in other parts of the world. The key variable in the following is geographical distance, which penalizes bilateral trade flows.

First, in case of trade in machinery parts and components, the absolute values of the coefficients for geographical distance in intra-East-Asia trade are by far smaller than those in intra-Europe trade (Kimura, Takahashi, and Hayakawa (2007)). If we interpret geographical distance as a measure reflecting the magnitude of service link cost, we can conclude that East Asia provides more favorable environment for production networking than Europe in terms of service links.

Second, as for intra-East-Asia trade, the absolute values of the coefficients for geographical distance for machinery parts & components are larger than those for machinery finished products and all merchandise trade (Ando and Kimura (2007)). It suggests that transactions among fragmented production blocks require something more than simple transport cost, i.e., service link cost in production-process-wise division of labor.

Third, also for intra-East-Asia trade, the absolute values of the coefficients for geographical distance slightly increased over the 1990s and after (Ando and Kimura (2007)). Taking into account the explosive growth in intra-East-Asia trade during the period, we should not regard it as indicating the aggravation of trade impediments. Rather, it must be interpreted as the reflection that variety of traded goods are substantially enlarged; what was not traded in the past is now actively traded. Another factor is the development of trade among neighboring developing countries.

(2) Four layers in spatial structure

Together with casual observations from case studies and fieldworks, we

identify four layers in the spatial structure of production networks in East Asia: 1) global, 2) region-wide, 3) sub-regional, and 4) local.

The first layer “global” means connections beyond East Asia. East Asia is not like “fortress Europe,” but trade with other parts of the world, particularly with North America and Europe, has also actively conducted. However, transactions in the second layer “region-wide” have grown at a much faster pace, particularly in transactions of machinery parts & components. As a result, the weight of inter-regional transactions (i.e., between East Asia and other parts of the world) has declined in the relative sense.

The regionalization of trade in East Asia, corresponding to the second layer goes together with the deepening and extension of production networks. MNEs design and construct production networks by combining intra-firm transactions in long distance and arm’s-length transactions in short distance. The boundary of networks has gradually expanded to latecomers in Southeast Asia and even India.

The fourth layer “local” comes into the stage of forming active vertical transactions in agglomeration developed in a number of places in Southeast Asia and China. The required geographical proximity so as to effectively utilize arm’s-length

transactions seems to be within a few-hour drive by truck. This distance allows multiple shuttles of deliveries a day and milk runs in just-in-time system with quick back-up arrangements for emergency, which saves service link costs of both types of fragmentation. In such agglomeration, local firms start penetrating into networks originally established by MNEs.

The third layer “sub-regional” is newly developed in Southeast Asia where parts & components producers are spread over multiple countries. Once service link cost becomes low enough, some competitive vendors try to establish middle-range transactions with clients so as to avoid relocation cost. Indeed, some electronic machinery producers set up a within-24-hour just-in-time system between Thailand and Malaysia by air, for example. In addition, transactions in some finished products such as domestic electric appliances among Southeast Asian countries start increasing as the reshuffling of assembly plant location is accelerated by tariff reduction led by ASEAN Free Trade Area (AFTA). As a result, Southeast Asia steps up a stage from simple vertical production sharing to network transactions.

We certainly observe differences in the development of international

production networks across industries. Some industries such as iron & steel and fresh food industry are not suited for fragmentation because of strong economies of scale in production and/or high service link cost. A polar example is electronic industry in which production processes are well diversified and service link cost is low. The contrast between electronics industry and automobile industry is of interest because location patterns are widely different even if both industries use a large number of parts & components. However, the fragmentation theory can explain such differences across industries in a consistent way. The contrast between electronic industry and automobile industry comes from technological and managerial differences; the former is good at modulation while the latter is due to its total-integration-type network management. Such differences are neatly explained in the framework of highlighting a tradeoff between relocation cost and service link cost; vendors in electronics industry prefer paying service link cost while those in automobile industry are willing to pay relocation cost.

(3) Dynamic aspects of production networks

Since forces of fragmentation utilize diversity in location advantages, production networks are necessarily accompanied with dynamism in nature. Differences in income levels are one of the fundamental sources of differentiating location advantages. East Asia includes countries at diversified development stages and provides suitable economic conditions for fragmentation. As economic development proceeds, the frontier of production networks will move outward, and the role of each location in production networks is continuously revised. Such dynamism has vividly been observed in East Asia.

Production blocks on the frontier are typically labor-intensive. When a wage hike or congestion occurs at the original position due possibly to the growth of agglomeration, such activities start seeking a new location. Agglomeration is accompanied with both positive and negative effects, and some sorts of activities are particularly sensitive to the latter. Forces of trickle-down are thus generated, which pushes the frontier of production networks further.

Fragmentation can thus have beneficial impact on economic development. Developing countries should leave a part of their destiny in hands of MNEs, which

would certainly be an uncomfortable aspect. Instead, they could utilize the energy of globalizing corporate activities. In general, the mechanism of fragmentation makes developing countries, particularly smaller ones, easier to invite inward FDI. Traditional strategies of hosting import-substituting FDI can work only in countries with potentially large markets; otherwise, countries have to provide highly market-distorting incentives for inward FDI. MNEs have room for deciding how to cut out production blocks, and production blocks are interconnected by relation-specific transactions. Thus, developing countries may not need to improve the overall investment climate but can concentrate on pinpointed treatment on its bottleneck. Developing countries can also take advantage of competition among MNEs. Vietnam has recently succeeded in attracting the first wave of FDI so as to be incorporated with production networks in East Asia. Inland China, Cambodia, Laos, and Myanmar are also potentially under potential trickle-down effects from agglomeration in the coastal area of China and the Thailand-Malaysia-Singapore nexus if economic condition for fragmentation meets.

Countries being caught up by latecomers need to step forward. As the wage level goes up, location advantages for labor-intensive activities are necessarily

weakened. So as to keep a certain mass of production blocks, positive agglomeration effects should be strengthened, and location advantages for higher levels of activities must be prepared. At this stage, economic infrastructure for efficient just-in-time vertical transactions and the development of local human resources and indigenous firms become crucially important. Malaysia, Thailand, and the coastal area of China seem to be pretty successful in overcoming this challenge while the Philippines, Indonesia, and others are having a hard time.

In such dynamism, developed countries including Japan, Korea, Taiwan, Hong Kong, Singapore, and others also face a new challenge. As neighboring countries are catching up, economic activities attracted to developed countries may become thinner and thinner. Particularly in cases of Japan, Korea, and Taiwan, their own firms tend to extend production networks abroad, and the return to their activities does not necessarily come back to the home countries. This is the other side of coin in globalizing corporate activities. Courageous strategies taken by Singapore and Penang are of interest in that they try to capture agglomeration effects on electronics and biotechnology industries. If a country would like to avoid hollorization and keep its

own firms within the territory, it has to strengthen investment climate of its own country.

4. The link with policy discussion

Why does East Asia so far have sophisticated production networks while other parts of the world do not? The mechanism of production networks is actually utilized by firms with various firm nationalities, which include not only Asians but also Americans and Europeans. We may thus consider location factors of East Asia more important than actors' characteristics. Policy environment for inward FDI and local firms is actually crucial to the development of production networks.

The fragmentation theory infers a set of policies that support the formation of production networks. Table 1 is a 2x3 matrix that illustrates the system of policies. Two rows stand for two-dimensional fragmentation: fragmentation along the distance axis and along the disintegration axis. For each type of fragmentation, costs are disaggregated into three categories in columns: the cost to set up production networks, service link cost, and production cost *per se*. In order to make fragmentation possible,

we must have small enough network set-up cost, small enough service link cost, and large enough production cost saving. These costs heavily depend on government policies, together with economic priors or initial conditions for economic development.

== Table 1 ==

Although the components of the table may look like just a traditional set of policies, the whole structure of policy package is actually completely novel. Under the traditional import-substitution development strategies, a country used to emphasize the importance of location advantages. On the other hand, service link cost was often intentionally heightened so as to attract the whole operation of the industry concerned. The key point of new development strategies is to reduce service link cost and enhance specific, rather than general, aspects of location advantages for specific production blocks in a strategic manner. To develop sophisticated production networks, policy environment for disintegration-type fragmentation also becomes important.

A key turning point from traditional thought is on a mind set for inward FDI.

Although it may not be well planned beforehand, East Asia has successfully constructed a superb policy environment that has fostered international production/distribution networks. So as to fully utilize incoming FDI for accelerating their industrialization, Southeast Asian countries and China have made long-lasting cumulative effort of improving investment climate since the mid-1980s. Because LDCs in other parts of the world such as Latin America and Africa are still obsessed with the strong fear of MNEs and globalization, FDI is accepted only with heavily distortive regulations and incentives. As a result, their development of international production networks is distinctively limited.

In the implementation of these policies, careful consideration of development stages is needed. At the early stage of development, a prime concern is how to attract the initial wave of production blocks and participate in production networks managed by MNEs, where strategic policy package for improving local business environment primarily for distance-type fragmentation is called for. A country at this stage does not have to immediately improve overall investment environment for the whole economy; such improvement is typically very difficult to implement. Rather, a minimal set of FDI

facilitation, infrastructure services, and convenient service link arrangement should be provided at some specific city or industrial estate so as to attract the initial wave of production blocks. It does not have to worry too much about the lack of interaction among production blocks, the lack of links with local firms, or possible footloose behavior of shallow value-added operation of MNEs; rather, it is important to attract as many production blocks as possible. Unskilled labor is typically a strong point in their location advantages, and the country should not feel guilty in taking advantages of it. Bottlenecks to overcome are typically unstable bureaucratic procedure in accepting FDI and high service link cost including customs clearance and logistics arrangements.

After a successful kick-off, a series of policies helping the formation of agglomeration come to the center of stage where disintegration-type fragmentation among MNEs also becomes important. It is crucial to host as many production blocks as possible by removing bottlenecks in location advantages and service link arrangements. Well-organized one-stop services in accepting FDI are required at this stage. In particular, attracting FDI by foreign small and medium enterprises (SMEs) is crucial; SMEs often play important role in the formation of vertical production links.

Hasty performance requirements for employment creation, technological transfer, local procurement, and others imposed on MNEs often end up with negative outcome; rather than trying to control MNEs' behavior, keeping competitive environment for MNEs is effective in the international competition of attracting FDI.

At a higher stage of development, the participation of local firms as well as the strengthening of core ingredients of agglomeration such as human resources and economic/social infrastructure should be stressed. Due to the growth of agglomeration, a country typically loses advantages of low-wage unskilled labor. To keep massive economic activities and proceed to further industrialization, it requires other types of strengths. Positive externalities from agglomeration are extremely important so as to stabilize industrial structure. Various actors in production networks including production blocks of both foreign and local firms should be located there, attractive human resources to support higher levels of economic activities must be available, and efficient logistic arrangements should be developed so as to allow sophisticated value chain management.

The recent wave of economic integration can effectively be utilized for

promoting proper policy reform so as to further promote international production/networks. Development strategies in the globalization era should completely be different from traditional ones where domestic economy insulated from foreign competition was the base. Rather, national border barriers should be lowered, and international competition must be introduced. This is not, however, a simple-minded strategy of just free trade and investment but a deliberately designed strategy of utilizing globalizing forces for accelerating industrialization. In addition to efforts on the individual country basis, the designing of free trade agreements (FTAs) can also become a powerful tool for this purpose.

5. Concluding remarks

This chapter reviews the current status of the development of fragmentation theory and provides a framework for analyzing the mechanics of production networks in East Asia. Although it is not at all easy to construct an aggregated model for international production networks that makes a rigorous welfare analysis possible, the two-dimensional fragmentation model provides an effective angle of research for the

mechanics of production networks at the firm level. The analytical framework also provides organized view of policy matters so as to provide suitable business environment.

Southeast Asia is presenting a novel model of economic development in which the mechanics of international production networks are aggressively pursued. Further research on East Asia's dynamism is called for so as to draw lessons not only for Southeast Asian countries themselves but also for countries in the other parts of the world.

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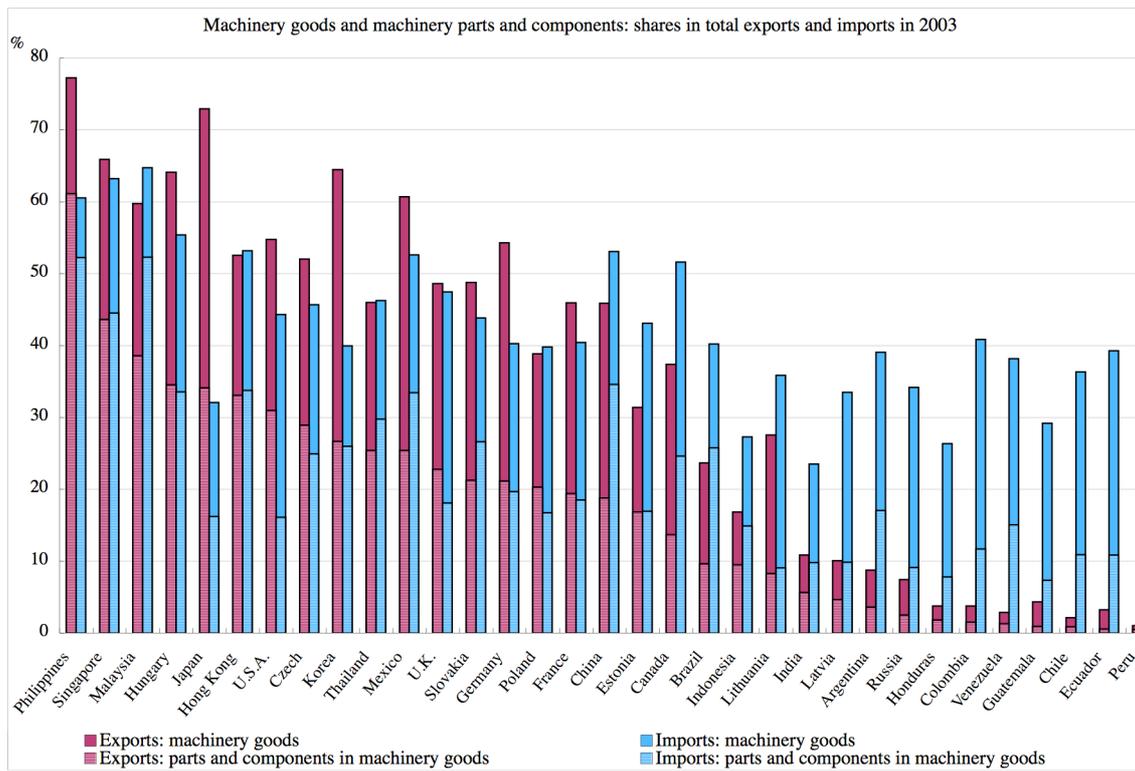
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Figure 1 Machinery goods and parts & components: shares in total export and imports in 2003



Source: Ando and Kimura (2005).

Figure 2 Cross-border production sharing in the US-Mexico nexus: an illustration

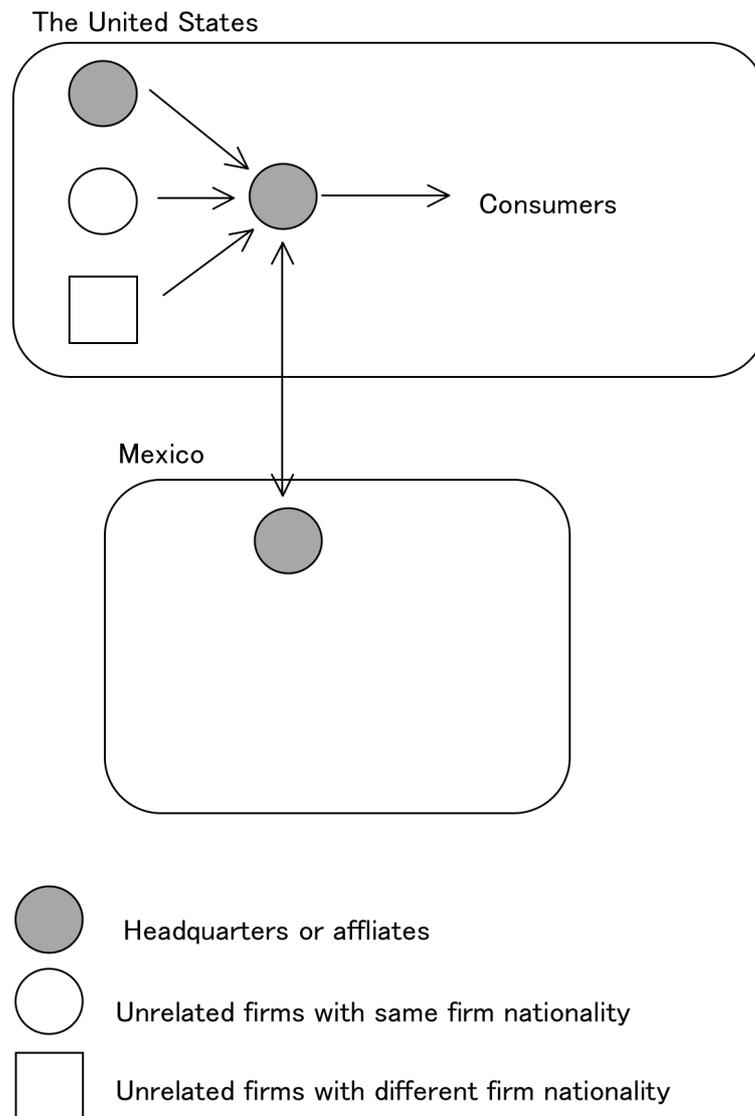
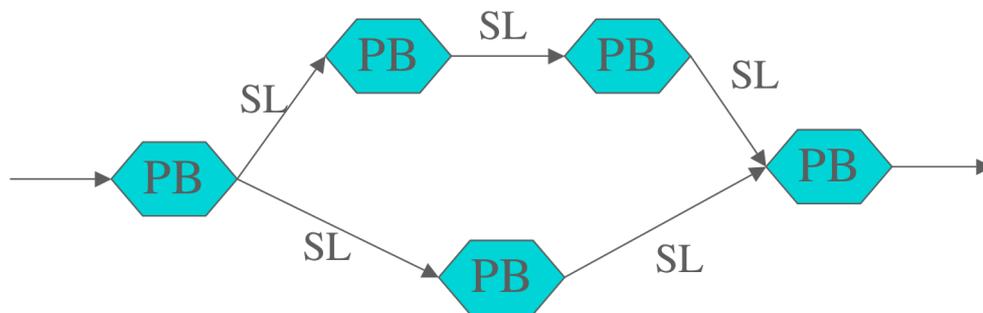


Figure 3 The original idea of fragmentation: an illustration

Before fragmentation



After fragmentation



PB: production block
SL: service link

Figure 4 Production networks in East Asia: an illustration

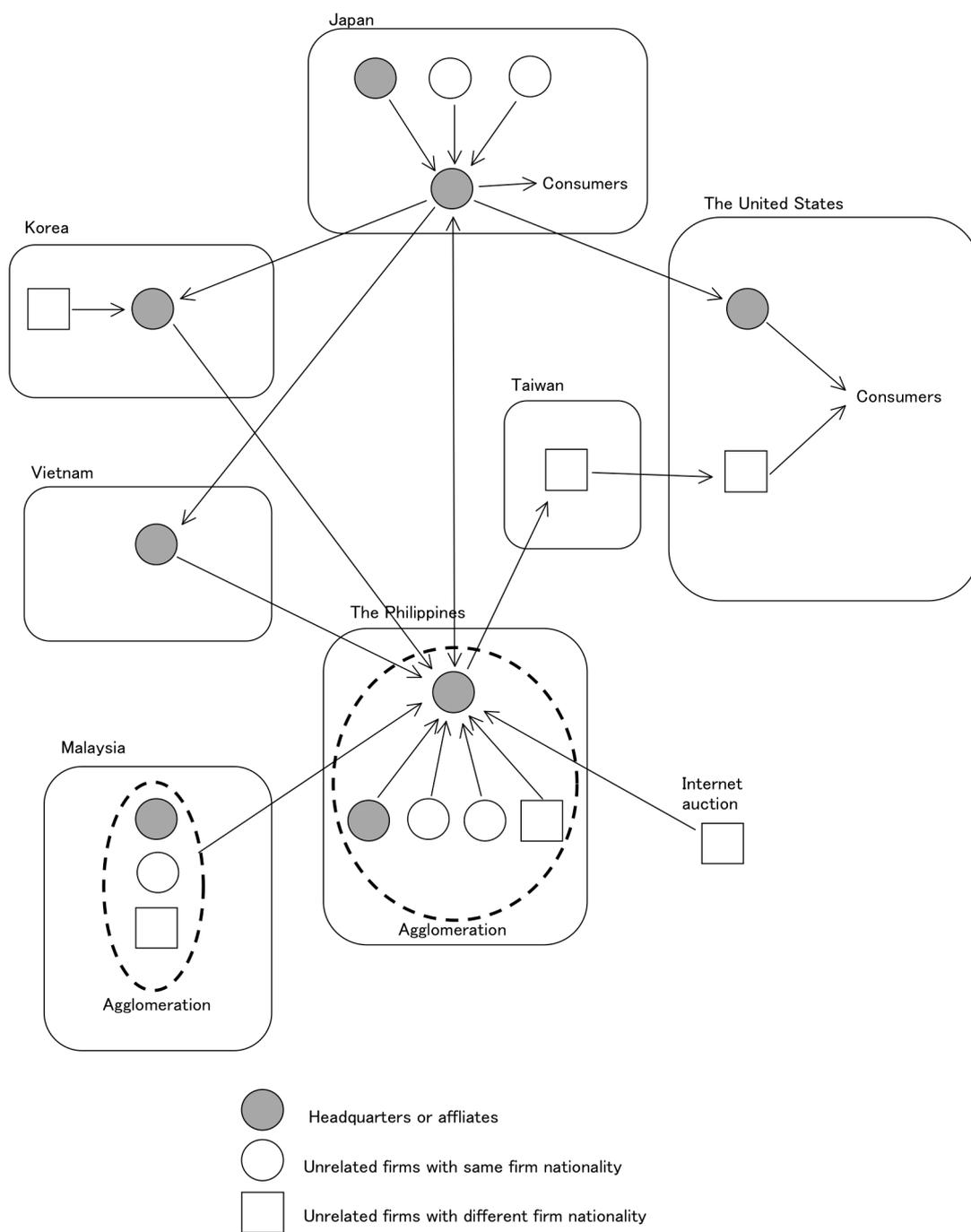
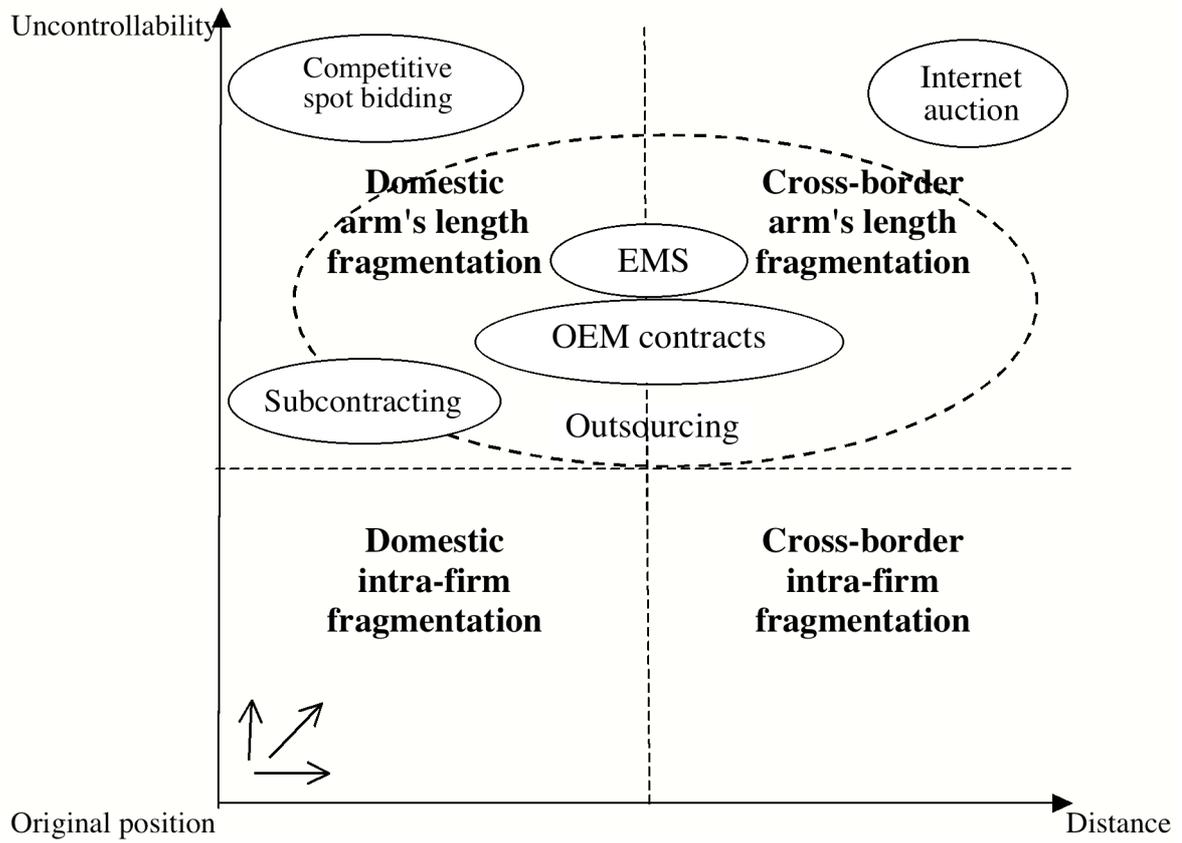


Figure 5 Two-dimensional fragmentation

Figure 1 Two dimensions of fragmentation



Source: Kimura and Ando (2005).

Table 1 Policy matrix for two-dimensional fragmentation

	Reduction in fixed costs to develop production/distribution networks	Reduction in service link costs connecting production blocks	Further cost reduction in production cost per se in production blocks
Fragmentation along the distance axis	<p>Various policies to reduce investment costs</p> <p>Examples : (i) improvement in stability, transparency, and predictability of investment-related policies, (ii) investment facilitation in FDI-hosting agencies and industrial estates, (iii) liberalization and development in financial services related to capital investment</p>	<p>Various policies to overcome geographical distance and border effects</p> <p>Examples : (i) reduction/removal of trade barriers such as tariffs, (ii) trade facilitation including simplification and improved efficiency in custom clearance/procedures, (iii) development of transport infrastructure and improved efficiency in transport and distribution services, (iv) development of telecommunication infrastructure, (v) improved efficiency in financial services related to operation and capital movements, (vi) reduction in costs of coordination between remote places by facilitation of the movement of natural persons</p>	<p>Various policies to strengthen location advantages</p> <p>Examples: (i) establishment of educational/occupational institutions for personnel training to secure various types of human resources, (ii) establishment of stable and elastic labor-related laws and institutions, (iii) establishment of efficient international and domestic financial services, (iv) reduction in costs of infrastructure services such as electricity and other energy, industrial estates services, (v) development of agglomeration to facilitate vertical production chains, (vi) establishment of economic institutions such as investment rule and intellectual property rights, (vii) various trade and investment facilitation</p>
Fragmentation along the disintegration axis	<p>Establishment of economic environment to reduce set-up costs of arm's length transactions</p> <p>Examples : (i) establishment of economic system to allow co-existence of various business partners as well as making various types of contracts, (ii) various policies to reduce costs of information gathering on potential business partners, (iii) securing fairness, stability, and efficiency in contracts, (iv) establishment of stable and effective institutions to secure intellectual property rights</p>	<p>Development of institutional environment to reduce the cost of implementing arm's length transactions</p> <p>Examples: (i) policies to reduce monitoring cost of business partners, (ii) improvement in legal system and economic institutions to activate dispute settlement mechanism, (iii) policies to promote technical innovations in modulation to further facilitate outsourcing</p>	<p>Various policies to strengthen competitiveness of potential business partners</p> <p>Examples : (i) hosting and fostering various types of business partners including foreign and indigenous firms, (ii) strengthening supporting industries, (iii) various policies to promote the formation of agglomeration</p>