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Chapter 2

Corporate Activities and the Spatial Structure of Production/Distribution Networks in East Asia

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Abstract

This paper argues that a variety of firm specificity supported by sophisticated inter-firm relationships is an essential element to 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.

Keywords: Fragmentation, Service Link, Transaction Cost, Firm Specificity, Spatial Economy

1. Firm specificity and the spatial structure of networks

Corporate firms play a prime role in the formation of international production/distribution networks. Typically one firm or a small number of firms in 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. Firm-specific nature and characteristics are naturally influenced for the process of network formation. As a result, we observe a wide variety of production/distribution networks even in the same industry or in the same product line. Firm specificity is a fundamental, essential property 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, such a giant total integration model has critically been reviewed since the 1990s. Current corporate firms are trying to enhance their productivity and profitability by concentrating their resources on their core competence 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 for long struggled for incorporating 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” international trade theory led by a group of young scholars including Mark Melitz and Pol Antras makes a breakthrough by explicitly introducing firm heterogeneity in the general equilibrium setting.² However, the base setting of their models is still too simplistic; firms with high productivity simply become bigger and internalize more activities such as exporting activities and foreign operations through foreign direct investment (FDI). A crucial missing element is inter-firm relationships. Current leading firms are able to concentrate on their own competences because they can outsource some of the activities to other firms. Some firms rather concentrate on jobs outsourced by other firms. We do not have a simple “the bigger, the better” story anymore because sophisticated inter-firm relationships are developed.

This paper claims that rich firm specificity supported by sophisticated inter-firm relationships is an essential element to understanding the mechanics and spatial structure of international production/distribution networks in East Asia. Geographical distance is one of the crucial factors in the choice of transaction types. When a firm needs a close communication with (or a 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 works 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.

The paper plan is as follows: the next section provides the overview of a wide variety of outsourcing in East Asia with referring 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 the factors that affect the choice of layers in transactions with the framework of two-dimensional fragmentation. The last section concludes the paper.

2. Proliferation of outsourcing in East Asia

The fragmentation theory is a powerful conceptual tool for understanding the mechanics of international production/distribution networks. The seminal work of fragmentation theory is Jones and Kierzkowski (1990), and Kimura and Ando (2005) propose an expanded version of the framework called “two-dimensional fragmentation.” Figure 1 illustrates the two dimensions. 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 comes from a complicated combination of two kinds of fragmentation.

An important aspect of two-dimensional fragmentation is the spatial implication of the 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 accident occurs. The intimacy between disintegration-type fragmentation and geographical proximity is one of the major sources for 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 host country's market are mostly arm's-length. Transactions with other East Asia are in the middle (Ando and Kimura (2008)). This is an important evidence to 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. *Shitauke* system in Japan, subcontracting in Taiwan, and Hong Kong – Guangdong operations are examples. Some of the arm's-length transactions in East Asia are direct extension of these prototypes in the international setting. Furthermore, the abundance in opportunities for exploiting differences in location advantages and firm-specific assets in East Asia results in the proliferation of outsourcing. Original equipment manufacturers (OEM), original design manufacturers (ODM), electronics manufacturing services (EMS), and foundries are such examples. The designers or managers of networks are also of variety, 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 obviously supporting the proliferation of various business models in East Asia. As being mentioned above, the evolution of business models, particularly in computer industry, from vertically integrated giants to firms concentrating on core competence is one of the crucial changes in the mind set of corporate managers. Another significant trend is the development of lean production method, just-in-time system, value (supply) chain management, and cash flow management. Furthermore, the deepening of product architecture argument, namely modular versus integral, is also crucial to the development of various business models.

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

3. Four-layer spatial structure

In current East Asian production networking, machinery industries are dominant players, both in quantity and quality. Because machines typically consist of a large number of parts & 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 thus surely present the most sophisticated form of production networking in the globalizing world so that we can draw important economic logic that is largely applicable to other industries.

An assembly plant in machinery industries uses a large number of parts & components, and the procurement of parts & 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 1st layer (local),” “the 2nd layer (sub-regional),” “the 3rd layer (regional),” and “the 4th layer (world).”

The first layer covers transactions with gate-to-gate lead time of less than 2.5 hours and the delivery frequency of once or more in a day. Most of such transactions are handled by trucks and are predominantly arm’s-length. The geographical area of such transactions corresponds to what we call “industrial agglomeration” in which tight just-in-time system with frequent deliveries and monitoring is operated. Transactions with business partners that are new, small, and are not 100% trusted are mostly conducted within this geographical boundary. Integral interface is here possible, and the penetration of 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 such that the first-layer transactions occur with dense vertical links include Bangkok-Eastern Seaboard area in Thailand, Selangor and Penang in Malaysia, the Pearl River Delta and the backyard of Shanghai in China, and others. Figure 2 is a map of Bangkok-Eastern Seaboard area in Thailand with major industrial estates. If we draw a circle of 100km diameter with placing the center at the east of Bangkok, most of the industrial estates in this area are covered. This is exactly the geographical area in which, say, Toyota sets up a tight just-in-time system for most than 80% of parts & components; Toyota plants are holding less-than-two-hour inventories only for most of the parts & components. The Pearl River Delta has almost the same geographical size so that such agglomeration may develop. The distance of 100km corresponds to Tokyo-Takasaki, Tokyo-Mishima, Nagoya-Iwata, Osaka-Suzuka, and Osaka-Akoh; thus, a circle of 100km diameter roughly covers extended Tokyo, Nagoya, and Osaka, respectively.

The 2nd layer includes transactions with the lead time of 1 to 7 days and the delivery frequency of once or more in a week. Transport modes are of variety; they can be trucks, ships, or airplanes. In cases of intra-firm transactions, the 2nd layer covers transactions between plants held by the same multinationals. In cases of arm’s-length transactions, parts & components with modular interface occupy a large portion; trade in modules of computers and transactions with EMS firms are typical examples. Some transactions have integral-type interface; in such cases, parts & components producers often have high reputation and negotiating power so that they do not follow the downstream firms’ request for relocation. In addition, plant-level economies of scale are sometimes crucial in this type of transactions.

An example of geographical area in which the 2nd layer transactions are

conducted is the North-South corridor between Bangkok and Singapore. The distance between these two cities is roughly 1,500km, which is equivalent to the length of Honshu Island in Japan. This is the longest distance for the 2nd layer transactions. Figure 3 presents daily traffic in highways in ASEAN, and the arrow denotes the distance of 1,500km. Traffic connection between Singapore and Malaysia is known to be dense through multiple bridges and high-grade highways. In addition, cross-border operations between Thailand and Malaysia are gradually developed, accompanied with the improvement of customs clearance at the border and the mutual acceptance of trucks without re-loading. Figure 4 depicts the location of major ports and their annual cargo handling in ASEAN. We can conceive that a large portion of the 2nd layer transactions is transactions among industrial agglomerations. Figure 5 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 occupies a large share in cross-border trade in electronic parts & components that carry high values per weight or volume. With the improvement of customs clearance, 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.

If we draw a circle of 1,500km diameter, one circle covers the core part of whole Southeast Asia or the flat area of mainland China. However, we do not so far observe the 2nd layer transactions everywhere. The 2nd layer transactions can extend to the distance of 1,500km only when industrial agglomerations are grown on both sides together with the development of transport infrastructure, logistic industries, and trade facilitation.

The 3rd layer includes transactions with the lead time of 1 to 2 weeks and the typical delivery frequency of one a week. The corresponding geographical area covers the whole East Asia; transactions between Japan and China/ASEAN fall into this category. Actually, the size of North America is about the same, and Europe is a bit smaller than East Asia. Because transactions are allowed to have some flexibility in their delivery timing, marine transportations are major modes. Air transportation is utilized as supplements in urgency. 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 4th layer includes transactions covering the whole world. The lead time is typically 2 weeks to 2 months, and the frequency of delivery is, say, once a week. Predominant transport mode is marine transportation with containers through regular shipping routes. Although quick air transportation is sometimes used, the proportion is relatively small. For machinery producers located in East Asia, markets outside East Asia are still important though the market shares are gradually decreasing due to the development of East Asian market itself (Ando and Kimura (2008)).

4. Factors affecting the choice of transaction layers

By going back to the framework of two-dimensional fragmentation, we can list up major factors that affect which transaction layers are chosen as 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 cost or relocation cost, (ii) service link cost, and (iii) location advantages to save production cost *per se*. When the network set-up cost or relocation cost is small, we had better make transactions in shorter distance, and vice versa. When service link cost including transport cost is large, transactions in shorter distance are chosen, and vice versa. When differences in location advantages are large, long-distance transactions are permitted, and vice versa. When plant-level economies of scale are strong, long-distance transactions may be warranted.

As for the fragmentation along the disintegration axis, the relationship between transaction cost and geographical proximity is crucial. If the intimacy or trustfulness between business partners is high, geographical distance in transactions can be far, and vice versa. Therefore, arm's-length transactions are predominant in the 1st layer while intra-firm transactions occupy a large share in the 3rd layer. In cases of arm's-length transactions, when credibility is weak (strong), the 1st layer (2nd layer) is chosen. When the power balance between upstream and downstream firms is unbalanced, the 1st layer is chosen. When the power of upstream and downstream firms is balanced, the 2nd layer can be opted. In addition, the architecture of inter-firm interface is important. When modular interface is selected, transactions can be in the 2nd layer or 3rd layer. On the other hand, when the interface is in total integration, the 1st layer is predominantly chosen.

The list of factors in Table 2 is useful in understanding differences in spatial structure of production networking across industries and product lines. Production networks for personal computers consist of the 1st layer for production-supporting services, the 2nd layer for modules, and the 3rd and 4th layer for distribution. HDD assembly consists of the 1st and 2nd layers. Automobile industry primarily utilizes the 1st layer while some parts with economies of scale such as sperking plugs are in the 2nd layer. Production networks with OEM/ODM contract or EMS firms are in the 1st and 2nd layers. By assessing the weights of these factors, we can lucidly explain the choice of transaction layers.

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

Further investigation will be waited for.

5. 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, much clearer picture of spatial designs for production/distribution networks is revealed.

The concept of four layers of transactions provides 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 coming from congested industrial agglomeration in the neighborhood. At this phase, the nature of transactions by invited production blocks must mostly be in the 2nd layer. On the other hand, developing countries at higher phases of economic development should try to formulate efficient industrial agglomeration; at that phase, transactions in the 1st layer become important. Or, in the context of developing economies outside East Asia, long-distance transactions such as the 3rd layer would be important. Required policies as well as demand for hard and soft infrastructure are certainly different, depending on what sorts of transactions are expected. It is worth further exploring the spatial structure argument with policy discussion.

Notes

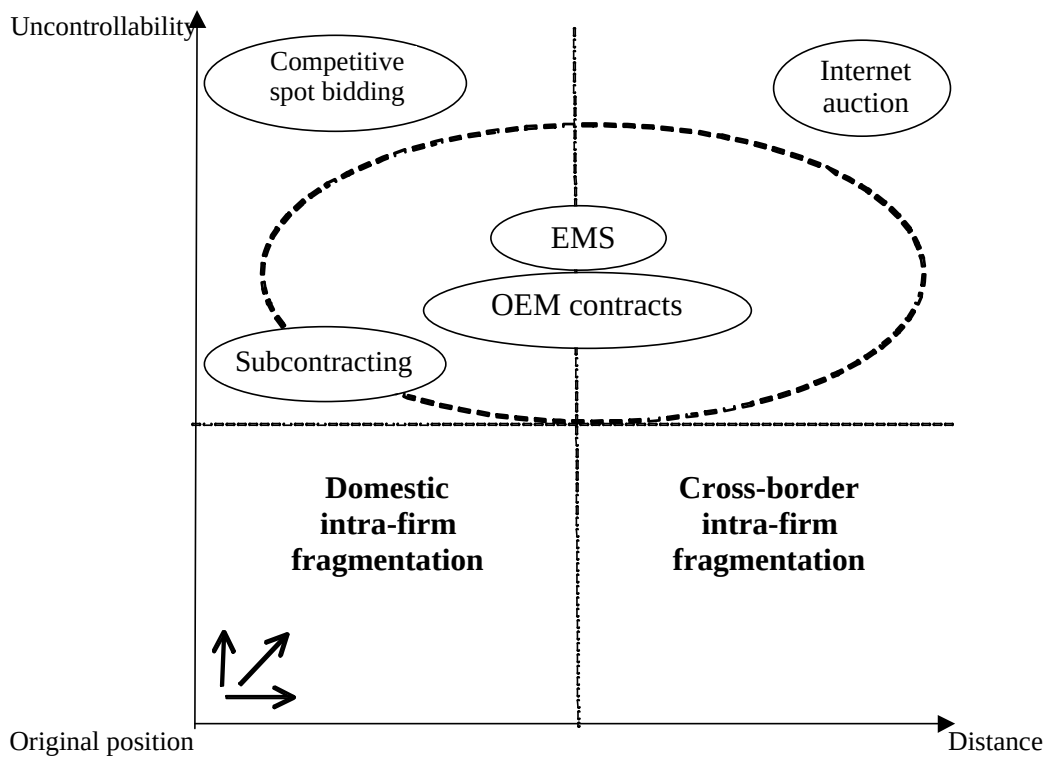
1. Berger (2005) provides excellent argument on recent changes in corporate strategies.
2. See in particular Melitz (2003), Bernard, Eaton, and Kortum (2003), Helpman, Melitz, and Yeaple (2004), and Antras and Helpman (2004).

References

- Ando, Mitsuyo and Fukunari Kimura. 2008. "Production Fragmentation and Trade Patterns in East Asia: Further Evidence," Presented at Ninth Global Development Network Conference, Research Workshop "Emerging Trends and Patterns of Trade and Investment in Asia (Brisbane, Australia; February 1-2, 2008).
- Antras, Pol and Elhanan Helpman. 2004. "Global Sourcing," *Journal of Political Economy*, 112: 552-580.
- Berger, Suzanne and the MIT Industrial Performance Center. 2005. *How We Compete: What Companies around the World Are Doing to Make It in Today's Global Econom*, New York: Currency Books/Doubleday, Random House, Inc.
- Bernard, A.B.; J. Eaton; J.B. Jensen; and S. Kortum. 2003. "Plants and Productivity in

- International Trade,” *American Economic Review*, 93(4): 1268-1290.
- Helpman, E.; M.J. Melitz; and S.R. Yeaple. 2004. “Export versus FDI with Heterogeneous Firms,” *American Economic Review*, 94, No. 1: 300-316.
- JETRO. 2007. *ASEAN Butsuryu Network Map*. Tokyo: JETRO (in Japanese).
- Jones, R. W. and H. Kierzkowski. 1990. “The Role of Services in Production and International Trade: a Theoretical Framework,” In *The Political Economy of International Trade: Essays in Honor of R. E. Baldwin*, ed. R. W. Jones and A. O. Krueger. Oxford: Basil Blackwell.
- Kimura, Fukunari. 2006. “International Production and Distribution Networks in East Asia: Eighteen Facts, Mechanics, and Policy Implication,” *Asian Economic Policy Review*, 1, Issue 2 (December): 326-344.
- Kimura, Fukunari and Mitsuyo Ando. 2005. “Two-dimensional Fragmentation in East Asia: Conceptual Framework and Empirics,” *International Review of Economics and Finance (special issue on “Outsourcing and Fragmentation: Blessing or Threat” edited by Henryk Kierzkowski)*, 14, Issue 3: 317-348.
- Melitz, M.J. 2003. “The Impact of Trade on Aggregate Industry Productivity and Intra-Industry Reallocation,” *Econometrica*, 71(6): 1695-1725.

Figure 1 Two dimensions of fragmentation



Source: Kimura and Ando (2005).

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: By the author.

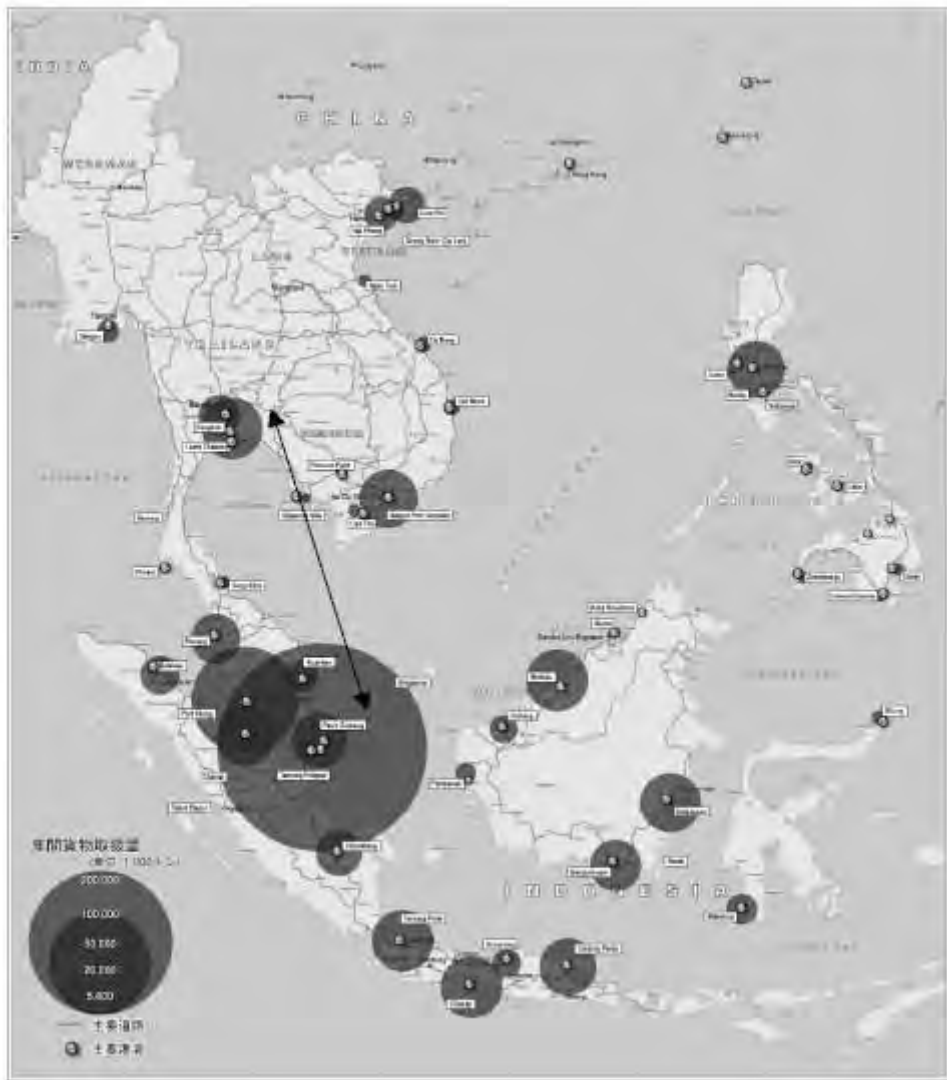
Figure 3. Daily Traffic of the ASEAN Highways



Source: JETRO (2007)

Note: The arrow is added by the author.

Figure 4. Major ports and their cargo handling in ASEAN



Source: JETRO (2007)

Note: The arrow is added by the author.

Figure 5. Frequency of air traffic in ASEAN



Source: JETRO (2007)

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: By the author.