

“Fragmentation in East Asia: Further Evidence”\*

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## Abstract

The most salient phenomenon in recent international trade in East Asia is the formation of international production/distribution networks. This paper applies the two-dimensional fragmentation framework (Kimura and Ando (2005a)) to investigate the structure and characteristics of international production/distribution networks. Two important issues are investigated. The one is how the formation of international production/distribution networks, particularly in machinery industries, has changed the overall pattern in East Asian trade, both intra-regional and inter-regional. We find that about half of intra-regional export expansion in East Asian countries in 1990-2003 is due to an increase in trade of machinery parts and components, which suggests the existence of a large “magnification” effect in intra-regional trade volumes. The relative importance of markets outside East Asia, notably North American and EU markets, seems rather to decline a bit due to the expansion of East Asian markets themselves. The other issue is how corporate firms effectively combine two kinds of fragmentation, i.e., fragmentation in terms of geographical distance and disintegration. The statistical data of affiliates of Japanese firms in East Asia indicate that transactions with Japan are likely to be intra-firm, while transactions in local markets tend to be arm’s-length (inter-firm), which is consistent with our analytical framework which explains the close link between geographical proximity and outsourcing.

## 1. Introduction

It has been widely recognized in academic/semi-academic literature of both international trade and development economics that the formation of international production/distribution networks in East Asia is an extremely important, novel phenomenon. The pattern of industrial location and international trade in East Asia is no longer a typical North-South pattern. Vertical intra-industry trade, particularly in machinery industries, is explosively increasing, while European-type horizontal intra-industry trade is rarely observed.<sup>1</sup> De facto economic integration proceeded without a doubt in East Asia, but it has not necessarily followed the experience of predecessors such as the EU. It is a challenge for both academicians and policy makers to understand what is taking place in East Asia.

The formation of international production/distribution networks is a quite recent phenomenon, only starting in the 1990s, and undermines or at least partially nullifies a large class of old theories and hypotheses. The influential “East Asian Miracle” report, i.e., the World Bank (1993), was written before the development of production networks, and thus the analysis failed to emphasize the crucial role of foreign direct investment (FDI) in development. The old “export platform” argument claimed that Japanese production operations in East Asia were a strategy for circumventing trade disputes with the U.S. and other markets. Such an idea, however, currently explains only a small portion of international production/distribution networks in East Asia. Nowadays, players in production networks are not only Japanese firms and the expansion of East Asian market itself is significant.

How about the flying geese pattern argument? It cannot be applied anymore to recent international location patterns of manufacturing sectors in the sense that they are dominated by more subtle production-process-wise location patterns, not by industry-by-industry location patterns. There is no longer a simple link between development stages and competitive industries. How about discussion on industrial promotion policies or MITI-type picking-winner policies? Such old-fashioned industrial policies for import substitution are not at the center of policy discussion

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<sup>1</sup> Fukao, Ishito, and Ito (2003) provide extensive statistical data analysis of European-type horizontal intra-industry trade, while Ando (2006) further analyzes the characteristics of East Asian-type vertical intra-industry trade.

anymore. The focus of an industry promotion policy by developing countries is placed on how to connect indigenous firms with international production/distribution networks. What would be the desired format of economic integration in East Asia? A new policy package must be included in the FTA framework in order to further promote international production/distribution networks. These are all novel arguments and discussion in East Asia.

The authors proposed a conceptual framework of two-dimensional fragmentation in their previous work (Kimura and Ando (2005a)). It provided a useful analytical approach to understand the mechanics of international production/distribution networks in East Asia. It explained well location patterns of fragmented production blocks across countries with different location advantages, emphasizing the importance of a service link that connects remotely located production blocks. Moreover, it effectively described the logic of production/distribution networks extending beyond the boundary of a firm. Arm's-length (inter-firm) fragmentation is an essential element in the formation of agglomeration, and such sophisticated networks in turn provide opportunities for indigenous firms penetrating into production networks developed by multinational enterprises (MNEs).

As an extending analysis, this paper is devoted to some of the unsolved questions in connection with the conceptual framework and empirics of international production/distribution networks. The first is how the formation of international production/distribution networks, particularly in machinery industries, has changed the overall pattern of international trade, both intra-regional and inter-regional. Are U.S. and EU markets becoming less important along with the expansion of East Asian market itself? How big is the "magnification" effect of parts and components trade in the expansion of East Asian intra-regional trade? The paper looks into these issues to address the first question.

The second question is how corporate firms effectively combine two kinds of fragmentation. In transactions among Japan, NIEs, ASEAN, and China, is there any systemic pattern of intra-firm or arm's-length transactions? Do we observe significant changes over time? Although it is extremely difficult to comprehend these aspects of networks in statistics, analysis using the micro data of Japanese affiliates can provide us some clues.

The outline of the paper is as follows: the next section reviews the framework

of two-dimensional fragmentation and establishes a link with empirical studies conducted in the paper. Section 3 presents the overall picture of intra-regional and inter-regional trade of East Asian countries. Section 4 concentrates on machinery industries and analyzes the nature of fragmentation in two dimensions, i.e., distance and disintegration, by using the micro data of Japanese affiliates abroad. The last section concludes the paper.

## 2. Conceptual framework of two-dimensional fragmentation

The formation of international production/distribution networks has fundamentally changed the pattern of production location and international trade in East Asia. Although networks can be formulated in various industries, most important, both qualitatively and quantitatively, are those in machinery industries including general machinery, electric machinery, transport equipment, and precision machinery. Machinery industries deal with a large number of multi-layered vertical production/distribution processes, and East Asian firms including Japanese firms have a competitive edge in exploring modulation techniques and constructing vertical value chains. International production/distribution networks in East Asia are distinctive and most developed in the world at this point in time in (i) their significance in each economy in the region, (ii) their extensiveness covering a number of countries in the region, and (iii) their sophistication in subtle combinations of intra-firm and arm's-length (inter-firm) transactions.<sup>2</sup>

Literature on the fragmentation theory and its empirical applications has grown since a seminal work by Jones and Kierzkowski (1990) and has proved its applicability in analyzing cross-border production sharing at the production process level.<sup>3</sup> International production/distribution networks in East Asia, however, have developed beyond the original idea of fragmentation, and some expansion of the analytical framework is needed in order to incorporate intra-firm and arm's-length transactions. Kimura and Ando (2005a) propose the concept of two-dimensional fragmentation, in particular to analyze the mechanics of production networks in East

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<sup>2</sup> See Ando and Kimura (2005).

<sup>3</sup> Also see Arndt and Kierzkowski (2001), Deardorff (2001), and Cheng and Kierzkowski (2001) for the fragmentation theory.

Asia.

Figure 1 illustrates a simple version of the Maquila operation in the U.S.-Mexico nexus. Cross-border production sharing between the U.S. and Mexico is mostly a simple intra-firm fragmentation, accompanied with back-and-forth intra-firm transactions between headquarters in the U.S. and an affiliate in Maquila, Mexico. A typical pattern is as follows: parts and components are sent from the U.S. headquarters to a factory in Mexico, the assembly process is conducted there, and the finished products are sent back to the U.S. headquarters. On the other hand, production/distribution networks in East Asia contain a much more complicated combination of intra-firm and arm's-length transactions across a number of countries in the region. Figure 2 is drawn with reference to an actual example of a Japanese manufacturer in the electronic machinery industry, extending production/distribution networks all over East Asia and the U.S. The framework of two-dimensional fragmentation tries to capture such a sophisticated structure of international production/distribution networks.

Figure 1

Figure 2

Figure 3 presents fragmentation in a two-dimensional space. The horizontal axis denotes geographical distance. From the original position, a production block can be detached and placed in geographical distance. The dotted line in the middle is a national border, which distinguishes cross-border fragmentation from domestic fragmentation. The vertical axis, on the other hand, represents the organization (integration and disintegration) of corporate activities. A fragmented production may be conducted by either intra-firm establishments or unrelated firms. The dotted line is a boundary of a firm, distinguishing arm's-length (inter-firm) fragmentation or outsourcing from intra-firm fragmentation.<sup>4</sup>

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<sup>4</sup> Disintegration and accompanied transaction costs have long been analyzed in industrial organization literature on vertical integration. For references on the Japanese subcontracting system, particularly corporate firms' choices over vertical integration, subcontracting, and spot market bidding in parts and components procurement, see

Figure 3

When do corporate firms choose fragmentation? First, there must be a substantial cost reduction in the production of fragmented production blocks (see Table 1). Geographical distance may provide opportunities to explore different production conditions. In particular, cross-border fragmentation enables firms to enjoy diversified location advantages including workers' wages, economic infrastructure, policy environment, and others. The disintegration axis yields chances to utilize business partners' strengths. Instead of doing everything in-house, arm's-length fragmentation or outsourcing may make the entire production system more efficient. Second, service link costs to connect fragmented production blocks should not be too high. Fragmentation beyond national borders and/or a boundary of a firm is inevitably accompanied by substantial service link costs, but such costs must be low enough to result in total cost reduction.

Table 1

Service link costs change as illustrated in Figure 4 when fragmentation takes place along the distance or disintegration axis. When fragmentation occurs in the horizontal direction as [i] and [ii] in Figure 3, service link costs increase according to the distance from the original position. In particular, once fragmentation crosses a national border, service link costs jump because of the national border effect. When fragmentation takes place in the vertical direction as [iii] and [iv], service link costs increase as the controllability of a firm over the fragmented production block becomes weaker. Various types of outsourcing along the disintegration axis from subcontracting to internet auction are illustrated in Figure 4. An important observation here is that geographical proximity saves service link costs or transaction costs, as [iii] is drawn much lower than [iv].

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Kimura (2002). For renewed interest in a global context, see, for instance, Antras (2005), Antras and Helpman (2004), and Grossman and Helpman (2005), which are based on the framework of contract theories.

Figure 4

In East Asia, geographical fragmentation and agglomeration go hand in hand. In contrast to market-oriented agglomeration in Europe, agglomeration in East Asia is often motivated by production-side logic.<sup>5</sup> The forces of fragmentation and agglomeration are countervailing in the first place; they are vectors pointing in opposite directions. In particular, when a firm decides whether to make use of intra-firm fragmentation, fragmentation or agglomeration is a binary decision. However, at the industry/aggregate level, fragmentation and agglomeration may go together.

The concentration of fragmented production blocks occurs at least through the following two channels: first, two kinds of service link costs do not have a monotonic pattern, and local minimal points of service link costs tend to attract a large number of production blocks. Particularly in cases of less developed countries (LDCs), each country, each local province, each city, or each industrial estate has a different investment climate. Service link costs are not monotonic at all in both dimensions of distance and disintegration. Moreover, a service link is often accompanied with strong economies of scale. Therefore, when a country successfully reduces two kinds of service link costs with proper policies, fragmented production blocks may rush in, and service link costs may be pushed down even further.

Second, the concentration of production blocks may also take place due to the close relationship between the service link cost along the disintegration axis and geographical proximity as indicated in Figure 4. The service link cost in arm's-length fragmentation is extremely sensitive to geographical distance. The closer the distance with business partners, the smaller the service link cost in searching potential business partners, consulting detailed specs of products, managing product quality and delivery timing, solving disputes over contracts, monitoring, and others. The northwest area in Figure 4 is a hot spot of this type of agglomeration. Here, the concentration of production blocks would reduce the service link cost, and the low service link cost

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<sup>5</sup> For previous literature on agglomeration, mostly in the context of developed countries such as EU and the U.S., see Fujita, Krugman, and Venables (1999) and Baldwin, Forslid, Martin, Ottaviano, and Robert-Nicoud (2003).



would further attract production blocks; the arrows of causality would go in both directions. The concentrated production blocks in this mechanism generate interactive industrial structure among production blocks.

The two-dimensional fragmentation framework captures multilayered fragmentation as illustrated in Figure 5. By shifting the original position from the headquarters in the home country to an affiliate abroad, for example, the complicated structure of fragmentation with intra-firm and arm's-length transactions can be depicted.

Figure 5

### 3. The evolution of intra- and inter-regional trade

Now let us examine the first question: how the formation of international production/distribution networks in machinery industries has changed the overall pattern of international trade in East Asia, particularly the pattern of intra-regional and inter-regional trade.

Before focusing on intra- and inter-regional trade patterns, we demonstrate the significance of machinery trade in East Asia. Figures 6 and 7 present the shares of machinery goods and machinery parts and components in total exports to and imports from the world at the beginning of the 1990s and in 2003 for major economies in East Asia and other regions.<sup>6</sup> The figures plot countries from the one with the highest export share of machinery parts and components, to address the relative significance of machinery intermediate goods trade.

Figure 6

Figure 7

As both figures vividly show, the share of machinery goods in East Asian countries drastically increased in both absolute and relative terms. At the beginning of the 1990s, most countries with relatively high shares of machinery parts and

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<sup>6</sup> See Table A.1 for the definition of machinery parts and components in this paper.

components were developed countries such as Japan, the United States, U.K, and Germany. In 2003, however, East Asian developing countries moved up to the left side, presenting high shares of both machinery intermediate exports and imports. This implies the existence of back-and-forth transactions and growing export-oriented operations in those countries. The trade pattern of Japan also suggests drastic changes in trade and production patterns in the region; while a large portion of its machinery exports composed of machinery final goods in 1990, half of its machinery exports composed of machinery parts and components, with increased shares of their imports, in 2003. In East Asia, inter-industry trade patterns between developed and developing countries seem to have considerably changed, and international production/distribution networks in machinery industries have rapidly developed, involving a number of countries in the region.<sup>7</sup>

In other regions, in contrast, higher shares of machinery trade and those of machinery parts and components trade are observed for only some specific countries such as the U.S., Mexico, U.K, Germany, Hungary, the Czech Republic, and Slovakia. This suggests the development of production networks in machinery industries between the U.S. and Mexico and between U.K./Germany and Central and Eastern European countries, but these networks do not cover an extensive number of countries in the regions like East Asia. Other countries, particularly those in Latin America except Mexico, are found on the right side with far lower shares of machinery exports. In addition, the shares of machinery exports are much lower than those of imports, suggesting import-oriented operations.

Table 2, in turn, presents current-price exports of all products, machinery goods (total), final machinery goods, and machinery parts and components in East Asia including China, ASEAN4 (i.e., Indonesia, Malaysia, the Philippines, and Thailand), NIEs3 (i.e., Korea, Hong Kong, and Singapore), and Japan in 1990, 2001, and 2003, by

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<sup>7</sup> Ando (2006) analyzes changes in East Asian trade structure in the 1990s by decomposing each country's machinery trade (exports plus imports) with the world at the finely disaggregated level (HS six-digit) into one-way trade, vertical intra-industry trade (vertical IIT), and horizontal intra-industry trade (horizontal IIT), and emphasizes that vertical IIT, particularly vertical IIT in machinery parts and components, expanded. The explosive expansion of machinery intermediates trade indeed resulted in changes in the main trade pattern of East Asia from one-way trade to vertical IIT.

distinguishing intra-East Asian exports from inter-regional exports.<sup>8</sup> To investigate the relative importance of the U.S. market for East Asian exports in particular, corresponding figures are also displayed in parenthesis. Note that Taiwan, one of the most important players in international production networks of machinery industries, is unfortunately not included in East Asia due to the lack of data available from UN COMTRADE, and thus the value and share of intra-East Asian trade would be underestimated in these tables.

Table 2

Clearly, the share of intra-East Asian exports in total exports (all products) by East Asia as a whole has risen, indicating its increasing relative importance compared to inter-regional exports. The increasing relative importance of intra-regional trade is more vividly observed in machinery trade. In the case of machinery intermediates exports in East Asia, the share of intra-regional trade climbed up to 58 percent in 2003 from 40 percent in 1990. The corresponding figures for Japan, NIEs3, ASEAN4, and China are 48 percent in 2003 (28 percent in 1990), 65 percent (54 percent), 60 percent (51 percent), and 56 percent (74 percent), respectively.<sup>9</sup> Moreover, even focusing on finished machinery products, the portion of intra-regional exports increased, while that of inter-regional exports declined. These figures confirm the enhancing relative significance of intra-regional trade patterns to inter-regional trade patterns in machinery industries, particularly in machinery parts and components trade. In other words, the importance of markets outside the region for East Asian exports, including the U.S. market, has relatively declined. Considering the expansion in domestic demand accompanying economic growth in East Asian countries, which has not appeared in transactions beyond national borders, the relative importance of the intra-East Asian market would have been enhanced more notably than suggested by the figures above.

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<sup>8</sup> See Tables A.2-A.5 in the Appendix for the corresponding tables for Japan, NIEs3, ASEAN4, and China.

<sup>9</sup> Although the share of intra-East Asian trade in machinery parts and components has declined in China, the value of machinery intermediate exports itself has explosively increased. Moreover, the U.S. share increased to over 20 percent at the end of the 1990s from a low share of 10 percent in 1992, but around a 20 percent-share of the U.S. market is more or less equivalent to the cases of other East Asian countries.

How fast has intra-East Asian trade (inter-regional trade) grown in absolute terms since the 1990s, and what induced such an expansion of intra-East Asian trade? Table 2 (b(i)) presents the growth from 1990 to 2003 in intra-East Asian exports and inter-regional exports for all products, total machinery goods, final machinery goods, machinery parts and components. During that period, intra-East Asian trade of all commodities expanded by two to three times in absolute terms: the growth rates are 191 percent for East Asia, 160 percent for Japan, 170 percent for NIEs3, 247 percent for ASEAN4, and 226 percent for China. For machinery trade as a whole and machinery parts and components trade, the corresponding figures are much higher; even in the short period from 2001 to 2003, surprisingly, drastic growth was observed (Table 2(a)).<sup>10</sup> These figures imply that machinery trade has and will remain significant contributors to growth in intra-East Asian trade since the 1990s.

To what extent did machinery trade contribute to intra-regional export growth? Tables 2 (b(ii)) and Figure 8 show the percentage of the contribution of machinery trade to the growth in intra-East Asian exports of all products in the period between 1990 and 2003; 66 percent of the 191 percent growth in intra-East Asian exports during those 13 years can be explained by machinery trade. More importantly, over 70 percent of the growth in machinery trade, which is equivalent to half of the growth in total intra-East Asian exports, is explained by machinery parts and components. In other words, a large portion of the growth in intra-East Asian trade was induced by the expansion of machinery trade, mostly that of machinery parts and components in East Asia. This can be regarded as a sort of “magnification effect” of machinery intermediates trade, which is referred to by Yi (2003). In East Asia, back-and-forth transactions in international production networks exist, and they are reflected in this magnification effect.

#### Figure 8

In the case of inter-regional trade in East Asia, similarly, machinery trade

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<sup>10</sup> The growth rates in machinery trade as a whole and in machinery parts and components trade are 322 percent and 452 percent for East Asia, 163 percent and 261 percent for Japan, 310 percent and 429 percent for NIEs3, 828 percent and 886 percent for ASEAN4, and 640 percent and 992 percent for China, respectively.

explains over 60 percent of growth. The main factor of machinery trade which contributed to the growth, however, is different from the case of intra-East Asian trade; around 60 percent of the growth in machinery trade (i.e., over 30 percent of the growth in exports of all products) was induced by an expansion of final machinery goods, not that of machinery parts and components. This implies that final machinery goods produced in international production networks in East Asia are sold to the United States, Europe, and so on, though the relative importance of these markets are decreasing as discussed above.

#### 4. Intra-firm and arm's-length transactions: changing behavior of Japanese firms

The second question is how corporate firms combine two kinds of fragmentation in production/distribution networks. The intensive use of disintegration-type fragmentation or outsourcing arrangements is one of the most salient phenomena in East Asia. Firms in East Asia have indigenous traditions of inter-firm linkages. An old legendary subcontracting system existed among Japanese firms, based on the dualistic structure of large firms in the downstream and small/medium enterprises in the upstream. Taiwan had a tradition of peculiar horizontal subcontracting arrangements among machinery manufacturers. The Hong Kong Guangdong nexus developed an innovative system of processing deal trade in textile and machinery industries. These traditions perhaps worked as prototypes of disintegration-type fragmentation in East Asia. The development of modulation technique was a technological backbone facilitating outsourcing arrangements.

Formal empirical analysis of intra-firm and arm's-length transactions is plagued by a serious deficiency of statistical data. The analysis using the micro data of Japanese affiliates abroad, however, provides some limited information on the characteristics of production/distribution networks.

The analysis in this section is based on the micro data compiled by the Ministry of Economy, Trade, and Industry (METI), Government of Japan (the former name was the Ministry of International Trade and Industry (MITI)): *The 1993F/Y, 1996F/Y, 1999F/Y, and 2002F/Y Survey of Overseas Business Activities of Japanese Companies*. This database presents information on the performance of foreign affiliates of Japanese firms. In particular, the extensive surveys conducted every three years,

which are used in this section, include detailed information on overseas business activities such as intra-firm and arm's length transactions. In this data set, foreign affiliates include both "affiliates abroad" with no less than 10 percent ownership by Japanese parent firms and "affiliates of affiliates abroad" with no less than 50 percent ownership by "affiliates abroad," except those in finance, insurance, or real estate. We must note that the effective return ratios are unfortunately as low as 60 percent since the survey is voluntary (i.e., non-compulsory).

Table 3 presents the number of Japanese affiliates located in East Asia and their performance in terms of total sales/purchases, by-destination sales/by-origin purchases ratios, and intra-firm transaction ratios in 1992, 1995, 1998, and 2001. As Table 3 shows, machinery industries (industry 290 to 320) hold over 30 percent and approximately 40 percent of the total number of Japanese affiliates in East Asia and their total sales/purchases in 2001, respectively. In particular, electric machinery (300) and transport equipment (310) sectors compose of a large portion of Japanese machinery affiliates in East Asia in terms of their number and their activities. To clarify features of their transactions, Tables 4-5 focuses on intra-firm and arm's length transactions by Japanese electric machinery affiliates and Japanese transport equipment affiliates in East Asia, NIEs4, ASEAN4, and China, respectively, which are calculated based on Table 3 and corresponding tables to Japanese affiliates located in NIEs4, ASEAN4, and China.<sup>11</sup> In the tables, "local" refers to the country in which the affiliate concerned is located, "third countries" are countries other than Japan and "local," and "East Asia" indicates countries in East Asia other than Japan and "local."

Table 3

Table 4

Table 5

The nature of fragmentation and its changes over time can be observed

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<sup>11</sup> The corresponding tables on Japanese affiliates in NIEs4, ASEAN4, and China are omitted from the paper, and are available upon request.

particularly in the largest sector, electric machinery (300), and patterns of by-destination sales and by-origin purchases vividly present the development of international production/distribution networks. The most salient phenomenon is the large and increasing share of sales/purchases with other East Asian countries, suggesting the extensiveness of networks and their development: shares of other East Asian countries increased from 18 percent (nine percent) in 1992 to 22 percent (20 percent) for sales and 15 percent (eight percent) in 1992 to 28 percent (20 percent) in the electric machinery sector (machinery sectors as a whole). In addition, increasing shares of Japan in sales and decreasing shares of Japan in purchases indicate the expansion of back-and-forth cross-border production sharing as well as the development of local vendors. The declining trend of local sales ratios suggests a shift in weight from import-substituting-type industries to export-oriented, network-forming industries.

Ratios of intra-firm/arm's-length transactions conform to our two-dimensional fragmentation framework. Intra-firm transaction ratios for transactions with Japan, other East Asian countries, and local become smaller in this order (Table 3). In other words, intra-firm transactions are large in transactions with Japan while arm's-length transactions are important in local transactions, and transactions with other East Asian countries are categorized in the middle. This observation proves a close link between geographical proximity and disintegration-type fragmentation, indicating the formation of agglomeration of fragmented production blocks, as discussed in Section 2.

The above-mentioned characteristics seem to be reflected most closely in the case of Japanese affiliates in ASEAN4. That is, intra-firm transactions are large in transactions with Japan while arm's-length transactions are important in local transactions, and transactions with other East Asian countries are categorized in the middle, reflecting a close link between geographical proximity (agglomeration) and arm's length fragmentation (Table 4). In the case of Japanese affiliates in China, we must note that operations by Japanese firms in China seriously started only recently (see values of sales and purchases in Tables 4 and 5).<sup>12</sup> Rapid increases in local purchases

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<sup>12</sup> The performance of Japanese electric machinery affiliates in China drastically expanded from 70 billion JPY in 1992 to 1,298 billion JPY in 2001 for sales and from 47 billion JPY in 1992 to 919 billion JPY in 2001 for purchases. The number of affiliates also confirm the recent expansion of Japanese firms' operations in China: the number of Japanese electric machinery affiliates in China in the dataset is 30 (54) in

ratios from 16 percent in 1992 to 37 percent in 2001, eventually reaching up to the level of ASEAN4, with the rapid expansion of arm's length transactions in the local market, suggest the formation of local vertical links in agglomeration in China.

On the other hand, the declining trend in purchases from Japan, mostly intra-firm purchases, is clearly observed: shares of purchases from Japan (intra-firm purchases from Japan) in total purchases by Japanese electric machinery affiliates in China are 84 percent (78 percent) in 1992 and 38 percent (25 percent) in 2001. In China, purchases from Japan, particularly intra-firm purchases from Japan, seem to be significantly replaced by local arm's length purchases according to the above-mentioned development of agglomeration in the local market, and intra-firm purchases from other East Asian countries, probably mainly ASEAN countries. Although arm's length transaction ratios are large for transactions with other East Asian countries by Japanese electric machinery affiliates in ASEAN4, intra-firm transaction ratios are large by those in China. Such a difference in intra-firm transaction ratios with other East Asian countries may indicate proximity among ASEAN countries and remoteness of China from ASEAN4. Low intra-firm sales ratios in selling to the local market perhaps reflect regulations in the local distribution sector.

In contrast with the electric machinery sector, the transport equipment sector (310) has been heavily affected by import-substitution policies. Extremely high ratios of local sales in total sales in the 1990s reflect trade protection and import-substitution-type operations in most of the East Asian countries. The ratios, however, have been in a declining trend even in this sector, particularly in ASEAN4, reflecting trade liberalization and the removal of local contents requirements, which encourages exports of parts and components as well as built up cars.<sup>13</sup>

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1992 and 281 (552) in 2001 in the electric machinery sector (machinery sectors as a whole), which accounts for around seven percent and 27 percent of Japanese electric machinery in East Asia, respectively.

<sup>13</sup> Ando (2006) also demonstrates that even in the transportation equipment sector, in which one-way trade is still the main pattern of trade in the whole sector largely due to import substitution policies, vigorous transactions of parts and components across borders were observed in 2000, while they were seldom found at the beginning of the 1990s.



## 5. Concluding remarks

This paper applies the two-dimensional fragmentation framework to empirically examine the structure and characteristics of international production/distribution networks. The analysis on international trade data, particularly trade in machineries and machinery parts and components, verifies the importance of international production/distribution networks in East Asian economies, and the enhancing relative importance of intra-East Asian markets to other markets outside of the region including the U.S market for East Asian exports. The investigation of the data set of affiliates of Japanese firms in East Asia suggests the microstructure of vertical production chains effectively combining intra-firm and arm's-length transactions. The authors believe that the paper successfully reconfirms the distinctive characteristics of international production distribution networks; i.e., their significance, extensiveness, and sophistication.

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Figure 1 Typical maquila operation by the US MNEs: an illustration

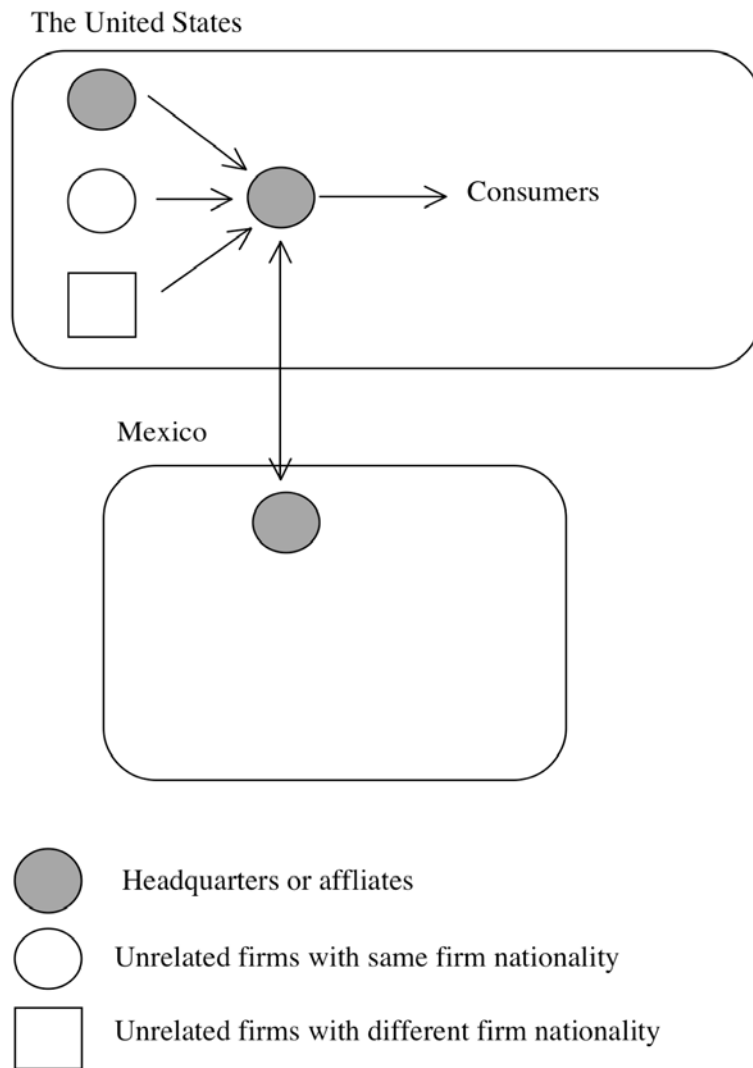


Figure 2 Typical East Asian operation by Japanese MNEs: an illustration

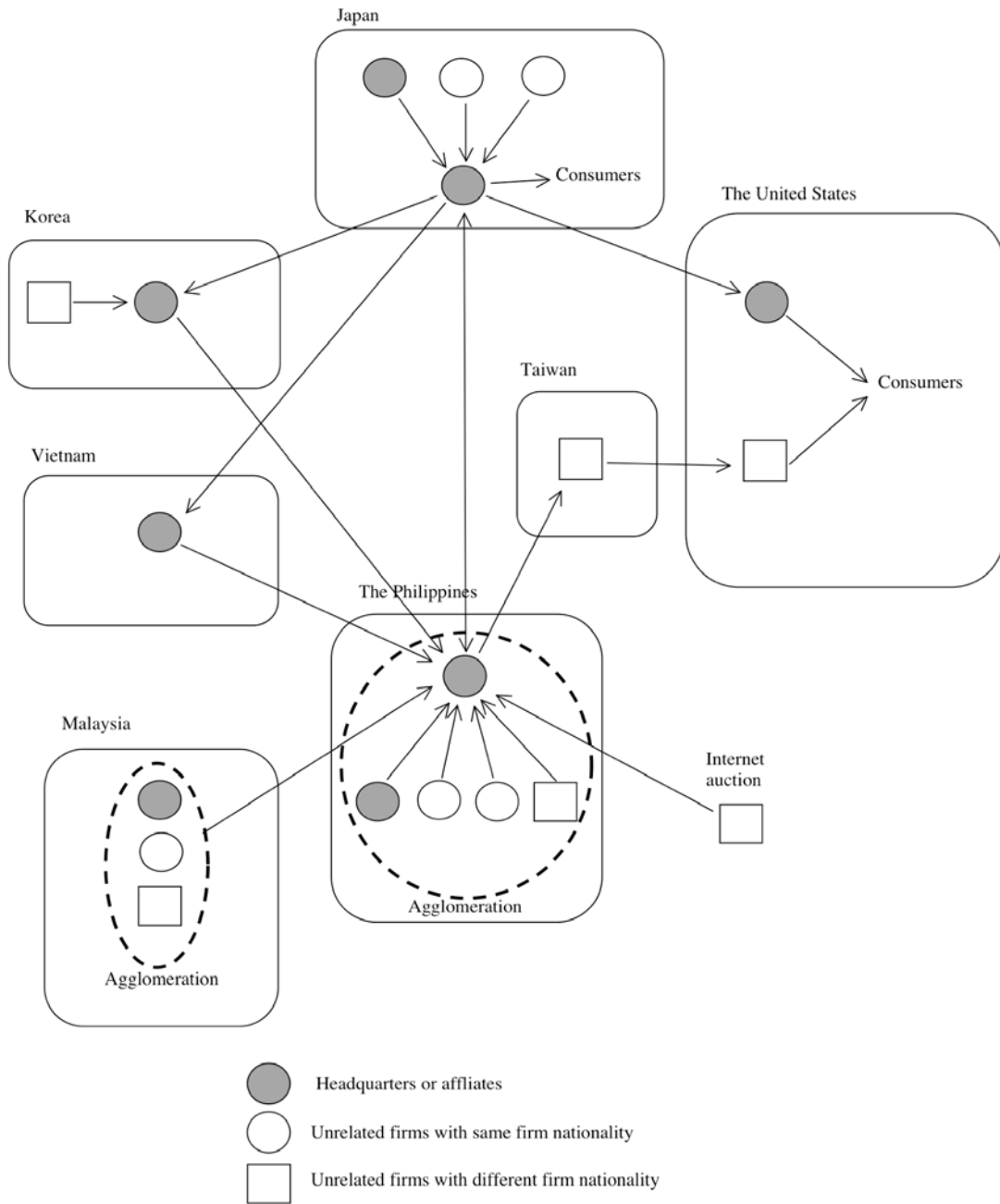


Figure 3 Fragmentation in a two-dimensional space

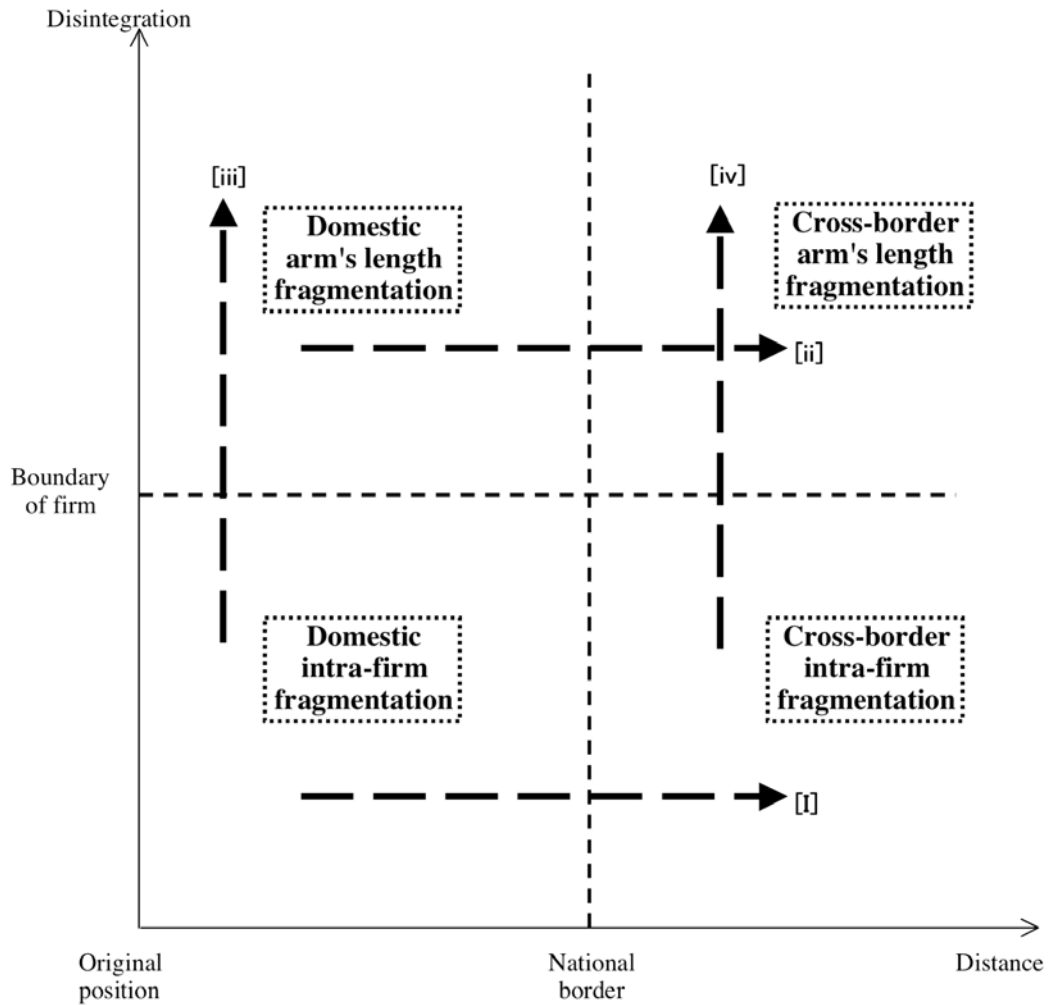


Table 1 Tradeoffs in two-dimensional fragmentation

|   | Service link cost connecting production block   | Production cost per se in production blocks   |
|---|---|---|
| Fragmentation along the distance axis       | Cost due to geographical distance<br>Elements (examples): transportation, telecommunications, inefficiency in distribution, trade impediments, coordination cost  | Cost reduction from location advantages<br>Elements (examples): wage level, access to resources, infrastructure service inputs such as electricity, water, and industrial estates, technological capability   |
| Fragmentation along the disintegration axis | Transaction cost due to losing controllability<br>Elements (examples): Information gathering cost on potential business partners, monitoring cost, risks on the stability of contracts, immature dispute settlement mechanism, other deficiency in legal system and economic institutions | Cost reduction from (dis)internalization<br>Elements (examples): availability of various types of potential business partners including foreign and indigenous firms, development of supporting industry, institutional capacity for various types of contracts, degree of incomplete information |

Figure 4 Two kinds of service link cost

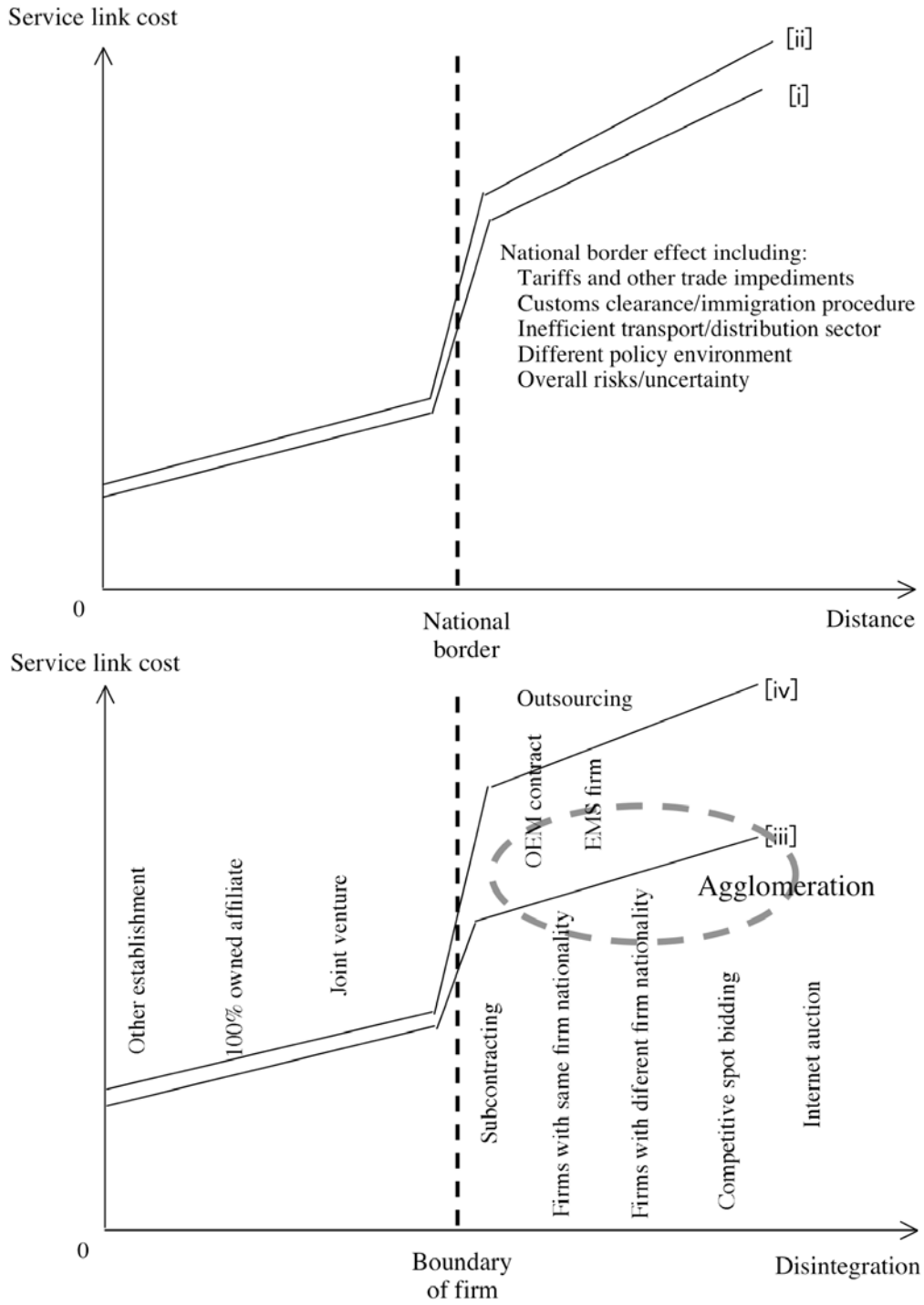


Figure 5 Multilayered fragmentation in East Asia: an illustration

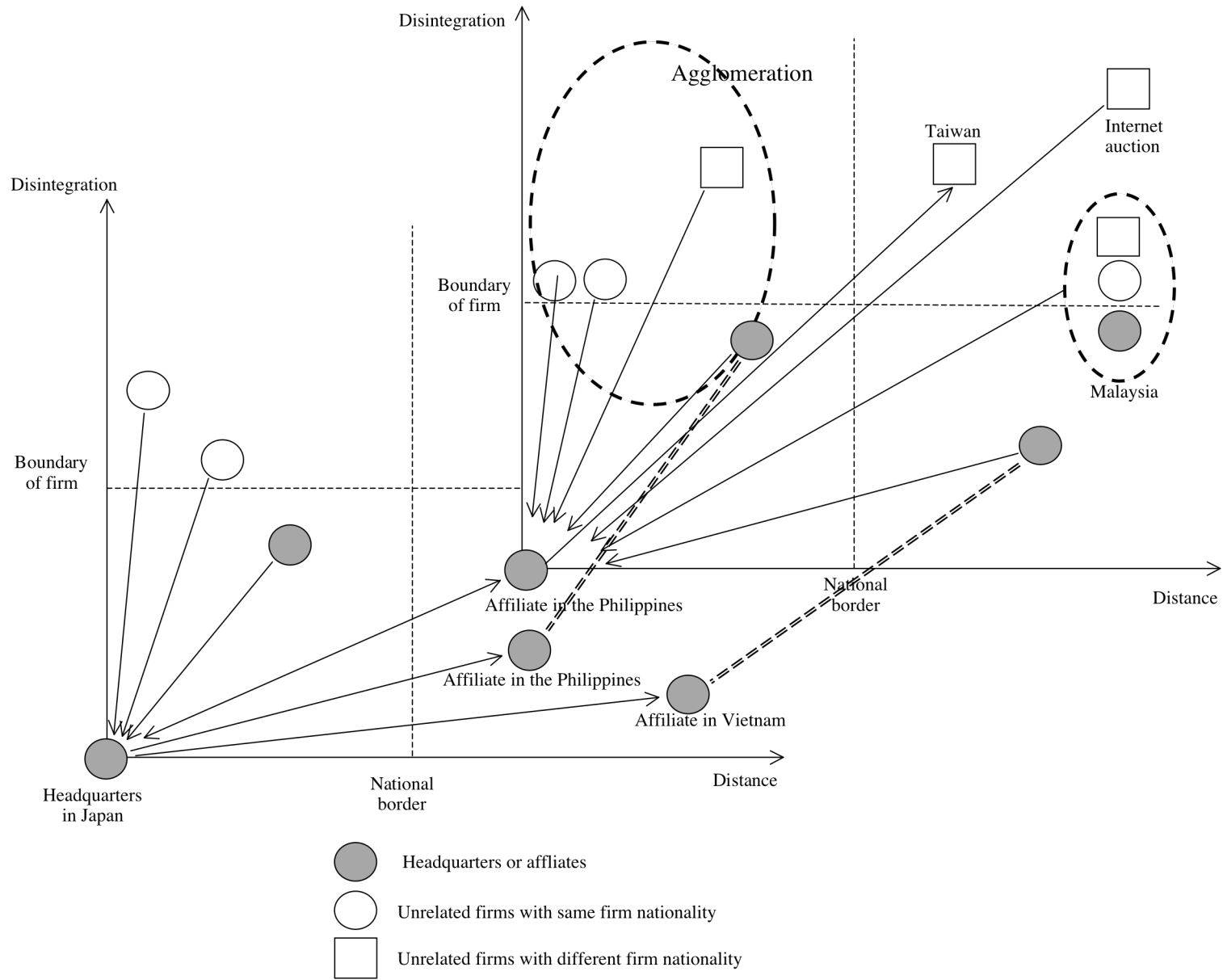
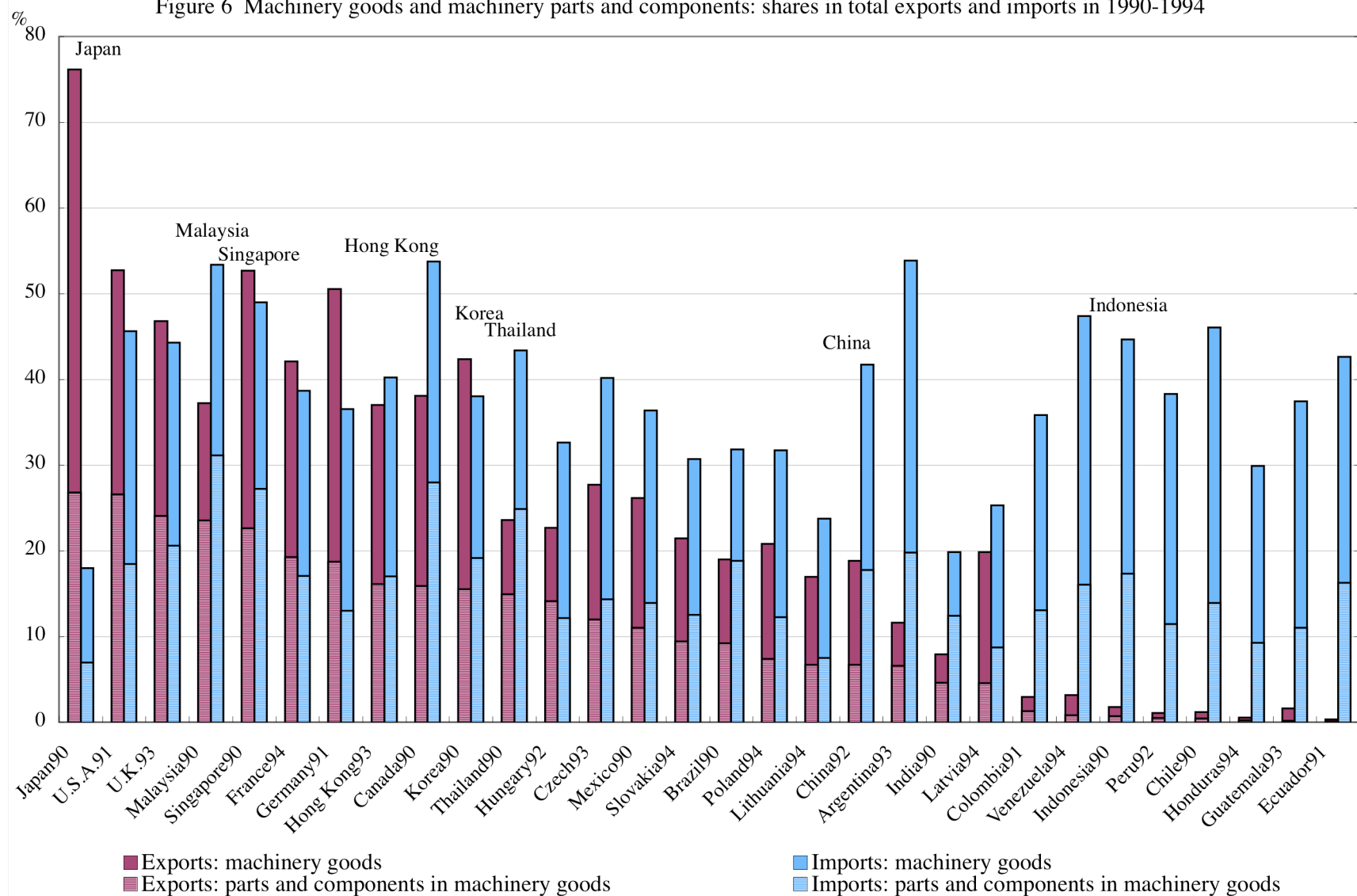


Figure 6 Machinery goods and machinery parts and components: shares in total exports and imports in 1990-1994

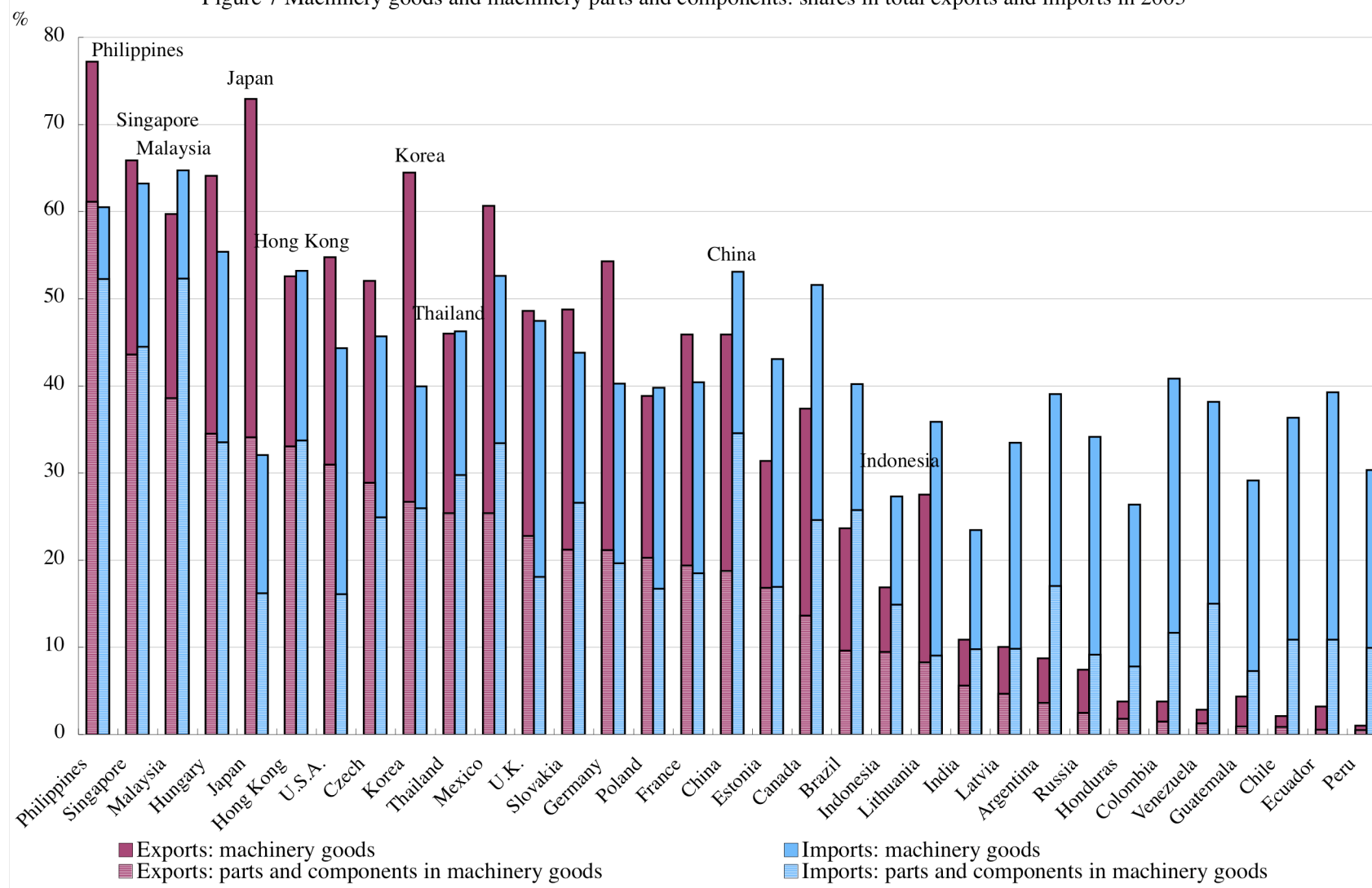


Data source: Ando (2006).

Note: data is of 1990 or close to 1990. For instance, Japan90 and U.S.A.91 indicate that data is of 1990 for Japan and 1991 for U.S.A.



Figure 7 Machinery goods and machinery parts and components: shares in total exports and imports in 2003



Data source: Authors' calculation, based on UN COMTRADE.

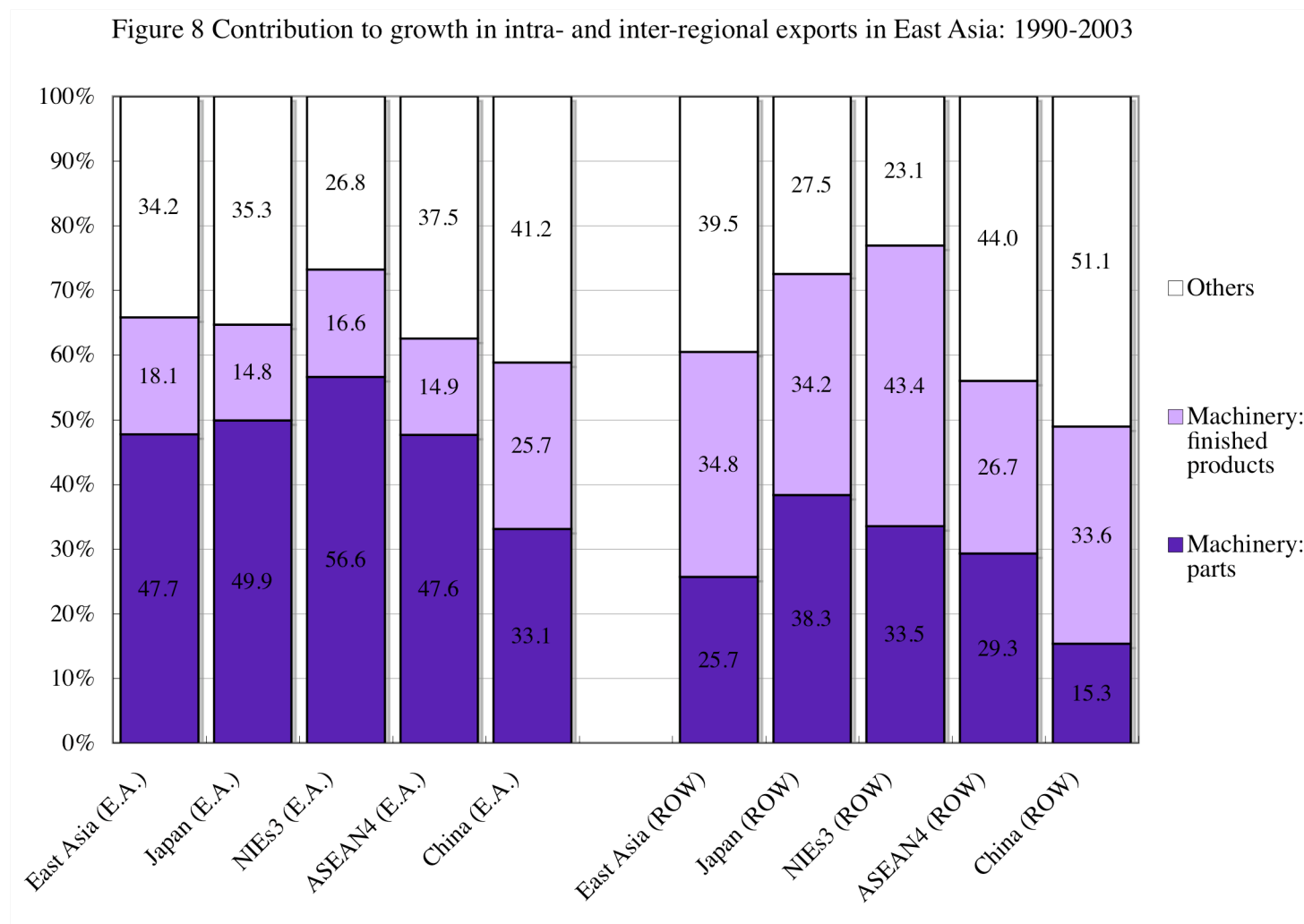
Table 2 Development of intra-regional exports in East Asia

| <b>(a) Intra- and inter-regional exports (millions US\$)</b> |           |        |           |        |           | <b>(b) Factors of growth in exports (1990-2003)</b> |  |
|--|-----------|--------|-----------|--------|-----------|---|--|
|  | 1990      |        | 2001      |        | 2003      |   |  |
|  | Value     | %      | Value     | %      | Value     | %   |  |
| <b>Machinery goods: parts and components</b>                 |           |        |           |        |           | <b>&lt;Intra-East Asian exports&gt;</b>             |  |
| Intra-East Asia  | 54,336    | 39.6   | 205,636   | 51.4   | 300,137   | 57.5  | (i) Growth in intra-East Asian exports |
| Inter-regional   | 82,915    | 60.4   | 194,805   | 48.6   | 221,637   | 42.5  | All products                           |
| (U.S.)   | (39,624)  | (28.9) | (81,426)  | (20.3) | (82,543)  | (15.8)  | Machinery goods (total)                |
| Total  | 137,251   | 100.0  | 400,442   | 100.0  | 521,774   | 100.0   | - Machinery final goods                |
|  |           |        |           |        |           |   | - Machinery parts and components       |
| <b>Machinery goods: final goods</b>                          |           |        |           |        |           | (ii) Contribution to the growth (all products)      |  |
| Intra-East Asia  | 50,932    | 23.2   | 99,364    | 26.1   | 144,368   | 28.8  | Machinery goods (total)                |
| Inter-regional   | 168,597   | 76.8   | 281,492   | 73.9   | 356,732   | 71.2  | - Machinery final goods                |
| (U.S.)   | (70,183)  | (32.0) | (130,088) | (34.2) | (143,634) | (28.7)  | - Machinery parts and components       |
| Total  | 219,529   | 100.0  | 380,856   | 100.0  | 501,100   | 100.0   |  |
| <b>Machinery goods: total</b>                                |           |        |           |        |           | <b>&lt;Inter-regional exports&gt;</b>               |  |
| Intra-East Asia  | 105,268   | 29.5   | 305,001   | 39.0   | 444,505   | 43.5  | (i) Growth in inter-regional exports   |
| Inter-regional   | 251,512   | 70.5   | 476,297   | 61.0   | 578,369   | 56.5  | All products                           |
| (U.S.)   | (109,807) | (30.8) | (211,513) | (27.1) | (226,177) | (22.1)  | Machinery goods (total)                |
| Total  | 356,780   | 100.0  | 781,297   | 100.0  | 1,022,875 | 100.0   | - Machinery final goods                |
|  |           |        |           |        |           |   | - Machinery parts and components       |
| <b>All products</b>  |           |        |           |        |           | (ii) Contribution to the growth (all products)      |  |
| Intra-East Asia  | 270,465   | 38.5   | 579,108   | 42.1   | 786,197   | 44.7  | Machinery goods (total)                |
| Inter-regional   | 432,736   | 61.5   | 795,192   | 57.9   | 973,074   | 55.3  | - Machinery final goods                |
| (U.S.)   | (174,978) | (24.9) | (332,883) | (24.2) | (355,643) | (20.2)  | - Machinery parts and components       |
| Total  | 703,201   | 100.0  | 1,374,300 | 100.0  | 1,759,271 | 100.0   |  |

Data source: authors' calculation, based on UN COMTRADE

Note: "East Asia" here includes China, ASEAN4, NIES3, and Japan. Due to lack of data available from UN COMExports, (i) Taiwan is not included in East Asia, (ii) data for China in 1992 and Hong Kong in 1993 are used in calculating intra-East Asian exports in 1990, (iii) data for the Philippines are not included in calculating intra-East Asian exports in 1990.

Figure 8 Contribution to growth in intra- and inter-regional exports in East Asia: 1990-2003



Data source: Table 2(b) and Tables A.2(b)-A.5(b).

Note: "E.A." and "ROW" in the figure indicate intra-regional exports and inter-regional exports, respectively.

Table 3 Sales and purchases by Japanese affiliates in East Asia

| Year             | Industry            | Number of affiliates | %     | Total sales (billion JPY) | %     | By-destination sales ratio (%) |      |       |      |                 |               | Intra-firm transaction ratio (%) |      |       |      |                 |           |
|------------------|---------------------|----------------------|-------|---------------------------|-------|--------------------------------|------|-------|------|-----------------|---------------|----------------------------------|------|-------|------|-----------------|-----------|
|                  |                     |                      |       |                           |       | Japan                          |      | Local |      | Third countries |               | Japan                            |      | Local |      | Third countries |           |
|                  |                     |                      |       |                           |       |                                |      |       |      | East Asia       | North America | Europe                           |      |       |      |                 | East Asia |
| <b>(a) Sales</b> |                     |                      |       |                           |       |                                |      |       |      |                 |               |                                  |      |       |      |                 |           |
| 1992             | Manufacturing total | 1,463                | 56.3  | 7,887                     | 50.7  | 15.8                           | 66.0 | 18.2  | 10.0 | 3.4             | 1.8           | 84.2                             | 6.3  | 42.9  | 44.6 | 62.6            | 47.7      |
|                  | Machinery total     | 715                  | 27.5  | 5,202                     | 33.4  | 16.8                           | 66.2 | 17.0  | 9.4  | 4.0             | 1.8           | 90.5                             | 7.8  | 57.7  | 53.9 | 76.6            | 65.0      |
|                  | 290                 | 91                   | 3.5   | 216                       | 1.4   | 23.6                           | 53.0 | 23.4  | 11.3 | 2.1             | 9.8           | 96.7                             | 3.0  | 71.2  | 55.6 | 54.3            | 93.9      |
|                  | 300                 | 416                  | 16.0  | 2,872                     | 18.5  | 27.2                           | 45.7 | 27.1  | 17.7 | 4.9             | 2.1           | 90.0                             | 8.0  | 56.2  | 53.5 | 82.6            | 58.0      |
|                  | 310                 | 171                  | 6.6   | 1,999                     | 12.8  | 1.7                            | 92.6 | 5.7   | 0.8  | 3.1             | 0.4           | 73.9                             | 7.2  | 60.2  | 57.9 | 71.2            | 28.3      |
|                  | 320                 | 37                   | 1.4   | 115                       | 0.7   | 51.8                           | 36.9 | 11.3  | 1.6  | 4.5             | 3.3           | 96.5                             | 32.4 | 46.6  | 77.9 | 51.1            | 50.8      |
|                  | Total               | 2,597                | 100.0 | 15,556                    | 100.0 | 21.8                           | 59.4 | 18.8  | 9.3  | 2.4             | 1.2           | 64.1                             | 4.7  | 28.9  | 33.1 | 53.5            | 44.8      |
| 1995             | Manufacturing total | 2,966                | 64.5  | 12,300                    | 50.0  | 18.8                           | 58.4 | 22.8  | 13.3 | 3.6             | 1.8           | 83.2                             | 15.8 | 45.4  | 49.1 | 57.0            | 60.7      |
|                  | Machinery total     | 1,428                | 31.0  | 9,080                     | 36.9  | 20.8                           | 56.6 | 22.6  | 12.8 | 4.0             | 1.9           | 90.6                             | 19.9 | 55.4  | 60.2 | 64.8            | 71.5      |
|                  | 290                 | 234                  | 5.1   | 541                       | 2.2   | 28.5                           | 48.5 | 23.1  | 13.9 | 0.7             | 5.4           | 97.6                             | 1.5  | 68.8  | 66.5 | 71.4            | 98.7      |
|                  | 300                 | 755                  | 16.4  | 5,107                     | 20.8  | 28.7                           | 38.0 | 33.2  | 19.6 | 5.6             | 2.2           | 88.9                             | 9.0  | 52.6  | 59.5 | 56.7            | 58.4      |
|                  | 310                 | 339                  | 7.4   | 3,095                     | 12.6  | 2.2                            | 92.8 | 5.0   | 0.8  | 2.3             | 0.8           | 85.1                             | 27.3 | 65.4  | 30.3 | 97.2            | 94.5      |
|                  | 320                 | 100                  | 2.2   | 337                       | 1.4   | 51.2                           | 27.7 | 21.1  | 15.9 | 1.9             | 2.2           | 98.9                             | 66.6 | 74.7  | 76.6 | 69.3            | 75.5      |
|                  | Total               | 4,600                | 100.0 | 24,579                    | 100.0 | 17.8                           | 54.7 | 27.5  | 13.5 | 2.5             | 1.4           | 67.6                             | 10.4 | 24.3  | 31.2 | 49.1            | 58.3      |
| 1998             | Manufacturing total | 3,835                | 61.7  | 12,325                    | 53.0  | 25.4                           | 49.2 | 25.4  | 16.9 | 4.5             | 2.7           | 73.1                             | 7.6  | 45.9  | 47.2 | 48.3            | 40.7      |
|                  | Machinery total     | 1,809                | 29.1  | 8,485                     | 36.5  | 44.1                           | 38.6 | 17.3  | 15.4 | 1.1             | 0.4           | 80.6                             | 15.6 | 48.7  | 47.5 | 50.8            | 63.7      |
|                  | 290                 | 315                  | 5.1   | 689                       | 3.0   | 40.7                           | 32.4 | 27.0  | 14.8 | 5.5             | 4.6           | 90.7                             | 6.9  | 79.7  | 76.7 | 91.5            | 87.4      |
|                  | 300                 | 916                  | 14.7  | 5,192                     | 22.3  | 32.9                           | 32.3 | 34.8  | 24.9 | 5.3             | 3.0           | 73.6                             | 14.5 | 51.4  | 55.4 | 46.0            | 37.4      |
|                  | 310                 | 478                  | 7.7   | 2,140                     | 9.2   | 11.1                           | 81.0 | 7.9   | 2.2  | 3.5             | 1.5           | 82.1                             | 2.8  | 73.0  | 52.2 | 98.5            | 52.6      |
|                  | 320                 | 100                  | 1.6   | 464                       | 2.0   | 45.9                           | 27.2 | 26.9  | 23.1 | 1.5             | 2.0           | 70.6                             | 26.8 | 16.3  | 15.9 | 11.3            | 18.6      |
|                  | Total               | 6,213                | 100.0 | 23,235                    | 100.0 | 21.9                           | 49.6 | 28.4  | 21.2 | 3.4             | 2.6           | 62.7                             | 5.6  | 32.3  | 30.1 | 47.4            | 34.1      |
| 2001             | Manufacturing total | 4,247                | 62.5  | 20,382                    | 56.6  | 25.9                           | 46.1 | 28.0  | 18.6 | 4.9             | 2.6           | 77.4                             | 10.9 | 46.1  | 44.0 | 58.1            | 43.8      |
|                  | Machinery total     | 2,121                | 31.2  | 14,826                    | 41.2  | 29.1                           | 40.1 | 30.9  | 19.9 | 5.8             | 2.9           | 79.3                             | 13.7 | 52.6  | 51.6 | 62.4            | 47.6      |
|                  | 290                 | 381                  | 5.6   | 1,084                     | 3.0   | 40.0                           | 35.1 | 24.9  | 17.0 | 2.4             | 1.7           | 93.9                             | 22.8 | 81.5  | 75.0 | 96.5            | 94.3      |
|                  | 300                 | 1,041                | 15.3  | 8,539                     | 23.7  | 34.4                           | 31.2 | 34.4  | 22.0 | 7.4             | 2.8           | 77.6                             | 15.6 | 54.3  | 55.8 | 55.7            | 52.4      |
|                  | 310                 | 582                  | 8.6   | 4,575                     | 12.7  | 8.1                            | 66.1 | 25.8  | 16.4 | 2.9             | 4.0           | 80.7                             | 9.3  | 33.0  | 23.3 | 94.6            | 29.4      |
|                  | 320                 | 117                  | 1.7   | 628                       | 1.7   | 40.4                           | 42.5 | 17.2  | 12.7 | 2.9             | 1.3           | 72.2                             | 14.1 | 79.7  | 78.0 | 91.4            | 74.4      |
|                  | Total               | 6,799                | 100.0 | 35,984                    | 100.0 | 25.0                           | 47.5 | 27.5  | 18.8 | 4.2             | 2.5           | 67.2                             | 8.2  | 39.5  | 34.6 | 60.0            | 40.7      |

(Continue)

| Year                 | Industry            | Number of affiliates | %     | Total purchases (billions JPY) | %     | By-origin purchases ratio (%) |           |               |                 |       |           | Intra-firm transaction ratio (%) |        |       |                 |               |        |
|----------------------|---------------------|----------------------|-------|--------------------------------|-------|-------------------------------|-----------|---------------|-----------------|-------|-----------|----------------------------------|--------|-------|-----------------|---------------|--------|
|                      |                     |                      |       |                                |       | Japan                         |           |               | Third countries |       |           | Japan                            |        |       | Third countries |               |        |
|                      |                     |                      |       |                                |       | Local                         | East Asia | North America | Europe          | Local | East Asia | North America                    | Europe | Local | East Asia       | North America | Europe |
| <b>(b) Purchases</b> |                     |                      |       |                                |       |                               |           |               |                 |       |           |                                  |        |       |                 |               |        |
| 1992                 | Manufacturing total | 1,463                | 56.3  | 3,384                          | 43.3  | 37.9                          | 48.4      | 13.7          | 8.1             | 1.6   | 0.0       | 78.2                             | 4.2    | 42.7  | 50.2            | 47.7          | -      |
|                      | Machinery total     | 715                  | 27.5  | 2,466                          | 31.5  | 46.2                          | 43.4      | 10.3          | 8.3             | 1.3   | 0.0       | 84.4                             | 2.0    | 62.6  | 58.8            | 80.8          | -      |
|                      | 290                 | 91                   | 3.5   | 138                            | 1.8   | 47.8                          | 49.0      | 3.3           | 0.7             | 1.1   | 0.3       | 93.9                             | 4.5    | 49.7  | 84.8            | 80.3          | 23.9   |
|                      | 300                 | 416                  | 16.0  | 1,469                          | 18.8  | 46.7                          | 36.6      | 16.7          | 15.2            | 1.1   | 0.1       | 84.6                             | 1.9    | 62.5  | 59.8            | 86.6          | 98.1   |
|                      | 310                 | 171                  | 6.6   | 790                            | 10.1  | 43.8                          | 52.9      | 3.2           | 1.0             | 1.7   | 0.4       | 81.7                             | 0.6    | 76.7  | 34.6            | 76.2          | 86.2   |
|                      | 320                 | 37                   | 1.4   | 68                             | 0.9   | 60.2                          | 34.2      | 5.6           | 0.3             | 0.1   | 0.0       | 85.6                             | 17.5   | 4.9   | 100.0           | 0.0           | -      |
|                      | Total               | 2,597                | 100.0 | 7,817                          | 100.0 | 34.7                          | 38.5      | 26.8          | 11.6            | 1.6   | 0.0       | 82.8                             | 5.1    | 21.2  | 33.6            | 36.3          | -      |
| 1995                 | Manufacturing total | 2,966                | 64.5  | 6,914                          | 47.5  | 40.3                          | 40.3      | 19.4          | 14.4            | 1.4   | 0.7       | 76.5                             | 15.1   | 40.8  | 44.9            | 32.6          | 50.7   |
|                      | Machinery total     | 1,428                | 31.0  | 5,479                          | 37.6  | 29.3                          | 43.3      | 27.5          | 18.6            | 4.7   | 2.7       | 76.2                             | 9.3    | 53.6  | 54.3            | 59.1          | 46.3   |
|                      | 290                 | 234                  | 5.1   | 380                            | 2.6   | 44.0                          | 42.9      | 13.2          | 12.6            | 1.1   | 1.0       | 82.9                             | 1.6    | 25.7  | 35.4            | 25.1          | 13.2   |
|                      | 300                 | 755                  | 16.4  | 2,834                          | 19.5  | 38.9                          | 33.8      | 27.3          | 24.8            | 1.3   | 0.2       | 86.0                             | 14.1   | 46.5  | 45.9            | 33.1          | 48.2   |
|                      | 310                 | 339                  | 7.4   | 2,008                          | 13.8  | 51.6                          | 45.6      | 2.8           | 1.0             | 0.8   | 0.7       | 73.6                             | 16.1   | 68.8  | 39.9            | 97.2          | 85.2   |
|                      | 320                 | 100                  | 2.2   | 257                            | 1.8   | 44.3                          | 34.9      | 20.8          | 20.6            | 0.1   | 0.1       | 85.9                             | 42.4   | 73.7  | 74.5            | 0.0           | 0.3    |
|                      | Total               | 4,600                | 100.0 | 14,559                         | 100.0 | 31.5                          | 36.1      | 32.4          | 14.9            | 1.3   | 1.4       | 69.1                             | 14.2   | 23.2  | 36.2            | 44.7          | 27.5   |
| 1998                 | Manufacturing total | 3,835                | 61.7  | 7,502                          | 49.3  | 35.1                          | 43.3      | 21.6          | 18.6            | 1.5   | 0.6       | 58.7                             | 7.1    | 44.9  | 47.0            | 44.7          | 31.6   |
|                      | Machinery total     | 1,809                | 29.1  | 5,764                          | 37.9  | 36.8                          | 41.3      | 21.8          | 20.3            | 1.0   | 0.4       | 61.9                             | 6.7    | 49.3  | 50.0            | 51.6          | 21.8   |
|                      | 290                 | 315                  | 5.1   | 401                            | 2.6   | 32.2                          | 57.7      | 10.1          | 8.8             | 0.8   | 0.4       | 79.1                             | 3.4    | 76.1  | 85.1            | 21.2          | 0.0    |
|                      | 300                 | 916                  | 14.7  | 3,711                          | 24.4  | 37.0                          | 35.8      | 27.2          | 26.3            | 0.4   | 0.2       | 64.0                             | 6.5    | 49.7  | 50.8            | 24.0          | 7.4    |
|                      | 310                 | 478                  | 7.7   | 1,381                          | 9.1   | 37.2                          | 53.4      | 9.4           | 6.1             | 2.5   | 0.7       | 43.8                             | 5.2    | 48.4  | 36.2            | 89.5          | 17.0   |
|                      | 320                 | 100                  | 1.6   | 272                            | 1.8   | 41.2                          | 40.2      | 18.6          | 14.5            | 2.6   | 1.5       | 72.9                             | 20.5   | 22.6  | 22.3            | 0.0           | 65.3   |
|                      | Total               | 6,213                | 100.0 | 15,223                         | 100.0 | 33.4                          | 41.1      | 25.5          | 20.7            | 1.5   | 1.3       | 59.3                             | 9.9    | 35.6  | 39.4            | 41.8          | 15.4   |
| 2001                 | Manufacturing total | 4,247                | 62.5  | 13,781                         | 51.5  | 35.8                          | 43.3      | 21.0          | 18.6            | 1.0   | 0.6       | 66.0                             | 9.5    | 42.0  | 42.6            | 43.1          | 19.2   |
|                      | Machinery total     | 2,121                | 31.2  | 10,417                         | 38.9  | 38.0                          | 40.3      | 21.7          | 20.2            | 0.7   | 0.3       | 69.9                             | 10.1   | 46.4  | 45.4            | 64.7          | 41.3   |
|                      | 290                 | 381                  | 5.6   | 786                            | 2.9   | 36.2                          | 59.0      | 4.8           | 4.3             | 0.3   | 0.1       | 67.1                             | 9.8    | 48.3  | 48.7            | 40.9          | 56.5   |
|                      | 300                 | 1,041                | 15.3  | 6,249                          | 23.3  | 35.3                          | 35.2      | 29.4          | 28.0            | 0.5   | 0.3       | 74.4                             | 8.6    | 44.7  | 44.4            | 33.3          | 39.0   |
|                      | 310                 | 582                  | 8.6   | 2,945                          | 11.0  | 46.5                          | 47.3      | 6.2           | 3.9             | 1.6   | 0.4       | 59.6                             | 13.7   | 71.4  | 65.4            | 98.2          | 46.2   |
|                      | 320                 | 117                  | 1.7   | 437                            | 1.6   | 42.5                          | 49.9      | 7.7           | 7.4             | 0.0   | 0.2       | 68.5                             | 11.4   | 52.1  | 52.4            | 79.0          | 26.3   |
|                      | Total               | 6,799                | 100.0 | 26,784                         | 100.0 | 33.9                          | 42.5      | 23.6          | 19.3            | 1.8   | 1.2       | 62.6                             | 12.9   | 39.6  | 42.5            | 38.2          | 10.4   |

Data source: authors' calculation, based on METI database.

Note: machinery industries are general machinery (290), electric machinery (300), transport equipment (310), and precision machinery (320).

Table 4 Intra-firm and arm's length transactions by Japanese electric machinery affiliates in East Asia

|                              | Japanese affiliates in East Asia |             |             |             | Japanese affiliates in NIEs <sup>4</sup> |             |             |             | Japanese affiliates in ASEAN <sup>4</sup> |             |             |             | Japanese affiliates in China |             |             |             |
|------------------------------|----------------------------------|-------------|-------------|-------------|--|-------------|-------------|-------------|---|-------------|-------------|-------------|------------------------------|-------------|-------------|-------------|
|                              | 1992                             | 1995        | 1998        | 2001        | 1992                                     | 1995        | 1998        | 2001        | 1992                                      | 1995        | 1998        | 2001        | 1992                         | 1995        | 1998        | 2001        |
| <b>(a) Sales</b>             |                                  |             |             |             |  |             |             |             |   |             |             |             |                              |             |             |             |
| <b>Value</b> (billions JPY)  | 2,872                            | 5,107       | 5,192       | 8,539       | 1,706                                    | 2,793       | 2,161       | 3,542       | 1,083                                     | 1,984       | 2,235       | 3,595       | 70                           | 311         | 750         | 1,298       |
| <b>Share (%)</b>             |                                  |             |             |             |  |             |             |             |   |             |             |             |                              |             |             |             |
| (i) Japan                    | <b>27.2</b>                      | <b>28.7</b> | <b>32.9</b> | <b>34.4</b> | <b>24.7</b>                              | <b>22.6</b> | <b>28.1</b> | <b>30.3</b> | <b>27.7</b>                               | <b>36.2</b> | <b>41.9</b> | <b>40.0</b> | <b>81.2</b>                  | <b>29.7</b> | <b>22.5</b> | <b>32.2</b> |
| -intra-firm                  | 24.5                             | 25.6        | 24.2        | 26.7        | 23.3                                     | 19.9        | 19.9        | 18.0        | 23.1                                      | 32.1        | 31.8        | 35.7        | 80.7                         | 28.3        | 15.8        | 26.5        |
| -arm's length                | 2.7                              | 3.2         | 8.7         | 7.7         | 1.4                                      | 2.7         | 8.2         | 12.3        | 4.6                                       | 4.1         | 10.1        | 4.4         | 0.4                          | 1.4         | 6.7         | 5.8         |
| (ii) Local                   | <b>45.7</b>                      | <b>38.0</b> | <b>32.3</b> | <b>31.2</b> | <b>52.2</b>                              | <b>45.4</b> | <b>44.2</b> | <b>41.4</b> | <b>38.4</b>                               | <b>29.3</b> | <b>17.2</b> | <b>18.5</b> | <b>13.4</b>                  | <b>34.1</b> | <b>40.8</b> | <b>37.2</b> |
| -intra-firm                  | 3.7                              | 3.4         | 4.7         | 4.9         | 5.0                                      | 3.2         | 5.6         | 4.1         | 2.3                                       | 3.8         | 3.7         | 5.6         | 0.0                          | 2.5         | 4.5         | 5.7         |
| -arm's length                | 42.0                             | 34.6        | 27.6        | 26.3        | 47.2                                     | 42.2        | 38.7        | 37.4        | 36.2                                      | 25.5        | 13.4        | 12.9        | 13.4                         | 31.6        | 36.3        | 31.6        |
| (iii) Other East Asia        | <b>17.7</b>                      | <b>19.6</b> | <b>24.9</b> | <b>22.0</b> | <b>16.3</b>                              | <b>17.4</b> | <b>18.8</b> | <b>16.4</b> | <b>20.6</b>                               | <b>20.3</b> | <b>28.4</b> | <b>26.8</b> | <b>5.1</b>                   | <b>30.8</b> | <b>31.7</b> | <b>22.0</b> |
| -intra-firm                  | 9.5                              | 11.6        | 13.8        | 12.3        | 5.2                                      | 9.2         | 6.4         | 7.5         | 15.1                                      | 11.7        | 15.8        | 14.2        | 5.1                          | 27.9        | 27.2        | 17.0        |
| -arm's length                | 8.2                              | 7.9         | 11.1        | 9.7         | 11.0                                     | 8.1         | 12.3        | 8.9         | 5.4                                       | 8.6         | 12.6        | 12.6        | 0.0                          | 2.9         | 4.5         | 5.0         |
| (i+ii+iii) East Asia (total) | <b>90.6</b>                      | <b>86.3</b> | <b>90.1</b> | <b>87.6</b> | <b>93.1</b>                              | <b>85.3</b> | <b>91.1</b> | <b>88.1</b> | <b>86.7</b>                               | <b>85.9</b> | <b>87.4</b> | <b>85.3</b> | <b>99.8</b>                  | <b>94.6</b> | <b>95.0</b> | <b>91.4</b> |
| -intra-firm                  | 37.6                             | 40.6        | 42.7        | 43.9        | 33.5                                     | 32.3        | 31.9        | 29.6        | 40.5                                      | 47.6        | 51.3        | 55.4        | 85.9                         | 58.6        | 47.5        | 49.1        |
| -arm's length                | 53.0                             | 45.7        | 47.4        | 43.8        | 59.6                                     | 53.0        | 59.2        | 58.6        | 46.2                                      | 38.2        | 36.1        | 29.9        | 13.8                         | 35.9        | 47.5        | 42.3        |
| <b>(b) Purchases</b>         |                                  |             |             |             |  |             |             |             |   |             |             |             |                              |             |             |             |
| <b>Value</b>                 | 1,469                            | 2,834       | 3,711       | 6,249       | 757                                      | 1,455       | 1,700       | 2,653       | 654                                       | 1,157       | 1,452       | 2,602       | 47                           | 209         | 532         | 919         |
| <b>Share</b>                 |                                  |             |             |             |  |             |             |             |   |             |             |             |                              |             |             |             |
| (i) Japan                    | <b>46.7</b>                      | <b>38.9</b> | <b>37.0</b> | <b>35.3</b> | <b>48.7</b>                              | <b>37.8</b> | <b>42.5</b> | <b>40.8</b> | <b>42.1</b>                               | <b>37.1</b> | <b>33.7</b> | <b>28.3</b> | <b>83.6</b>                  | <b>53.3</b> | <b>33.3</b> | <b>38.3</b> |
| -intra-firm                  | 39.5                             | 33.5        | 23.7        | 26.3        | 43.2                                     | 33.6        | 27.8        | 33.1        | 32.8                                      | 30.7        | 21.7        | 19.4        | 78.4                         | 45.1        | 19.4        | 24.9        |
| -arm's length                | 7.2                              | 5.4         | 13.3        | 9.0         | 5.5                                      | 4.2         | 14.7        | 7.7         | 9.4                                       | 6.4         | 12.0        | 8.9         | 5.2                          | 8.2         | 13.9        | 13.4        |
| (ii) Local                   | <b>36.6</b>                      | <b>33.8</b> | <b>35.8</b> | <b>35.2</b> | <b>34.3</b>                              | <b>38.4</b> | <b>36.4</b> | <b>31.3</b> | <b>39.7</b>                               | <b>31.2</b> | <b>36.0</b> | <b>38.7</b> | <b>16.1</b>                  | <b>18.7</b> | <b>33.7</b> | <b>37.3</b> |
| -intra-firm                  | 0.7                              | 4.8         | 2.3         | 3.0         | 0.3                                      | 7.5         | 2.6         | 3.6         | 0.7                                       | 1.8         | 2.1         | 2.1         | 6.3                          | 1.8         | 2.6         | 4.1         |
| -arm's length                | 35.9                             | 29.0        | 33.5        | 32.2        | 33.9                                     | 30.8        | 33.8        | 27.7        | 39.0                                      | 29.4        | 33.9        | 36.6        | 9.9                          | 16.9        | 31.1        | 33.2        |
| (iii) Other East Asia        | <b>15.2</b>                      | <b>24.8</b> | <b>26.3</b> | <b>28.0</b> | <b>15.9</b>                              | <b>20.4</b> | <b>20.7</b> | <b>26.3</b> | <b>15.9</b>                               | <b>30.1</b> | <b>29.1</b> | <b>31.2</b> | <b>0.1</b>                   | <b>27.0</b> | <b>32.1</b> | <b>23.8</b> |
| -intra-firm                  | 9.1                              | 11.4        | 13.4        | 12.4        | 15.0                                     | 12.0        | 11.1        | 12.8        | 3.5                                       | 7.9         | 10.1        | 10.5        | 0.1                          | 22.4        | 27.1        | 16.1        |
| -arm's length                | 6.1                              | 13.4        | 12.9        | 15.6        | 1.0                                      | 8.4         | 9.6         | 13.5        | 12.5                                      | 22.2        | 19.0        | 20.7        | 0.0                          | 4.6         | 5.0         | 7.8         |
| (i+ii+iii) East Asia (total) | <b>98.5</b>                      | <b>97.5</b> | <b>99.1</b> | <b>98.5</b> | <b>98.9</b>                              | <b>96.6</b> | <b>99.5</b> | <b>98.4</b> | <b>97.8</b>                               | <b>98.4</b> | <b>98.8</b> | <b>98.2</b> | <b>99.8</b>                  | <b>99.0</b> | <b>99.1</b> | <b>99.5</b> |
| -intra-firm                  | 49.3                             | 49.6        | 39.4        | 41.7        | 58.6                                     | 53.1        | 41.5        | 49.5        | 36.9                                      | 40.4        | 33.9        | 32.0        | 84.8                         | 69.3        | 49.1        | 45.0        |
| -arm's length                | 49.2                             | 47.9        | 59.8        | 56.8        | 40.4                                     | 43.5        | 58.1        | 48.9        | 60.9                                      | 58.0        | 64.8        | 66.2        | 15.0                         | 29.7        | 50.0        | 54.4        |

Data source: authors' calculation, based on METI database.

Table 5 Intra-firm and arm's length transactions by Japanese transport equipment affiliates in East Asia

|                             |                   | Japanese affiliates in East Asia |             |             |             | Japanese affiliates in NIEs4 |             |             |             | Japanese affiliates in ASEAN4 |             |             |             | Japanese affiliates in China |             |             |             |
|-----------------------------|-------------------|----------------------------------|-------------|-------------|-------------|------------------------------|-------------|-------------|-------------|-------------------------------|-------------|-------------|-------------|------------------------------|-------------|-------------|-------------|
|                             |                   | 1992                             | 1995        | 1998        | 2001        | 1992                         | 1995        | 1998        | 2001        | 1992                          | 1995        | 1998        | 2001        | 1992                         | 1995        | 1998        | 2001        |
| <b>(a) Sales</b>            |                   |                                  |             |             |             |                              |             |             |             |                               |             |             |             |                              |             |             |             |
| <b>Value</b> (billions JPY) |                   | 1,999                            | 3,095       | 2,140       | 4,575       | 811                          | 758         | 557         | 829         | 974                           | 1,920       | 843         | 2,379       | 35                           | 145         | 281         | 696         |
| <b>Share (%)</b>            |                   |                                  |             |             |             |                              |             |             |             |                               |             |             |             |                              |             |             |             |
| (i)                         | Japan             | <b>1.7</b>                       | <b>2.2</b>  | <b>11.1</b> | <b>8.1</b>  | <b>2.3</b>                   | <b>1.9</b>  | <b>3.1</b>  | <b>3.1</b>  | <b>1.8</b>                    | <b>2.5</b>  | <b>25.3</b> | <b>9.4</b>  | <b>1.5</b>                   | <b>5.5</b>  | <b>7.9</b>  | <b>14.0</b> |
|                             | -intra-firm       | 1.3                              | 1.9         | 9.1         | 6.5         | 1.1                          | 1.6         | 1.4         | 2.7         | 1.7                           | 2.1         | 21.0        | 7.1         | 1.2                          | 5.2         | 7.0         | 12.2        |
|                             | -arm's length     | 0.5                              | 0.3         | 2.0         | 1.6         | 1.2                          | 0.2         | 1.7         | 0.4         | 0.1                           | 0.5         | 4.3         | 2.3         | 0.2                          | 0.3         | 0.9         | 1.8         |
| (ii)                        | Local             | <b>92.6</b>                      | <b>92.8</b> | <b>81.0</b> | <b>66.1</b> | <b>92.2</b>                  | <b>92.8</b> | <b>91.0</b> | <b>84.1</b> | <b>92.3</b>                   | <b>91.9</b> | <b>59.9</b> | <b>54.4</b> | <b>92.4</b>                  | <b>87.9</b> | <b>88.4</b> | <b>82.4</b> |
|                             | -intra-firm       | 6.7                              | 25.3        | 2.3         | 6.1         | 0.6                          | 22.7        | 5.3         | 6.3         | 11.8                          | 34.3        | 3.2         | 8.7         | 0.0                          | 0.3         | 0.4         | 0.8         |
|                             | -arm's length     | 85.9                             | 67.4        | 78.8        | 59.9        | 91.6                         | 70.1        | 85.7        | 77.8        | 80.5                          | 57.6        | 56.6        | 45.7        | 92.4                         | 87.5        | 88.0        | 81.6        |
| (iii)                       | Other East Asia   | <b>0.8</b>                       | <b>0.8</b>  | <b>2.2</b>  | <b>16.4</b> | <b>1.6</b>                   | <b>0.7</b>  | <b>2.9</b>  | <b>7.0</b>  | <b>0.5</b>                    | <b>0.9</b>  | <b>3.6</b>  | <b>21.8</b> | <b>0.0</b>                   | <b>1.9</b>  | <b>1.4</b>  | <b>1.4</b>  |
|                             | -intra-firm       | 0.5                              | 0.3         | 1.1         | 3.8         | 0.8                          | 0.3         | 0.9         | 3.7         | 0.4                           | 0.3         | 2.7         | 5.6         | 0.0                          | 0.2         | 0.1         | 0.2         |
|                             | -arm's length     | 0.3                              | 0.6         | 1.1         | 12.6        | 0.8                          | 0.4         | 2.1         | 3.3         | 0.1                           | 0.7         | 0.9         | 16.2        | 0.0                          | 1.7         | 1.3         | 1.2         |
| (i+ii+iii)                  | East Asia (total) | <b>95.1</b>                      | <b>95.8</b> | <b>94.3</b> | <b>90.6</b> | <b>96.1</b>                  | <b>95.4</b> | <b>97.0</b> | <b>94.2</b> | <b>94.6</b>                   | <b>95.3</b> | <b>88.7</b> | <b>85.7</b> | <b>93.9</b>                  | <b>95.2</b> | <b>97.7</b> | <b>97.9</b> |
|                             | -intra-firm       | 8.4                              | 27.5        | 12.5        | 16.5        | 2.5                          | 24.6        | 7.5         | 12.7        | 13.8                          | 36.6        | 27.0        | 21.5        | 1.2                          | 5.7         | 7.5         | 13.2        |
|                             | -arm's length     | 86.7                             | 68.3        | 81.8        | 74.1        | 93.6                         | 70.7        | 89.5        | 81.5        | 80.8                          | 58.7        | 61.8        | 64.2        | 92.6                         | 89.5        | 90.2        | 84.6        |
| <b>(b) Purchases</b>        |                   |                                  |             |             |             |                              |             |             |             |                               |             |             |             |                              |             |             |             |
| <b>Value</b>                |                   | 790                              | 2,008       | 1,381       | 2,945       | 215                          | 389         | 419         | 479         | 512                           | 1,380       | 520         | 1,658       | 6                            | 91          | 171         | 394         |
| <b>Share</b>                |                   |                                  |             |             |             |                              |             |             |             |                               |             |             |             |                              |             |             |             |
| (i)                         | Japan             | <b>43.8</b>                      | <b>51.6</b> | <b>37.2</b> | <b>46.5</b> | <b>38.3</b>                  | <b>34.6</b> | <b>31.7</b> | <b>22.6</b> | <b>45.0</b>                   | <b>61.1</b> | <b>41.0</b> | <b>54.8</b> | <b>39.3</b>                  | <b>52.9</b> | <b>43.0</b> | <b>38.4</b> |
|                             | -intra-firm       | 35.8                             | 38.0        | 16.3        | 27.7        | 16.9                         | 19.0        | 13.0        | 18.2        | 43.5                          | 50.3        | 25.5        | 32.5        | 38.2                         | 45.0        | 9.8         | 19.7        |
|                             | -arm's length     | 8.0                              | 13.6        | 20.9        | 18.8        | 21.4                         | 15.6        | 18.7        | 4.4         | 1.6                           | 10.8        | 15.5        | 22.4        | 1.0                          | 7.9         | 33.2        | 18.6        |
| (ii)                        | Local             | <b>52.9</b>                      | <b>45.6</b> | <b>53.4</b> | <b>47.3</b> | <b>59.9</b>                  | <b>64.3</b> | <b>60.8</b> | <b>62.2</b> | <b>51.4</b>                   | <b>35.7</b> | <b>46.0</b> | <b>39.6</b> | <b>40.5</b>                  | <b>43.3</b> | <b>52.3</b> | <b>57.9</b> |
|                             | -intra-firm       | 0.3                              | 7.3         | 2.8         | 6.5         | 0.0                          | 0.4         | 5.6         | 0.5         | 0.5                           | 9.5         | 4.9         | 10.2        | 0.0                          | 24.1        | 0.1         | 0.5         |
|                             | -arm's length     | 52.6                             | 38.3        | 50.6        | 40.8        | 59.9                         | 64.0        | 55.2        | 61.6        | 51.0                          | 26.1        | 41.1        | 29.4        | 40.5                         | 19.2        | 52.2        | 57.3        |
| (iii)                       | Other East Asia   | <b>1.0</b>                       | <b>1.0</b>  | <b>6.1</b>  | <b>3.9</b>  | <b>0.4</b>                   | <b>0.2</b>  | <b>6.1</b>  | <b>12.2</b> | <b>1.1</b>                    | <b>1.1</b>  | <b>8.0</b>  | <b>3.0</b>  | <b>9.9</b>                   | <b>1.0</b>  | <b>1.8</b>  | <b>1.1</b>  |
|                             | -intra-firm       | 0.4                              | 0.4         | 2.2         | 2.6         | 0.3                          | 0.1         | 1.1         | 9.1         | 0.3                           | 0.6         | 4.2         | 2.0         | 9.9                          | 0.7         | 1.7         | 0.7         |
|                             | -arm's length     | 0.7                              | 0.6         | 3.9         | 1.4         | 0.1                          | 0.2         | 5.0         | 3.1         | 0.9                           | 0.5         | 3.8         | 1.0         | 0.0                          | 0.2         | 0.1         | 0.4         |
| (i+ii+iii)                  | East Asia (total) | <b>97.8</b>                      | <b>98.3</b> | <b>96.7</b> | <b>97.7</b> | <b>98.6</b>                  | <b>99.2</b> | <b>98.7</b> | <b>97.0</b> | <b>97.6</b>                   | <b>97.9</b> | <b>95.0</b> | <b>97.5</b> | <b>89.6</b>                  | <b>97.2</b> | <b>97.1</b> | <b>97.3</b> |
|                             | -intra-firm       | 36.5                             | 45.7        | 21.3        | 36.8        | 17.2                         | 19.5        | 19.7        | 27.9        | 44.2                          | 60.4        | 34.6        | 44.7        | 48.1                         | 69.9        | 11.5        | 20.9        |
|                             | -arm's length     | 61.3                             | 52.6        | 75.4        | 61.0        | 81.4                         | 79.7        | 79.0        | 69.1        | 53.4                          | 37.4        | 60.4        | 52.8        | 41.5                         | 27.3        | 85.6        | 76.4        |

Data source: authors' calculation, based on METI database.

Table A.1 Definition of machinery parts and components

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HS classification

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840140, 840290, 840390, 840490, 840590, 8406, 8407, 8408, 8409, 8410, 8411, 8412, 8413, 8414, 841520, 841590, 8416, 8417, 841891, 841899, 841990, 842123, 842129, 842131, 842191, 842199, 842290, 842390, 842490, 8431, 843290, 843390, 843490, 843590, 843680, 843691, 843699, 843790, 843890, 843991, 843999, 844090, 844190, 844240, 844250, 844390, 8448, 845090, 845190, 845240, 845290, 845390, 845490, 845590, 8466, 846791, 846792, 846799, 846890, 8473, 847490, 847590, 847690, 847790, 847890, 847990, 8480, 8481, 8482, 8483, 8484, 8485, 8503, 850490, 8505, 850690, 8507, 850890, 850990, 851090, 8511, 8512, 851390, 851490, 851590, 851690, 851790, 8518, 8522, 8529, 853090, 8531, 8532, 8533, 8534, 8535, 8536, 8537, 8538, 8539, 8540, 8541, 8542, 854390, 8544, 8545, 8546, 8547, 8548, 8607, 8706, 8707, 8708, 870990, 8714, 871690, 8803, 8805, 9001, 9002, 9003, 900590, 900691, 900699, 900791, 900792, 900890, 900990, 901090, 901190, 901290, 9013, 9014, 901590, 901790, 902490, 902590, 902690, 902790, 902890, 902990, 903090, 903190, 903290, 9033, 9110, 9111, 9112, 9113, 9114, 9209

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Source: Ando and Kimura (2005).



Table A.2 Development of intra-regional exports in Japan

| <b>(a) Intra- and inter-regional exports (millions US\$)</b> |          |        |           |        |           |        | <b>(b) Factors of growth in exports (1990-2003)</b> |      |
|--|----------|--------|-----------|--------|-----------|--------|---|------|
|  | 1990     |        | 2001      |        | 2003      |        |   |      |
|  | Value    | %      | Value     | %      | Value     | %      |   |      |
| <b>Machinery goods: parts and components</b>                 |          |        |           |        |           |        | <b>&lt;Intra-East Asian exports&gt;</b>             |      |
| Intra-East Asia  | 21,217   | 27.5   | 55,797    | 40.1   | 76,645    | 47.6   | (i) Growth in intra-East Asian exports              |      |
| Inter-regional   | 55,921   | 72.5   | 83,205    | 59.9   | 84,232    | 52.4   | All products  | 160% |
| (U.S.)   | (26,401) | (34.2) | (39,191)  | (28.2) | (35,694)  | (22.2) | Machinery goods (total)                             | 163% |
| Total  | 77,138   | 100.0  | 139,002   | 100.0  | 160,877   | 100.0  | - Machinery final goods                             | 72%  |
|  |          |        |           |        |           |        | - Machinery parts and components                    | 261% |
| <b>Machinery goods: final goods</b>                          |          |        |           |        |           |        | (ii) Contribution to the growth (all products)      |      |
| Intra-East Asia  | 22,861   | 16.2   | 27,649    | 17.6   | 39,330    | 21.5   | Machinery goods (total)                             | 65%  |
| Inter-regional   | 118,560  | 83.8   | 129,165   | 82.4   | 143,856   | 78.5   | - Machinery final goods                             | 15%  |
| (U.S.)   | (49,971) | (35.3) | (60,832)  | (38.8) | (59,307)  | (32.4) | - Machinery parts and components                    | 50%  |
| Total  | 141,421  | 100.0  | 156,814   | 100.0  | 183,186   | 100.0  |   |      |
| <b>Machinery goods: total</b>                                |          |        |           |        |           |        | <b>&lt;Inter-regional exports&gt;</b>               |      |
| Intra-East Asia  | 44,078   | 20.2   | 83,446    | 28.2   | 115,974   | 33.7   | (i) Growth in inter-regional exports                |      |
| Inter-regional   | 174,480  | 79.8   | 212,370   | 71.8   | 228,088   | 66.3   | All products  | 34%  |
| (U.S.)   | (76,373) | (34.9) | (100,023) | (33.8) | (95,001)  | (27.6) | Machinery goods (total)                             | 31%  |
| Total  | 218,559  | 100.0  | 295,815   | 100.0  | 344,062   | 100.0  | - Machinery final goods                             | 21%  |
|  |          |        |           |        |           |        | - Machinery parts and components                    | 51%  |
| <b>All products</b>  |          |        |           |        |           |        | (ii) Contribution to the growth (all products)      |      |
| Intra-East Asia  | 69,431   | 24.2   | 131,772   | 32.7   | 180,469   | 38.2   | Machinery goods (total)                             | 72%  |
| Inter-regional   | 217,517  | 75.8   | 271,591   | 67.3   | 291,527   | 61.8   | - Machinery final goods                             | 34%  |
| (U.S.)   | (90,944) | (31.7) | (122,549) | (30.4) | (117,539) | (24.9) | - Machinery parts and components                    | 38%  |
| Total  | 286,947  | 100.0  | 403,364   | 100.0  | 471,996   | 100.0  |   |      |

Data source: authors' calculation, based on UN COMTRADE.

Note: "Intra-East Asia" here includes China, ASEAN4, and NIES3. Due to lack of data available from UN COMTRADE, Taiwan is not included in East Asia.

Table A.3 Development of intra-regional exports in NIEs3

| <b>(a) Intra- and inter-regional exports (millions US\$)</b> |          |        |          |        |          |        | <b>(b) Factors of growth in exports (1990-2003)</b> |      |
|--|----------|--------|----------|--------|----------|--------|---|------|
|  | 1990     |        | 2001     |        | 2003     |        |   |      |
|  | Value    | %      | Value    | %      | Value    | %      |   |      |
| <b>Machinery goods: parts and components</b>                 |          |        |          |        |          |        | <b>&lt;Intra-East Asian exports&gt;</b>             |      |
| Intra-East Asia  | 23,518   | 53.6   | 84,623   | 59.0   | 124,336  | 65.4   | (i) Growth in intra-East Asian exports              |      |
| Inter-regional   | 20,357   | 46.4   | 58,739   | 41.0   | 65,738   | 34.6   | All products  | 170% |
| (U.S.)   | (9,600)  | (21.9) | (20,881) | (14.6) | (21,247) | (11.2) | Machinery goods (total)                             | 310% |
| Total  | 43,875   | 100.0  | 143,363  | 100.0  | 190,074  | 100.0  | - Machinery final goods                             | 160% |
|  |          |        |          |        |          |        | - Machinery parts and components                    | 429% |
| <b>Machinery goods: final goods</b>                          |          |        |          |        |          |        | (ii) Contribution to the growth (all products)      |      |
| Intra-East Asia  | 18,499   | 30.1   | 34,740   | 28.8   | 48,111   | 32.1   | Machinery goods (total)                             | 73%  |
| Inter-regional   | 43,033   | 69.9   | 86,046   | 71.2   | 101,913  | 67.9   | - Machinery final goods                             | 17%  |
| (U.S.)   | (17,336) | (28.2) | (32,909) | (27.2) | (36,329) | (24.2) | - Machinery parts and components                    | 57%  |
| Total  | 61,532   | 100.0  | 120,786  | 100.0  | 150,024  | 100.0  |   |      |
| <b>Machinery goods: total</b>                                |          |        |          |        |          |        | <b>&lt;Inter-regional exports&gt;</b>               |      |
| Intra-East Asia  | 42,017   | 39.9   | 119,363  | 45.2   | 172,447  | 50.7   | (i) Growth in inter-regional exports                |      |
| Inter-regional   | 63,390   | 60.1   | 144,785  | 54.8   | 167,651  | 49.3   | All products  | 91%  |
| (U.S.)   | (26,936) | (25.6) | (53,790) | (20.4) | (57,576) | (16.9) | Machinery goods (total)                             | 164% |
| Total  | 105,407  | 100.0  | 264,148  | 100.0  | 340,098  | 100.0  | - Machinery final goods                             | 137% |
|  |          |        |          |        |          |        | - Machinery parts and components                    | 223% |
| <b>All products</b>  |          |        |          |        |          |        | (ii) Contribution to the growth (all products)      |      |
| Intra-East Asia  | 104,639  | 41.3   | 213,351  | 46.1   | 282,712  | 49.9   | Machinery goods (total)                             | 77%  |
| Inter-regional   | 148,478  | 58.7   | 249,903  | 53.9   | 284,008  | 50.1   | - Machinery final goods                             | 43%  |
| (U.S.)   | (61,841) | (24.4) | (92,466) | (20.0) | (96,642) | (17.1) | - Machinery parts and components                    | 33%  |
| Total  | 253,116  | 100.0  | 463,254  | 100.0  | 566,720  | 100.0  |   |      |

Data source: authors' calculation, based on UN COMTRADE.

Note: "Intra-East Asia" here includes China, ASEAN4, and Japan. Due to lack of data available from UN COMTRADE, (i) Taiwan is not included in East Asia, and (ii) data for Hong Kong in 1993 are used in calculating intra-East Asian exports in 1990.

Table A.4 Development of intra-regional exports in ASEAN4

|  | 1990     |        | 2001     |        | 2003     |        |   |
|--|----------|--------|----------|--------|----------|--------|---|
|  | Value    | %      | Value    | %      | Value    | %      |   |
| <b>(a) Intra- and inter-regional exports (millions US\$)</b> |          |        |          |        |          |        | <b>(b) Factors of growth in exports (1990-2003)</b> |
| <b>Machinery goods: parts and components</b>                 |          |        |          |        |          |        | <b>&lt;Intra-East Asian exports&gt;</b>             |
| Intra-East Asia  | 5,383    | 51.0   | 40,842   | 54.7   | 53,087   | 59.9   | (i) Growth in intra-East Asian exports              |
| Inter-regional   | 5,170    | 49.0   | 33,851   | 45.3   | 35,583   | 40.1   | All products  |
| (U.S.)   | (3,162)  | (30.0) | (14,335) | (19.2) | (13,102) | (14.8) | Machinery goods (total)                             |
| Total  | 10,553   | 100.0  | 74,693   | 100.0  | 88,670   | 100.0  | - Machinery final goods                             |
|  |          |        |          |        |          |        | - Machinery parts and components                    |
| <b>Machinery goods: final goods</b>                          |          |        |          |        |          |        | (ii) Contribution to the growth (all products)      |
| Intra-East Asia  | 2,187    | 34.7   | 15,005   | 34.2   | 17,129   | 34.9   | Machinery goods (total)                             |
| Inter-regional   | 4,107    | 65.3   | 28,912   | 65.8   | 31,883   | 65.1   | - Machinery final goods                             |
| (U.S.)   | (2,004)  | (31.8) | (12,776) | (29.1) | (15,157) | (30.9) | - Machinery parts and components                    |
| Total  | 6,293    | 100.0  | 43,918   | 100.0  | 49,012   | 100.0  |   |
| <b>Machinery goods: total</b>                                |          |        |          |        |          |        | <b>&lt;Inter-regional exports&gt;</b>               |
| Intra-East Asia  | 7,570    | 44.9   | 55,848   | 47.1   | 70,217   | 51.0   | (i) Growth in inter-regional exports                |
| Inter-regional   | 9,276    | 55.1   | 62,763   | 52.9   | 67,466   | 49.0   | All products  |
| (U.S.)   | (5,166)  | (30.7) | (27,110) | (22.9) | (28,259) | (20.5) | Machinery goods (total)                             |
| Total  | 16,846   | 100.0  | 118,611  | 100.0  | 137,682  | 100.0  | - Machinery final goods                             |
|  |          |        |          |        |          |        | - Machinery parts and components                    |
| <b>All products</b>  |          |        |          |        |          |        | (ii) Contribution to the growth (all products)      |
| Intra-East Asia  | 40,548   | 51.9   | 114,181  | 47.3   | 140,831  | 49.9   | Machinery goods (total)                             |
| Inter-regional   | 37,649   | 48.1   | 127,404  | 52.7   | 141,497  | 50.1   | - Machinery final goods                             |
| (U.S.)   | (13,594) | (17.4) | (47,819) | (19.8) | (48,835) | (17.3) | - Machinery parts and components                    |
| Total  | 78,197   | 100.0  | 241,584  | 100.0  | 282,327  | 100.0  |   |

Data source: authors' calculation, based on UN COMTRADE.

Note: "Intra-East Asia" here includes China, NIES3, and Japan. Due to lack of data available from UN COMTRADE, (i) Taiwan is not included in East Asia, and (ii) data for the Philippines are not included in calculating intra-East Asian trade in 1990.

Table A.5 Development of intra-regional exports in China

| <b>(a) Intra- and inter-regional exports (millions US\$)</b> |         |        |          |        |          | <b>(b) Factors of growth in exports (1990-2003)</b>   |  |
|--|---------|--------|----------|--------|----------|---|--|
|  | 1990    |        | 2001     |        | 2003     |   |  |
|  | Value   | %      | Value    | %      | Value    | %   |  |
| <b>Machinery goods: parts and components</b>                 |         |        |          |        |          | <b>&lt;Intra-East Asian exports&gt;</b>               |  |
| Intra-East Asia  | 4,218   | 74.2   | 24,374   | 56.2   | 46,069   | 56.1  | (i) Growth in intra-East Asian exports |
| Inter-regional   | 1,468   | 25.8   | 19,010   | 43.8   | 36,084   | 43.9  | All products 226%                      |
| (U.S.)   | (460)   | (8.1)  | (7,018)  | (16.2) | (12,500) | (15.2)  | Machinery goods (total) 640%           |
| Total  | 5,685   | 100.0  | 43,384   | 100.0  | 82,154   | 100.0   | - Machinery final goods 439%           |
|  |         |        |          |        |          |   | - Machinery parts and components 992%  |
| <b>Machinery goods: final goods</b>                          |         |        |          |        |          | <b>(ii) Contribution to the growth (all products)</b> |  |
| Intra-East Asia  | 7,385   | 71.8   | 21,970   | 37.0   | 39,798   | 33.5  | Machinery goods (total) 59%            |
| Inter-regional   | 2,898   | 28.2   | 37,369   | 63.0   | 79,080   | 66.5  | - Machinery final goods 26%            |
| (U.S.)   | (872)   | (8.5)  | (23,572) | (39.7) | (32,841) | (27.6)  | - Machinery parts and components 33%   |
| Total  | 10,283  | 100.0  | 59,339   | 100.0  | 118,878  | 100.0   |  |
| <b>Machinery goods: total</b>                                |         |        |          |        |          | <b>&lt;Inter-regional exports&gt;</b>                 |  |
| Intra-East Asia  | 11,603  | 72.7   | 46,344   | 45.1   | 85,868   | 42.7  | (i) Growth in inter-regional exports   |
| Inter-regional   | 4,366   | 27.3   | 56,379   | 54.9   | 115,164  | 57.3  | All products 780%                      |
| (U.S.)   | (1,332) | (8.3)  | (30,590) | (29.8) | (45,340) | (22.6)  | Machinery goods (total) 2538%          |
| Total  | 15,968  | 100.0  | 102,723  | 100.0  | 201,032  | 100.0   | - Machinery final goods 2629%          |
|  |         |        |          |        |          |   | - Machinery parts and components 2358% |
| <b>All products</b>  |         |        |          |        |          | <b>(ii) Contribution to the growth (all products)</b> |  |
| Intra-East Asia  | 55,848  | 65.7   | 119,804  | 45.0   | 182,185  | 41.6  | Machinery goods (total) 49%            |
| Inter-regional   | 29,092  | 34.3   | 146,294  | 55.0   | 256,043  | 58.4  | - Machinery final goods 34%            |
| (U.S.)   | (8,599) | (10.1) | (70,050) | (26.3) | (92,626) | (21.1)  | - Machinery parts and components 15%   |
| Total  | 84,940  | 100.0  | 266,098  | 100.0  | 438,228  | 100.0   |  |

Data source: authors' calculation, based on UN COMTRADE.

Note: "Intra-East Asia" here includes ASEAN4, NIES3, and Japan. Due to lack of data available from UN COMTRADE, (i) Taiwan is not included in East Asia, and (ii) data for China in 1992 are used in calculating intra-East Asian trade in 1990.