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Outsourcing of Intermediate Manufacturing Products in Asian Economies*

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[Abstract]

We aim to investigate transition and trend of outsourcing production among Asian Economies. With the use of highly-disaggregated Harmonized System (HS) classification code dataset, we can investigate narrowly-defined intermediate manufacturing products within automobile industry. By calculating unit value of intermediate products, we created the quality rankings of products among these countries. After making clear recent trend for production of intermediate products in Asian countries, we investigate whether these trends are autonomous or Japanese-FDI related. We find investments by automobile suppliers increase automobile component trade in the region.

Keywords: Asian Economies, Automobile Industry, Component Trade, Fragmentation, Outsourcing,

JEL classification codes: F14(Country and Industry Studies of Trade),
F21(International Investment)
L62(Automobiles, Other Transportation Equipment)

1. Introduction

Table 1 presents the shares of Japan, the Asia and the US in the exports of the Asian countries for the period between 1990 and 2000. We can see that US and Japan have been taking prominent roles in purchasing products from Asian economies. In 2000, the share of the US as the export destination ranges from 14 percent (Indonesia) to 30 percent (the Philippines), while that of Japan as the export destination varies from 6percent (Hong Kong) to 23percent (Indonesia). For the Asian economies, regional trade is also important along trades with the US and Japan. The share of the Asia as a region for exports ranges from 25 percent (Philippines) to 42 percent (Hong Kong).

However, these aggregate data only reveal partial picture of complicated, multinational trade dynamics among Asian countries. It is well documented that more productions are internationally fragmented, or outsourced, that is some parts of production process are shifted outside of national boundary from developed economy's point of view, see Yeats (2001). From developing countries side, it is direct increase in intermediate production and consequently increase in intermediate exports.

Fragmentation of production process allows a firm to locate parts of production in regions where intensively used factors are available at lower cost. At the same time, a firm faces extra cost incurred for "service links" among physically dislocated production sites, see Jones (2000). By a dramatic reduction in information and communication cost across borders in recent years, we observe on-going expansion of international fragmentation of process and a consequent rise in the volume of international inter-industry trade.

The direct empirical examination of outsourcing is not straightforward because

outsourcing data is not readily available. For example, Swenson (2005) uses US offshore assembly program (OAP) data to examine the extent of overseas assembly which uses the US components and ship value-added products back to the US. From the OAP trade data, however, assembly by independent foreign firms and assembly by subsidiary firms can not be distinguished. Outsourcing always involves fragmentation of production process; however, it does not go the other way around.

Locations of production for some industries have moved around the world as firms constantly searched better production sites in terms of cost reduction. For a well cited example, productions of textile and apparel industry have shifted from North America and Western Europe, first to Japan, then to the 'Big Three' Asian apparel producers (Hong Kong, Taiwan and Korea), and finally to China and Southeast Asian countries, see Gereffi (1999)[1].

A more interesting and more complex example involves continuous expansion of production locations for automotive industry. In 2002, 23 countries are producing more than 100,000 units of automobiles[2]. More countries are also involved in supplying automobile parts. It is also well documented in automobile industry that complex global production networks involve intra-industry trades both at the levels of final products and intermediate products.

In this paper we aim to investigate exports of finely disaggregated intermediate products among the Asian economies, including Japan. Namely, we focus on exports of parts and components for automobiles. We examine the recent growth in trades for

[1] The objective of Gereffi (1999) is, however, to explain the production shift in 1990's to higher wage countries by industrial upgrading.
[2] Fourin (2004) reports automobile productions for the following countries; US, Canada, Mexico, Brazil, Argentina, Germany, France, Italy, UK, Spain, Belgium, Portugal, Sweden, Czech, Turkey, Japan, Korea, China, India, Taiwan, Thailand, Malaysia, and Indonesia.

automobile components among the region. Among 28 categories for automobile components, we observe the trend in recent years that more countries in the Asia participate in global automobile production network and the Asian countries increases in the variety of production for automobiles components.

We also examine on the changing roles in component exports among the Asian economies. By comparing unit prices among the Asian exporters, we can presumably rank the quality of their exporting products. Qualities of automobile products measured by unit price are shown to reveal head-to-head competition for one group of products and are ranked among the Asian economies for other groups of products.

Then we investigate whether these changes are brought by the production growth of local firms or led by multinationals' direct investments in these countries. The production processes for automobiles are highly fragmented and most of the processes are outsourced to components suppliers. In our empirical examinations we distinguish foreign direct investment by automobile makers from FDI by automobile component suppliers. We present empirical evidence that automobile makers' investments in importing country and automobile suppliers' investments in both exporting and importing country increases components trade in the region.

We also find some evidence for two important effects of foreign direct investments in China; the growing role of China as assemblers and the spillover effect of components production in China. When trade flows are restricted only to bilateral trade between Japan and the Asian economies, we find that the only significant effect of FDI is shown to be suppliers' investments on exports of the Asian economies to Japan. This result is clearly consistent with the recent important development of fragmentation and outsourcing in international trade literature.

This paper is organized as follows. In next section we review and discuss the complex production networks for automobile industry among the Asian economies. We describe the dataset used for empirical investigation in section 3. Section 4 investigates if quality ladder among the Asian economies has changed in recent years. In section 5, we investigate whether these changes are based on the autonomous growth of local manufactures or led by multinationals' investments. Section 6 summarizes the study's findings and conclusions.

2. Automobile industry: car manufactures and parts suppliers in Asian economies

With cross-border investments in foreign competitors, mergers and acquisitions formed several global giant automobile groups. These are General Motors group, Ford group, Daimler Chrysler group, Toyota group, Volkswagen group, and Renault/Nissan group.[3] Table 2 provides recent production by these groups and lists major affiliates for these groups. These car manufacturers develop multinational production networks throughout the world.

Reflecting the expansion of global production strategies of multinational manufacturers and the emergence of local manufacturers, Japan and eight Asian economies as the region produced 12.6 million units of automobiles in 1984 and came close to double its production to 21.1 million units in 2003, see table 3. These eight Asian economies include Korea, China, Taiwan, India, Thailand, Malaysia, Indonesia, and Philippines. The increase in automobiles production in the region came from these non-Japan Asian economies; production in Japan actually decreased about one million during the sample periods. Main contributions go to China, Korea and India,

[3] Other major automobile manufactures includes Peugeot group, Honda, Hyundai/Kia, and BMW.

each respectively increased 4.1 million, 2.9 million and 1 million units between 1984 and 2003.

Sales in the region increased from 6.6 million in 1984 to 14.7 million in 2003, see table 4. While sales in Japan are not much different at beginning and end of the sample, China increased sales about 4.1 million and India increased about 0.9 million units. These figures closely matches with their national production, reflecting the fact automobile imports are restricted in these countries. Sales increase was also large in Korea, about 1.1 million; however, it does not match with increase in Korean production, reflecting export promotion strategy of Korean automobile manufacturers.

Developing countries often give automobile industry the highest priority for national development strategy. These policies include import restrictions, limited foreign ownership and local contents requirements among other measures. For example, Philippines introduced in 1986 Motor Vehicle Development Program which required automobile assembling manufactures 35 to 40 percent of content procurements locally. Due to this local content requirement, automobile parts suppliers started to operate in Philippines.

On the other hand, Taiwan reviewed previous automobile policy, which aimed to keep out foreign manufactured cars from Taiwan, in 1985. The Taiwan government declared that tariff on automobiles would be eventually reduced to 30% from 65% and local content requirement to 50% from 70%. The Taiwan government also welcomed investments and technology transfers from foreign countries. This is called New Automobile Industry Development Project.

China had two strict regulations for automobile makers to establish assembly subsidiaries/plants in China. One is to keep foreign ownership no more than 50

percent and limits joint ventures up to maximum of two firms for each international automobile makers. The other is on local content requirement. However, regulation on local content requirement was lifted upon accession to a WTO membership.

These protective measures seemed to successfully foster the growth of automobile manufactures in China[4]. Now in China, there are more than 100 automobile makers, both purely local and joint ventures with foreign makers. The top ten automobile makers in terms of sales in 2003 are China FAW Group Corporation, Shanghai Volkswagen Automotive Co., Ltd., Dongfeng Motor Co., Ltd., FAW-Volkswagen Automotive Co., Ltd., Shanghai GM Automotive Co., Ltd., Guangzhou Honda Automobile Co., Ltd., Beiqi Foton Motor Co., Ltd., Shengyang Brilliance Automotive Co., Ltd., Fengshen Automotive Co., Ltd., Changan Automobile Co., Ltd.

Coupled with the national protective measures in automobile industry, we observed multinationals constant search for optimal locations to outsource parts of their production process formed complex regional production network in the Asia. As a consequence, intra-industry trade for automobile industry among the region has increased rapidly. We will examine more closely these intra-industry trade in the following sections.

3. Data Description

Harmonized System (HS) classification code defines traded goods with corresponding 6-digit codes. Each country is left with discretion of further

[4] We can also observe emergence of local automobile makers in India and Malaysia.

disaggregation with additional digits after universal 6-digit codes.[5] The United Nations Commodity Trade Statistics database (UNCOMTRADE) collects trade data at HS 6-digit level from 130 countries including non-OECD countries. Moreover, Ministry of Finance (MOF), Japan, provides more finely disaggregated 9-digit trade data. These finely disaggregated data are optimal for our empirical object, however, these data not readily available for non-OECD countries.

In section 4, we use MOF data due to its superiority in data disaggregation because we examine unit price for each category of automobile components. If products are more broadly defined, more likely it is to be biased. In section 5, however, we turn to UNCOMTRADE data for its broader coverage for bilateral trades among the Asian economies. MOF data only covers trade directly associated with Japan.

For our investigation, "8708" subsection represents parts and components for automobile and other transportation equipment and contains 17 subcategories. Under the subheading of Machinery "84" and Electrical Appliances "85", there are parts related to automobiles, seven subcategories in each. Appendix 1 contains list of definitions for these 31 subcategories. Exports data are collected for each pair among nine economies; Japan, China, Hong Kong, Korea, Indonesia, Malaysia, Philippines, Thailand, and India[6,7].

Overseas Japanese Companies Data (OJCD), Toyo Keizai, provides detailed data for over 20,000 Japanese subsidiaries. These subsidiaries are described for host

[5] For example, Japan uses 9-digit codes whereas US uses 10-digit coding systems for trade accountings. For Japanese data, Ministry of Finance (MOF) provides downloadable monthly-organized data files on its website. For US data, Bureau of Census (BOC) also provides monthly CD-ROM datasets.

[6] From 1992 to 1995 for Philippines we used imports data from other eight economies to construct Philippine exports although we sometimes observed large discrepancies, which can not be explained by CIF/FOB difference, between export and import data.

[7] As an importing country only, we also included the US.

country, object of investment, industry, established year, invested capital, parent company among other information. From OJCD, we extract these subsidiaries associated with automobile industry. We further distinguish these subsidiaries between makers and components suppliers. Therefore, our foreign direct investment data is represented by the accumulated number of subsidiaries for each year in each country.

Annual units of automobile production for 23 countries are provided in Fourin (2004). Automobile production in the Asian economies is summarized in our table 3.

4. Changing roles for Intermediate Productions in the Asia

In this section we restrict our attention to exports of the Asian countries to Japan in order to examine the recent development in automobile components production in the Asian economies. One reason to use MOF data in this section is the fact that we observed large discrepancies for COMTRADE datasets from comparisons of same trade from the report of exporting country and importing country. The advantage of using MOF data is the general reliability of reports from importing country because of more strict enforcement is imposed for tariff collection. For the purpose of comparing exporting countries, it is well-suited to use only one reporting country in order to avoid some reporting country's bias.

Table 5A and 5B present value of exports for subcategories of automobile parts and components for Asian economies in 1988 and 2004 respectively[8]. From comparing two tables, we find outsourcing in Asia has gone through dramatic changes during this period. First, number of Asian economies participating in fragmentation of Japanese automobile production became larger, from 11 countries to 14 countries.

[8] Due to the occasional changes in HS coding, HS codes in two periods do not match exactly. Please see the appendix for the definitions of HS codes used in this study.

(Myanmar dropped and Vietnam, Cambodia, Pakistan and Sri Lanka joined.) Many countries are participating in producing for more variety of intermediate products in 2004. Most of Asian economies are producing same products under very finely classified category in recent years.

In 1988 Korea and Taiwan represents the two largest automobile component exporters to Japan, 3.4 billion yen for Korea and 3.7 billion yen for Taiwan. Exports from China and Hong Kong combined come only slightly above one percent of exports of these two countries. In 2004 China emerges as the largest automobile components exporter for Japan with the traded value of 59 billion yen. The second largest exporter of automobile components is Thailand with 35 billion yen. From these tables alone, we can observe how outsourcing strategy of Japanese automobiles production has evolved in recent years.

At the early stage of developing automobile industry in the Asian economies, there were only a few categories a country can produce and export facing competition from neighboring countries. As the industry in a country accumulates skilled labors and acquire technologies, the variety of products for production increases. Figure 1 represents the number of automobile components exports for 11 Asian countries. As Korea and Taiwan have been exporting almost all categories from 1988, the rest of Asian countries stated from 3 (India and Philippines) to 15 (Singapore) categories in 1988 and expanded to export 19 (Hong Kong) to 32 (China) categories.

For better understanding interactions of intermediate export data among Asian economies, we calculate unit price from MOF. The MOF reports both values and quantity for each partner country. We calculate unit price from the ratio of traded value to traded quantity, shown as equation (1).

$$P_{i,j,t} = \frac{V_{i,j,t}}{Q_{i,j,t}} \qquad (1)$$

$P_{i,j,t}$ is unit price, $V_{i,j,t}$ is export value and $Q_{i,j,t}$ is export quantity. Subscripts denote country *i*, for component product *j* in year *t*.

There is one caveat for interpretation of unit price index as an indicator for quality for products. We have to note that even within this most disaggregated trade category there is heterogeneity in products. If the products are so narrowly defined such as 3.5 inch floppy disk then difference in unit prices are reflecting quality of products if there is no market distortion. However, definitions in intermediate products in automobile and other transportation equipments are not that specific. For example, "870810000" in MOF code is "bumper and its components," which does not distinguish the corresponding size of automobiles. This category includes bumpers for both compact car and large-scale truck. Of course, a bumper for larger size automobile should cost higher because of more use of raw materials. However, using metric weight for denominator should mitigate this bias. Figure 2 represents Japanese import unit prices for bumper and its components from Asian economies in 2004. Hong Kong, Thailand, and Korea export high price bumper and its components (relative to amount of material used), whereas Malaysia, Indonesia and Philippines export low price products.

In order to capture the dynamic changes in quality of exports from the Asian countries, we ranked unit price for each category from highest to lowest in each year[9].

[9] There are some researches which compare import unit price with export unit price to determine whether a product can be classified as vertical intra-industry trade, see Ando (2005) for an example.

The highest price is scored as 11 and score decreases as ranking lowers. If a country does not export for a particular category, score of 0 is assigned. Then these ranking scores are summed for each country in each year. The summed ranking score for a country increases if a country expands variety of exporting products and/or climbs the quality ladder in each exporting products. Figure 3 represents unit-price ranking for all automobile components exports for the 11 Asian economies.

The most striking feature is that we can observe convergence among the Asian exporting countries. Countries with lowest ranking scores in 1988 were Philippines and India. China, Malaysia, Thailand, Hong Kong, Indonesia belong to the second lowest ranking group in 1988. All these countries raised ranking scores in recent years. The highest ranking group in 2004 includes Korea, Taiwan, Thailand, China, Singapore and Malaysia. The second ranking group consists of Hong Kong, Indonesia, Philippines, and India. Vietnam is still far below the rest of the Asian countries.

5. Autonomous Production or FDI-led Production?

Having observed changes in automobile components trade among the region in the previous section, we aim to answer empirically very important question, i.e., whether these changes in the region are the results of autonomously chosen strategy by domestic exporting firms in the Asian economies or foreign multinationals business strategies to reallocate production plants in the region.

Straightforward way to investigate this question is to regress export values in a panel regression equation on foreign direct investment data as an explanatory variable along with other control variables as in equation (2).

$$EX_{i,j,k,t} = \lambda_i + \mu_k + \alpha_0^X FDIX_{i,t} + \alpha_0^M FDIM_{j,t} + \delta Z_{i,j,k,t} + \varepsilon_{i,j,k,t} \qquad (2)$$

The dependent variables is the value of exports, $EX_{i,j,k,t}$. Subscripts are for exporting country, *i*, importing country, *j*, component product, *k*, and time, *t*. Foreign direct investments are distinguished between investments in exporting countries, $FDIX_{i,t}$ and importing countries, $FDIM_{j,t}$. Country dummies and commodity dummies are respectively captured by λ_i and μ_k. Control variables are included as a Z vector and $\varepsilon_{i,j,k,t}$ represents the disturbance term.

Relationship between exports and FDI in destination country is investigated in the number of researches, see Belderbos and Sleuwagen (1998), Clausing (2000), Blonigen (2001) and Head and Ries (2001). These papers all focused on substitution/complimentarity relationship between exports of a country and FDI by that country. In our framework we capture this effect in α_0^M. Theoretical framework for relationship between exports and FDI in exporting country is called export-platform FDI in the literature. The seminal work in this literature is Motta and Norman (1996) who investigate various patters of investment strategies by multinational firms in a game theoretic three-country framework. Other important works include Neary (2002), Yeaple (2003), Ekholm et al. (2003) and Grossman et al. (2003). Ito and Yoshida (2006) provides empirical evidence that inward FDIs in exporting country promote its exports. In our framework this effect is captured in α_0^X.

Although the use of foreign direct investment at this aggregation is very common; however, the expected effect of foreign direct investments are different whether investments are made by automobile makers or automobile components suppliers. Our data source allows us to distinguish foreign direct investments between automobile makers and automobile components suppliers. Now we have four FDI

variables according to whether export or import and whether makers or component suppliers as in equation (3).

$$EX_{i,j,k,t} = \lambda_i + \mu_k + \alpha^X Ma\ker FDIX_{i,t} + \alpha^M Ma\ker FDIM_{j,t} + \beta^X PartsFDIX_{i,t} + \beta^M PartsFDIM_{j,t} + \delta Z_{i,j,k,t} + \varepsilon_{i,j,k,t} \quad (3)$$

Expected effects of these four FDI variables on international component trades are summarized with simple diagrams in figure 4.

In panel A, direct investment in an exporting country by makers, *MakerFDIX*, is very likely to discourage component exports because the new plant may procure component produced domestically, therefore reducing export capacity.

The effects of *MakerFDIM* and *PartsFDIX* on component trade are very clear. In panel B, direct investment in an importing country by automobile makers, *MakerFDIM,* promotes component exports to that recipient country because an increase in automobile production in importing country creates additional demand for components. In panel C, direct investment in an exporting country by component suppliers, *PartsFDIX*, also increases component exports due to an increase in production capacity. If export is directed to Japan, associated direct investment is classified as vertical FDI. On the other hand, if export is directed to other countries, associated direct investment is called as export-platform FDI

The effect of *PartsFDIM* on component trade can be ambiguous. In panel D, direct investment in an importing country by component suppliers, *PartsFDIM*, are described in two cases. Top figure in panel D presents the case for high substitution relationship between component FDI and component trade. For example, the effect is obviously negative for engine trade if FDI is to establish a new plant for engine

production. However, expected sign might be reversed if there are complimentary relationship between FDI and trade. Although our direct investment variable is more disaggregaed than those used in previous studies, PartsFDIM still includes different automobile component products. For example, gear box exports from other countries might be induced if a new plant for drive axels is established in one country in the region.

A. General results

For the exporting countries, eight Asian economies and Japan are selected. For destination or importing countries, the US is included in addition to those selected nine exporting economies. As control variables, we use the units of automobile production, PROD, in importing countries and time trend, TREND. First, foreign direct investments are constructed as accumulated number of Japanese subsidiaries combining both automobile makers and automobile components industry as in equation (2)[10]. The first two columns in table 6 show that automobile component exports are positively linked with foreign direct investments in both exporting country and importing country. If our analysis stops here, we might interpret the results to conclude that component trade is always promoted by FDI in trading countries notwithstanding whether it is in importing country or exporting country. However, this result needs to be interpreted with qualifications.

The last two columns in table 6 provide that automobile makers' investments in exporting countries, *MakerFDIX*, do not promote automobile components exports from these countries whereas other investments raise component exports. The

[10] We should note that our results in the followings need to be interpreted with the caution because we do not observe any Japanese FDI in Japan.

expected sign of *MakerFDIX* is consistent with the estimators in table 6 although it is not statistically significant. Ambiguity for the effect of *PartsFDIM* in figure 4 leaves it to a pure empirical question. The result seems to suggest that complimentary effect is overwhelming at the level of aggregation for current FDI variable construction. The one last noteworthy point is that difference in the size of estimators for FDI between makers and component suppliers. Because our FDI is constructed as the number of subsidiaries instead of value of subsidiaries, the size difference in FDI between two groups are captured in estimated coefficients. For the importing country, FDI by automobile makers increase component trade by two to three times more than FDI by component suppliers.

Other important parts of the regression results can be summarized as the followings. First, productions of car units in importing countries, PROD, appear always significant and positive. Second, after controlling foreign direct investments and automobile productions, we observe significant downward trend in component exports. It is very difficult at this stage to provide a reasonable interpretation of this downward trend; however, we can present a partial answer in the immediately following subsection. Third, commodity dummies appear to increase substantially the fitness of regression as observed in adjusted R-squared. We will always include both country and commodity dummies in the following analysis.

B. China effects

We have already observed recent rapid growth of automobile industry in China. Chinese automobile production became the fourth largest in the world following the US, Japan and Germany. We now turn to examine whether investments in China have any

significant effect on exports of other Asian economies within the region not involving China. This is to say, for example, that we estimate the impact of investment in China on Indonesian export to Thailand. Table 7 presents estimation results for automobile components exports with Chinese FDI variables in addition to previous regressions. For this analysis we exclude China from both exporting and importing countries from the original sample. Because the number of observation is reduced due to exclusion of trade with China, in the first column we rerun the previous regression with reduced sample for the comparison purpose.

Interestingly, when we drop China from the sample, automobile makers FDI becomes statistically insignificant. This result combined with column [4] in table 6 indicates that makers FDI in China promotes component exports of other Asian countries to China while makers FDI in other Asian countries do not impose a significant effect on component exports. This is the first asymmetry we observe in this study between China and the rest of the Asian economies.

The second column shows that FDI in China significantly affect automobile components trade between other Asian economies. First, establishments of new plants in China by Japanese makers discourage automobile components trades among other economies in the region while new plants for components in China promote components trade between other Asian economies. This negative effect on trades in the region can be interpreted as production shift of final assembly. As final production process is shifted to China from other Asian countries, demand for components decreased because some of assembly plants are shut down or used for other functions. We interpret this result as the growing role of China for assemblers.

Second, new plants for component suppliers FDI are shown to be significantly

positive. This result might be demonstrating the spillover effect of expansion of components production in China. Increase in production for one category of automobile components in China increases demand for related components in the region. Then increases in production of these related components in each Asian economy further create new demand for other parts from neighboring countries.

We also note that, in the second column, the estimated coefficient of *TREND* is no longer negative. Previous statistically significant negative estimates are very likely to be driven by the lack of inclusion of *MakerFDICHN* in the regressions.

C. Japanese trades

We now turn our attention to the trade between the Asian economies and the second largest world automobile producer country, namely Japan. Here we restrict our investigation for the Asian trades to only those with respect to Japan. This analysis can reveal only partial segment of trade in the region but it is more suitable with our use of only Japanese FDI data.

Since we use only Japanese investments data for FDI variables in this empirical investigation, we are restricted to use asymmetric structure for estimating trade equations between Japan and the Asian countries. For the export of Japan, FDI in the Asian countries are represented as *MakerFDIM* and *PartsFDIM*. On the other hand, we do not have corresponding FDI variables for the exporting country. On the import for Japan, appearance of FDI variables is just reversed.

On the Japanese export side, Japanese automobile components export are shown not to be related with Japanese outward bilateral FDI. The first column of table 8 shows FDI by both automobile makers and components suppliers are not statistically

significant. This result is in stark contrast with the work of Blonigen (2001). He finds that Japanese suppliers' production in the US discourages Japanese exports; however, we found that Japanese suppliers' FDI in the Asian economies does not affect Japanese exports. Comparisons of our work with Blonigen (2001) provides confirming evidences that horizontal FDI in developed country and export-platform/ or vertical FDI in developing country are quite different in nature. Our work complements the work of Blonigen (2001) in this sense.

For the Japanese import side, i.e., automobile component exports from the Asian economies, the maker-supplier distinction of Japanese outward FDI shows an interesting result. Automobile makers' investments do not increase exports of components products, while suppliers' investments do raise exports of these countries. The second column[11] of table 8 shows investments by components suppliers is statistically significant at one percent level. This result is clearly consistent with the recent important development of fragmentation and outsourcing in international trade literature.

6. Conclusions

One novelty in this paper is that we clearly distinguished between final product and component product in the same industry for both trade and foreign direct investment. The other novelty is use of FDI in both exporting country and importing country for explaining bilateral trade. Two previous papers come partly close to our framework. Belderbos and Sleuwaegen (1998) investigates the effect of FDI on product level exports in electronics industry. They distinguish between distributional

[11] We excluded *TREND* variable for Japanese import equation to avoid possible multicolinearity with *PROD*, which in this case represents only Japan.

subsidiaries and manufacturing subsidiaries in empirical examination, but not between component subsidiaries and maker subsidiaries. On examining the effect of Japanese automobile production in the US on Japanese exports to the US, Blonigen (2001) distinguishes between makers' production and suppliers' production. However, FDI data is used only on importing country's side.

The direct evidences of role-changing among the Asian economies are presented. The variety of automobile components exports increased for each Asian economy. While Korea and Taiwan have been exporting almost all categories for automobile components in our sample period, China and Thailand remarkably quadrupled their exports variety. Qualities of automobile products measured by unit price are shown to reveal head-to-head competition for one group of products and differentiated quality among the Asian economies for other groups of products.

The dynamic changes in the regional trade for automobile components are investigated in a relation with foreign direct investments. We have presented empirical evidence that automobile makers' investments in importing country and automobile suppliers' investments in both exporting and importing country increases components trade in the region.

In addition, we have examined growing presence of China in terms of dominant inward investments by multinational firms in the industry. Establishments of makers' assembly plants in China discourage components exports to other countries in the region. We interpret this result as the growing role of China for assemblers. New plants for automobile components in China promote inter-regional components trades. This result might be demonstrating the spillover effect of expansion of components production in China. Increase in production for one category of automobile

components in China increases demand for related components in the region. Then increases in production of these related components in each Asian economy further create new demand for other parts from neighboring countries.

We also examined bilateral trade between Japan and the Asian economies. Interestingly, the only significant effect of FDI is shown to be suppliers' investments on exports of the Asian economies to Japan. This result is clearly consistent with the recent important development of fragmentation and outsourcing in international trade literature.

Finally, we should note that our empirical results should be interpreted with qualifications in our mind that we have only used Japanese FDI data. Further investigations with thorough FDI data including US and European investment data will be fruitful. However, our current empirical investigation is also important in the sense that partial data of inflow of FDI into the Asian economies revealed substantial relationship with automobile component trade among the Asia.

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Appedix 1: HS-6 codes for automobile components

840732
840733
840734
840820
840991
840999
841430

851110
851120
851130
851140
851180
851190
851240

870810
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870829
870831
870839
870840
870850
870860
870870
870880
870891
870892
870893
870894

Appendix 2: Definitions for subcategories of "8708" subsection

(8708: Parts and accessories of the motor vehicles of headings 87.01 to 87.05)

Definitions	HS (MOF)	Unit 1	Unit 2
Bumpers and parts thereof	870810 000		KG
Other parts and accessories of bodies (including cabs):			
Safety seat belts	870821 000		KG
Other	870829 000		KG
Brakes and servo-brakes and parts thereof			
Mounted brake linings	870831 000		KG
Other	870839 000		KG
Gear boxes	870840 000		KG
Drive-axles with differential, whether or not provided with other transmission components	870850 000		KG
Non-driving axles and parts thereof	870860 000		KG
Road wheels and parts and accessories thereof			
For tractors of heading 87.01	870870 010		KG
Other	870870 090		KG
Suspension shock-absorbers	870880 000	NO	KG
Other parts and accessories:			
Radiators	870891 000	NO	KG
Silencers and exhaust pipes	870892 000		KG
Clutches and parts thereof	870893 000		KG
Steering wheels, steering columns and steering boxes	870894 000		KG
Other			
For tractors of heading 87.01	870899 010		KG
Other	870899 090		KG

Figure 1: The numbers of automobile components exported to Japan

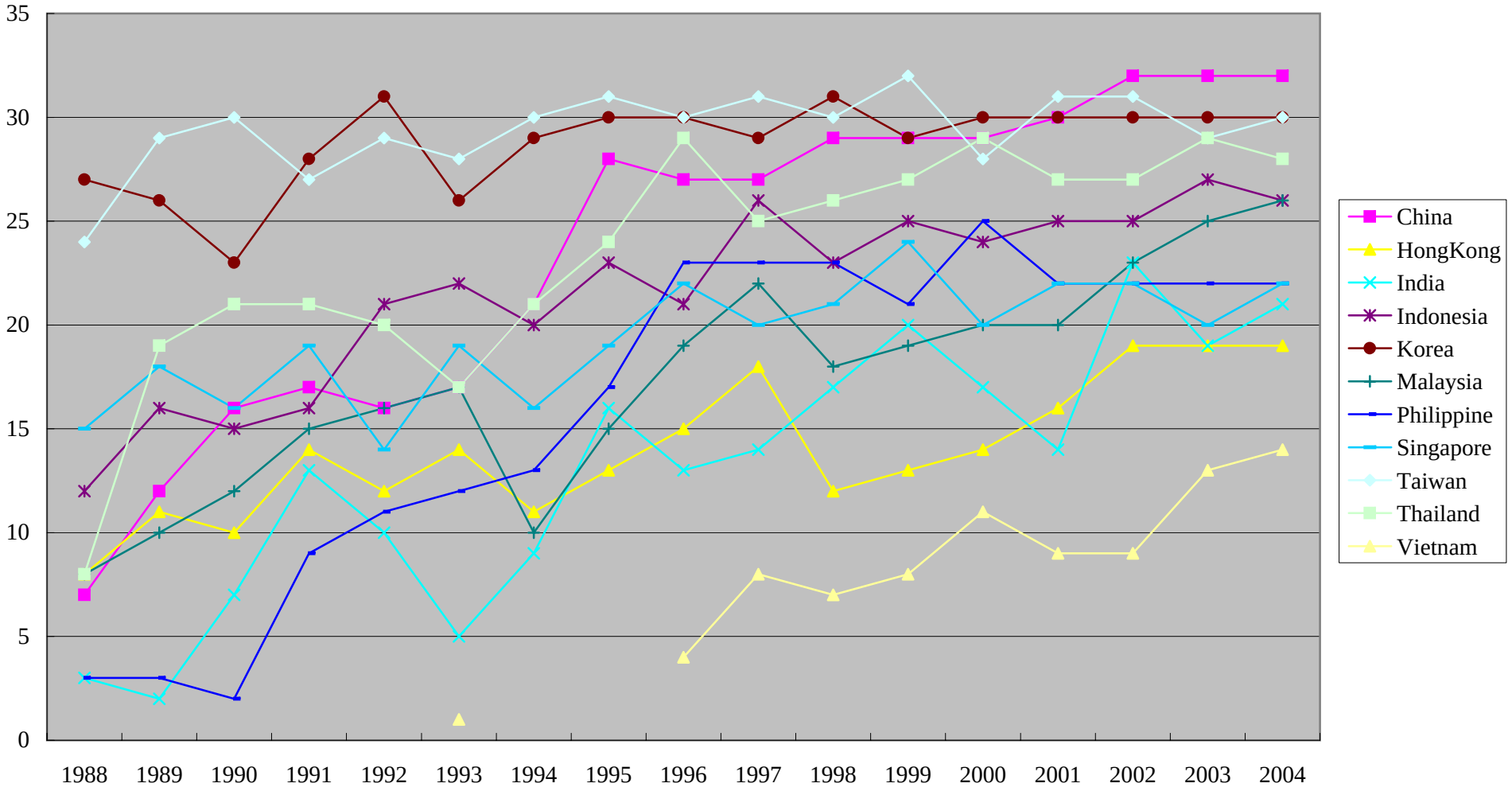


Figure 2. Unit Price for Bumper and its components (MOF, 870810000)

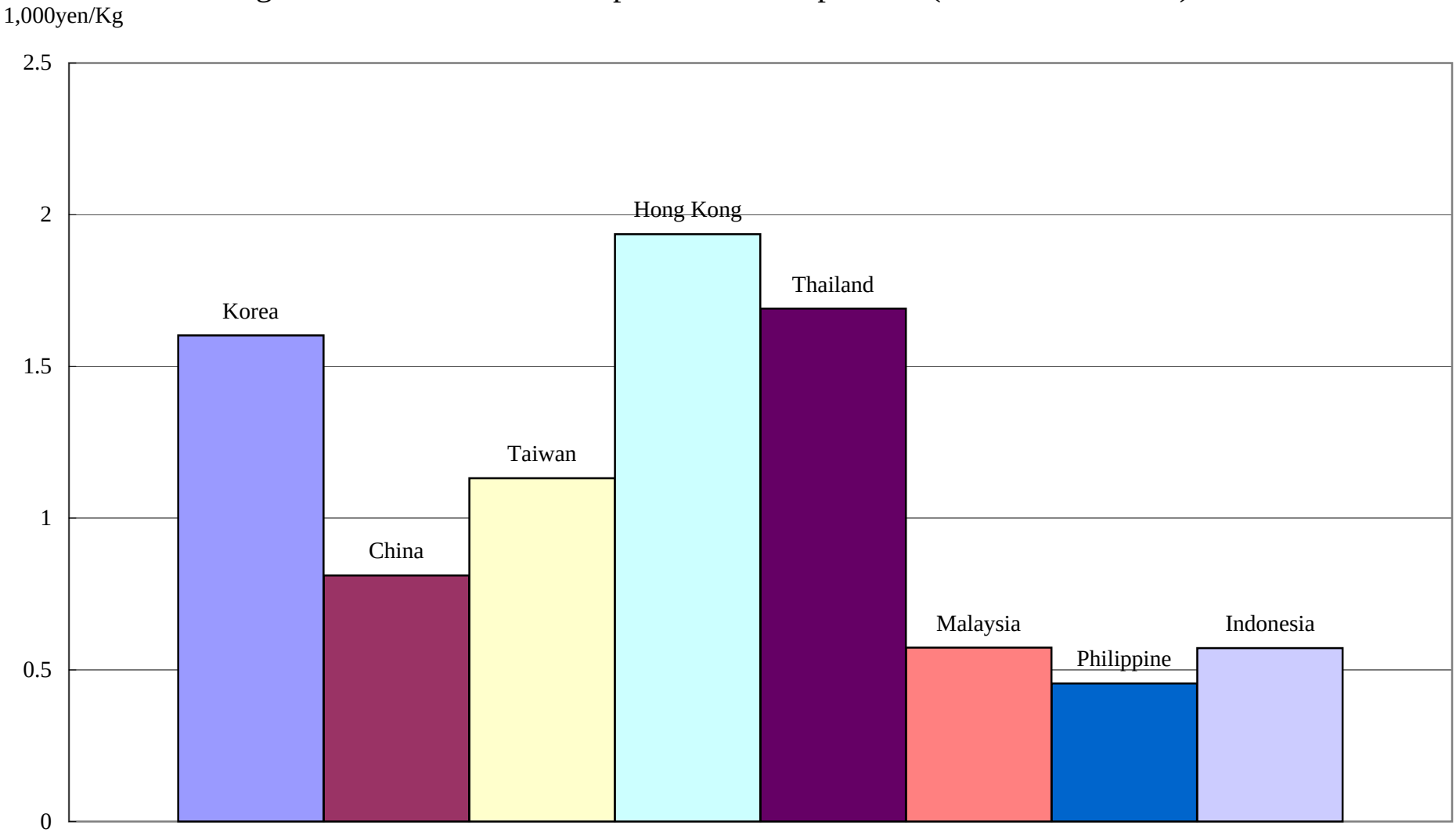


Figure 3: Unit-price Ranking

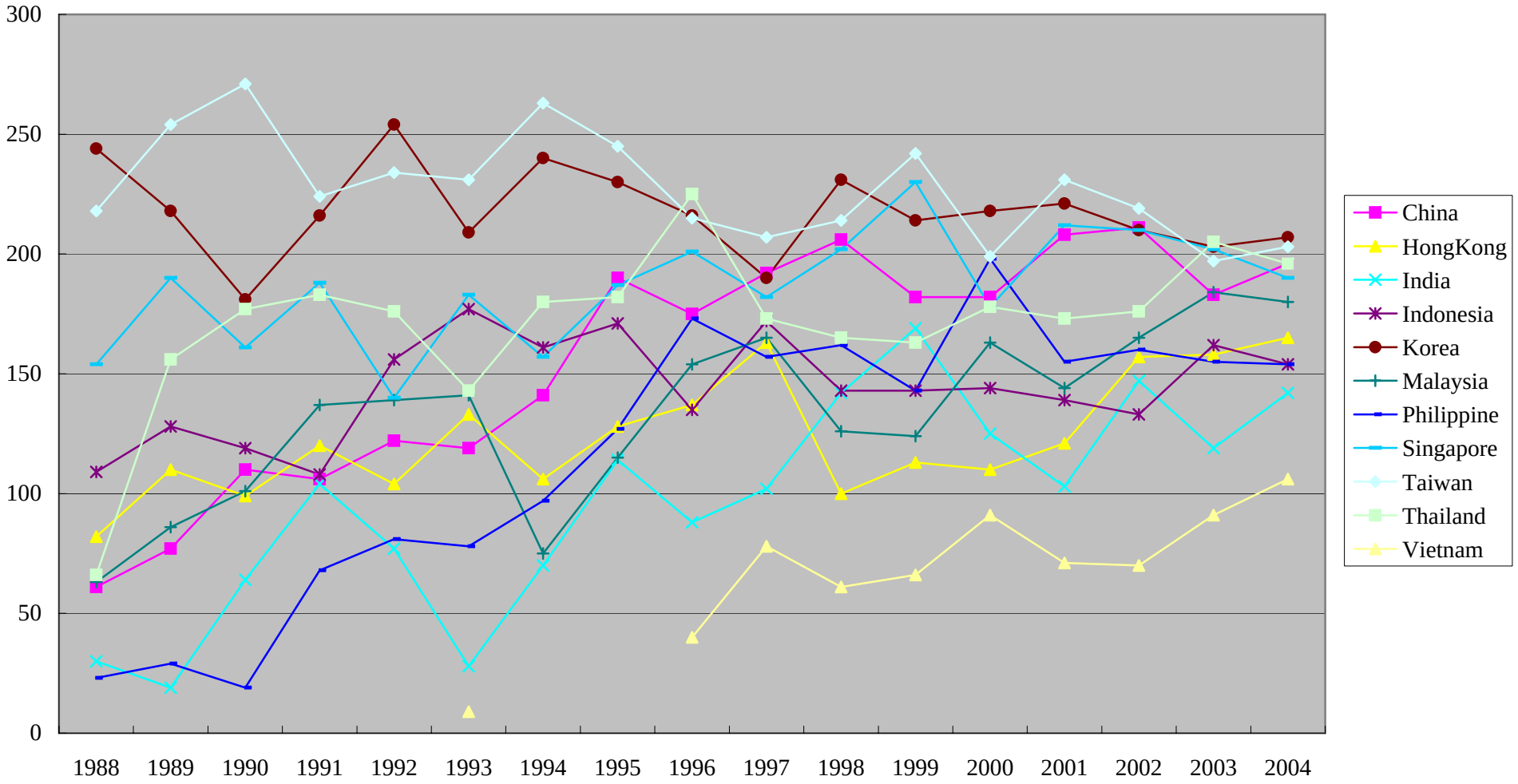
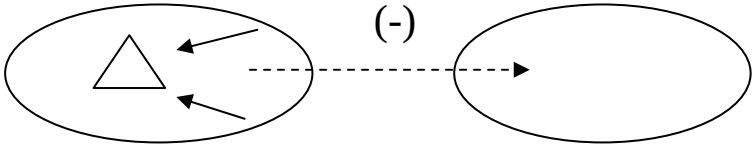
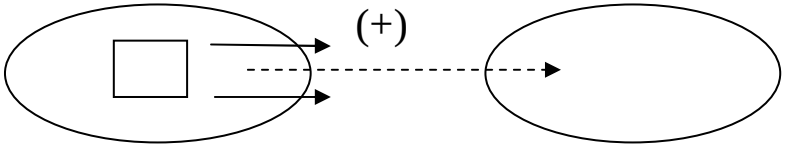


Figure 4: Expected effects of four FDI variables on component trade

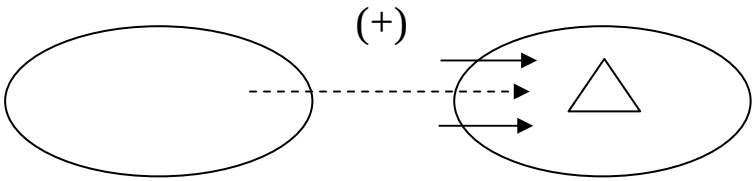
(Panel A) MakerFDIX



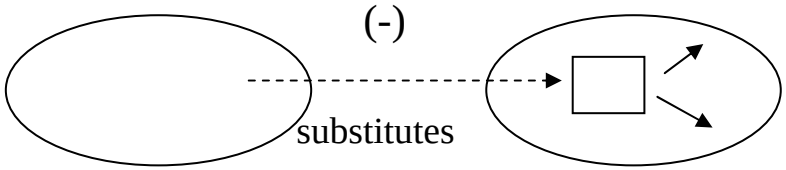
(Panel C) PartsFDIX

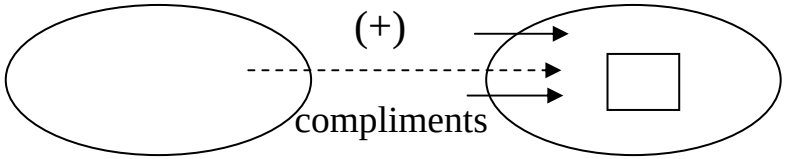


(Panel B) MakerFDIM



(Panel D) PartsFDIM





△ … automobile maker FDI ------→ (broken lines) internatinal component trade
□ … component supplier FDI ——→ (solid lines) additional flows of component produts after FDI

Table 1 : Share of Trade by Japan, the Asia and US in the Asian countries

Exporting Country	1990			1995			2000		
	Japan	Asia	US	Japan	Asia	US	Japan	Asia	US
China	0.15	0.50	0.08	0.19	0.35	0.17	0.17	0.28	0.21
Korea	0.19	0.13	0.29	0.13	0.28	0.19	0.12	0.27	0.22
Hong Kong	0.06	0.34	0.24	0.06	0.41	0.22	0.06	0.42	0.23
Singapore	0.09	0.31	0.21	0.08	0.40	0.18	0.08	0.40	0.17
Thailand	0.17	0.19	0.23	0.17	0.28	0.18	0.15	0.27	0.21
Indonesia	0.43	0.21	0.13	0.27	0.27	0.14	0.23	0.31	0.14
Philippine	0.20	0.15	0.38	0.16	0.21	0.36	0.15	0.25	0.30
Malaysia	0.15	0.39	0.17	0.12	0.37	0.21	0.13	0.36	0.21

Source: Direcion of Trade, IMF

Table 2: World Production of Automobiles by Major Manufacturers in 40 countries

Automobile Makers:

	1997	2002
General Motors	14,777,958	13,416,595
Ford	8,367,191	7,766,627
Toyota	5,908,397	6,603,547
Daimler Chrysler	6,116,707	6,304,779
Volkswagen	4,535,149	5,031,098
Renault-Nissan	4,945,056	5,108,780
PSA	2,146,705	3,167,920
Honda	2,388,134	2,916,279
Hyundai	2,039,264	2,820,531
BMW	683,381	1,097,421
others	3,893,892	4,855,810
Total	55,801,834	59,089,387

GM	Ford	Toyota	DC	VW	Renault	PSA	Hyundai
GM	Ford	Toyota	Chrysler	Volkswagen	Renault	Peugeot	Hyundai
Fiat Auto	Mazda	Daihatsu	Mercedes/Smart	SEAT	Nissan	Citoroen	Kia
Daewoo	Volvo	Hino	Mitsubishi	Skoda	Nissan Diesel		
Isuzu	Land Rover		Evobus	Audi	Dacia		
Suzuki	Jaguar		Setra	Lamborghini	Renault-Samsung		
Fuji (Subaru)	Aston Martin		Freightliner	Bentley			
			Stering Truck	Rolls-Royce			
			Thomas Built Bus	Scania			
			Westrn Star				
			American LaFrance				

Source: Fourin's Monthly Report on the Global Automotive Industry (No.213, p.1, May 2003)
Note: The above figures may include double counting.

Table 3: Production of Automobiles in the Asia

	Japan	Korea	China	Taiwan	India	Thailand	Malaysia	Indonesia	Philippine	ASIA8	ASIA8+JPN
1984	11,464,920	265,361	316,367		180,919	111,037	122,074	153,678		1,149,436	12,614,356
1985	12,271,095	378,162	443,377		230,560	82,106	105,470	139,438		1,379,113	13,650,208
1986	12,259,817	601,546	372,753		238,875	74,162	61,837	162,630		1,511,803	13,771,620
1987	12,249,174	979,739	472,538		288,930	98,147	49,153	159,635	7,905	2,056,047	14,305,221
1988	12,699,807	1,083,655	646,951		312,356	154,183	85,057	156,192	17,456	2,455,850	15,155,657
1989	13,025,735	1,129,470	586,936		337,125	213,548	142,487	174,314	46,101	2,629,981	15,655,716
1990	13,486,796	1,321,630	509,242		364,393	304,843	206,094	271,712	54,374	3,032,288	16,519,084
1991	13,245,432	1,497,818	708,820		355,036	283,115	232,399	254,737	46,000	3,377,925	16,623,357
1992	12,499,284	1,729,696	1,061,721		320,164	327,989	171,289	172,234		3,783,093	16,282,377
1993	11,227,545	2,050,058	1,296,778		371,630	420,041	180,407	203,588	80,920	4,603,422	15,830,967
1994	10,554,119	2,311,663	1,353,368		475,150	434,001	217,892	325,021	100,098	5,217,193	15,771,312
1995	10,195,536	2,526,400	1,452,697		636,016	525,680	312,349	387,541	123,177	5,963,860	16,159,396
1996	10,346,699	2,812,714	1,474,905		757,916	559,428	390,609	325,495	136,556	6,457,623	16,804,322
1997	10,975,087	2,818,275	1,852,682		749,655	360,303	449,765	389,279	110,983	6,730,942	17,706,029
1998	10,041,958	1,954,494	1,627,829	404,545	627,679	158,130	164,125	58,079	45,040	5,039,921	15,081,879
1999	9,892,389	2,843,114	1,830,323	350,273	815,151	327,233	302,822	123,244	65,588	6,657,748	16,550,137
2000	10,140,796	3,114,998	2,069,423	372,613	801,306	411,721	359,192	345,416	70,851	7,545,520	17,686,316
2001	9,777,191	2,946,329	2,347,616	271,712	824,936	459,418	428,701	328,226	65,202	7,672,140	17,449,331
2002	10,257,315	3,147,584	3,286,804	333,699	927,806	584,951	456,822	353,528	74,844	9,166,038	19,423,353
2003	10,286,318	3,177,870	4,443,686	386,686	1,172,668	750,512	424,107	374,146	84,208	10,813,883	21,100,201

Source: The Global Automotive Statistics, Fourin, 2004

Table 4: Sales of Automobiles in the Asia

	Japan	Korea	China	Taiwan	India	Thailand	Malaysia	Indonesia	Philippine	Singapore	Asia9	Asia+J
1984	5,436,759	210,118	405,110		175,642	113,502	127,090	152,331	11,594		1,195,387	6,632,146
1985	5,556,834	246,282	797,369		222,855	86,178	106,988	144,314	6,778		1,610,764	7,167,598
1986	5,707,814	288,251	522,805		235,251	78,454	67,308	162,029	4,182		1,358,280	7,066,094
1987	6,018,399	420,048	539,720		287,292	101,624	48,996	159,720	8,182		1,565,582	7,583,981
1988	6,721,004	523,476	746,184		313,567	146,480	71,592	158,140	20,311		1,979,750	8,700,754
1989	7,256,673	762,959	672,490		319,506	208,243	109,357	178,147	46,993		2,297,695	9,554,368
1990	7,777,493	954,277	574,672		340,395	304,062	165,861	274,603	57,865		2,671,735	10,449,228
1991	7,524,759	1,104,184	807,274		317,500	268,560	181,877	261,344	47,949		2,988,688	10,513,447
1992	6,959,073	1,268,374	1,271,808		304,684	362,987	145,084	169,533	60,360		3,582,830	10,541,903
1993	6,467,279	1,435,967	1,606,877		351,904	456,468	167,928	210,679	83,811		4,313,634	10,780,913
1994	6,526,696	1,555,602	1,636,428		437,690	485,678	200,435	321,760	103,471		4,741,064	11,267,760
1995	6,865,034	1,555,902	1,610,812		586,901	571,580	285,792	378,704	128,162		5,117,853	11,982,887
1996	7,077,745	1,644,132	1,550,768		679,578	589,126	364,788	332,035	162,087		5,322,514	12,400,259
1997	6,725,026	1,512,935	1,901,721		701,775	363,156	404,837	386,691	144,435		5,415,550	12,140,576
1998	5,879,425	779,905	1,653,620	475,143	607,400	144,065	163,851	58,303	80,231	42,681	4,005,199	9,884,624
1999	5,861,216	1,273,029	1,855,420	423,109	820,831	218,330	288,432	93,814	74,414	53,582	5,100,961	10,962,177
2000	5,963,042	1,430,460	2,084,990	421,276	842,405	262,189	343,173	300,964	83,949	85,706	5,855,112	11,818,154
2001	5,906,471	1,451,450	2,395,212	347,388	829,036	297,052	396,381	299,560	76,670	85,100	6,177,849	12,084,320
2002	5,792,094	1,622,268	3,384,507	398,597	877,837	409,242	434,954	317,788	85,587	77,946	7,608,726	13,400,820
2003	5,828,178	1,318,312	4,565,619	413,361	1,076,318	533,176	405,010	354,629	92,336	98,836	8,857,597	14,685,775

Source: The Global Automotive Statistics, Fourin, 2004
For China, production + imports upto 1997, production + imports-exports from 1998.

Table 5A: Japanese Imports in 1988,
Parts and Components for Automobile and other Transportation Equipm

(1,000 yen)

	Korea	China	Taiwan	Hong Kong	Thailand	Singapore	Malaysia	Philippine	Indonesia	Myanmar	India
HS (MOF)											
'840733000'											
'840734000'	2,186	402	7,882						3,416		
'840820000'			630		653		627		1,589		
'840991010'	450,228	1,545	469,015	974	269,216	4,941			861		
'840999010'	30,456		37,558		93,606						3,524
'841583010'											
'841590010'			10,707				82,762				
'851110010'			8,515			1,050			10,667		
'851120000'											
'851130000'	82,896		858	371							
'851140000'	3,230		10,919			421					
'851180000'	2,536		10,188								
'851190010'	15,914	10,595	34,553			32,049			366		
'851190090'	830		7,748	2,706		40,459			3,706		
'851240000'	1,216		26,847								
'870810000'	56,676		101,731								
'870821000'	4,333					5,187					
'870829010'	2,167	740	514							431	
'870829090'	1,454,521	799	306,736	1,487	6,557	411	10,134	3,511	1,086		
'870831000'	404				6,714	209			8,619		
'870839000'	13,784	314	40,610	230	56,221	6,837	1,039				12,525
'870840000'	7,536			311				106,671			
'870850000'	8,132		11,627			302			344		
'870860000'	10,372										1,258
'870870010'	235,753		12,310		829						
'870870090'	187,355		1,960,454	14,697		323	40,809		174,905		
'870880000'	1,564					693					
'870891000'	690						17,880		720		
'870892000'	97,986		3,286			279					
'870893000'	5,031		82,257				250		10,526		
'870894000'	13,518		20,597	545							
'870899010'	174,535	2,935	4,340			7,173				261	
'870899090'	546,960		500,428	4,299	10,101	2,926	17,009	1,052,120			
Total	3,410,809	17,330	3,670,310	25,620	443,897	103,260	170,510	1,162,302	216,805	692	17,307

Table 5B: Japanese Imports in 2004,
Parts and Components for Automobile and other Transportation Equipments

(1,000 yen)

	Korea	China	Taiwan	Hong Kong	Vietnam	Thailand	Singapore	Malaysia	Philippine	Indonesia	Cambodi	India	Pakistan	Sri Lanka
HS (MOF)														
'840733000	517	480						1,831				1,017		
'840734000	3,865	46,391	704	8,336		21,348	2,561	4,062	759	4,909,627		6,023	741	
'840820000	3,116	54,459	8,763	1,745		71,495	1,824	1,625		14,065		753	643	
'840991010	2,151,548	3,542,662	1,507,608	5,320	507,306	3,308,657	24,538	270,007	3,428,114	2,178,189		86,821		
'840999010	1,645,394	1,231,350	350,567	12,646	54,208	1,743,796	64,794	151,943	50,175	793,751		11,239		
'841520000'		2,440					237	460		329		334		
'841590010	318,985	1,775,332	159,661	968		2,047,013	5,584	29,148	63,702	113,558				
'851110010'		5,557	90,542			457	3,101	1,420		17,402		2,605		
'851120000	380	12,406	658		21,650	494								
'851130000	5,572	1,212,167	6,688	17,878		147,609			121,428			17,748		
'851140000	193,960	232,485	104,742	2,131	3,242	302,920	31,518	2,409	5,971	148,080		112,374		
'851180000	11,668	140,654	4,303			35,027		1,219	282,057			2,229		
'851190010	85,595	556,594	182,273	1,110	10,935	323,495	13,996		858,047	439,149		74,427		
'851190090	60,771	254,301	18,402	3,401	120,029	29,132	748,756	812	144,957	13,296				
'851240000	364,046	202,015	24,645					16,912						
'870810000	8,300	195,065	388,628	1,661		48,129		98,602	233,060	18,923				
'870821000	8,826	1,223,116	44,174			6,941,365	2,195	4,523	8,288	568				
'870829000	2,925,803	6,994,455	1,881,249	14,670	398,772	9,222,175	191,088	255,491	5,683,961	198,566	758	106,463		13,739
'870831000	3,222	31,677	125,423			221,353				152,987				
'870839000	1,795,303	1,964,130	903,544	35,049	93,461	367,514	1,207	50,179	578,703	121,995		376,089		
'870840000	286,351	1,082,295	655	236	28,263	94,069		10,231	30,733	151,984		6,085		
'870850000	173,298	130,613	6,932			693,171	559	19,378	10,440	3,217		226		
'870860000	270,555	82,950	42,533			111,955		991	32,404	6,651		951		
'870870010	36,580	86,450	13,050	677			516	3,745		20,063				
'870870090	10,091,205	23,142,251	9,774,813	6,917	180,997	5,805,638	4,682	525,863	296,314	6,330,087		56,894	1,074	459
'870880000	314,344	380,504	124,491			18,098	35,505	286				525		
'870891000	1,179,940	2,634	7,093	1,785		121,486	1,822	957		582,094				
'870892000	130,948	136,210	211,193		18,004	21,617	1,174		625	11,891				
'870893000	1,055,959	1,306,495	140,473	5,871	536,875	338,752	9,105	7,498	209,405	318,807				
'870894000	1,029,748	684,206	138,092	5,600		77,182		3,658	1,824,454	1,240,818		108,026		
'870899010	1,024,096	797,037	174,190		20,640	1,417	3,104		562	40,958		243		
'870899090	5,357,171	11,620,742	2,336,488	47,505	1,308,672	3,218,619	93,774	1,083,905	5,269,066	2,006,020		52,156		
Total	30,537,066	59,130,123	18,772,577	173,506	3,303,054	35,333,983	1,241,640	2,547,155	19,133,225	19,833,075	758	1,023,228	2,458	14,198

Table 6: FDI and Automobile components export

Dependent variable: Automobile component export

	[1]	[2]	[3]	[4]
Independent variables:				
PROD	0.522 ***	0.569 ***	0.541 ***	0.594 ***
	0.059	0.057	0.060	0.058
FDIX	27203 ***	34195 ***		
	10498	10096		
FDIM	62765 ***	63849 ***		
	5235	5029		
MakerFDIX			-58967	-11351
			102607	98625
MakerFDIM			121706 ***	144728 ***
			45969	44173
PartsFDIX			39936 **	40988 **
			18304	17583
PartsFDIM			53719 ***	51420 ***
			8760	8416
TREND	-316023 ***	-271882 ***	-316398 ***	-268977 ***
	80556	77408	80747	77589
Country Dummies	yes	yes	yes	yes
Commodity Dummies	no	yes	no	yes
Adj R^2	0.12	0.19	0.12	0.19
NOB	12963	12963	12963	12963

Note: The figures below the coefficient estimates are standard deviations.

Table 7: China Effect

Dependent variable: Automobile component export

	[1]	[2]
Independent variables:		
PROD	0.518 ***	0.514 ***
	0.072	0.072
MakerFDIX	105692	111073
	260288	260482
MakerFDIM	66928	64280
	63679	63662
MakerFDICHN		-283248 ***
		110477
PartsFDIX	52864 **	55121 ***
	20853	20891
PartsFDIM	65031 ***	65876 ***
	9127	9134
PartsFDICHN		31779 *
		18030
TREND	-275547 ***	43532
	87267	361202
Country Dummies	yes	yes
Commodity Dummies	yes	yes
Adj R^2	0.19	0.19
NOB	9781	9781

Note: The figures below the coefficient estimates are standard deviations.

Table 8: Japanese automobile components trade

Dependent variable:	Japanese export	Japanese import
Independent variables:		
PROD	23.33 ***	-0.349
	2.61	0.508
MakerFDIX		-89118
		95707
MakerFDIM	-335714	
	392276	
PartsFDIX		103060 ***
		15446
PartsFDIM	-49424	
	72384	
TREND	-780221 ***	
	304085	
Country Dummies	yes	yes
Commodity Dummies	yes	yes
Adj R^2	0.44	0.29
NOB	2427	1776

Note: The figures below the coefficient estimates are standard deviations.