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Outsourcing in East Asia and Its Impact on the Japanese and Korean Labor Markets

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1. Introduction

In East Asia, the fragmentation of production processes and the international division of labor have made significant progress in the last decade.[1] The production processes of individual commodities within an industry are divided into ever smaller production processes, which are then relocated around Asia so as to minimize the total production cost. Intra-regional outsourcing of intermediate inputs within East Asia increased at a large scale, as we shall show later. In addition, there has also been a substantial increase in the intra-regional outsourcing of intermediate inputs within East Asia, as we will show below. Since there are a large factor price differences within the region, the division of labor through outsourcing may have had a significant impact on the labor market of developed economies such as Japan and Korea. In this paper, using industry level data, we investigate this impact.

The remainder of the paper is organized as follows. In Section 2, we present an overview of the pattern of East Asian trade in intermediate goods. We also describe patterns of foreign direct investment (FDI) within the region. In Section 3, after providing an overview of trends in labor markets in Japan and Korea, we discuss previous studies focusing on the relationship between international outsourcing and domestic skill upgrading and then show the trends in international outsourcing by industry since the 1990s for Japan and Korea. In section 4, we conduct econometric analyses to investigate the impact of international outsourcing on labor markets in Japan and Korea. Section 5, finally, presents our conclusions.

2. Overview of Trade and FDI Pattern of East Asian Countries

We begin our analysis by looking at changes in intra-regional and external trade patterns of the East Asia region in the period of 1990-2003, For the purpose of our study, East Asia comprises Japan, the NIEs 3 (Korea, Singapore and Taiwan), the ASEAN 4 (Thailand, Malaysia, Indonesia and

[1] For a discussion of the theoretical basis of fragmentation, see Jones (2000) and Arndt and Kierzkowski (2003).

Philippines), China and Hong Kong. Figures 2.1-2.6 show East Asia's intra-regional and external trade by industry and by commodity category.[2] These figures are based on the Research Institute of Economy, Trade and Industry's "Trade Industry Database (RIETI-TID)." For this database, RIETI converted commodity trade data from the UN Comtrade Statistics and Taiwan's official trade statistics at the five-digit level (SITC R2 or R3) to 13 industries, using the concordance of commodities and industries in Japan's IO tables. RIETI also classifies commodities into five categories according to their end use – raw materials, processed intermediate goods, parts and components, capital goods, and consumption goods – using the Broad Economic Categories (BEC) of the United Nations. In principle, the RIETI-TID uses the trade data from the side of the importing country and that data are on a CIF basis.

Looking at trade trends, the first thing we find is that East Asia's intra-regional trade grew faster than its external trade in the period of 1990-2003 (Figures 2.1, 2.5 and 2.7). In this period, intra-regional trade grew 3.2-fold from US$290 billion to US$920 billion, while the region's exports to and imports from the rest of the world (ROW) expanded 2.5-fold and 2.1-fold respectively. This means that regional integration through international trade intensified during this period. The largest increase in intra-regional trade occurred in the period of 1990-1995 (the annual growth rate was 15%). After that, growth slowed down (the annual growth rate in the period of 1995-2003 dropped to 5%). As we shall show later, the slowdown was mainly caused by the stagnation of Japan's international trade after 1995.

INSERT Figures 2.1-2.8

More than half of the expansion of intra-regional trade owes to the growth in trade in electrical and general machinery (Figure 2.1). The share of the electrical and general machinery industry in total

[2] In order to avoid double counting, we used only export data when calculating intra-regional trade.

intra-regional trade increased from 28% in 1990 to 46% in 2003. From the viewpoint of the end uses of goods, the share of parts and components trade within intra-regional trade significantly increased (Figure 2.2). As Figure 2.3 shows, intra-regional trade in parts and components increased about six-fold in the period 1990-2003 (the average annual growth rate was 13%). The growth of intra-regional trade in parts and components is closely related with the expansion of intra-regional trade in electrical and general machinery. In 2003, 90% of total intra-regional trade in parts and components consisted of electrical and general machinery (Figure 2.4).

As Figure 2.2 shows, in 2003, more than 60% of all the intra-regional trade was in intermediate goods (processed intermediate goods and parts and components). In the case of processed intermediate goods, 53% of intra-regional trade consisted of metal products and related mining and chemical products (Figure 2.3).

To sum up the above developments, there has been an intensification in intra-regional trade in East Asia and the main engine of this trend was outsourcing and the international fragmentation of production. The expansion of parts and components trade (Figure 2.4) and processed intermediate goods trade (Figure 2.3) accounts for 65% of the total increase of intra-regional trade from 1990 to 2003, while the expansion of trade in capital goods trade and consumption goods trade accounts for 34% of the total increase.

Turning to trade with the rest of the world, Figure 2.5 shows that, after 1995, East Asia's exports to ROW expanded more rapidly (the annual growth rate in the period of 1995-2003 was 6 %) than its intra-regional trade.[3] This rapid expansion of exports was mainly caused by the increase of China's exports to the US and other countries. As Figures 2.5 and 2.6 illustrate, East Asia's exports to ROW consist mainly of final goods such as general, electrical and transport machinery, household electric appliances, and toys and miscellaneous manufactured products. More than 60 % of the region's exports are either consumption or capital goods.

[3] The situation was very much the opposite during 1990-1995, so that intra-regional trade grew faster than exports to the ROW over the full 1990-2003 period.

Compared with intra-regional trade and exports to ROW, East Asia's imports grew at a relatively slow pace (Figure 2.7). But again, we can observe a rapid growth of parts and components imports. East Asia's parts and components imports from ROW expanded 4.1-fold, from US$43 billion in 1990 to US$174 billion in 2003. The rapid increase of both exports of final goods to ROW and imports of parts and components from ROW implies that East Asia's outsourcing and division of labor are not confined within the region but extend outside the region. East Asia plays the role of a huge assembling factory for the world.[4]

Next, we look at the trade and foreign direct investment of the major East Asian countries and the ASEAN 4. Figure 2.9 shows the developments in Japan's trade by commodity category and by trade partner from 1990 to 2003. From 1990 to 1995, Japan doubled her exports of parts and components. And the increase was mainly occurred in Japan's exports to East Asian countries. Japan's exports of processed intermediate goods and capital goods to East Asian countries also doubled in this period. However, Japan's exports stagnated after 1995. It seems that on the export side Japan, was left behind in the dynamic progress being made in the division of labor in East Asia from 1995 onward. In contrast, on the import side, Japan steadily increased her purchases of processed intermediate goods, parts and components, and investment goods from East Asia from 1990. From 1990 to 1995, Japan also increased her imports of consumption goods, mainly from China and Hong Kong.

INSERT Figure 2.9

Both Japan's overall import-GDP ratio and manufactured product imports-GDP ratio have increased rapidly from the middle of the 1990s (Table 2.1).[5] According to Japan's trade statistics, the

[4] See Athukorala and Yamashita (2006) for more on this issue.

[5] Japan's overall import-GDP ratio declined drastically in the 1980s. Until the 1990s, most of Japan's imports consisted of raw materials. The stagnation in the international prices of oil and other raw materials and the relative decline of Japan's heavy industries, such as steel, chemicals, and ship building, slowed down Japan's imports of raw materials.

increase in imports is mainly concentrated in electrical machinery and labor intensive goods such as apparel and wooden products. Since the share of the manufacturing sector in GDP declined during this period, the ratio of imports of manufactured products to gross value added in the manufacturing sector increased rapidly: by 19.7 percentage-points from 15.5% in 1985 to 35.2% in 2004 (Table 2.1). The United States experienced a similar trend during the 1980s, when this ratio jumped by 12.4 percentage-points from 18.3% in 1978 to 30.7% in 1990 (Sachs and Shatz 1994). We would expect an impact of a similar scale on Japan's manufacturing sector as a result of the recent surge in imports.[6]

INSERT Table 2.1

Japan's trade in manufactured products with the rest of East Asia has increased rapidly in the past decade and a half. As a result, the combined share of the nine major East Asian trading partners –the NIEs 3, the ASEAN 4, China, and Hong Kong – in Japan's total manufactured imports reached 49.4% in 2003 (up from 27.4% in 1990), while exports to these countries accounted for 44.5% (up from 29.5% in 1990) (see Figure 2.10). Since Asian economies are relatively abundant in unskilled labor and scarce in physical capital and skilled labor, this trade expansion may have deepened the international division of labor between Japan and the rest of the world and contributed to an increase in the demand for skilled labor and physical capital in Japan through the factor price equalization mechanism.

INSERT Figure 2.10

[6] Comparing export shares and import penetration in the US, Canada, UK and Japan during the period from 1974-93, Campa and Goldberg (1997) found import penetration to be extremely stable and significantly lower in Japan than in the other countries. However, if we were to conduct a similar analysis using more recent data, it seems probable that this conclusion no longer holds.

Japan's direct investment abroad has substantially contributed to the increase in trade between Japan and East Asia. Table 2.2 shows that Japanese manufacturing affiliates in the nine East Asian economies accounted for a large proportion of the trade with these economies, amounting to 45.3% of Japan's imports and 27.7% of exports in fiscal 2002. Thus, direct investment in and trade with the rest of East Asia are closely related, as was also shown in Fukao, Ishido, and Ito (2003). Using data from the electrical machinery industry, this study demonstrated that foreign direct investment plays a significant role in the rapid increase in vertical intra-industry trade in East Asia.

INSERT Table 2.2

Underlying the rapid increase of Japan's trade in manufactured products with East Asia is a large expansion of Japanese multinationals' production in the region. As Figure 2.11 shows, the number of workers employed by Japanese multinationals in East Asia's manufacturing sector increased from 0.88 million in 1990 to 2.1 million in 2003. This increase occurred mainly in the information and communication appliances industries in the ASEAN 4 and China.

INSERT Figure 2.11

Compared with Japan, Korea experienced even more rapid progress in outsourcing to the East Asian economies, especially to the ASEAN 4, China and Hong Kong (Figure 2.12). Her imports of processed intermediate goods and parts and components from the East Asian economies increased from US$17.4 billion in 1990 to US$53.9 billion in 2003. Although Japan has always been an important supplier of processed intermediate goods and parts and components to Korea, the other East Asian economies' exports of such commodities to Korea has in fact increased more rapidly than Japan's exports to the country.

INSERT Figure 2.12

Korea increased her total exports of processed intermediate goods, parts and components, and capital goods even more rapidly than her total imports of such commodities. Since 2000, Korea has been a net exporter of processed intermediate goods, parts and components, and capital goods both vis-à-vis the other nine East Asian economies and the rest of the world.

Figure 2.13 shows the trade pattern of the ASEAN 4. Like Korea, the ASEAN 4 increased both their imports and exports of processed intermediate goods and parts and components at high speed. Moreover, the increase in the exports of such commodities was greater than the increase in such imports. While in the 1990s, the ASEAN 4 were net importers of processed intermediate goods and parts and components, since 2000, they have been net exporters of these commodities. Probably three factors contributed to this change. First, a large number of foreign multinationals had located assembling plants specializing in labor intensive assembling processes in the region in the 1990s. As labor cost increased in ASEAN 4, especially in Thailand and Malaysia, foreign multinationals moved their assembling factories to other countries with cheaper labor, such as China and Vietnam. However, in the 2000s, the ASEAN 4, especially Thailand and Malaysia, were successful in attracting production activities of processed intermediate goods and parts and components by multinationals from developed economies through improvements of their infrastructure, increases in the number of skilled workers, and the development of industrial clusters. Second, following the East Asian Currency Crisis, domestic demand (especially investment) in the ASEAN 4 continued to stagnate. This stagnation slowed down ASEAN's total imports.

INSERT Figure 2.13

China's and Hong Kong's present trade pattern resembles that of the ASEAN 4 in the 1990s. China and Hong Kong specialize in assembling processes, importing large amounts of processed

intermediate goods and parts and components and export large amounts of final goods (especially consumption goods) all over the world (Figure 2.14). Major supplier of processed intermediate goods and parts and components are Japan and the NIEs 3. But China's imports of such commodities from the ASEAN 4 are also rapidly increasing.

As China deregulated and rationalized her machinery industry, improved her infrastructure and other determinants of logistics costs relevant for fragmentation, and promoted inward FDI in assembly factories through special trade zones, low corporate tax rates, etc., assembling processes were relocated from the ASEAN countries and developing economies to China in the 1990s and early 2000s. As labor costs in China's costal area have been shooting up in the last several years, a further relocation of assembling processes seems to be starting now, this time from China to new frontier countries such as Vietnam and India. On the other hand, China and Hong Kong are becoming important exporters of processed intermediate goods and parts and components. In 2003, China's and Hong Kong's total exports of such commodities were greater than such exports by both Korea and the ASEAN 4.[7]

INSERT Figure 2.14

Behind the recent surge of the Chinese economy as a factory for the world are the activities of foreign multinationals. It is foreign multinationals that have made Chinese goods produced using cheap labor exportable to sophisticated markets in developed economies by pouring their technologies and designs into the country and also cutting production costs further by introducing extremely efficient production networks with fragmentation and outsourcing on a large scale, which covers the whole of East Asia and the US.

We can confirm this fact by looking at Figures 2.15, 2.16 and 2.17. Inward FDI in China

[7] Note that China's and Hong Kong's exports (Figure 2.14) and the ASEAN 4's exports (Figure 2.13) include trade between China and Hong Kong and intra-ASEAN 4 respectively.

significantly increased in the middle of the 1990s. Figures 2.16 and 2.17 show the share of exports and imports conducted by the Chinese affiliates of foreign firms in China's total trade by destination and by origin, respectively. In 2005, about 60% of China's exports and imports were conducted by foreign multinationals. And in the case of China's imports from Taiwan, Korea and Japan, more than 70% of her imports were conducted by foreign multinationals. Similarly, more than 60% of China's exports to Hong Kong, Japan, the US and Taiwan were conducted by foreign multinationals.

INSERT Figures 2.15, 2.16, and 2.17

3. Trends in Labor Market and International Outsourcing in Japan and Korea

As explained in the previous section, the international division of labor among East Asian countries has deepened since the late 1980s. The deepening has accelerated since the latter half of the 1990s because of China's economic growth and its growing importance as a destination of foreign direct investment. In this and following sections, we analyze the effects of outsourcing of intermediate inputs on labor demand in Japan and in Korea, focusing on the effects of outsourcing to China and other Asian countries.

The effect of international outsourcing on the demand for skilled and unskilled labor has been the subject of numerous studies. Pioneering works by Feenstra and Hanson (1996a, 1996b, 1999) have been followed by Falk and Koebel (2002), Strauss-Kahn (2004), Hijzen, Görg and Hine (2005), Ekholm and Hakkala (2006), and others. In the case of Japan, this issue has been investigated by Sakurai (2000), Ito and Fukao (2005a, 2005b), Sasaki and Sakura (2005), and Yamashita (2006). Although the studies by Sakurai (2000) and Ito and Fukao (2005a), using the data for the 1990s, did not find a strong effect of international outsourcing on skill upgrading in Japan, more recent studies which include data for the early 2000s, found some evidence that international outsourcing has a positive impact on the demand for skilled labor. Particularly, Ito and Fukao (2005b) and Yamashita (2006) found that vertical intra-industry trade with Asian countries or imports from Asian countries

had a significant positive impact on the demand for skilled labor.

Before conducting an econometric analysis in the next section, it is useful to provide an overview of labor market trends and international outsourcing in Japan and Korea.

3.1 Trends in Labor Markets

We begin with an overview of labor market trends in Japan. Figure 3.1 shows the employment trends for different educational groups as well as part-time and self-employed workers.[8] Apparently, the number of employees with lower secondary education has been decreasing while the number of employees with tertiary education has been increasing both in the manufacturing and the service sectors. Looking at the shares of each educational group, the share of the number of employees with lower secondary education decreased from 36% to 21% in the manufacturing sector and from 17% to 10% in the service sector during the period from 1980 to 2002. (When part-time and self-employed workers are excluded, the share decreased from 47% to 13% in the manufacturing sector and from 25% to 7% in the service sector.) During the same period, the share of the number of employees with tertiary education increased from 10% to 14% in the manufacturing sector and from 17% to 23% in the service sector. (When part-time and self-employed workers are excluded, the share increased from 13% to 29% in the manufacturing sector and from 24% to 47% in the service sector.) As for the share of the number of employees with upper secondary education, this increased from 31% to 41% in the manufacturing sector and was quite stable at around 35% in the service sector. (When part-time and self-employed workers are excluded, the share increased from 41% to 58% in the manufacturing sector and slightly decreased from 50% to 47% in the service sector.) In addition, the share of the number of part-time workers increased from 8% to 12% in the manufacturing sector and from 8% to

[8] Following Ekholm and Hakkala (2006), we distinguish between three different skill groups based on educational attainment: employees with lower secondary, upper secondary, and tertiary education. Lower secondary education corresponds to junior high school graduates (9 years of schooling), while upper secondary education corresponds to high school graduates (12 years of schooling). Tertiary education corresponds to vocational school, college, or university graduates (more than 12 years of schooling).

14% in the service sector during the same period.

INSERT Figures 3.1 and 3.2

Figure 3.2 shows the trends in the nominal wage rate for the different educational groups. We calculated the ratio of the hourly wage for employees in each education group relative to the hourly wage for employees with tertiary education, which is shown in Figures 3.2(a) to 3.2(d). The different panels in Figure 3.2 indicate that the wage gap between employees with lower or upper secondary education and employees with tertiary education gradually shrank until 2000 but since then has expanded slightly.[9,10] The decrease in wage rates for unskilled employees (those with secondary education) relative to wage rates for skilled employees (those with tertiary education) in recent years may reflect a shift in demand towards skilled labor.[11] As mentioned by Sasaki and Sakura (2005),

[9] In the case of the machinery sector (general, electrical, and precision machinery and transportation equipment) in panel (c) and in the case of the electrical machinery sector in panel (d), the hourly wage rate for employees with lower secondary education is higher than that for employees with upper secondary education in many years from 1990 onward. This may be partly due to the fact that in the Japanese machinery industries, many skilled craftsmen have long experience in a company and receive a high salary although they did not graduate from high school. These skilled craftsmen have played an important role in skill upgrading, particularly in small and medium-sized enterprises.

[10] Previous studies such as Sakurai (2004) and OECD (1996) show that until the first half of the 1990s there had been hardly any increase in wage inequality in Japan, which contrasts with the rapid increase in wage inequality in the United States and the United Kingdom. However, according to the *Basic Survey of Wage Structure* conducted annually by Japan's Ministry of Health, Labour and Welfare, wage inequality between employees of different educational groups and between production and non-production workers has increased since the late 1990s.

[11] As is widely known, the enrollment rate in tertiary education rapidly increased during Japan's high-speed growth era. Moreover, under the seniority wage system, workers with long experience in a company receive a higher wage and consequently, wages for elder workers tend to be higher even though they did not receive more formal education. Japanese labor statistics (for example, Ministry of Health, Labour and Welfare, 2004) indicate that both the average age and the average duration of service of workers with lower education are higher than those of workers with higher education. As a result, it is sometimes observed that younger employees with tertiary education hold less skilled jobs receiving a lower wage, or that they receive a lower wage even though they hold skilled jobs. Therefore, educational attainment may not be the best measure of workers' skill levels. In

continuing increase in the supply of workers with tertiary education in Japan should have exerted downward pressure on the wage rate of workers with tertiary education. However, in recent years, the demand for workers with tertiary education may have increased sufficiently to cancel out the downward pressure and even push up the wage rate for workers with tertiary education.

Next, let us move on to recent trends in the Korean labor market. While the *Economically Active Population Survey* by the Korean National Statistical Office (KNSO) reports official estimates of the number of employees by educational attainment, it does so only for the total economy and, unfortunately, not for the manufacturing or the service sector separately. Figure 3.3 shows the employment trends for different educational groups. The number of employees with lower secondary education peaked in 1991 and has been decreasing since 2000. In contrast, the number of employees with tertiary education has been increasing since 1980.

The number of employees with upper secondary education increased during the 1980s and the early 1990s, but the growth in their number has slowed down since the late 1990s. A sudden decline in employment was observed for each educational attainment group in 1998, reflecting the impact of the Asian financial crisis. The share of employees with lower secondary education peaked at 21.7% in 1983 and gradually decreased to 11.3% in 2006. The share of employees with tertiary education rapidly increased from only 6.7% in 1980 to 33.7% in 2006. The share of employees with upper secondary education increased from 21.8% in 1980 to a peak of 44.4% in 2001 and has been declining slightly since. Nonetheless, employees with upper secondary education accounted for the largest share

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an econometric analysis of international outsourcing and skill upgrading, we may need to define the different worker groups on the basis of age, length of experience, or job types, combined with education attainment. However, in the case of Sweden, Ekholm and Hakkala (2006) did not find any robust pattern in the relationship between labor demand for different worker groups and international outsourcing when they defined three age groups (workers aged 25-39, 40-54, and 55-65). On the other hand, Hijzen, Görg and Hine (2005), using information on employees' occupations, found that international outsourcing had a strong negative impact on the demand for unskilled labor for the United Kingdom. For Japan, Ito and Fukao (2005a, 2005b) also used information on employees' occupations. However, they used the number of workers with different job types rather than wage rates, since data on wage rates for each job type were not available.

with 42.2% in 2006.

INSERT Figures 3.3 and 3.4

Figures 3.4(a) to 3.4(d) show the ratio of the average monthly wage for employees with lower or upper secondary education relative to the average monthly wage for employees with tertiary education. Unlike in Japan, the wage gap in Korea has been broadly expanding since the mid-1990s, both in manufacturing and in services. Like in Japan, employees with lower secondary education were on average paid more than those with upper secondary education in the case of the general machinery sector, which seems to be the result of the seniority wage system in the period of rapidly expanding upper secondary and tertiary education. However, such a reversal is not observed in the case of the electrical machinery sector in Korea.

Using the information on the number of employees and wage rates for each education group, we calculated the wage shares by educational attainment at the industry level for Japan and Korea (Table 3.1).[12] In the case of Japan, it is apparent that the wage share of workers with tertiary education has been increasing while the wage share of lower secondary education has been decreasing. In the service sector, the wage share of workers with upper secondary education also has been decreasing. In the manufacturing sector, however, the wage share of workers with upper secondary education has increased from 40% to 54% during the period from 1980 to 2002. As already seen above, the share of the number of employees with upper secondary education increased from 41% to 58% (excluding part-time and self-employed workers) during the same period in the manufacturing sector. This means that the increase in wage rates for workers with upper secondary education has been slower than for workers of other educational groups.

[12] For Japan, we compile the wage share data at the JIP industry level (108 industries including 52 manufacturing industries and 48 service industries). For Korea, we used information from the *Basic Statistics Survey of Wage Structure* by the Ministry of Labor.

In the case of Korea, the wage share of workers in each skill group shows a similar trend as in Japan. However, the increase in wage share of workers with upper secondary education in manufacturing is much smaller in Korea than in Japan during the period from 1990 to 2000. Moreover, the wage share for workers with tertiary education is much higher in Korea than in Japan.

INSERT Table 3.1

The data on the changes in labor input quantities in Figure 3.1 imply that the reductions in the quantity of unskilled labor input (i.e., those with secondary education) have been greater than those in the quantity of skilled labor input (i.e., those with tertiary education) in Japan.[13] Moreover, in both Japan and Korea, the absolute wage of skilled labor has also risen faster than that of unskilled labor in recent years, as shown in Figures 3.2 and 3.4. Therefore, the key issue addressed below is whether the demand shift towards skilled labor can be explained by industries engaging in the international outsourcing of production.

3.2 Measurement of Outsourcing

A number of recent studies, using a variety of data source, have tried to analyze trends in the trade in intermediate inputs. One of the empirical issues in these studies has been how to measure the importance of trade in intermediate inputs or international outsourcing. Following Hijzen, Görg and Hine (2005) and Ekholm and Hakkala (2006), we measure the degree of international outsourcing

[13] As for labor turnover rates, we cannot see any clear trend towards the use of more skilled labor. The turnover rate for employees with lower secondary education has substantially increased since the late 1990s. However, this trend may be related to increase in retirement and decrease in entry of employees in this educational category. In the manufacturing sector and the machinery sector, the turnover rate has been increasing in recent years not only for unskilled workers but also for skilled workers. This trend may be associated with various changes in demographic structure, seniority wage system, internal promotion system, industrial structure, and so on. Relationships between labor turnover rates and demand shift towards skilled labor do not seem to be straightforward.

using information on imported inputs from input-output tables.[14] Data on imported intermediate inputs are obtained directly from the input-output tables of Japan and Korea. Following Feenstra and Hanson (1999) and Ekholm and Hakkala (2006), we distinguish between *narrow* and *broad* outsourcing. The narrow definition of international outsourcing only considers imported intermediate inputs in a given industry from the same industry (which corresponds to diagonal terms of the import-use matrix). Broad outsourcing includes imported non-energy intermediate inputs from all other industries. Both the narrow and the broad measures of international outsourcing are defined as imported intermediate inputs in relation to industry output:

<Narrow> $$z_i^N = \frac{m_{ii}}{Y_i} \qquad (1)$$

<Broad> $$z_i^B = \frac{\sum_{j=1}^{N} m_{ij}}{Y_i} \qquad (2)$$

where m_{ij} is industry i's use of imported intermediate inputs from industry j and Y_i is output in industry i.

We use direct information about industry use of imported intermediates from input-output tables. In Japan and Korea, comprehensive and detailed input-output tables are available every five years. Utilizing the comprehensive input-output tables for 1990, 1995, and 2000 as benchmark data, we construct time series for outsourcing measures as follows. Equation (1) can be rewritten as the product of the share of imported inputs in total imports and the ratio of imports to output:

$$z_i^N = \frac{m_{ii}}{M_i}\frac{M_i}{Y_i} \qquad (3)$$

where M_i is total imports in industry i. We observe the share of intermediate inputs in total imports in industry i, m_{ii}/M_i, in 1990, 1995, and 2000, while we observe imports in relation to domestic output every year. We use a liner interpolation of m_{ii}/M_i based on the 1990, 1995, 2000 values in order to

[14] As pointed out by Hijzen, Görg and Hine (2005), there are two main drawbacks associated with using input-output tables to analyze outsourcing. First, we have to ignore the possibility of outsourcing of the final production stage such as assembly when focusing on trade in intermediate goods. Second, the data do not capture outsourcing when products are not re-imported, but exported to third countries.

obtain values of z_i^N for 1991-1994 and 1996-1999. For 1988 and 1989, we use m_{ii}/M_i for the year 1990. For 2001-2004, we use m_{ii}/M_i for the year 2000.

Similarly, we construct a time series for the broad measure. Equation (2) can be rewritten as:

$$z_i^B = \sum_{j=1}^{N} \frac{m_{ij}}{M_j} \frac{M_j}{Y_i} \qquad (4)$$

We observe industry *i*'s use of intermediate inputs in industry *j* as a share of total imports in industry *j*, m_{ij}/M_j, in 1990, 1995, and 2000 and the ratio of imports in industry *j* to output in industry *j* every year. Again, we use a linear interpolation of 1990, 1995, and 2000 values of m_{ij}/M_j for the years 1991-1994 and 1996-1999. For 1988 and 1989, we use m_{ij}/M_j for the year 1990, and for 2001-2004, we use m_{ij}/M_j for the year 2000. Thus, we assume that the relationship between an industry's use of imported inputs from its own and other industries and total imports in these industries change slowly and follow a trend.

Table 3.2 shows the trends in international outsourcing for Japan and Korea during the period from 1990 to 2000 (and for 1980 for Japan for reference). We use both the narrow and the broad measures of international outsourcing. These measures are put both in relation to the industry's total use of inputs (from the industry itself in the case of the narrow measure and from all industries in the case of the broad measure), as well as in relation to the industry's output. These measures for the manufacturing sector indicate that in the case of both Japan and Korea international outsourcing increased between 1990 and 2000, although the level of international outsourcing is much higher in the case of Korea than Japan. However, in the case of the service sector, the share of imported inputs decreased between 1990 and 2000 in Japan when evaluated by the broad measure, while international outsourcing in services increased particularly rapidly during the latter half of the 1990s in Korea. According to Ekholm and Hakkala (2006), imports of services account for the largest percentage increases both in the manufacturing and in the service sector in the case of Sweden during the period from 1995 to 2000. While the Korean figures in Table 3.2 show similar trends to their Swedish figures, our statistics for Japan, contrary to their Swedish figures, imply that the increase in international

outsourcing (particularly narrow outsourcing) was most prominent in manufacturing (not in services).[15] Thus, we found that international outsourcing in the Japanese manufacturing sector increased during the 1990s, though Campa and Goldberg (1997) found that Japanese manufacturing industries experienced a reduction in international outsourcing during the period from 1974 to 1993, while the United States and the United Kingdom experienced rapid increases in industry import penetration and imported input use during the same period. The contrast implies that there was a change in the trend in international outsourcing in Japan in the 1990s. Our broad measures for Japan in Table 3.2 indicate a reduction in outsourcing during the 1980s, which is consistent with the findings by Campa and Goldberg (1997). The reduction in outsourcing during the 1980s may be attributed to the yen appreciation in that decade, although this issue needs to be investigated more rigorously. The appreciation of the yen since the mid-1980s may have led to lower prices of imported inputs, resulting in the lower ratio of imported inputs to total industry output. Moreover, the international division of labor in East Asian countries still was not well developed in the 1980s. However, Japan's international outsourcing increased in the 1990s along with the economic development in the East and Southeast Asian countries, which may explain the increase in our outsourcing measures in the 1990s.

INSERT Table 3.2

We also construct the outsourcing measures by region, assuming that the country distribution of imports in industry *i* is the same for intermediate inputs as for final products. As for imported services,

[15] Comparing our Table 3.2 with Table 1 in Ekholm and Hakkala (2006), the shares of imported inputs in total output or inputs are much smaller in the case of Japan than in the case of Sweden. For example, the narrow outsourcing shares in output are in the range from 0.73% to 0.85% in all industries in the case of Japan, while the corresponding shares are in the range from 4.0% to 4.2% in all industries in the case of Sweden. As for the broad outsourcing shares, Japan's figures are approximately a third of the corresponding Swedish figures. Moreover, the shares of imported service inputs in total inputs in manufacturing are in the range from 0.16% to 0.18%, which is approximately a hundredth of the corresponding Swedish figures. We checked the figures in the Japanese input-output tables carefully and confirmed that there were no mistakes in our calculation. Therefore, if we believe the information in the Japanese input-output tables, only a small amount of imported services is used as intermediates by manufacturing industry.

we use the information from the regional balance of payment statistics provided by the Bank of Japan. Because the regional balance of payment statistics are available only since 1996, we assume that the regional distribution of imports in service industry *i* for the years before 1996 is the same as the regional distribution for 1996.[16]

Figure 3.5 shows narrow outsourcing to major regions for Japan and Korea in 1990, 1995, 2000, and 2004 in the manufacturing sector. Although the level of international outsourcing is much higher for Korea, both countries show similar increasing trends in outsourcing and similar regional distribution. As can be seen, outsourcing to Asia, particularly to China, has increased conspicuously since 1990. It should be noted, as pointed out by Ekholm and Hakkala (2006), that this outsourcing measure may underestimate the magnitude of the shift of intermediate goods production to low-income countries in Asia because outsourcing is measured based on the value of imports, which is affected by price changes and exchange rates. If lower production costs in low-income Asian countries lead to a shift of intermediate goods production to these countries, similar goods can be imported at lower prices from Asia than from higher-income countries. Therefore, the increase in outsourcing to Asia may be more pronounced on a volume basis.

Figures 3.6 and 3.7 show the development of international outsourcing to major regions for six broad industry groups for Japan and Korea, respectively. In the case of Japan (Figure 3.6), although narrow outsourcing has increased in every industry, the most conspicuous increase can be seen in the electrical machinery industry. The outsourcing measure for the electrical machinery industry rapidly

[16] Although this may be too strong an assumption, it will not affect the outsourcing measures for manufacturing industries very much because the share of imported service inputs in the total use of inputs in manufacturing is very small, as we saw in Table 3.2. Moreover, although the Bank of Korea provides the regional balance of payment statistics since 1998, we gave up trying to compile the data on the regional distribution of imports in service industries for Korea. The regional balance of payment statistics by the Bank of Korea are less detailed than those by the Bank of Japan. In addition, while for Japan data on imported service inputs are available annually until 2000 and for the years 2003 and 2005 (Extended Input-Output Tables published by the Ministry of Economy, Trade and Industry are available annually until 2000, 2003, and 2005.), such data are not available for Korea. Therefore, we did not include imported service inputs when calculating the outsourcing measures for Korea.

increased from 1990 to 1995 and from 2000 to 2004. The former increase was mainly driven by the increase in outsourcing to the ASEAN 4 countries (Indonesia, Malaysia, the Philippines, and Thailand), while the latter increase was mainly driven by the increase in outsourcing to China. In addition, the greatest part of the increase in outsourcing in the textile industry was brought about by the increase in outsourcing to China. In the case of Korea (Figure 3.7), international outsourcing shows a somewhat increasing trend in all industries except chemical products. The most conspicuous increase in outsourcing can be seen in the textile industry, and the greatest part of the increase has been driven by the increase in outsourcing to China. In chemical products and electrical machinery, outsourcing to Japan has been decreasing while outsourcing to China has been increasing. Outsourcing to China has increased rapidly and has been approaching the level of outsourcing to Japan in metal work and general machinery and electrical machinery. However, outsourcing to Japan still far surpasses the level of outsourcing to China in transport equipment. Nonetheless, according to Figures 3.5, 3.6, and 3.7, outsourcing to China shows a rapid increase since 1990 in many industries in both Japan and Korea.[17]

INSERT Figures 3.5, 3.6, and 3.7

4. Econometric Analysis

4.1 Econometric methodology

In this section, we conduct an econometric analysis in order to understand the linkage between trade, FDI, and labor market developments. Our econometric analysis is mainly based on the industry-level data taken from the JIP Database 2006 in the case of Japan and from the National Accounts, Census of Manufactures, and UN COMTRADE data in the case of Korea. Utilizing the JIP Database 2006 allows us to examine the issue for the period from 1988 to 2002 for Japan.[18] For Korea,

[17] We can see a similar trend in broad outsourcing measures as in Figures 3.5, 3.6, and 3.7.

[18] The JIP Database 2006 covers the period from 1970 to 2002 for many variables. However, detailed trade data are available only after 1988. Japanese Trade Statistics started employing the HS classification since 1988 and

we examine the issue for the period from 1993 to 2003.

The analysis so far has provided some evidence of a shift in demand to skilled labor (those with tertiary education) and highlighted some of the developments in international outsourcing in Japan and Korea. We now turn to the econometric examination of the relationship between international outsourcing and the skill structure of labor demand. The econometric analysis is based on a translog cost function. The cost function approach was first introduced by Berman, Bound and Griliches (1994) in the context of the demand for skilled labor and has been widely employed in the literature on the effects of outsourcing on the skilled-unskilled wage differential or skill upgrading.

As in Berman, Bound and Griliches (1994), it is assumed that industry cost functions can be approximated by a translog cost function, and the translog variable cost function can be presented as:

$$\begin{aligned}\ln C_i(w,x,z) = \beta_i &+ \sum_{j=1}^{S}\alpha_j \ln w_{ij} + \frac{1}{2}\sum_{j=1}^{S}\sum_{s=1}^{S}\gamma_{js}\ln w_{ij}\ln w_{is} + \sum_{k=1}^{K}\phi_k \ln x_{ik} \\ &+ \frac{1}{2}\sum_{j=1}^{S}\sum_{k=1}^{K}\delta_{jk}\ln w_{ij}\ln x_{ik} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K}\phi_{kl}\ln x_{ik}\ln x_{il} + \frac{1}{2}\sum_{r=1}^{R}\sum_{t=1}^{R}\kappa_{rt}z_{ir}z_{it} \\ &+ \sum_{r=1}^{R}\kappa_r z_{ir} + \frac{1}{2}\sum_{j=1}^{S}\sum_{r=1}^{R}\lambda_{jr}z_{ir}\ln w_{ij} + \frac{1}{2}\sum_{k=1}^{K}\sum_{r=1}^{R}\lambda_{kr}z_{ir}\ln x_{ik}\end{aligned} \qquad (5)$$

where C_i is the variable cost for industry i, w_{ij} denotes the wages of workers in skill group j and industry i, and x_{ik} denotes the fixed inputs or output k in industry i. z_{ir} represents technological change for proxy r in industry i. Time subscripts are omitted throughout for ease of presentation. A full set of year dummies is included in order to capture economy-wide technological change over time. Differentiating the translog cost function with respect to wages yields the factor payments to skill group j over the total wage bill:

$$\theta_{ij} = \alpha_j + \sum_{s=1}^{S}\gamma_{js}\ln w_{is} + \sum_{k=1}^{K}\delta_{jk}\ln x_{ik} + \sum_{r=1}^{R}\lambda_{jr}z_{ir} \qquad (6)$$

(j=1, …., S; s=1, …., S; r=1, …, R)

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we converted the HS-based trade data into the JIP industry-based data. For details of the JIP Database 2006, see Appendix.

where $\theta_{ij}=\partial lnC_i/\partial lnw_{ij}=(w_{ij}/C_i)/(\partial Ci/\partial w_{ij})=w_{ij}L_{ij}/\sum_{s=1}^{S} w_{is}L_{is}$ and L_{ij} denotes the demand for labor in skill group j. x_{ik} denotes the capital stock or value added, and z_{ir} variables capture factor-biased technological change (FBTC) in industry i.

The value of parameters γ_{js} will depend on whether different skill types of labor tend to be substitutes for or complements to one another while the values of parameters λ_{jr} depend on whether technological change is biased towards or away from the usage of labor belonging to skill group j.

We distinguish between three different skill groups based on educational attainment: workers with lower secondary, upper secondary, and tertiary education. Homogeneity of degree one in prices implies $\sum_{s=1}^{S}\gamma_{js}=0$. Symmetry of the underlying translog cost function requires $\gamma_{st}=\gamma_{ts}$. These restrictions are imposed in the analysis. As for technological change variables, we use two measures of FBTC: international outsourcing as described above (denoted z_{i1}^{h}, $h=N, B$) and R&D intensity (defined as the ratio of R&D expenditure to industry output and denoted z_{i2}). Moreover, we take account of overseas production by multinational firms. The measure of overseas production (denoted z_{i3}) is defined as the ratio of the number of employees in the foreign affiliates of multinationals to the total number of domestic workers in industry i in the case of Japan. For Korea, however, due to data constraints, the variable z_{i3} is defined as the ratio of the outbound FDI stock to the nominal capital stock in industry i. The system of share equations is estimated using Zellner's method for seemingly unrelated regression equations (SUR). Because the sum of labor cost shares equals to one ($\sum_{j=1}^{S}\theta_{ij}=1$), the disturbance covariance matrix of the system will be singular and one equation therefore needs to be dropped. Consequently, we only estimate two equations by iterating Zellner's method (ISUR) to ensure that estimates are independent of the equation deleted.

Using the estimation results, the elasticities of factor demand will be calculated. The elasticity of factor demand j with respect to a change in factor prices is given by:

$$\varepsilon_{jj}=\frac{\partial \ln L_{ij}}{\partial \ln w_{ij}}=\frac{\gamma_{jj}+\theta_{ij}^{2}}{\theta_{ij}}-1$$

$$\varepsilon_{js} = \frac{\partial \ln L_{ij}}{\partial \ln w_{is}} = \frac{\gamma_{js} + \theta_{is}\theta_{ij}}{\theta_{ij}}$$

$$\sum_{j=1}^{S} \varepsilon_{js} = 0$$

The elasticity of factor demand *j* with respect to a change in the capital stock or value added is given by:

$$\varepsilon_{jk} = \frac{\partial \ln L_{ij}}{\partial \ln x_{ik}} = \frac{\delta_{jk}}{\theta_{ij}}$$

The elasticity of factor demand *j* with respect to FBTC due to international outsourcing, R&D, or overseas production is given by:

$$\varepsilon_{jr} = \frac{\partial \ln L_{ij}}{\partial z_{ir}} = \frac{\lambda_{jr}}{\theta_{ij}}$$

We calculate these elasticities using parameter estimates and sample means.[19]

4.2 Estimation Results for Japan

Tables 4.1 and 4.2 report the elasticities derived from the regression results for Japan.[20] We use outsourcing measures distinguishing between imports from different regions: North America (NA), Europe (EUR), and Asia (ASIA). Asia is further broken down into China and the ASEAN 4. Outsourcing to regions of different income levels is expected to have different effects on skilled/unskilled labor demand because of differences in the labor-content of imported intermediate goods.[21] For each skill group, we carry out two sets of estimations: specification (1) is based on the

[19] For the derivation of the elasticities, see the Appendix in Ekholm and Hakkala (2006).

[20] Summary statistics for variables used in our regression analysis are shown in Appendix Table 2. The results of estimating the system of equations using pooled iterated SUR (pooled ISUR) may be obtained from the authors upon request.

[21] Following Ekholm and Hakkala (2006), we also tried to use outsourcing measures distinguishing between imports from low-income and high-income countries. However, according to the World Bank classification (as of July 2006), Asian countries such as China and the ASEAN-4 countries are not classified as low-income countries anymore, even though their wage levels are still much lower than Japan's. Therefore, the high- and low- income distinction cannot capture the increase in outsourcing to Asian countries. According to the regression results for Japan, the magnitude of the elaticities of outsourcing to low-income countries was very large. However, a one percentage point increase in outsourcing to low-wage countries would imply a hundred-fold increase from the

assumption that quality-adjusted wages are identical across industries, while specification (2) allows wages to differ across industries. Specification (2) includes industry-specific wage levels in the estimation and thereby allows us to obtain an estimate of wage elasticities.[22]

INSERT Tables 4.1 and 4.2

Table 4.1 shows the elasticities focusing on the narrow measure of outsourcing. According to the top panel of Table 4.1, total narrow outsourcing has a significant negative impact on the demand for workers with upper secondary education, while it has a significant positive impact on the demand for workers with tertiary education. The results for the regression suggest that for a given level of capital stock and value added, a one percentage point increase in the outsourcing measure decreases the demand for workers with upper secondary education by 0.7 percent. On the other hand, in the same specification, a one percentage point increase in the outsourcing measure increases the demand for workers with tertiary education by 0.9 percent and the estimated elasticity is statistically significant. The results in the top panel of Table 4.1 strongly indicate that overall narrow outsourcing tends to shift labor demand away from workers with upper secondary education towards workers with tertiary education. In the second and the third panels of Table 4.1, we show the results for the case when we distinguish between narrow outsourcing to different regions. We find a significant negative elasticity for workers with lower secondary education and a significantly positive elasticity for workers with tertiary education with respect to outsourcing to Asia (particularly China). On the other hand, we find a negative elasticity for workers with upper secondary education and a positive elasticity for workers

present level, because of the very low level of outsourcing to low-wage countries. Moreover, the estimated coefficients are less robust for outsourcing to low-wage countries. Therefore, in this paper, we mainly report the results using outsourcing measures distinguishing between imports from different regions rather than imports from low- and high-income countries.

[22] This specification may suffer from an endogeneity problem in that industry wages may be affected by the industry's wage cost shares for different workers.

with tertiary education with respect to outsourcing to Europe. Outsourcing to North America has a positive impact on labor demand for the lowest skill group (lower-secondary education), while it has a negative impact on labor demand for the highest skill group (tertiary education). These results indicate that imported inputs from Asia contain labor with the least education and are substitutes for the most unskilled-intensive activities in domestic production. Moreover, the results may indicate that imported inputs from Europe and North America contain labor with intermediate education and with the highest education, respectively, and are substitutes for medium skilled-intensive and the most skilled-intensive activities in domestic production, respectively.

Overseas production by Japanese multinationals tends to shift labor demand away from workers with upper secondary education, which is consistent with the results from Ekholm and Hakkala's (2006) study on Sweden. The estimated elasticities for other skill groups are positive and statistically significant. On average, a one percentage-point increase in the overseas production measure is realized when the number of workers employed by foreign affiliates of Japanese firms increased by approximately 2,700 persons for a given level of number of domestic employees in an industry. Based on the estimated elasticities, the one percentage-point increase in the overseas production measure decreases the demand for workers with upper secondary education by 0.05% (on average, 55 persons) and increases the demand for workers with lower secondary education and tertiary education by 0.07% (on average, 30 persons) and 0.04% (on average, 18 persons), respectively. According to this calculation, the impact of overseas production on domestic employment may be quantitatively very small, although the estimated elasticities are statistically significant.

As for the elasticity with respect to R&D, according to the results in Table 4.1, a one percentage point increase in R&D intensity decreases the demand for workers with upper secondary education by approximately 0.2 percent for a given level of capital stock and value added. On the other hand, we find positive elasticities for workers with lower secondary education, although the elasticities are not always statistically significant. Previous studies, such as Hijzen, Görg and Hine (2005) and Ekholm and Hakkala (2006), found a negative elasticity for workers with lower secondary education in the

case of the United Kingdom and Sweden, respectively, which is contrary to our results for Japan. In the case of Japan, as mentioned above, skilled craftsmen with long experience in a company have been playing an important role in skill upgrading, particularly in the machinery industries where R&D intensity is relatively high. The result may owe to the fact that the skilled craftsmen are not high school graduates but receive a high salary because of their long experience and high skill levels.

Table 4.2 shows the results based on the broad measure of outsourcing. The signs of the elasticities of broad outsourcing are consistent with those of narrow outsourcing presented in Table 4.1, and the results based on the broad outsourcing measure reveal that total outsourcing and outsourcing to Asia tend to shift labor demand away from workers with upper secondary education towards workers with tertiary education.

According to our results in Tables 4.1 and 4.2, both total narrow outsourcing and total broad outsourcing shift labor demand away from workers with upper secondary education towards workers with tertiary education. In particular, in the case of outsourcing to China, both the narrow and the broad measure have a strong positive impact on the demand for workers with tertiary education and a strong negative impact on the demand for workers with lower secondary education.

Thus, we find that labor demand is primarily shifted away from workers with intermediate education, which is consistent with the findings of Ekholm and Hakkala (2006) but not those of Hijzen, Görg and Hine (2005). The latter found that the negative impact of international outsourcing was significant on the demand for the most unskilled workers. As Ekholm and Hakkala (2006) explain, the difference in the results may partly be explained by the different definitions of skills: Hijzen, Görg and Hine (2005) use occupations to define skill groups while Ekholm and Hakkala (2006) and we use educational attainment.

In addition, it should be noted that outsourcing to China tends to have a negative impact on the demand for workers with lower secondary education but a positive impact on the demand for workers with upper secondary education. On the other hand, outsourcing to the ASEAN 4 countries or Europe tends to have a positive impact on the demand for workers with lower secondary education but a

negative impact on the demand for workers with upper secondary education. This may imply that the lowest skill group has been substituted by workers embodied in imported intermediates from China by now. Moreover, if skill levels in China were to catch up with those in the ASEAN 4 or Europe in the future, the semi-skilled workers might be substituted by workers embodied in imported intermediates from China.

4.3 Econometric Results for Korea

Tables 4.3 and 4.4 report the elasticities derived from the regression results for Korea.[23] We use outsourcing measures distinguishing between imports from the following different regions: North America (NA), Europe (EUR), and Asia (ASIA). Asia is further broken down into Japan, China, and the ASEAN 4.

INSERT Tables 4.3 and 4.4

Table 4.3 shows the elasticities with the narrow measure of outsourcing. According to the top panel of Table 4.3, unlike in the case of Japan, total outsourcing does not have significant effects on the demand for workers in Korea. Although the results are statistically insignificant, the signs of the coefficients suggest that outsourcing tends to have a positive impact on the demand for workers with tertiary education but a negative impact on the demand for workers with lower secondary education.

In fact, as the third panel of Table 4.3 shows, outsourcing to China has a significant negative elasticity for workers with lower secondary education and a significant positive elasticity for workers with tertiary education. On the other hand, outsourcing to Japan has a negative elasticity for workers with tertiary education and a positive elasticity for workers with lower secondary education. In other

[23] Summary statistics for variables used in our regression analysis are shown in Appendix Table 2. The results of estimating the system of equations using pooled iterated SUR (pooled ISUR) may be obtained from the authors upon request.

words, outsourcing to China shifts labor demand away from workers with lower secondary education towards workers with tertiary education, while outsourcing to Japan shifts labor demand away from workers with tertiary education towards workers with lower secondary education. These results suggest that imported inputs from China contain labor with the least education and are substitutes for low-skill-intensive activities in domestic production. The results also suggest that imported inputs from Japan contain labor with the highest education and are substitutes for the most skill-intensive activities in domestic production. In addition, imported inputs from the ASEAN 4 seem to contain labor with intermediate education and to be substitutes for medium skill-intensive activities in domestic production.

Table 4.4 shows the results based on the broad measure of outsourcing. The signs of the elasticities of broad outsourcing are largely consistent with those of narrow outsourcing presented in Table 4.3. Overall, the econometric results for Korea are broadly consistent with those for Japan.

4.4 Estimated Impacts of International Outsourcing on Labor Demand for Japan

The estimation results described above indicate that international outsourcing shifts labor demand away from workers with upper secondary education towards workers with tertiary education in Japan.[24] In particular, outsourcing to Asia has the strongest effect of skill upgrading, i.e., shifting demand away from less-skilled workers towards skilled workers. However, we did not find such strong evidence in the case of Korea. Therefore, focusing on the total international outsourcing and the

[24] However, the estimation in this section may not be convincing because of potential problems with our definition of skill groups. Educational attainment may not be the best measure of workers' skill levels. In order to measure workers' skill levels, we may have to use information on age, length of experience, and job types as well as educational attainment. Unfortunately, however, due to data constraints, it is not an easy task to construct such skill measures with multiple dimensions. Therefore, we checked the robustness of the estimation results for Japan by including the wage shares of part-time workers and self-employed workers or using the employment shares of job types as dependent variables. We obtained robust results which are consistent with the results in Tables 4.1 and 4.2 and found evidence that international outsourcing (particularly outsourcing to Asia) shifted labor demand away from less-skilled workers to the most skilled workers, i.e., "technical" workers. These regression results may be obtained from the authors upon request.

outsourcing to Asia in the case of Japan, we calculate an estimate of the number of employees affected by the change in outsourcing between 1995 and 2000, using the estimated elasticities shown in Tables 4.1 and 4.2. The calculation of the estimate is summarized in Table 4.5. The actual change in total narrow outsourcing in the manufacturing sector during the period from 1995 to 2000 was 0.226 percentage points and the actual change in total broad outsourcing in manufacturing in the same period was 0.906 percentage points. Similarly, the actual change in narrow (broad) outsourcing to Asia in manufacturing during the period was 0.134 (0.642) percentage points.[25] On the other hand, the total number of employees in each skill group in manufacturing in 1995 and 2000 is shown in columns (e) and (f) in Table 4.5. According to our estimates using these values, the actual change in broad outsourcing to all countries was associated with a reduction in the demand for workers with upper secondary education by 58, 775 workers. Of this figure, a reduction by 54,897 workers was associated with the actual change in broad outsourcing to Asia. As the actual reduction in the number of workers with upper secondary education was 463, 293 persons during the period from 1995 to 2000, the estimated reduction induced by broad outsourcing accounts for approximately 12-13% of the actual reduction.

Although it may be difficult to judge whether this negative impact on the demand for workers with upper secondary education is large or not, we may say that the positive impact on the demand for workers with tertiary education is somewhat significant. The actual change in outsourcing to Asia was associated with an increase in the demand for workers with tertiary education by 12,338 (narrow measure) and 27,881 (broad measure) workers, accounting for 10% (narrow measure) and 22% (broad measure) of the actual increase in the total number of employees with tertiary education during the period from 1995 to 2000.

Furthermore, we conduct a similar calculation for the Japanese electrical machinery industry, the result of which is shown in the lower panel of Table 4.5. As already seen in Figure 3.6, the increase in

[25] The actual change in narrow and broad outsourcing measures are calculated using the figures in Table 3.2.

international outsourcing is most conspicuous in the electrical machinery sector.[26] According to our estimates using the actual figures for changes in employment and outsourcing for the electrical machinery sector, the actual change in outsourcing to Asia was associated with a reduction in the demand for workers with upper secondary education by 30,307 (broad measure) while associated with an increase in the demand for workers with tertiary education by 18,816 (broad measure). Comparing these figures with those in the upper panel of Table 4.5, we find that more than half of the labor demand change induced by outsourcing to Asia is driven by the electrical machinery sector alone.

5. Conclusion

The last decade has seen substantial progress in the fragmentation of production processes in East Asia. As a result, there has been a rapid increase in the intra-regional outsourcing of intermediate inputs within East Asia. Applying a common empirical approach to comparable industry-level data on production, trade, and labor markets for Japan and Korea, this paper aimed to investigate the impacts of outsourcing on different sectors of the labor market focusing on differences in educational attainment.

The main findings of the paper can be summarized as follows. First, intra-regional trade in East Asia grew remarkably during the period 1990-2003. While overall trade with the rest of the world roughly doubled in this period, intra-regional trade in East Asia more than tripled.

Second, the main factor behind increased intra-regional trade in East Asia was the trade in intermediate goods through outsourcing and the international fragmentation of production. Multinational enterprises played an important role in the recent surge of China as a factory for the world, which has made a tremendous impact on labor markets in developed economies, including

[26] As we can see from Figure 3.6 and Table 4.5, the increase in broad outsourcing in the electrical machinery sector is more rapid than the increase in narrow outsourcing in the sector. This may be partly due to the relatively less-aggregated industry classification for the electrical machinery sector. In the JIP Database 2006, there are eight sub-sectors in the electrical machinery sector, which reflects the importance of the electrical machinery industry in Japan and the wide variety of products in the sector.

Japan and Korea.

Third, reflecting the fact that outsourcing to Asia (particularly to China) has a negative impact on the demand for workers with lower education and a positive impact on the demand for workers with higher education, relative wage shares of workers by educational attainment have changed substantially both in Japan and Korea.

Fourth, the overall effects of total outsourcing in terms of increasing (decreasing) the relative demand for workers with higher (lower) education have been insignificant in Korea partly because a substantial part of Korean outsourcing remained directed towards Japan, shifting labor demand away from workers with tertiary education towards workers with lower education.

Fifth, as a robustness check, using Japanese data with more direct measures of the demand for skill upgrading, this paper found evidence that international outsourcing (particularly outsourcing to Asia) shifted labor demand away from less-skilled workers to the most skilled workers, i.e., "technical" workers.

These findings are consistent with the Heckscher-Ohlin Theory and our results provide evidence of skill-upgrading in Japanese manufacturing as a result of outsourcing. For Korea, our results imply that labor demand would shift away from less-skilled workers towards more-skilled workers if outsourcing to China increased and outsourcing to Japan decreased in the future. However, as shown in Table 4.5, the actual impact of international outsourcing on labor demand in Japan may not be very striking. As mentioned in the previous section, the estimated reduction in the number of workers with upper secondary education induced by broad outsourcing accounts for 12-13% of the actual reduction, while the estimated increase in the number of workers with tertiary education induced by broad outsourcing accounts for 22% of the actual increase in the total number of workers in the education group. These figures, however, may be underestimates because of shortcoming in the way our outsourcing measures are constructed. As pointed out by Hijzen, Görg and Hine (2005), the

outsourcing measures used here do not capture trilateral trade-type outsourcing.[27] Yet, Japan (and Korea) export a significant volume of parts and components to other Asian countries such as China and ASEAN, where they are assembled and exported to a third country such as the United States and a European country. In this case, although Japan (or Korea) outsources the assembling stage to other Asian countries, our measure cannot capture such type of outsourcing. In future studies, we may need to incorporate such type of outsourcing to take account of the growing importance of international fragmentation in Asia.

Last, but not least, we should discuss the effects of international outsourcing on overall economy. A large body of literature has argued the productivity enhancing effects of international outsourcing.[28] It is expected that, at the firm-level, outsourcing enables a firm to relocate its relatively inefficient production processes to external providers with cheaper and more efficient production capabilities, and the firm can focus on areas where it has a comparative advantage. Moreover, at a more aggregate level, outsourcing can lead to the creation of new firms and the destruction of inefficient firms, resulting in enhanced productivity at the industry or macro level. Although the empirical evidence on the productivity enhancing effects of international outsourcing is still scant, skill-upgrading may imply productivity improvement as a result of increasing skill intensity. However, as our empirical results suggest, international outsourcing possibly reduces the number of unskilled jobs, thus unskilled workers may be worse off. The potential negative impact of outsourcing on wages and employment has created increasing public concerns.

The theoretical analysis by Grossman and Ross-Hansberg (2006) sheds more light on this issue. According to their theoretical model, low-skilled workers may gain when the productivity effect is large enough and unskilled labor supply does not increase too much.[29] They point out that the boost in

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[27] See footnote 14.

[28] Refer to Amiti and Wei (2006) and Olsen (2006), etc.

[29] They also specify a relative-price effect on factor prices. The relative-price effect occurs when a fall in outsourcing costs alters a large country's terms of trade.

productivity of low-skilled labor raises firms' demand for low-skilled labor, which tends to inflate their wages, exactly as would labor-augmenting technological progress. In addition, their theoretical conclusion implies the importance of reabsorption of workers who formerly performed tasks that are now carried out abroad.

Grossman and Ross-Hansberg (2006) have shown that outsourcing does not necessarily hurt low-skilled workers. And yet, our empirical findings suggest that international outsourcing to China from Japan (and Korea) so far has had a negative impact on the demand for less-skilled workers in Japan (and Korea), shifting labor demand away from the low-skilled to the high-skilled. Moreover, it is most likely that China will continue to supply a huge amount of unskilled labor to the global market. This means that governments have a pivotal role in making this structural adjustment more productive and less painful. In the short run, governments should provide safety nets such as job training programs and adjustment assistance for displaced workers. In the long run, governments should contribute to shifting the long-run supply of labor away from the low-skilled to the high-skilled. Upgrading the education system and strengthening the innovation system will be one of the key areas for government action in creating better jobs for the future.

Appendix: Data

1. Japan

JIP Database 2006

The JIP Database 2006 was compiled as part of the RIETI (Research Institute of Economy, Trade and Industry) research project "Development of a RIETI Manufacturing Database and Study of Productivity by Industry" for fiscal 2004-05. The JIP 2006 contains sector-level information on 108 sectors from 1970 to 2002 that can be used for total factor productivity analyses. These sectors cover the whole Japanese economy. A preliminary version of the JIP database is available from the RIETI website <http://www.rieti.go.jp/jp/database/d04.html>. Data on domestic and overseas employees, wage rate, industry output and input, and R&D expenditures are taken from the JIP Database 2006 in the case of Japan.

Trade data

In order to calculate outsourcing measures, we use direct information on the industry use of imported intermediates through comprehensive input-output tables for Japan published every five years by Ministry of Internal Affairs and Communications. The yearly data on imports at the industry level are taken from extended input-output tables published by the Ministry of Economy, Trade, and Industry for the years 1988, 89, 91-94, 96-99, 2003, and 2005. As extended input-output tables are not available for 2001, 2002 and 2004, import data are taken from the JIP Database 2006 in the case of the primary and the manufacturing sector. In the case of the service sector, we rely on a linear interpolation of industry imports based on the import values for 2000, 2003, and 2005, using the trends of total service imports.

2. Korea

Labor data

Information from the *Basic Statistics Survey of Wage Structure* by the Ministry of Labor was

used for calculating the wage shares by educational attainment. In 2004, for example, this survey covered a sample of 6,344 establishments hiring no less than 5 regular workers and compiled establishment-level information as well as employee-level information on about 370 thousand workers. For the total number of employees by education attainment, we used official estimates from the *Economically Active Population Survey* by the Korean National Statistical Office (KNSO).

Production data

Industry output, input, and R&D expenditures were calculated using the micro-data from the *Annual Survey of Mining and Manufacturing*. The survey covers all plants with five or more employees in the mining and manufacturing sectors and contains plant-level information on output, input, and a variety of additional information including the 5-digit Korean Standard Industry Classification (KSIC) code assigned to each plant based on its major product. For the analysis, we used the 78-sector classification of the National Accounts by the Bank of Korea. In order to calculate outsourcing measures, we used direct information on the industry use of imported intermediates through comprehensive input-output tables for Korea published every five years by the Bank of Korea.

Trade data

Trade data for Korea were drawn from the *UN Commodity Trade Statistics Database* ("UN COMTRADE"), which contains annual amounts of imports, exports, and re-exports in US dollars by commodity and by trading partner. Commodities are classified according to the International Trade Classification (SITC: Rev.1 from 1962, Rev.2 from 1976 and Rev.3 from 1988) and the Harmonized System (HS) (from 1988 with revisions in 1996 and 2002). Imports from and exports to Korea's major trading partners by commodity based on the SITC Rev.3 and on the HS system from 1993 to 2003 were downloaded from: [http://unstats.un.org/unsd/COMTRADE/].

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Figure 2.1 East Asia's Intra-regional Trade: by Industry and by Year

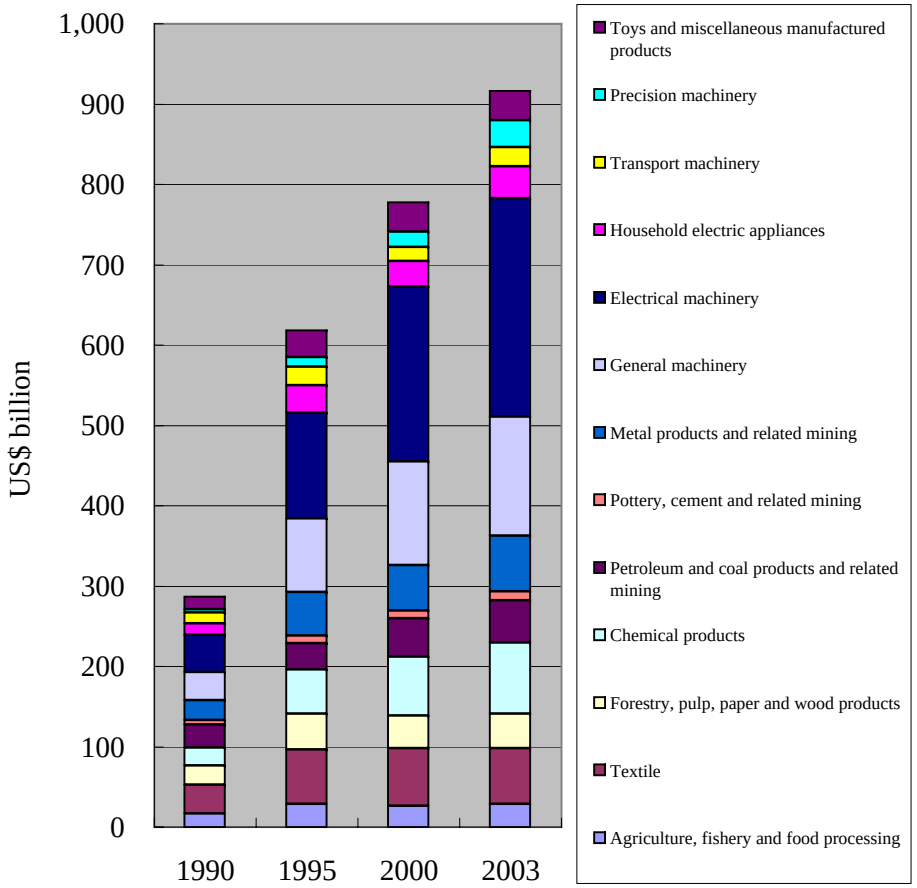
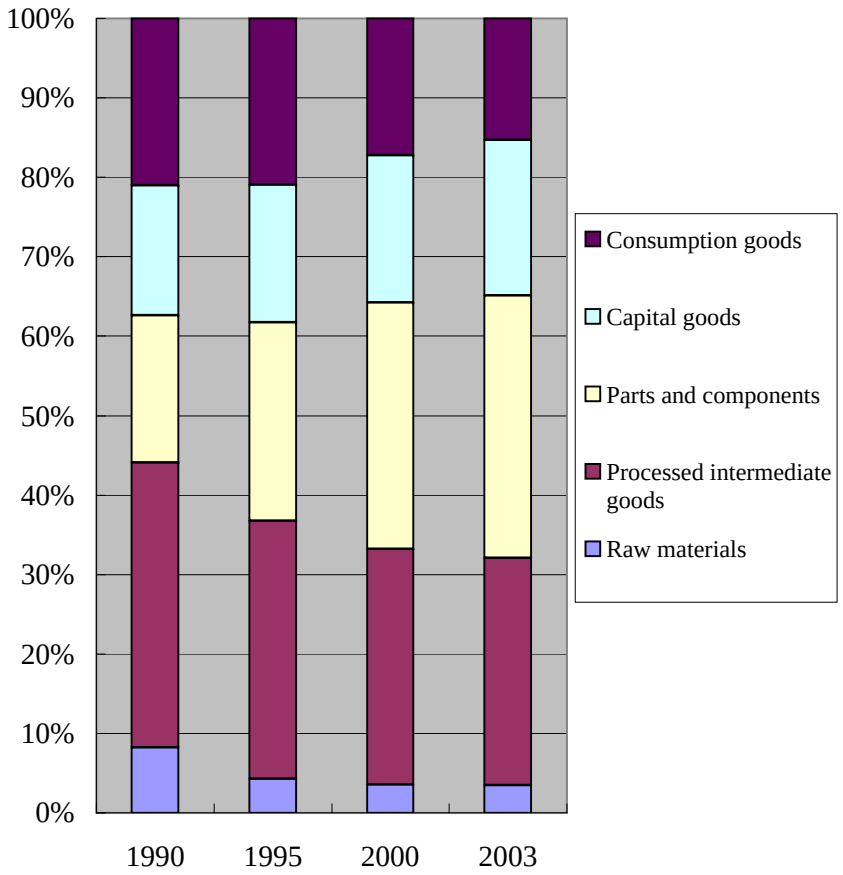


Figure 2.2 Composition of East Asia's Intra-regional Trade: by Commodity Category and by Year



Source: RIETI-Trade Industry Database (RIETI-TID).
Note: East Asia here consists of Japan, the NIEs 3, the ASEAN 4, China and Hong Kong.

Figure 2.3 Industry Composition of East Asia's Intra-regional Trade in Processed Intermediate Goods

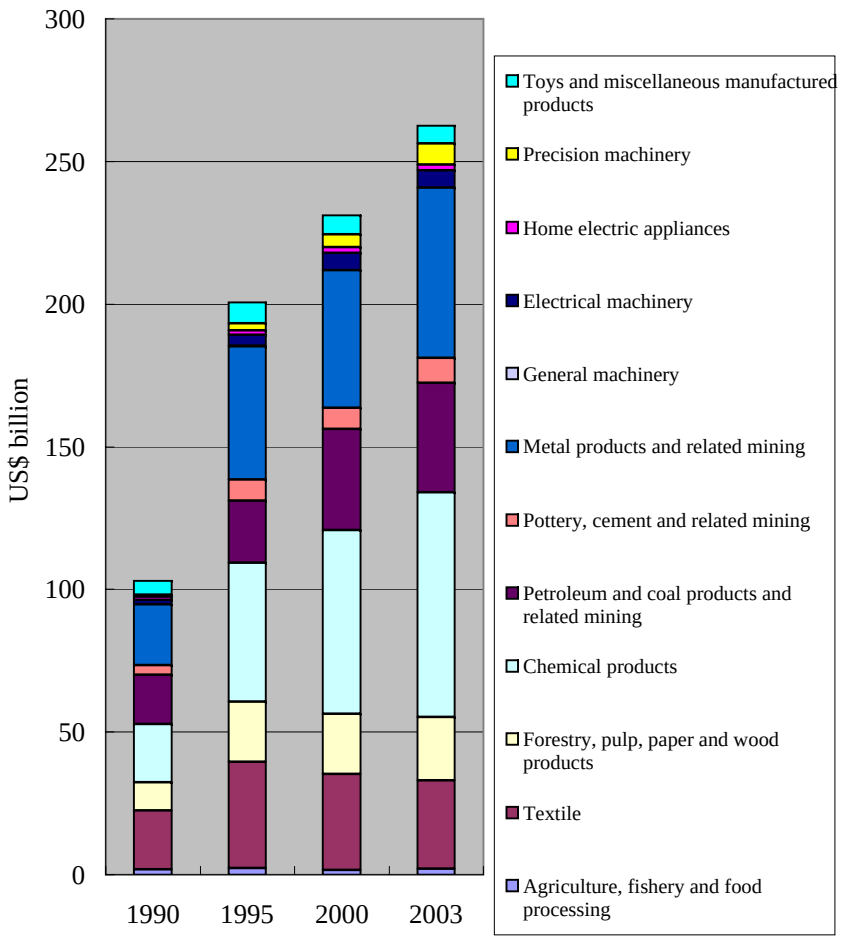
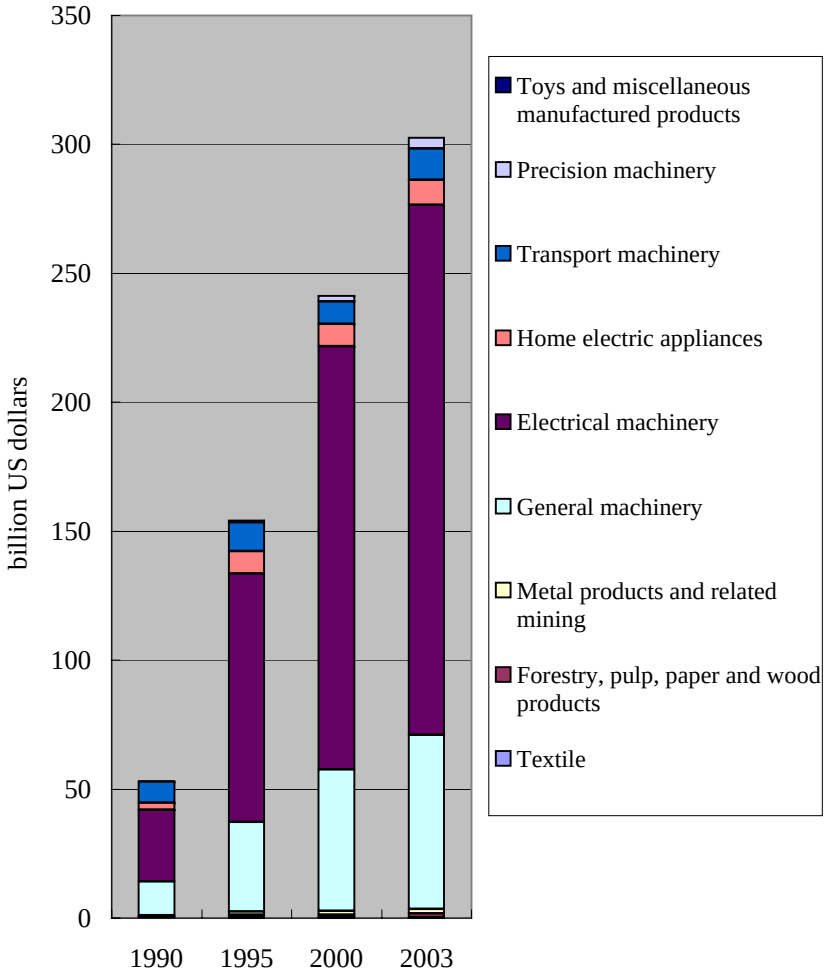


Figure 2.4 Industry Composition of East Asia's Intra-regional Trade in Parts and Components



Source: RIETI-Trade Industry Database (RIETI-TID).
Note: East Asia here consists of Japan, the NIEs 3, the ASEAN 4, China and Hong Kong.

Figure 2.5 East Asia's Exports to the Rest of the World: by Industry and by Year

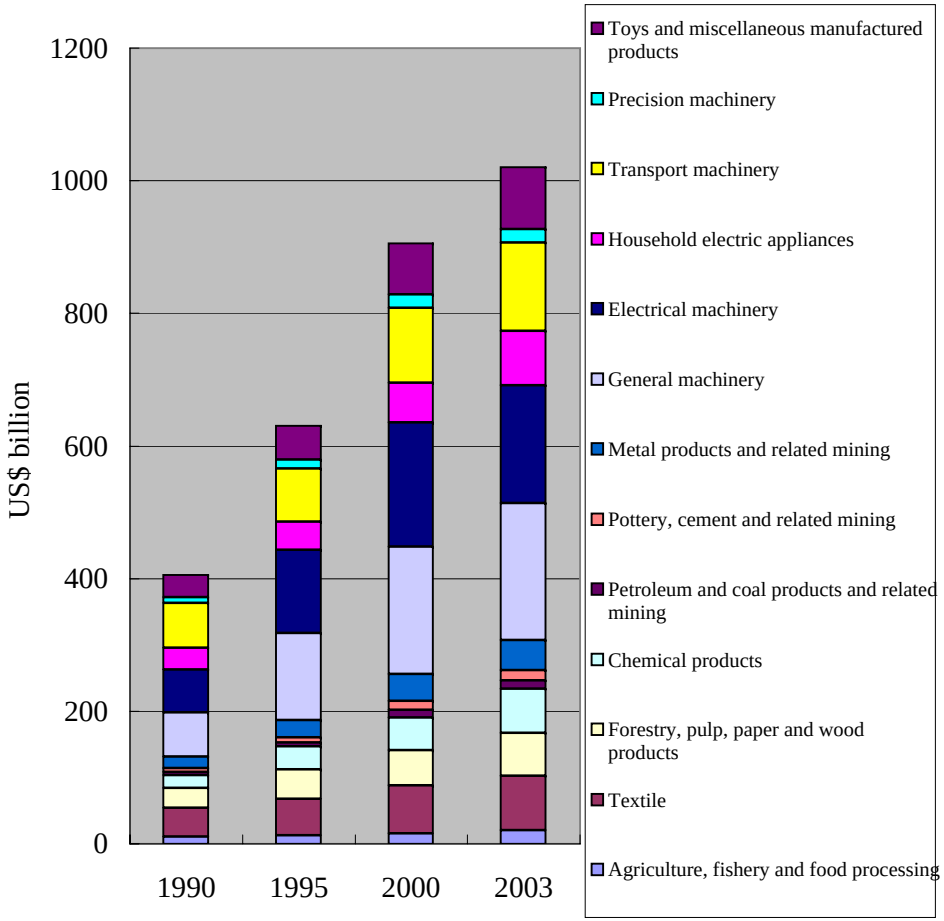
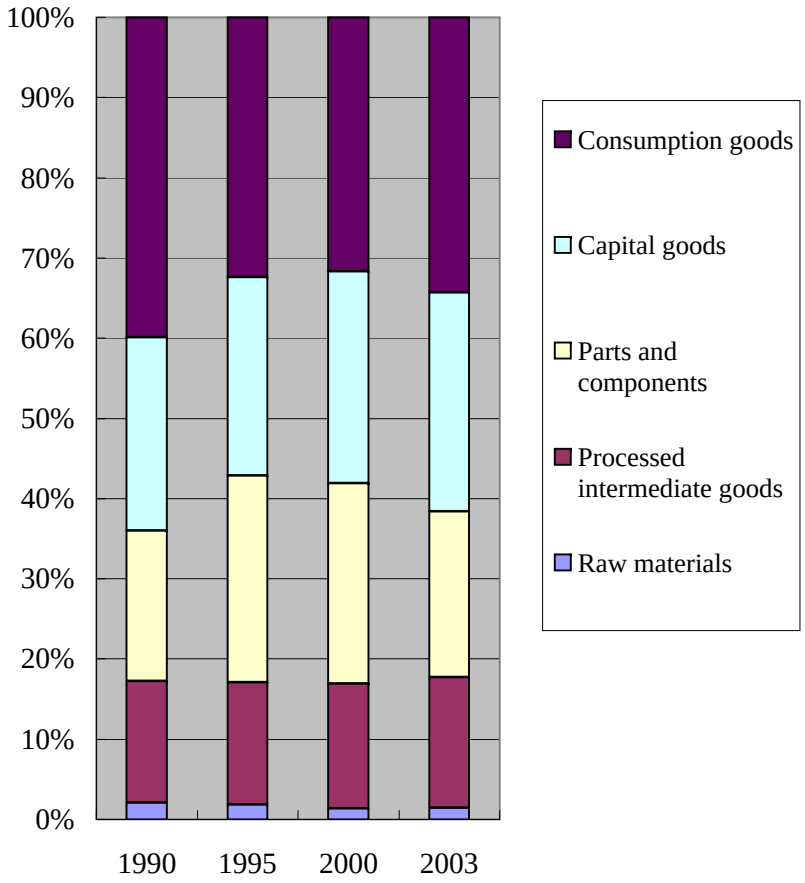


Figure 2.6 Composition of East Asia's Exports to the Rest of the World: by Commodity Category and by Year



Source: RIETI-Trade Industry Database (RIETI-TID).
Note: East Asia here consists of Japan, the NIEs 3, the ASEAN 4, China and Hong Kong.

Figure 2.7 East Asia's Imports from the Rest of the World: by Industry and by Year

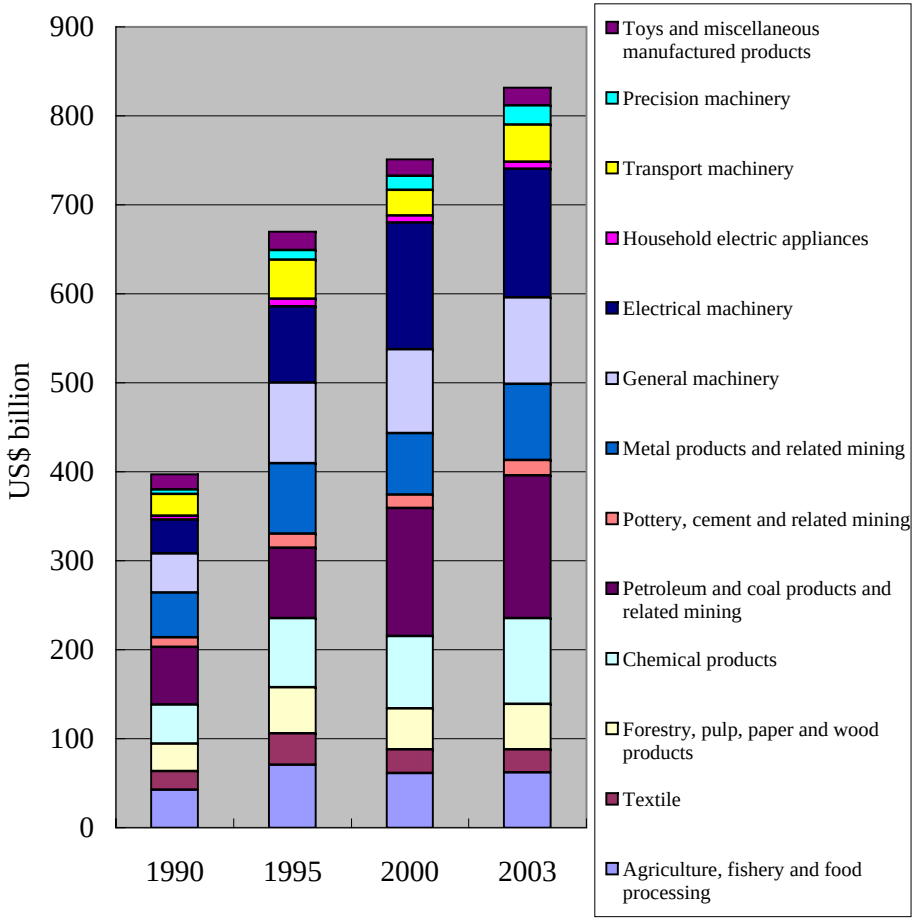
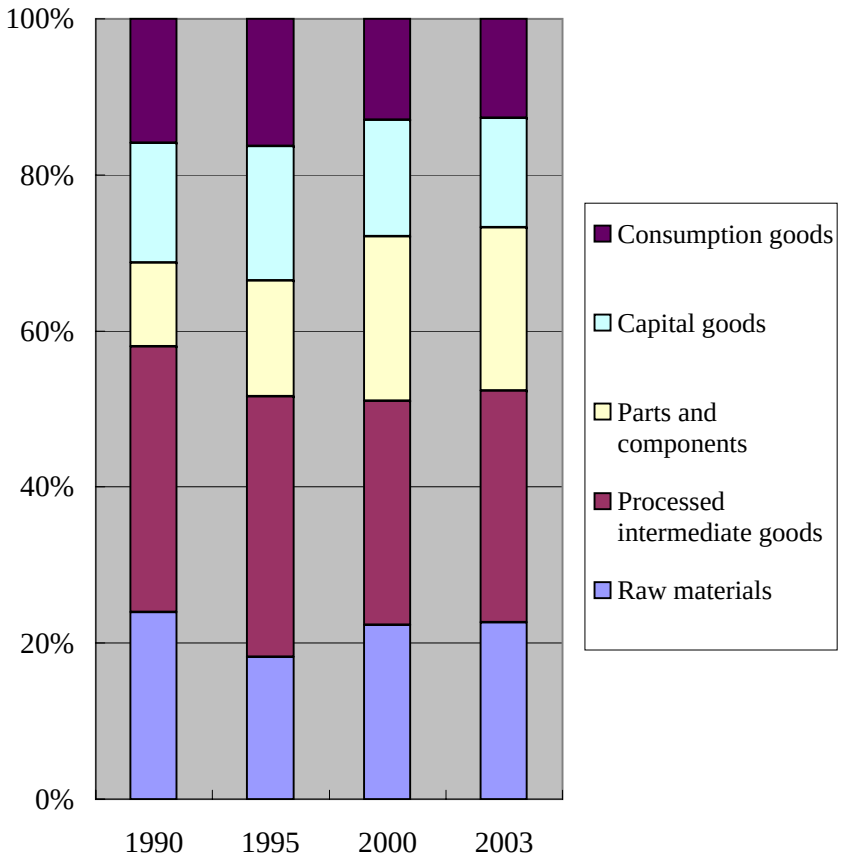
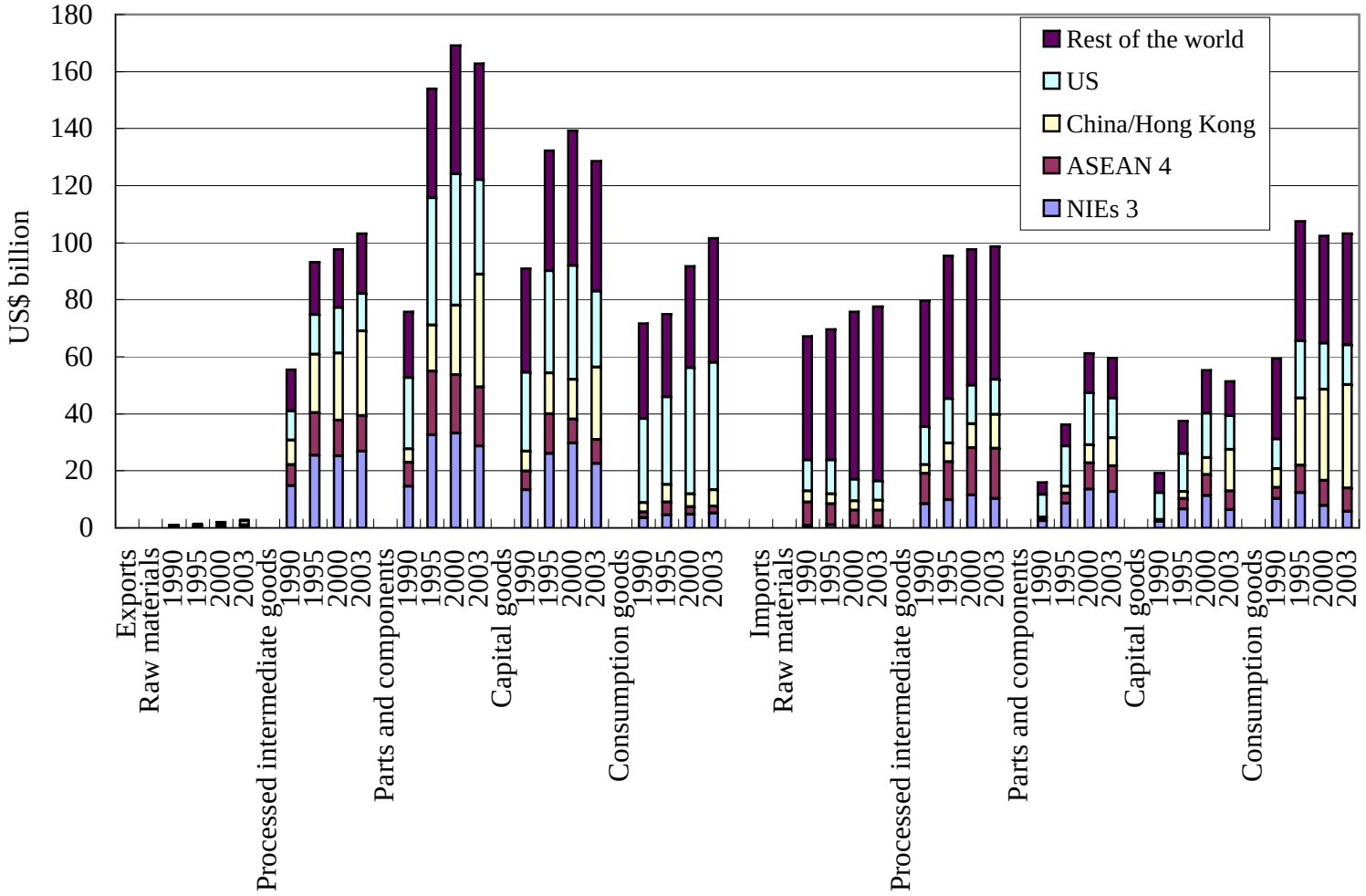


Figure 2.8 Composition of East Asia's Imports from the Rest of the World: by Commodity Category and by Year



Source: RIETI-Trade Industry Database (RIETI-TID).
Note: East Asia here consists of Japan, the NIEs 3, the ASEAN 4, China and Hong Kong.

Figure 2.9 Japan's Trade by Commodity Category, by Partner, and by Year



Source: RIETI-Trade Industry Database (RIETI-TID).
Notes: ASEAN 4: Thailand, Malaysia, Indonesia, and the Philippines. NIEs 3: Singapore, Taiwan, and Korea.

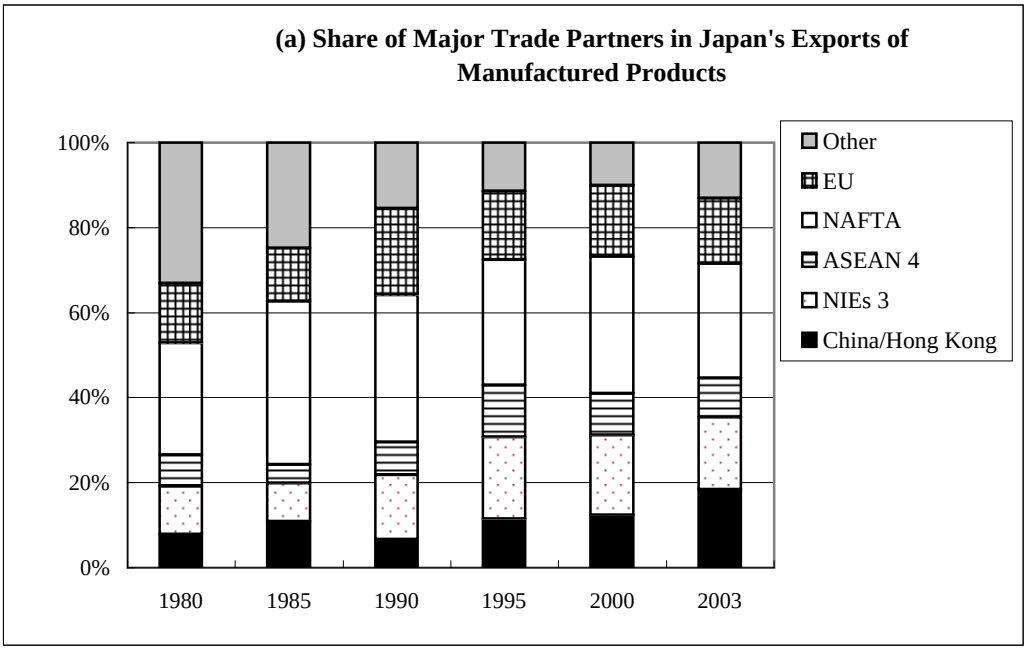
Table 2.1 Japan's Dependence on Imports and Share of Manufacturing Sector in GD

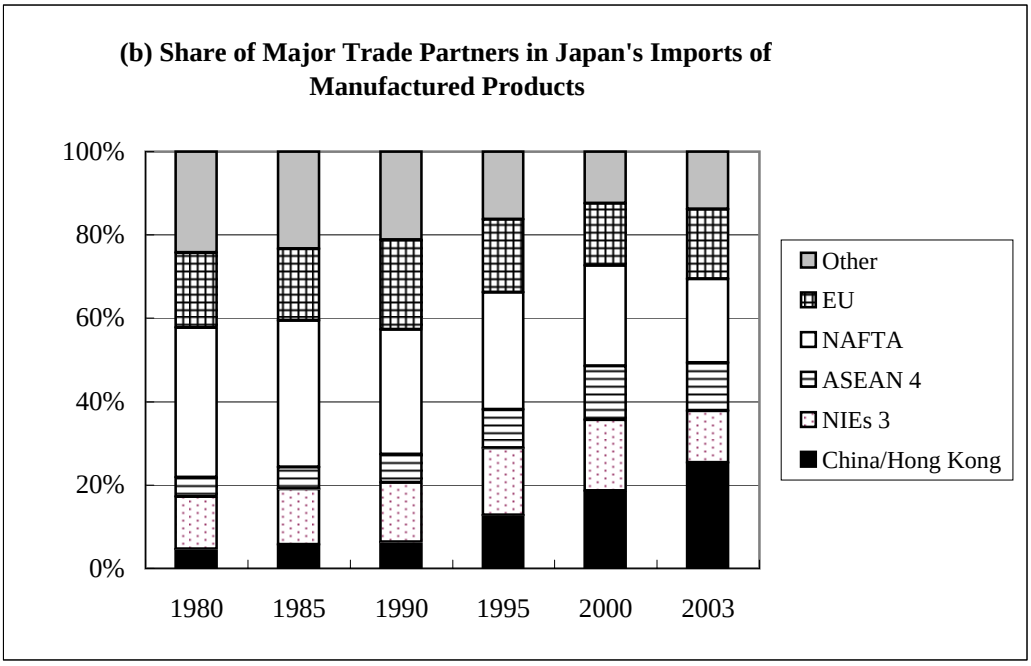
	Imports of goods and services/GDP	Imports of manufactured products (CIF)/GDP	Imports of services/GDP	Share of manufacturing sector in total GDP	Share of manufacturing sector in total employed persons	Imports of manufactured products (CIF)/gross value added by manufacturing sector
1980	13.5%	4.5%	1.5%	25.6%	24.7%	17.7%
1985	10.0%	4.0%	1.4%	25.9%	25.0%	15.5%
1990	8.3%	4.7%	1.5%	24.7%	24.7%	19.0%
1995	7.5%	4.8%	1.2%	23.0%	20.6%	21.1%
2000	9.2%	6.1%	1.3%	21.8%	18.7%	27.8%
2004	11.3%	7.4%	1.4%	21.0%	17.4%	35.2%

Sources: Economic and Social Research Institute, Cabinet Office, Government of Japan,*Annual Report on National Accounts 2006* ; Economic Planning Agency, Government of Japan,*Annual Report on National Accounts 2000* .

Notes: Official SNA statistics for the year 2000 are based on the 1993 SNA. For years before 1990, only statistics based on the 1968 SNA are available. In order to make long-term comparisons, we derived values before 1995 by extrapolation based on values of 1995 and the 1980-1995 growth rate of each variable reported in SNA statistics based on the 1968 SNA.

Figure 2.10 Japan's Major Trade Partners: Manufactured Products, 1980-200





Notes: All figures are in nominal terms.
NIEs 3: Korea, Taiwan, Singapore.
ASEAN 4: Indonesia, Thailand, Malaysia, and the Philippines.
Source: Ministry of Finance, *Trade Statistics*.

Table 2.2 The Role of Japanese Affiliates Abroad in Japan's Manufactured Imports and Exports with Nine East Asian Economies: 2002 Fiscal year (April 2002-March 2003)

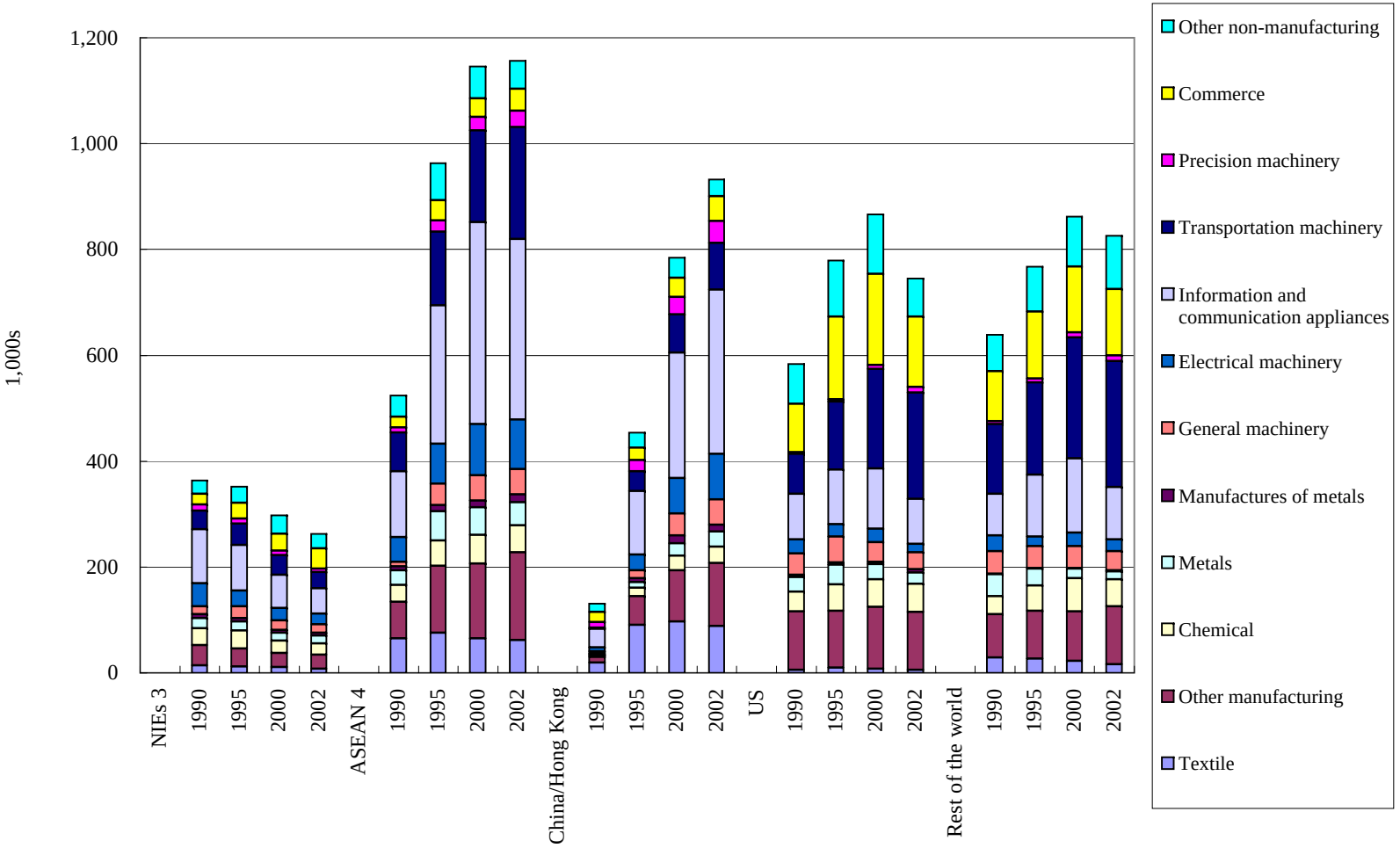
(billion yen, %)

		China/Hong Kong	NIEs 3	ASEAN 4	Nine East Asian economies total
Total manufactured imports from each region to Japan	a	6,823	3,333	3,012	13,168
Manufactured imports from Japanese manufacturing affiliates in each region to Japan	b	2,794	938	2,237	5,968
	b/a	40.9%	28.1%	74.3%	45.3%
Total manufactured exports from Japan to each region	c	7,979	8,074	4,597	20,651
Manufactured exports from Japan to Japanese manufacturing affiliates in each region	d	2,398	1,228	2,086	5,711
	d/c	30.0%	15.2%	45.4%	27.7%

Notes: NIEs 3: Korea, Taiwan, and Singapore.
ASEAN 4: Indonesia, Thailand, Malaysia, and the Philippines

Sources: JETRO Trade Statistics Database (http://www.jetro.go.jp/jpn/stats/).
METI (2005)

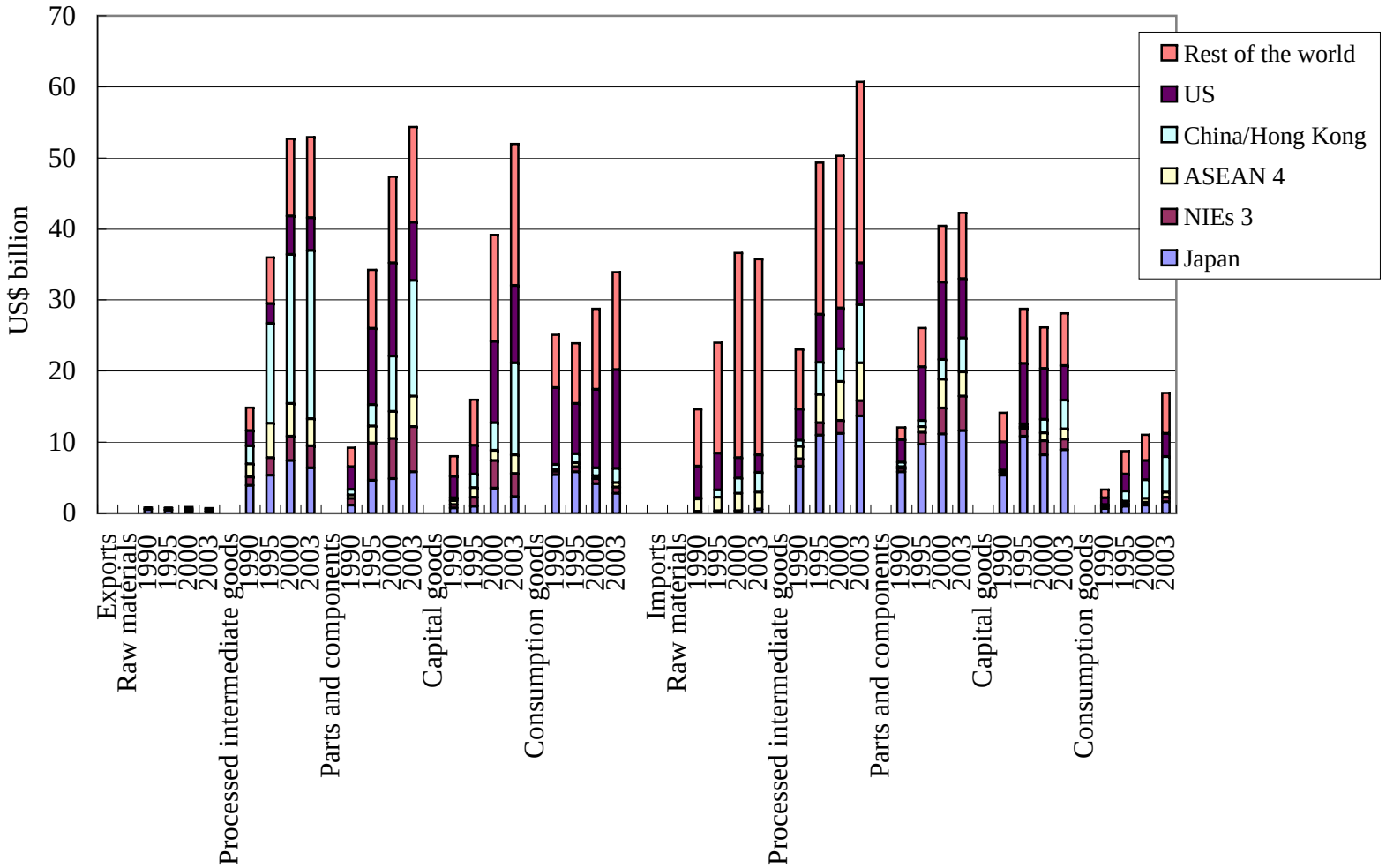
Figure 2.11 Number of Workers Employed by Japanese Affiliates Abroad: by Host Country, by Year and by Industry



Source: RIETI's estimates on employment of Japanese affiliates abroad (downloaded from http://www.rieti.go.jp/jp/database/d02.html on January 20, 2007).

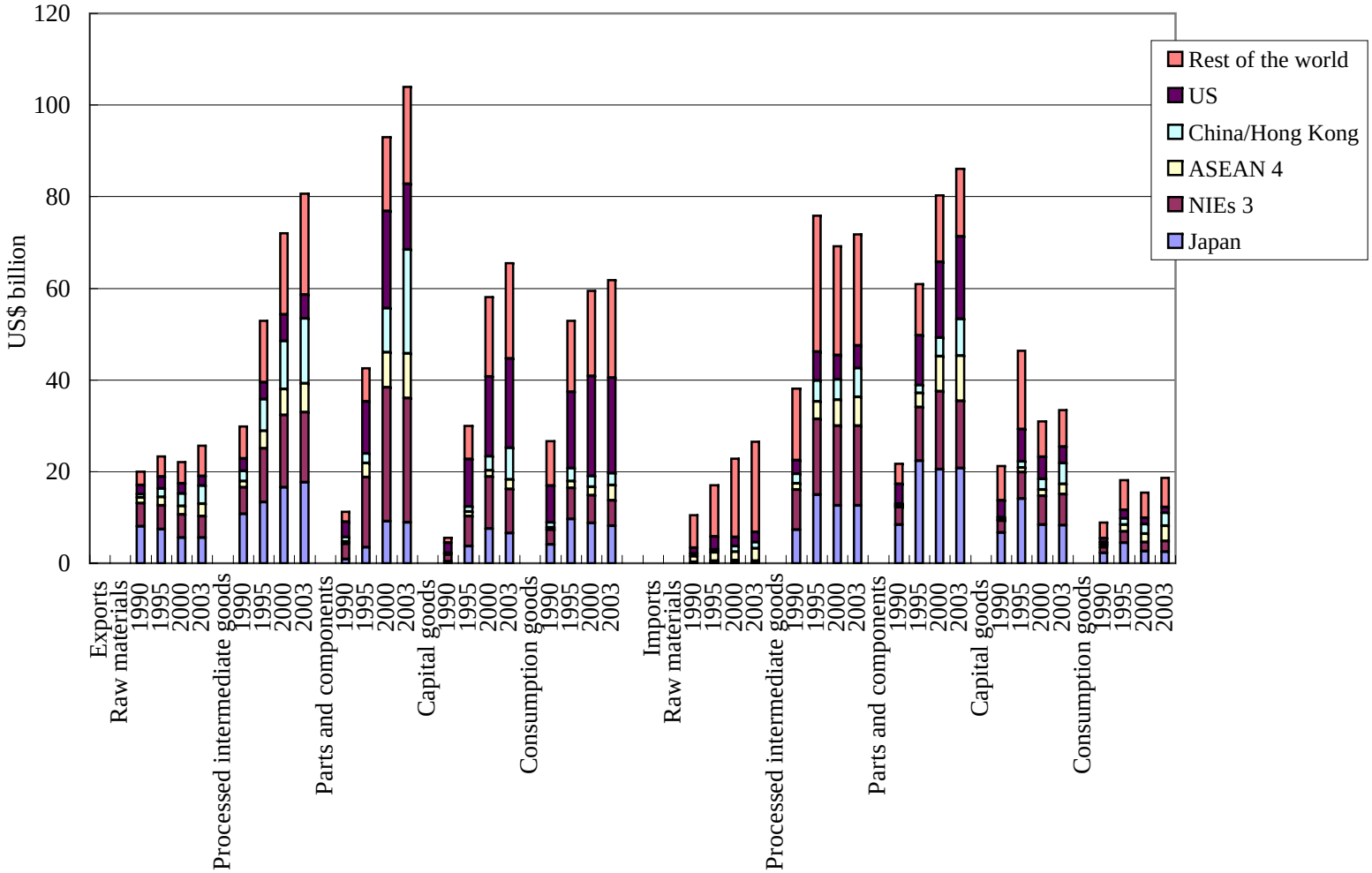
Note: When there are less than three affiliates in one industry of one country, workers of these affiliates are not included in the statistics for confidentiality.

Figure 2.12 South Korea's Trade by Commodity Category, by Partner, and by Year



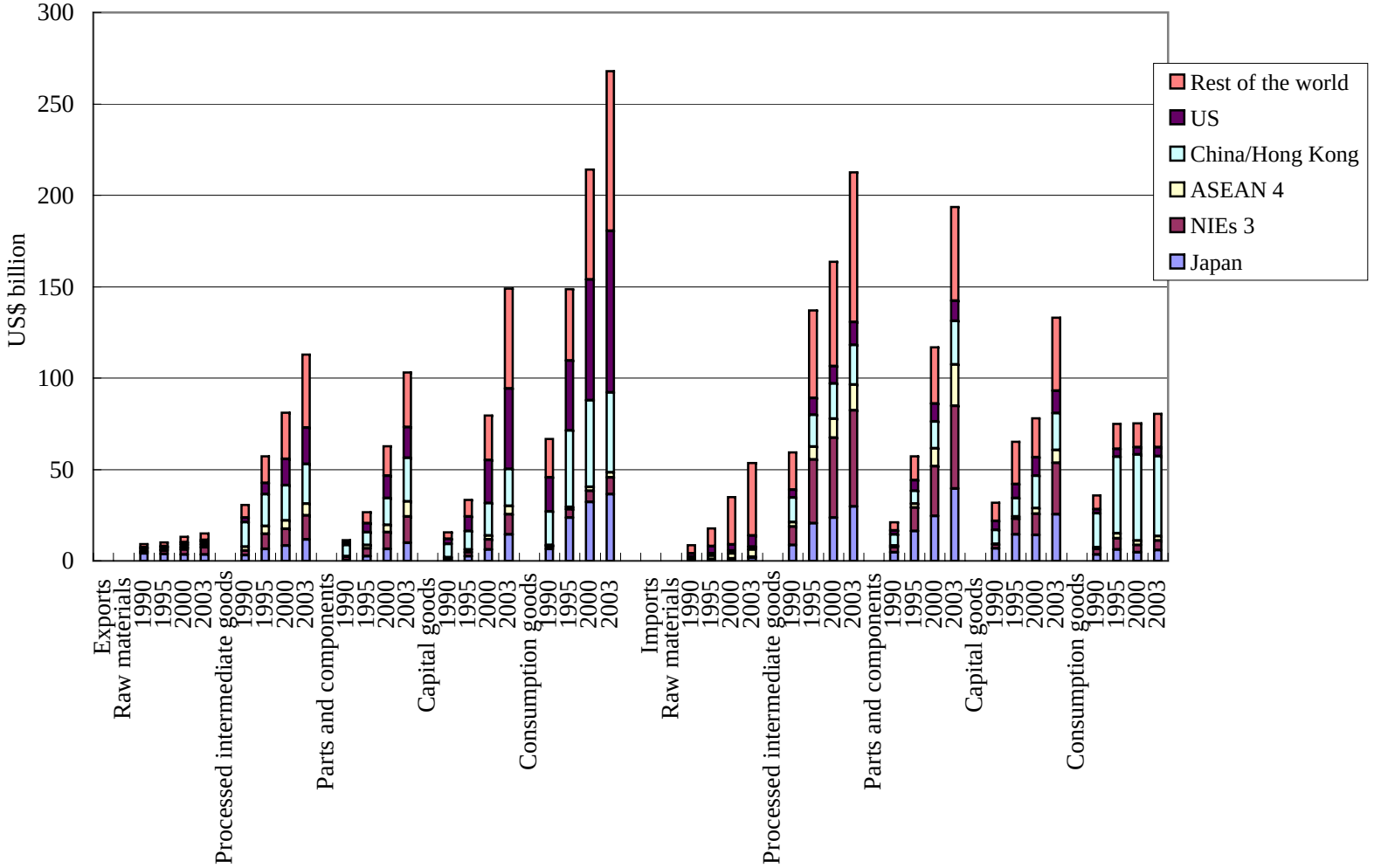
Source: RIETI-Trade Industry Database (RIETI-TID).
Notes: ASEAN 4: Thailand, Malaysia, Indonesia, and the Philippines. NIEs 3: Singapore, Taiwan, and Korea.

Figure 2.13 ASEAN 4's Trade by Commodity Category, by Partner, and by Year



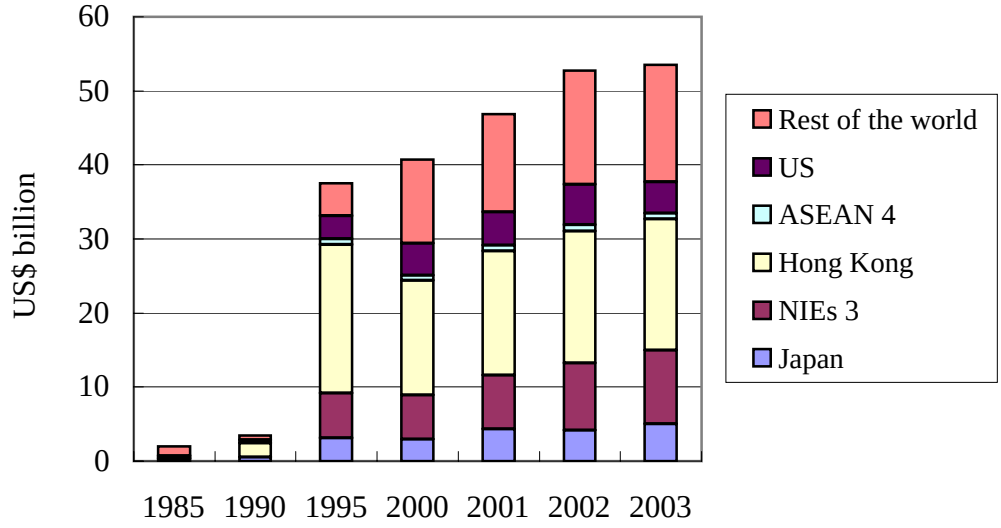
Source: RIETI-Trade Industry Database (RIETI-TID).
Notes: ASEAN 4: Thailand, Malaysia, Indonesia, and the Philippines. NIEs 3: Singapore, Taiwan, and Korea.

Figure 2.14 China and Hong Kong's Trade by Commodity Category, by Partner, and by Year



Source: RIETI-Trade Industry Database (RIETI-TID).
Notes: ASEAN 4: Thailand, Malaysia, Indonesia, and the Philippines. NIEs 3: Singapore, Taiwan, and Korea.

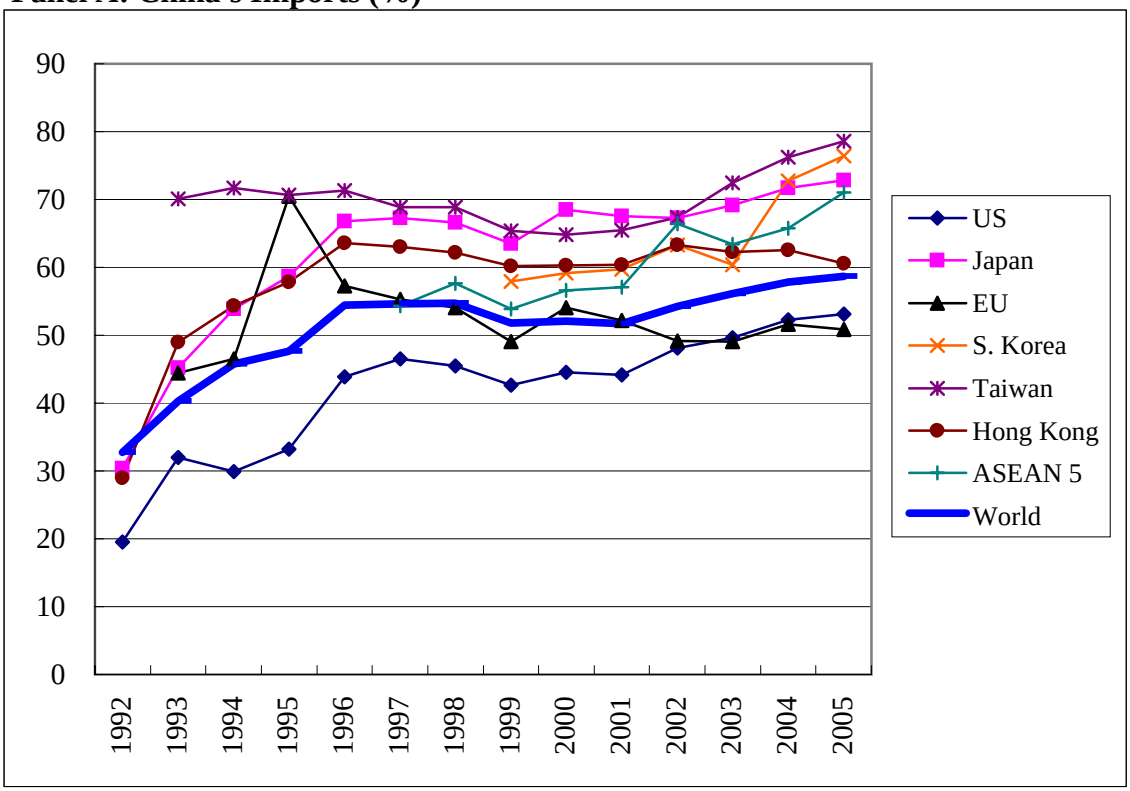
Figure 2.15 FDI in China (Execution Basis): by Home Country and by Year



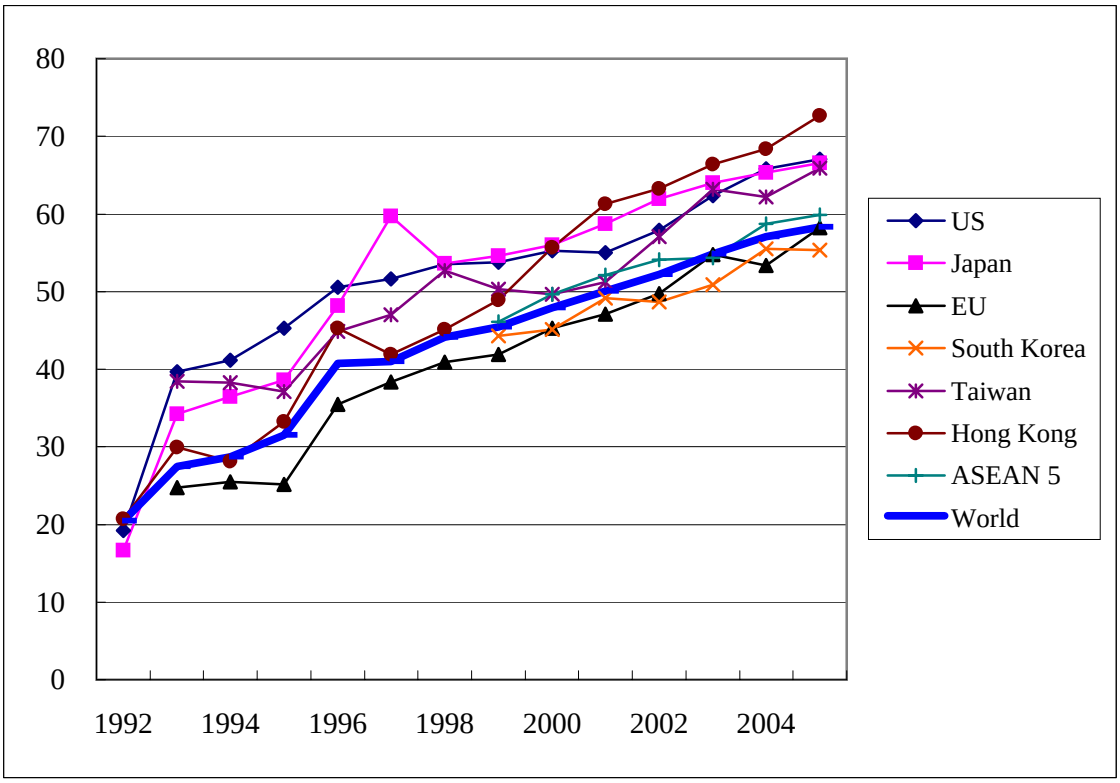
Source: *Yearbook of China's Foreign Economic Relations and Trade 2004.*

Figure 2.16 Share of Foreign-Owned Firms' Trade in China's Total Trade: by Year and by Trade Partner

Panel A: China's Imports (%)



Panel B: China's Exports (%)

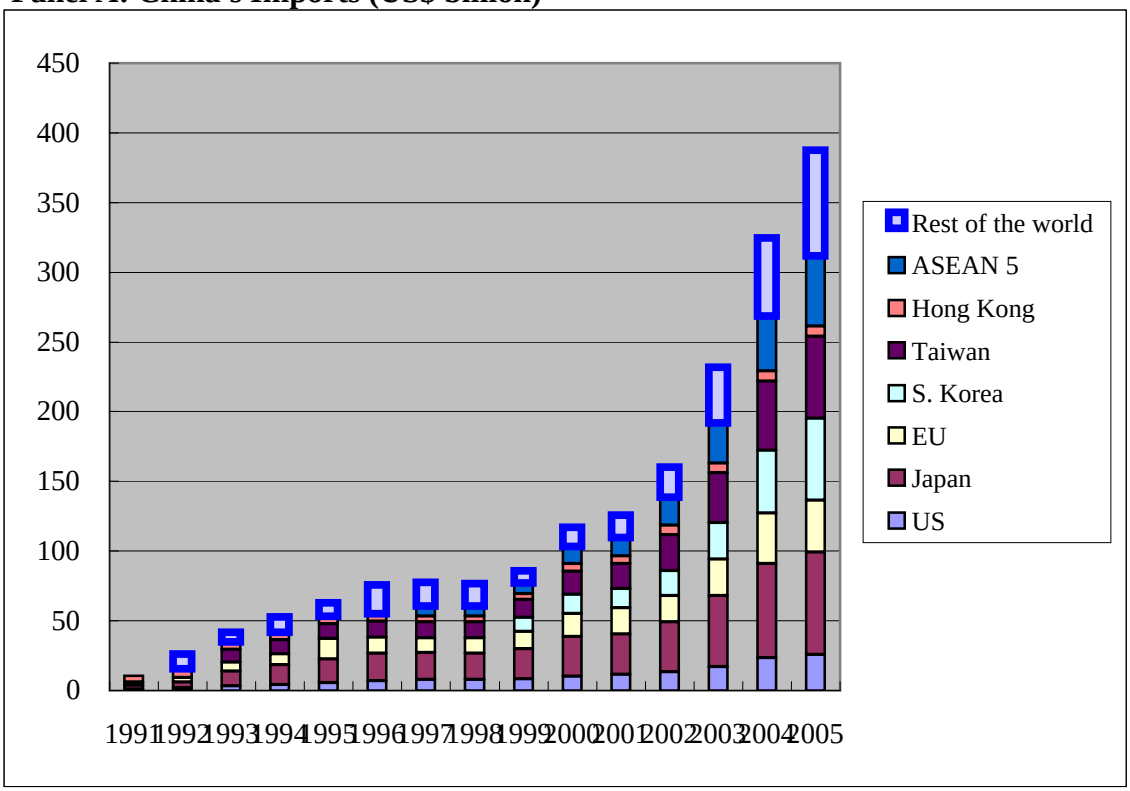


Source: National Bureau of Statistics, Chinese Government.

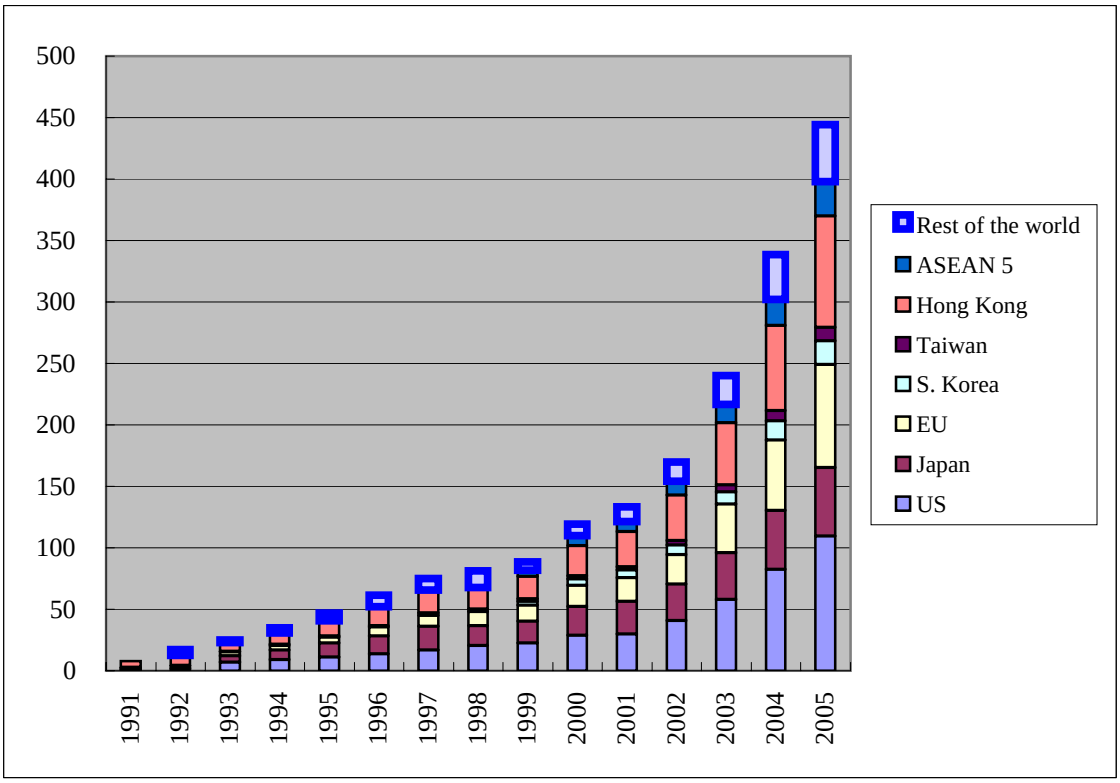
Note: ASEAN 5: Singapore, Thailand, Malaysia, Indonesia, and the Philippines.

Figure 2.17 Trade by Foreign-Owned Firms in China: by Year and by Trade Partner

Panel A: China's Imports (US$ billion)



Panel B: China's Exports (US$ billion)



Source: National Bureau of Statistics, Chinese Government.

Note: ASEAN 5: Singapore, Thailand, Malaysia, Indonesia, and the Philippines.

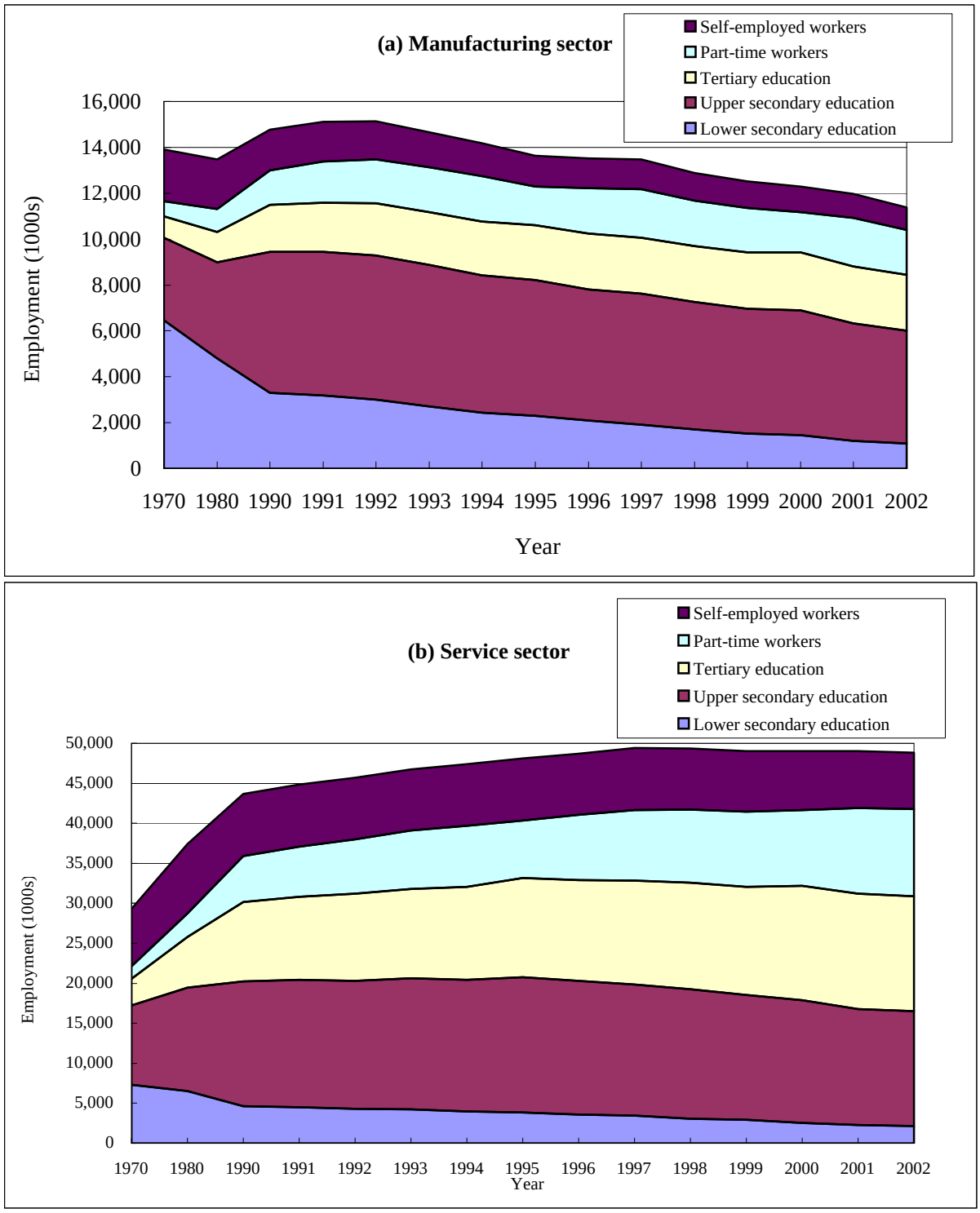


Figure 3.1 Employment Trends for Different Educational Groups for Japa

Note: Education attainment data are not available for part-time and self-employed workers.
Source: JIP Database 2006

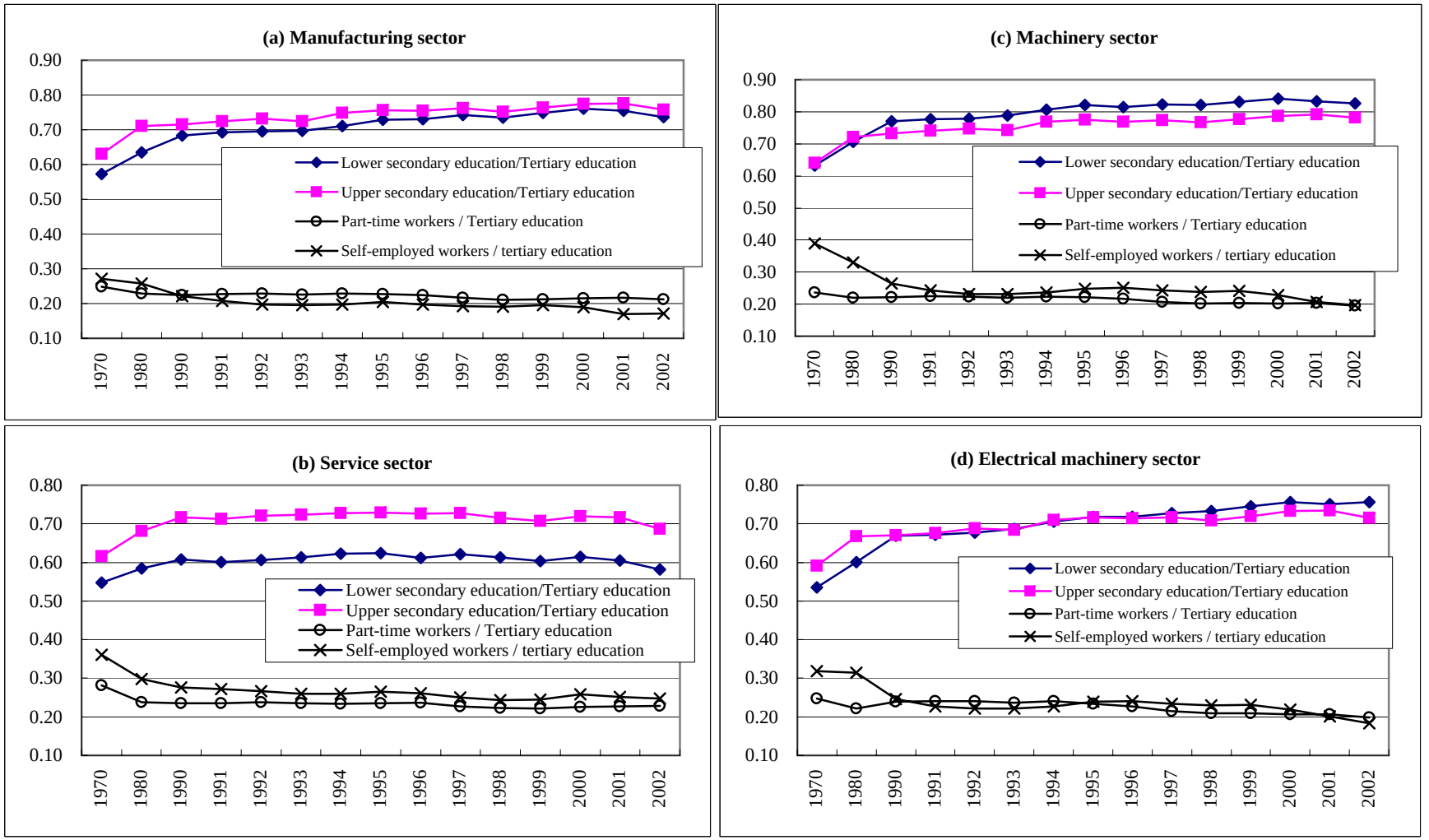


Figure 3.2 Nominal Wage Rate Trends for Different Educational Groups: Japar

Notes: Each graph indicates the ratio of the hourly wage for employees with lower or upper secondary education to the hourly wage for employees with tertiary education. The wage includes cash payments and other labor expenses.
Source: JIP Database 2006.

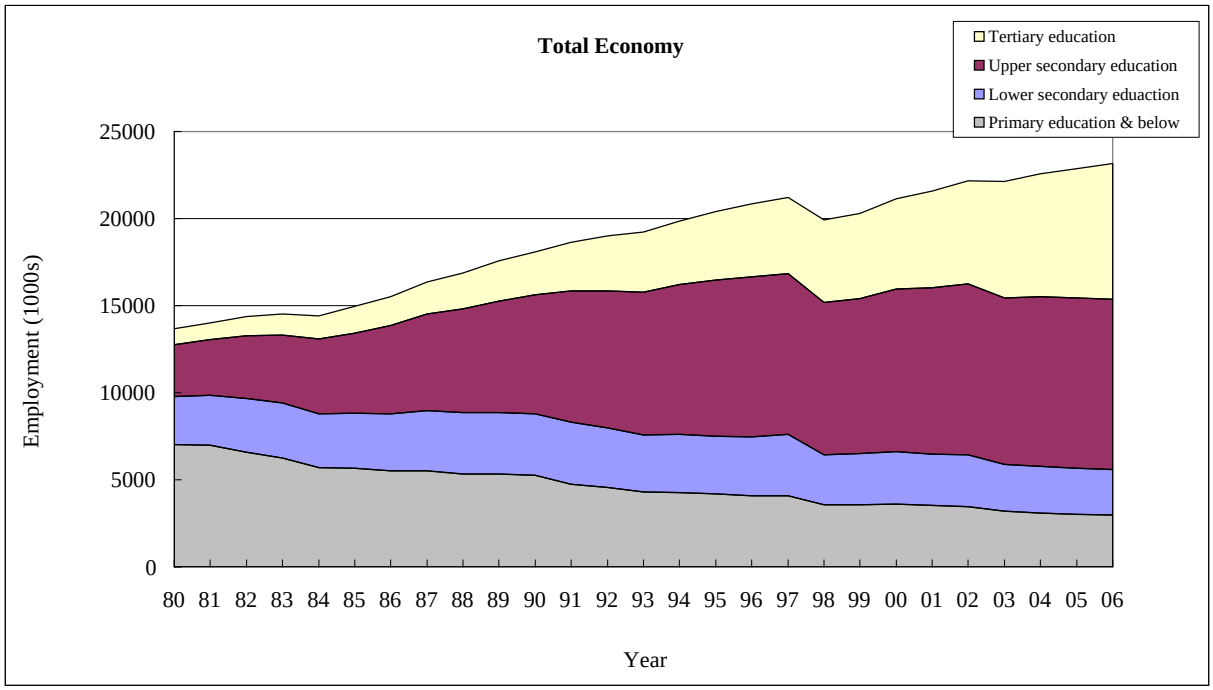


Figure 3.3 Employment Trends for Different Educational Groups in South Korea

Source: Korean National Statistical Office*Economically Active Population Survey* Korean Statistical Information System [http://kosis.nso.go.kr/eng/help.htm]

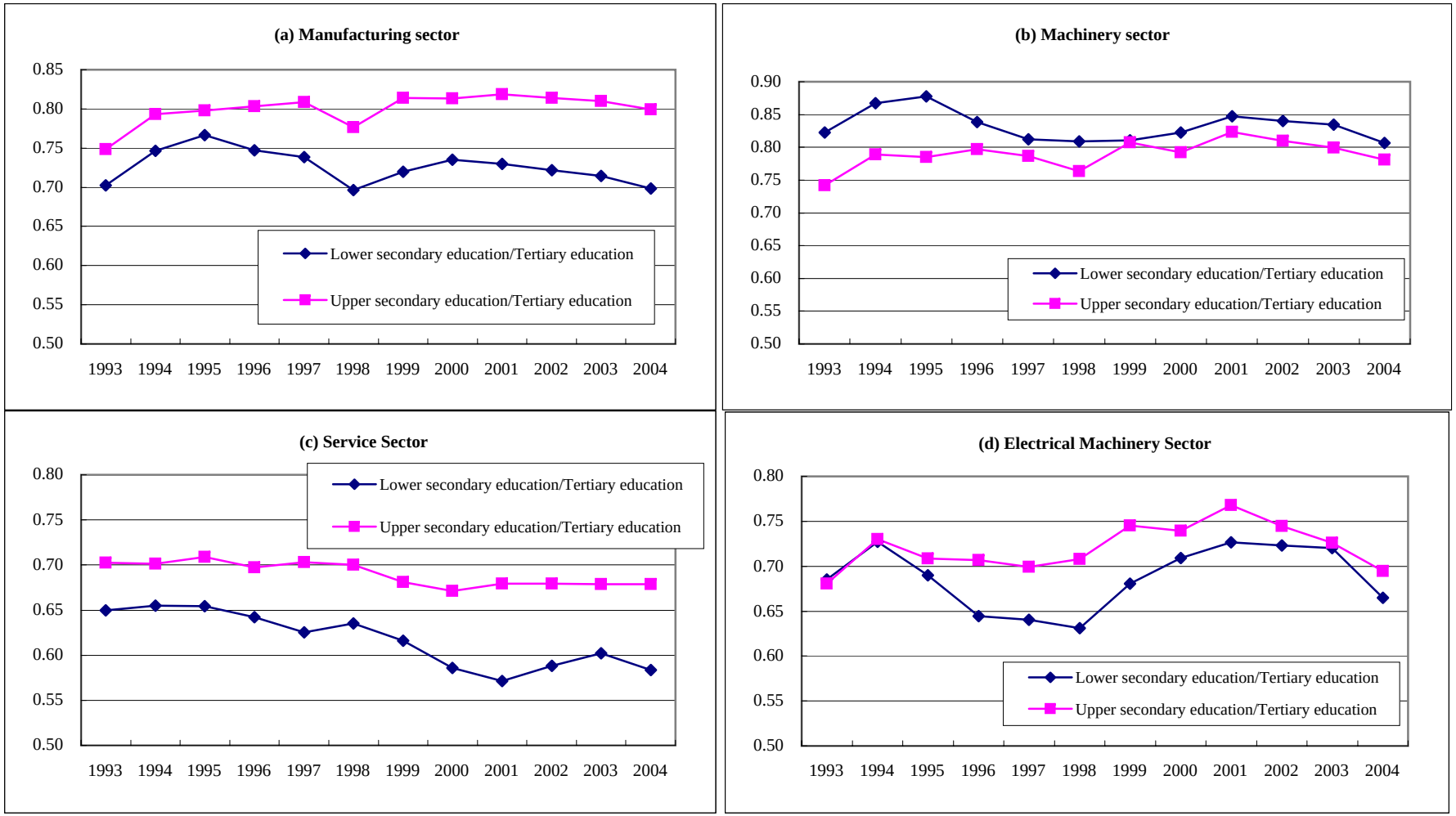


Figure 3.4 Nominal Wage Rate Trends for Different Educational Groups: Kore

Source: Ministry of Labor, *Basic Statistics Survey of Wage Structure*

Table 3.1 Wage Share by Educational Attainmen

	1970 (%)	1980 (%)	1990† (%)	2000 (%)	2004* (%)	Change 1990†-2000 (% points)	(%)
(a) Japan							
All industries	100.0	100.0	100.0	100.0	100.0		
Lower secondary	39.1	27.1	16.4	7.9	6.6	-8.5	-51.8
Upper secondary	40.7	45.0	48.2	44.4	42.6	-3.8	-7.9
Tertiary	20.3	27.9	35.4	47.7	50.8	12.3	34.8
Manufacturing	100.0	100.0	100.0	100.0	100.0		
Lower secondary	54.1	42.1	26.4	14.0	11.6	-12.3	-46.7
Upper secondary	32.8	40.3	50.6	54.3	53.9	3.7	7.3
Tertiary	13.2	17.6	23.0	31.6	34.5	8.6	37.4
Services	100.0	100.0	100.0	100.0	100.0		
Lower secondary	30.7	21.2	12.6	6.1	5.1	-6.6	-52.0
Upper secondary	45.2	46.9	47.4	41.6	39.6	-5.8	-12.2
Tertiary	24.1	31.9	39.9	52.3	55.3	12.4	31.0
(b) Korea							
All industries			100.0	100.0	100.0		
Lower secondary	n.a.	n.a.	18.0	11.1	7.5	-6.9	-38.5
Upper secondary	n.a.	n.a.	41.5	38.2	33.6	-3.4	-8.1
Tertiary	n.a.	n.a.	40.5	50.8	58.8	10.3	25.5
Manufacturing			100.0	100.0	100.0		
Lower secondary	n.a.	n.a.	23.3	14.2	10.2	-9.1	-39.0
Upper secondary	n.a.	n.a.	50.7	51.8	47.0	1.1	2.2
Tertiary	n.a.	n.a.	26.0	33.9	42.7	8.0	30.7
Services			100.0	100.0	100.0		
Lower secondary	n.a.	n.a.	12.1	8.0	4.4	-4.1	-33.8
Upper secondary	n.a.	n.a.	33.7	27.6	22.2	-6.1	-18.2
Tertiary	n.a.	n.a.	54.1	64.4	73.4	10.2	18.9
(c) Japan, including part-time and self-employed workers							
All industries	100.0	100.0	100.0	100.0	100.0		
Lower secondary	31.3	22.9	14.5	7.1	5.9	-7.4	-51.1
Upper secondary	32.6	37.9	42.5	39.7	37.8	-2.8	-6.6
Tertiary	16.2	23.5	31.2	42.6	45.0	11.4	36.6
Part-time	1.4	2.3	3.3	4.6	5.5	1.2	36.7
Self-employed	18.5	13.5	8.4	6.0	5.8	-2.4	-28.9
Manufacturing	100.0	100.0	100.0	100.0	100.0		
Lower secondary	49.2	38.4	24.6	13.2	10.9	-11.4	-46.2
Upper secondary	29.8	36.7	47.2	51.2	50.6	4.0	8.4
Tertiary	12.0	16.1	21.5	29.8	32.3	8.3	38.8
Part-time	1.5	2.4	2.9	3.5	4.3	0.6	22.2
Self-employed	7.6	6.4	3.8	2.3	2.0	-1.6	-40.7
Services	100.0	100.0	100.0	100.0	100.0		
Lower secondary	25.1	18.1	11.1	5.4	4.5	-5.7	-51.6
Upper secondary	36.9	40.0	41.8	37.0	34.8	-4.8	-11.5
Tertiary	19.7	27.2	35.2	46.5	48.7	11.3	32.1
Part-time	1.5	2.3	3.5	4.8	5.8	1.3	36.7
Self-employed	16.7	12.4	8.3	6.3	6.1	-2.0	-24.4

† For Korea, the wage share data are for the year 1993.

* For Japan, the wage share data are for the year 2002.

Sources: JIP Database 2006; Ministry of Labor, *Basic Statistics Survey of Wage Structure*

Table 3.2 International Outsourcing in 1990, 1995, and 2000:
Imported Inputs as a Percentage Share of Output and Inputs

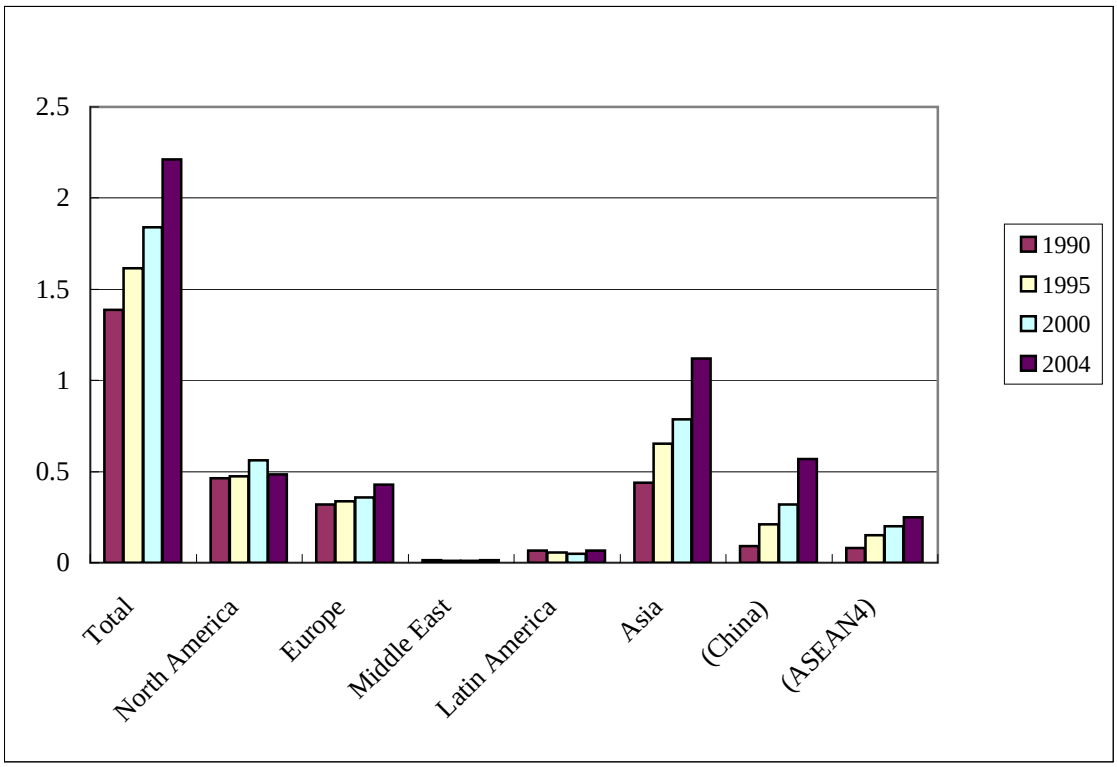
(a) Japan

Measure		1980 (%)	1990 (%)	1995 (%)	2000 (%)	Change 1990-2000 (% points)	(%)
Share in output							
All industries	Narrow	0.84	0.73	0.78	0.85	0.12	15.97
	Broad	2.86	2.50	2.26	2.54	0.04	1.43
Manufacturing	Narrow	1.05	1.39	1.61	1.84	0.45	32.62
	Broad	4.61	4.25	4.26	5.17	0.92	21.66
Services	Narrow	0.74	0.32	0.37	0.39	0.07	22.31
	Broad	1.60	1.41	1.27	1.32	-0.10	-6.80
Services within mfg.		0.29	0.18	0.17	0.19	0.02	8.97
Share in inputs							
All industries	Narrow	11.47	10.10	12.71	14.11	4.01	39.69
	Broad	5.28	5.10	4.84	5.51	0.40	7.91
Manufacturing	Narrow	7.20	8.96	11.20	13.15	4.18	46.68
	Broad	6.52	6.49	6.64	8.05	1.56	24.09
Services	Narrow	39.94	17.23	19.01	17.38	0.15	0.86
	Broad	3.87	3.72	3.37	3.53	-0.19	-5.05

(b) Korea

Measure		1980 (%)	1990 (%)	1995 (%)	2000 (%)	Change 1990-2000 (% points)	(%)
Share in output							
All industries	Narrow	n.a.	3.67	3.79	5.12	1.45	39.56
	Broad	n.a.	8.87	8.70	10.63	1.76	19.81
Manufacturing	Narrow	n.a.	6.99	7.38	8.85	1.86	26.68
	Broad	n.a.	15.90	15.85	17.74	1.83	11.52
Services	Narrow	n.a.	0.65	0.74	1.75	1.10	169.31
	Broad	n.a.	2.51	2.66	4.18	1.68	66.82
Services within mfg.		n.a.	0.11	0.15	0.65	0.55	500.04
Share in inputs							
All industries	Narrow	n.a.	29.65	29.52	33.50	3.86	13.00
	Broad	n.a.	15.29	15.39	18.08	2.79	18.25
Manufacturing	Narrow	n.a.	30.27	31.02	34.12	3.85	12.72
	Broad	n.a.	20.99	21.43	23.72	2.72	12.98
Services	Narrow	n.a.	27.87	20.97	31.18	3.31	11.87
	Broad	n.a.	5.89	6.29	9.40	3.52	59.79

Notes:
Narrow outsourcing measures:
Imported inputs within the industry divided by the industry's output.
Imported inputs within the industry divided by the industry's total use of inputs from the industry itself.
Broad outsourcing measures:
Imported inputs from all industries divided by the industry's output.
Imported inputs from all industries divided by the industry's total use of inputs from the industry itself.
Services within manufacturing:
Imported service inputs divided by manufacturing output.
Energy-related industries are excluded.
Sources: Input-Output Tables 1990, 1995, 2000 for Japan and Korea; JIP database 2006, Korea SNA data.



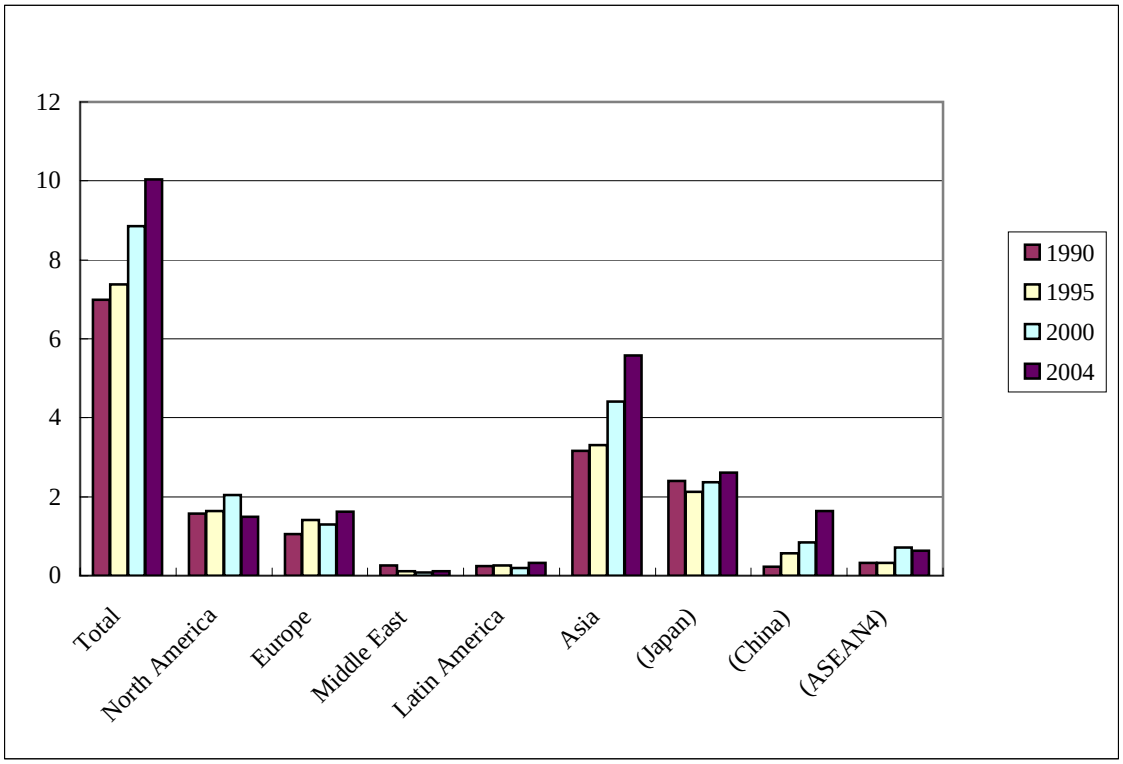


Figure 3.5 Narrow Outsourcing to Different Regions: Japan and Korea
(All Manufacturing Industries Except Energy-Related Industries

Sources: Authors' calculations based on the JIP Database 2006, Japan's Input-Output Tables, Balance of Payment Statistics, Korean Input-Output Tables, and UN Comtrade data.

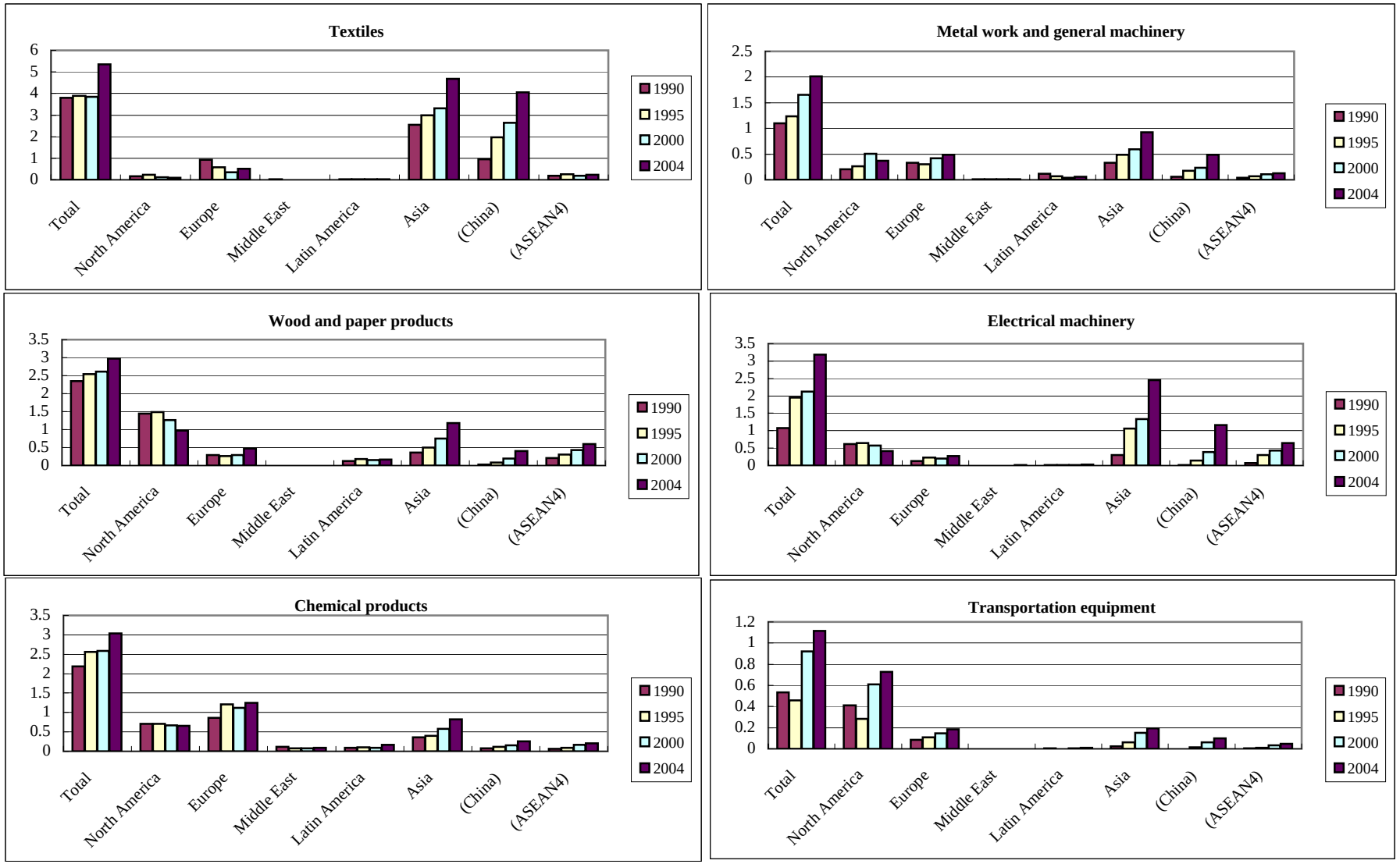


Figure 3.6 Japan's Narrow Outsourcing to Different Regions (by Industry

Sources: Authors' calculation based on the JIP Database 2006, Input-Output Tables, and Balance of Payment Statistics.

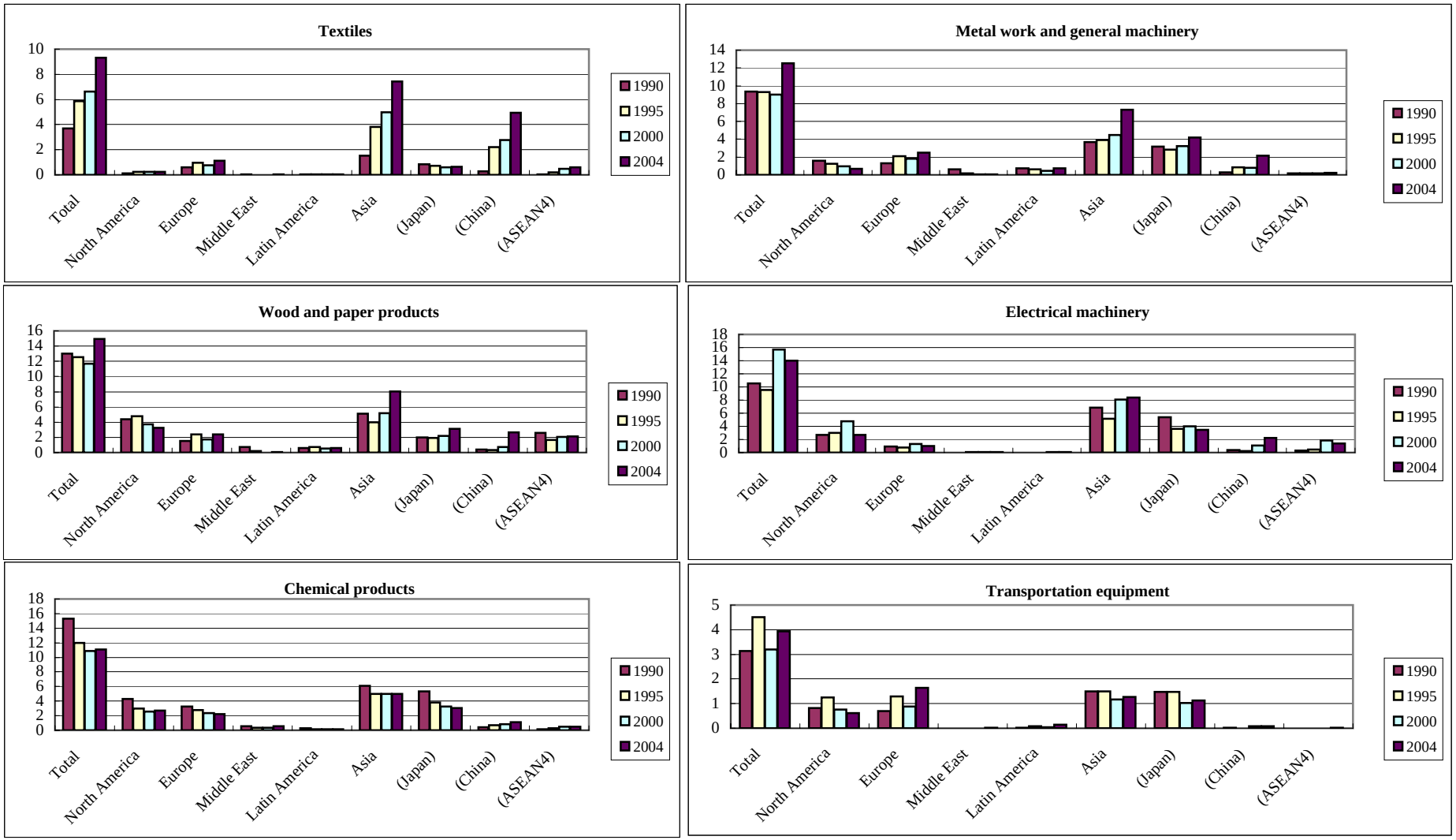


Figure 3.7 Korea's Narrow Outsourcing to Different Regions (by Industry)

Sources: Authors' calculation based on Korean Input-Output Tables and UN Comtrade data.

Table 4.1 Elasticities Calculated from Estimations of Translog Cost Functions: Narrow Measure of Outsourcing, Japan

		Changes in:				Outsourcing		Wages		
		Capital	Value added	R&D	Total	MNEshare	Lower sec.	Upper sec.	Tertiary	
Lower sec. edu.	(1)	0.294 ***	0.048 ***	0.581 ***	0.712 *	0.072 ***				
		(0.032)	(0.010)	(0.219)	(0.419)	(0.022)				
	(2)	0.297 ***	0.044 ***	0.555 **	0.493	0.067 ***	-0.153	-0.209	0.362 ***	
		(0.032)	(0.010)	(0.218)	(0.423)	(0.022)	(0.233)	(0.263)	(0.128)	
Upper sec. edu.	(1)	-0.167 ***	-0.024 ***	-0.169 *	-0.745 ***	-0.050 ***				
		(0.013)	(0.004)	(0.088)	(0.168)	(0.009)				
	(2)	-0.163 ***	-0.024 ***	-0.166 *	-0.659 ***	-0.046 ***	-0.073	0.148	-0.075	
		(0.013)	(0.004)	(0.086)	(0.168)	(0.009)	(0.092)	(0.131)	(0.068)	
Tertiary edu.	(1)	0.118 ***	0.012 ***	-0.062	0.900 ***	0.045 ***				
		(0.014)	(0.004)	(0.098)	(0.187)	(0.010)				
	(2)	0.108 ***	0.016 ***	-0.050	0.882 ***	0.041 ***	0.229 ***	-0.136	-0.093	
		(0.014)	(0.004)	(0.095)	(0.184)	(0.009)	(0.081)	(0.123)	(0.091)	

		Changes in:			Outsourcing			Wages		
		Capital	Value added	R&D	NA	EUR	ASIA	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.322 ***	0.051 ***	0.315	2.935 ***	2.742	-3.580 ***	0.075 ***			
		(0.032)	(0.010)	(0.225)	(0.924)	(1.972)	(1.114)	(0.022)			
	(2)	0.326 ***	0.048 ***	0.288	2.670 ***	2.501	-3.859 ***	0.071 ***	-0.135	-0.187	0.322 ***
		(0.032)	(0.010)	(0.224)	(0.923)	(1.961)	(1.111)	(0.021)	(0.231)	(0.263)	(0.124)
Upper sec. edu.	(1)	-0.166 ***	-0.023 ***	-0.171 *	-0.418	-1.876 **	-0.886 *	-0.049 ***			
		(0.013)	(0.004)	(0.091)	(0.376)	(0.801)	(0.453)	(0.009)			
	(2)	-0.162 ***	-0.024 ***	-0.173 *	-0.280	-1.747 **	-0.854 *	-0.045 ***	-0.065	0.139	-0.074
		(0.013)	(0.004)	(0.090)	(0.370)	(0.786)	(0.445)	(0.009)	(0.092)	(0.130)	(0.066)
Tertiary edu.	(1)	0.097 ***	0.009 **	0.110	-1.100 ***	1.664 *	3.871 ***	0.041 ***			
		(0.014)	(0.004)	(0.097)	(0.399)	(0.852)	(0.481)	(0.009)			
	(2)	0.086 ***	0.013 ***	0.131	-1.181 ***	1.584 *	3.990 ***	0.037 ***	0.204 ***	-0.134	-0.070
		(0.014)	(0.004)	(0.094)	(0.387)	(0.823)	(0.466)	(0.009)	(0.078)	(0.120)	(0.087)

		Changes in:			Outsourcing				Wages		
		Capital	Value added	R&D	NA	EUR	China	ASEAN4	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.287 ***	0.044 ***	0.487 **	2.544 ***	2.658	-10.26 ***	3.443	0.073 ***			
		(0.032)	(0.009)	(0.221)	(0.906)	(1.904)	(1.567)	(3.261)	(0.021)			
	(2)	0.292 ***	0.041 ***	0.454 **	2.307 **	2.477	-10.22 ***	2.260	0.069 ***	-0.176	-0.175	0.351 ***
		(0.032)	(0.010)	(0.220)	(0.904)	(1.893)	(1.558)	(3.272)	(0.021)	(0.228)	(0.262)	(0.123)
Upper sec. edu.	(1)	-0.162 ***	-0.022 ***	-0.185 **	-0.368	-2.030 **	0.819	-3.448 **	-0.049 ***			
		(0.013)	(0.004)	(0.092)	(0.376)	(0.790)	(0.650)	(1.353)	(0.009)			
	(2)	-0.158 ***	-0.023 ***	-0.185 **	-0.235	-1.945 **	0.912	-3.271 **	-0.045 ***	-0.061	0.126	-0.065
		(0.013)	(0.004)	(0.090)	(0.370)	(0.775)	(0.638)	(1.337)	(0.009)	(0.092)	(0.130)	(0.066)
Tertiary edu.	(1)	0.112 ***	0.013 ***	0.028	-0.942 **	1.998 **	5.007 ***	4.070 ***	0.043 ***			
		(0.014)	(0.004)	(0.096)	(0.396)	(0.832)	(0.685)	(1.426)	(0.009)			
	(2)	0.101 ***	0.016 ***	0.049	-1.035 ***	1.957 **	4.813 ***	4.498 ***	0.038 ***	0.222 ***	-0.118	-0.104
		(0.014)	(0.004)	(0.094)	(0.385)	(0.806)	(0.664)	(1.390)	(0.009)	(0.078)	(0.120)	(0.086)

Note: Standard errors in parentheses. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 4.2 Elasticities Calculated from Estimations of Translog Cost Functions: Broad Measure of Outsourcing, Japan

		Changes in:				Outsourcing		Wages			
		Capital	Value added	R&D		Total		MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.283 ***	0.032 ***	0.857 **		2.119 ***		0.041 *			
		(0.030)	(0.009)	(0.207)		(0.221)		(0.021)			
	(2)	0.284 ***	0.032 ***	0.843 ***		2.080 ***		0.040 *	-0.625 ***	0.275	0.351 ***
		(0.030)	(0.009)	(0.208)		(0.228)		(0.021)	(0.220)	(0.240)	(0.124)
Upper sec. edu.	(1)	-0.163 ***	-0.015 ***	-0.328 ***		-1.095 ***		-0.035 ***			
		(0.012)	(0.004)	(0.081)		(0.086)		(0.008)			
	(2)	-0.157 ***	-0.017 ***	-0.334 ***		-1.113 ***		-0.031 ***	0.096	0.018	-0.114 *
		(0.012)	(0.004)	(0.079)		(0.086)		(0.008)	(0.084)	(0.118)	(0.063)
Tertiary edu.	(1)	0.116 ***	0.007	0.053		0.643 ***		0.038 ***			
		(0.014)	(0.004)	(0.097)		(0.104)		(0.010)			
	(2)	0.105 ***	0.011 **	0.072		0.702 ***		0.032 ***	0.222 ***	-0.206 *	-0.015
		(0.014)	(0.004)	(0.094)		(0.102)		(0.009)	(0.079)	(0.115)	(0.088)

		Changes in:			Outsourcing	Outsourcing	Outsourcing	Wages			
		Capital	Value added	R&D	NA	EUR	ASIA	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.304 ***	0.033 ***	0.753 ***	3.569 ***	2.897 **	1.254 ***	0.045 **			
		(0.031)	(0.009)	(0.216)	(0.589)	(1.242)	(0.443)	(0.021)			
	(2)	0.304 ***	0.033 ***	0.746 ***	3.542 ***	2.778 **	1.240 ***	0.043 **	-0.668 ***	0.315	0.353 ***
		(0.031)	(0.009)	(0.216)	(0.590)	(1.255)	(0.444)	(0.021)	(0.221)	(0.241)	(0.122)
Upper sec. edu.	(1)	-0.162 ***	-0.014 ***	-0.376 ***	-0.800 ***	-1.431 ***	-1.443 ***	-0.032 ***			
		(0.012)	(0.004)	(0.084)	(0.229)	(0.483)	(0.173)	(0.008)			
	(2)	-0.156 ***	-0.016 ***	-0.385 ***	-0.833 ***	-1.433 ***	-1.471 ***	-0.028 ***	0.110	0.006	-0.116 *
		(0.012)	(0.004)	(0.082)	(0.223)	(0.474)	(0.168)	(0.008)	(0.084)	(0.117)	(0.062)
Tertiary edu.	(1)	0.101 ***	0.004	0.205 **	-0.808 **	0.761	1.822 ***	0.029 ***			
		(0.014)	(0.004)	(0.098)	(0.268)	(0.565)	(0.202)	(0.010)			
	(2)	0.090 ***	0.008 *	0.225 **	-0.731 ***	0.839	1.881 ***	0.023 **	0.223 ***	-0.210 *	-0.013
		(0.014)	(0.004)	(0.095)	(0.259)	(0.548)	(0.195)	(0.009)	(0.077)	(0.112)	(0.085)

		Changes in:			Outsourcing					Wages		
		Capital	Value added	R&D	NA	EUR	China	ASEAN4	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.226 ***	0.016 *	0.926 ***	0.945 *	4.638 ***	-10.08 ***	11.160 ***	0.046 **			
		(0.028)	(0.008)	(0.187)	(0.560)	(1.104)	(0.941)	(0.963)	(0.019)			
	(2)	0.220 ***	0.015 *	0.924 ***	0.756	4.310 ***	-10.42 ***	11.511 ***	0.041 **	-0.373 *	-0.179	0.552 ***
		(0.028)	(0.008)	(0.185)	(0.557)	(1.103)	(0.936)	(0.959)	(0.018)	(0.198)	(0.230)	(0.116)
Upper sec. edu.	(1)	-0.155 ***	-0.012 ***	-0.304 ***	-0.420 *	-1.986 ***	0.687 *	-3.816 ***	-0.036 ***			
		(0.012)	(0.004)	(0.081)	(0.242)	(0.476)	(0.406)	(0.416)	(0.008)			
	(2)	-0.145 ***	-0.012 ***	-0.320 ***	-0.276	-1.869 ***	1.038 ***	-4.336 ***	-0.030 ***	-0.063	0.224 *	-0.161 **
		(0.012)	(0.003)	(0.077)	(0.233)	(0.461)	(0.393)	(0.404)	(0.008)	(0.080)	(0.118)	(0.064)
Tertiary edu.	(1)	0.137 ***	0.011 **	-0.035	0.163	0.664	5.136 ***	-0.145	0.036 ***			
		(0.014)	(0.004)	(0.092)	(0.276)	(0.545)	(0.465)	(0.475)	(0.009)			
	(2)	0.123 ***	0.012 ***	-0.005	0.022	0.660	4.715 ***	0.574	0.029 ***	0.349 ***	-0.292 **	-0.057
		(0.014)	(0.004)	(0.090)	(0.270)	(0.534)	(0.455)	(0.471)	(0.009)	(0.074)	(0.115)	(0.086)

Note: Standard errors in parentheses. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 4.3 Elasticities Calculated from Estimations of Translog Cost Functions: Narrow Measure of Outsourcing, Korea

		Changes in:			Outsourcing		Wages		
		Capital	Value added	R&D	Total	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.103	0.280 ***	0.581	-0.238	-15.08			
		(0.074)	(0.034)	(1.137)	(0.303)	(120.2)			
	(2)	0.180 **	0.225 ***	0.178	-0.349	83.589	0.061	0.222	-0.283 **
		(0.071)	(0.034)	(1.081)	(0.288)	(115.5)	(0.146)	(0.145)	(0.128)
Upper sec. edu.	(1)	-0.116 ***	-0.057 ***	-0.647	0.043	-86.78 *			
		(0.028)	(0.013)	(0.427)	(0.114)	(45.19)			
	(2)	-0.109 ***	-0.048 ***	-0.752 *	-0.015	-107.5 **	0.085	-0.066	-0.019
		(0.027)	(0.013)	(0.417)	(0.111)	(44.57)	(0.055)	(0.096)	(0.073)
Tertiary edu.	(1)	0.127 **	-0.083 ***	0.701	0.078	152.58 *			
		(0.050)	(0.023)	(0.773)	(0.206)	(81.69)			
	(2)	0.067	-0.062 ***	1.129	0.244	124.79	-0.178 **	-0.031	0.209 *
		(0.047)	(0.022)	(0.721)	(0.193)	(76.60)	(0.080)	(0.120)	(0.124)

		Changes in:			Outsourcing	Outsourcing	Outsourcing		Wages		
		Capital	Value added	R&D	NA	EUR	ASIA	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.092	0.291 ***	0.687	2.117	-2.524 **	-0.193	2.646			
		(0.073)	(0.035)	(1.134)	(1.519)	(1.278)	(0.804)	(121.3)			
	(2)	0.171 **	0.233 ***	0.280	1.186	-2.049 *	-0.270	94.584	0.048	0.208	-0.257 **
		(0.071)	(0.035)	(1.081)	(1.453)	(1.218)	(0.766)	(116.6)	(0.146)	(0.145)	(0.128)
Upper sec. edu.	(1)	-0.119 ***	-0.056 ***	-0.675	0.650	-0.090	-0.450	-73.62			
		(0.028)	(0.013)	(0.427)	(0.571)	(0.481)	(0.302)	(45.62)			
	(2)	-0.111 ***	-0.048 ***	-0.789 *	0.512	-0.045	-0.574 *	-94.48 **	0.079	-0.055	-0.024
		(0.027)	(0.013)	(0.415)	(0.558)	(0.467)	(0.295)	(44.85)	(0.055)	(0.095)	(0.072)
Tertiary edu.	(1)	0.137 ***	-0.090 ***	0.682	-2.402 **	1.734 **	0.863	119.74			
		(0.050)	(0.024)	(0.767)	(1.027)	(0.864)	(0.543)	(82.00)			
	(2)	0.076	-0.066 ***	1.125	-1.589 *	1.362 *	1.116 **	96.348	-0.161 **	-0.040	0.201
		(0.047)	(0.023)	(0.717)	(0.963)	(0.807)	(0.508)	(76.94)	(0.080)	(0.119)	(0.124)

		Changes in:			Outsourcing					Wages		
		Capital	Value added	R&D	NA	EUR	Japan	China	ASEAN4	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.033	0.309 ***	0.972	-0.461	-1.563	5.643 ***	-5.903 ***	2.601	68.608			
		(0.073)	(0.034)	(1.089)	(1.526)	(1.242)	(1.514)	(1.542)	(1.786)	(117.9)			
	(2)	0.099	0.245 ***	0.590	-1.294	-1.041	4.834 ***	-6.405 ***	3.502 **	166.62	0.067	0.132	-0.199
		(0.070)	(0.034)	(1.034)	(1.453)	(1.180)	(1.442)	(1.464)	(1.716)	(113.0)	(0.142)	(0.145)	(0.124)
Upper sec. edu.	(1)	-0.104 ***	-0.053 ***	-0.677	0.841	-0.185	-0.353	-0.011	-1.824 ***	-71.49			
		(0.028)	(0.013)	(0.424)	(0.594)	(0.483)	(0.589)	(0.600)	(0.695)	(45.88)			
	(2)	-0.089 ***	-0.040 ***	-0.807 **	0.710	-0.166	-0.205	-0.066	-2.769 ***	-93.80 **	0.050	0.033	-0.083
		(0.028)	(0.013)	(0.408)	(0.573)	(0.465)	(0.568)	(0.577)	(0.691)	(44.62)	(0.055)	(0.097)	(0.073)
Tertiary edu.	(1)	0.151 ***	-0.107 ***	0.506	-1.097	1.288	-2.965 ***	3.729 ***	1.373	74.77			
		(0.050)	(0.023)	(0.744)	(1.042)	(0.848)	(1.034)	(1.053)	(1.220)	(80.58)			
	(2)	0.085 *	-0.088 ***	0.960	-0.358	0.928	-2.700 ***	4.135 ***	2.366 **	49.967	-0.125	-0.137	0.262 **
		(0.047)	(0.022)	(0.688)	(0.966)	(0.784)	(0.957)	(0.973)	(1.145)	(74.85)	(0.078)	(0.120)	(0.121)

Note: Standard errors in parentheses. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 4.4 Elasticities Calculated from Estimations of Translog Cost Functions: Broad Measure of Outsourcing, Korea

		Changes in:			Outsourcing		Wages		
		Capital	Value added	R&D	Total	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.102	0.279 ***	0.542	-0.115	-17.43			
		(0.074)	(0.035)	(1.139)	(0.183)	(120.1)			
	(2)	0.180 **	0.226 ***	0.167	-0.069	75.147	0.053	0.211	-0.263 **
		(0.071)	(0.034)	(1.085)	(0.175)	(115.5)	(0.147)	(0.146)	(0.128)
Upper sec. edu.	(1)	-0.116 ***	-0.057 ***	-0.645	0.007	-85.72 *			
		(0.028)	(0.013)	(0.428)	(0.069)	(45.16)			
	(2)	-0.110 ***	-0.049 ***	-0.768 *	-0.041	-106.8 **	0.080	-0.058	-0.023
		(0.027)	(0.013)	(0.417)	(0.068)	(44.48)	(0.056)	(0.097)	(0.073)
Tertiary edu.	(1)	0.128 **	-0.082 ***	0.722	0.062	152.31 *			
		(0.050)	(0.024)	(0.774)	(0.124)	(81.61)			
	(2)	0.069	-0.061 ***	1.161	0.111	128.92 *	-0.166 **	-0.037	0.203
		(0.047)	(0.023)	(0.723)	(0.117)	(76.56)	(0.080)	(0.120)	(0.124)

		Changes in:			Outsourcing	Outsourcing	Outsourcing		Wages		
		Capital	Value added	R&D	NA	EUR	ASIA	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.103	0.279 ***	0.768	-0.987	-1.154	0.658	-38.40			
		(0.073)	(0.035)	(1.141)	(0.957)	(0.981)	(0.569)	(120.2)			
	(2)	0.179 **	0.226 ***	0.371	-0.877	-0.901	0.614	55.652	0.040	0.211	-0.251 **
		(0.071)	(0.034)	(1.089)	(0.911)	(0.936)	(0.542)	(115.7)	(0.146)	(0.144)	(0.128)
Upper sec. edu.	(1)	-0.117 ***	-0.058 ***	-0.777 *	0.357	0.620 *	-0.443 **	-73.47			
		(0.027)	(0.013)	(0.427)	(0.358)	(0.367)	(0.213)	(44.93)			
	(2)	-0.109 ***	-0.051 ***	-0.926 **	0.287	0.746 **	-0.548 ***	-93.88 **	0.081	-0.035	-0.045
		(0.027)	(0.013)	(0.414)	(0.346)	(0.356)	(0.207)	(44.04)	(0.055)	(0.095)	(0.072)
Tertiary edu.	(1)	0.128 **	-0.079 ***	0.800	0.032	-0.297	0.317	145.29 *			
		(0.050)	(0.024)	(0.779)	(0.653)	(0.670)	(0.388)	(82.06)			
	(2)	0.067	-0.058 **	1.295 *	0.078	-0.664	0.518	119.83	-0.158 **	-0.075	0.233 *
		(0.047)	(0.023)	(0.727)	(0.607)	(0.624)	(0.362)	(76.78)	(0.080)	(0.119)	(0.124)

		Changes in:			Outsourcing					Wages		
		Capital	Value added	R&D	NA	EUR	Japan	China	ASEAN4	MNEshare	Lower sec.	Upper sec.	Tertiary
Lower sec. edu.	(1)	0.010	0.292 ***	1.665	-3.923 ***	-0.193	3.928 ***	-4.684 ***	4.880 ***	136.72			
		(0.072)	(0.036)	(1.097)	(1.007)	(0.966)	(0.931)	(1.132)	(1.290)	(121.2)			
	(2)	0.074	0.223 ***	1.162	-3.712 ***	0.227	3.354 ***	-4.859 ***	5.793 ***	214.21 *	0.090	0.056	-0.147
		(0.069)	(0.035)	(1.042)	(0.955)	(0.917)	(0.887)	(1.074)	(1.238)	(115.3)	(0.140)	(0.142)	(0.122)
Upper sec. edu.	(1)	-0.094 ***	-0.040 ***	-0.604	0.500	0.272	0.026	0.057	-2.150 ***	-45.87			
		(0.028)	(0.014)	(0.423)	(0.388)	(0.373)	(0.359)	(0.437)	(0.498)	(46.73)			
	(2)	-0.081 ***	-0.022	-0.686 *	0.383	0.323	0.181	-0.187	-2.866 ***	-53.50	0.021	0.118	-0.140 **
		(0.027)	(0.014)	(0.402)	(0.369)	(0.354)	(0.342)	(0.415)	(0.486)	(44.46)	(0.054)	(0.095)	(0.071)
Tertiary edu.	(1)	0.149 ***	-0.117 ***	-0.050	1.641 **	-0.326	-2.512 ***	2.850 ***	0.478	-10.29			
		(0.049)	(0.024)	(0.755)	(0.693)	(0.665)	(0.641)	(0.779)	(0.888)	(83.37)			
	(2)	0.087 *	-0.105 ***	0.400	1.701 ***	-0.676	-2.407 ***	3.362 ***	1.085	-46.40	-0.092	-0.231 **	0.323 ***
		(0.046)	(0.023)	(0.691)	(0.633)	(0.608)	(0.587)	(0.713)	(0.821)	(76.37)	(0.077)	(0.116)	(0.118)

Note: Standard errors in parentheses. Significance at the 1, 5, and 10 percent level is indicated by ***, **, and *, respectively.

Table 4.5 Implied Changes in Demand for Workers and Actual Increase in International Outsourcing in the Japanese Manufacturing: 1995-2000

		Estimated elasticity	Change in outsourcing	Implied change in labor demand		No. of employees in manufacturing		Actual change in No. of employees	
			(% points)	(persons)	(%)	1995 (persons)	2000 (persons)	(persons)	(%)
		(a)	(b)	(c=a*b*e)	(c/g)	(e)	(f)	(g=f-e)	(g/e)
Japan									
Lower secondary education									
All countries	Narrow	0.712	0.226	3,677	-0.44%	2,288,373	1,445,508	-842,865	-36.8%
	Broad	2.119	0.906	43,955	-5.22%	2,288,373	1,445,508	-842,865	-36.8%
Asia	Narrow	-3.580	0.134	-10,956	1.30%	2,288,373	1,445,508	-842,865	-36.8%
	Broad	1.254	0.642	18,433	-2.19%	2,288,373	1,445,508	-842,865	-36.8%
Upper secondary education									
All countries	Narrow	-0.745	0.226	-9,958	2.15%	5,924,006	5,460,713	-463,293	-7.8%
	Broad	-1.095	0.906	-58,775	12.69%	5,924,006	5,460,713	-463,293	-7.8%
Asia	Narrow	-0.886	0.134	-7,019	1.52%	5,924,006	5,460,713	-463,293	-7.8%
	Broad	-1.443	0.642	-54,897	11.85%	5,924,006	5,460,713	-463,293	-7.8%
Tertiary education									
All countries	Narrow	0.900	0.226	4,838	3.83%	2,383,392	2,509,664	126,272	5.3%
	Broad	0.643	0.906	13,889	11.00%	2,383,392	2,509,664	126,272	5.3%
Asia	Narrow	3.871	0.134	12,338	9.77%	2,383,392	2,509,664	126,272	5.3%
	Broad	1.822	0.642	27,881	22.08%	2,383,392	2,509,664	126,272	5.3%

		Estimated elasticity	Change in outsourcing	Implied change in labor demand		No. of employees in electrical machinery		Actual change in No. of employees	
			(% points)	(persons)	(%)	1995 (persons)	2000 (persons)	(persons)	(%)
		(a)	(b)	(c=a*b*e)	(c/g)	(e)	(f)	(g=f-e)	(g/e)
Japan: Electrical machinery sector									
Lower secondary education									
All countries	Narrow	0.712	0.181	340	-0.39%	263,338	175,511	-87,828	-33.4%
	Broad	2.119	2.349	13,110	-14.93%	263,338	175,511	-87,828	-33.4%
Asia	Narrow	-3.580	0.272	-2,562	2.92%	263,338	175,511	-87,828	-33.4%
	Broad	1.254	1.970	6,506	-7.41%	263,338	175,511	-87,828	-33.4%
Upper secondary education									
All countries	Narrow	-0.745	0.181	-1,440	1.26%	1,066,191	951,938	-114,253	-10.7%
	Broad	-1.095	2.349	-27,416	24.00%	1,066,191	951,938	-114,253	-10.7%
Asia	Narrow	-0.886	0.272	-2,567	2.25%	1,066,191	951,938	-114,253	-10.7%
	Broad	-1.443	1.970	-30,307	26.53%	1,066,191	951,938	-114,253	-10.7%
Tertiary education									
All countries	Narrow	0.900	0.181	855	2.67%	524,383	556,422	32,039	6.1%
	Broad	0.643	2.349	7,920	24.72%	524,383	556,422	32,039	6.1%
Asia	Narrow	3.871	0.272	5,517	17.22%	524,383	556,422	32,039	6.1%
	Broad	1.822	1.970	18,816	58.73%	524,383	556,422	32,039	6.1%

Source: Authors' calculation.

Appendix Table 1. List of Industries

(a) Japan

JIP industry classification	
1	Rice, wheat production
2	Miscellaneous crop farming
3	Livestock and sericulture farming
4	Agricultural services
5	Forestry
6	Fisheries
7	Mining
8	Livestock products
9	Seafood products
10	Flour and grain mill products
11	Miscellaneous foods and related products
12	Prepared animal foods and organic fertilizers
13	Beverages
14	Tobacco
15	Textile products
16	Lumber and wood products
17	Furniture and fixtures
18	Pulp, paper, and coated and glazed paper
19	Paper products
20	Printing, plate making for printing and bookbinding
21	Leather and leather products
22	Rubber products
23	Chemical fertilizers
24	Basic inorganic chemicals
25	Basic organic chemicals
26	Organic chemicals
27	Chemical fibers
28	Miscellaneous chemical products
29	Pharmaceutical products
30	Petroleum products
31	Coal products
32	Glass and its products
33	Cement and its products
34	Pottery
35	Miscellaneous ceramic, stone and clay products
36	Pig iron and crude steel
37	Miscellaneous iron and steel
38	Smelting and refining of non-ferrous metals
39	Non-ferrous metal products
40	Fabricated constructional and architectural metal products
41	Miscellaneous fabricated metal products
42	General industry machinery
43	Special industry machinery
44	Miscellaneous machinery
45	Office and service industry machine
46	Electrical generating, transmission, distribution and industrial apparatus
47	Household electric appliances
48	Electronic data processing machines, digital and analog computer equipment and accessories
49	Communication equipment
50	Electronic equipment and electric measuring instruments
51	Semiconductor devices and integrated circuits
52	Electronic parts
53	Miscellaneous electrical machinery equipment

(continued)

54	Motor vehicles
55	Motor vehicle parts and accessories
56	Other transportation equipment
57	Precision machinery & equipment
58	Plastic products
59	Miscellaneous manufacturing industries
60	Construction
61	Civil engineering
62	Electricity
63	Gas, heat supply
64	Waterworks
65	Water supply for industrial use
66	Waste disposal
67	Wholesale
68	Retail
69	Finance
70	Insurance
71	Real estate
72	Housing
73	Railway
74	Road transportation
75	Water transportation
76	Air transportation
77	Other transportation and packing
78	Telegraph and telephone
79	Mail
80	Education (private and non-profit)
81	Research (private)
82	Medical (private)
83	Hygiene (private and non-profit)
84	Other public services
85	Advertising
86	Rental of office equipment and goods
87	Automobile maintenance services
88	Other services for businesses
89	Entertainment
90	Broadcasting
91	Information services and internet-based services
92	Publishing
93	Video picture, sound information, character information production and distribution
94	Eating and drinking places
95	Accommodation
96	Laundry, beauty and bath services
97	Other services for individuals
98	Education (public)
99	Research (public)
100	Medical (public)
101	Hygiene (public)
102	Social insurance and social welfare (public)
103	Public administration
104	Medical (non-profit)
105	Social insurance and social welfare (non-profit)
106	Research (non-profit)
107	Other (non-profit)
108	Activities not elsewhere classified

(b) Korea

	SNA industry classification
1	Crops
2	Livestock Products
3	Forest Products
4	Fishery Products
5	Agriculture, Forestry and Fishing Service
6	Coal
7	Crude Petroleum and Natural Gas
8	Metal Ores
9	Non-Metal Ores
10	Food Products
11	Beverages
12	Tobacco Products
13	Textile
14	Apparel
15	Leather and Fur Products
16	Footwear
17	Wood and Wood Products
18	Pulp and Paper Products
19	Printing, Publishing and Reproduction of Recorded Media
20	Petroleum and Coal Products
21	Industrial Chemicals
22	Phamaceuticals, Medicinal Chemicals, Botanical Products and Cosmetics
23	Other Chemical Products
24	Rubber Products
25	Plastic Products
26	Glass and Glass Products
27	Ceramic Ware
28	Other Non-metallic Mineral Products
29	Iron and Steel Products
30	Non-ferrous Metal Products
31	Metal Products
32	General Industrial Machinery
33	Special Industrial Machinery
34	Domestic Electric and Electronic Appliances
35	Computer and Office Appliances
36	Electrical Machinery and Equipmen
37	Semiconductor and Electronic Components
38	Radio, Television and Communication Equipments
39	Precision Instruments
40	Motor Vehicles
41	Other Transport Equipment
42	Furniture
43	Other Manufacturing Products
44	Electricity
45	Gas, Steam and Hot Water Supply
46	Collection, Purification and Distribution of Water
47	Construction
48	Wholesale and Retail Trade
49	Hotels and Restaurants
50	Transport and Storage
51	Post and Telecommunications
52	Financial Intermediation and Insurance
53	Residential Buildings
54	Real Estate
55	Renting of Machinary and Equipment

(continued)

56	Advertising
57	Business Support Services
58	Business and Professional Organizations
59	Public Administration and Defense
60	Education <industry>
61	Education <national and public>
62	Education <private>
63	Health Services <industry>
64	Health Services <national and public>
65	Health Services <non-profit>
66	Social Work Activities <national and public>
67	Social Work Activities <non-profit>
68	Sanitary Services
69	Sanitary Services <national and public>
70	Broadcasting
71	Motion Picture and Performing Arts
72	Other Recreational Services
73	Cultural Services <national and public>
74	Personal Services
75	Maintenance and Repair Services
76	TIP
77	Other Social Services <non-profit>
78	Private Households with Employed Persons

Appendix Table 2. Summary Statistics

Japan

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Cost share of workers with					
lower secondary edu.1	750	0.1934	0.0844	0.0528	0.5094
upper secondary edu.1	750	0.5227	0.0437	0.4050	0.6365
tertiary edu.1	750	0.2839	0.0923	0.0853	0.5223
Log of capital stock	750	28.6018	0.8883	26.3633	30.5748
Log of value added	750	28.0616	0.9346	23.3705	29.7315
R&D intensity	750	0.0363	0.0584	0	0.3413
MNE share	700	0.2986	0.4842	0	4.4812
Narrow outsourcing					
Total	750	0.0172	0.0186	0	0.0864
North America	750	0.0056	0.0086	0	0.0622
Europe	750	0.0036	0.0049	0	0.0333
Asia	750	0.0060	0.0076	0	0.0390
China	750	0.0021	0.0040	0	0.0329
ASEAN4	750	0.0015	0.0024	0	0.0138
Broad outsourcing					
Total	750	0.0533	0.0532	0.0023	0.3569
North America	750	0.0182	0.0231	0.0004	0.1773
Europe	750	0.0093	0.0095	0.0002	0.0741
Asia	750	0.0166	0.0174	0.0007	0.1377
China	750	0.0048	0.0062	0.0001	0.0435
ASEAN4	750	0.0052	0.0081	0.0001	0.0590
Log of hourly wage rate					
lower secondary edu.	750	7.8789	0.2788	6.8883	8.5760
upper secondary edu.	750	7.9095	0.2474	7.1205	8.6891
tertiary edu.	750	8.1801	0.2113	7.5753	8.9237
Part-time	750	6.6328	0.0776	6.3909	6.7248
Self-employed	720	6.5808	0.2922	5.4440	7.1686

Korea

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Cost share of workers with					
lower secondary edu.	363	0.1918	0.1061	0.0256	0.5148
upper secondary edu.	363	0.5031	0.0648	0.2740	0.6587
tertiary edu.	363	0.3051	0.1032	0.0944	0.6799
Log of capital stock	363	14.9426	1.1013	12.6467	17.2398
Log of value added	363	15.1974	0.9123	12.2785	17.6161
R&D intensity	363	0.0117	0.0126	0	0.0846
MNE share	363	0.0001	0.0002	-2.23E-06	0.0017
Narrow outsourcing					
Total	363	0.0697	0.0814	-0.076137	0.6272
North America	363	0.0141	0.0186	-0.020505	0.1192
Europe	363	0.0140	0.0185	-0.025679	0.1758
Asia	363	0.0316	0.0309	-0.028926	0.1597
Japan	363	0.0160	0.0183	-0.027258	0.0857
China	363	0.0075	0.0113	-0.000532	0.0864
ASEAN4	363	0.0048	0.0105	-0.000384	0.1098
Broad outsourcing					
Total	363	0.1918	0.1203	-0.0099	0.6366
North America	363	0.0410	0.0321	-0.0084	0.1761
Europe	363	0.0325	0.0222	-0.0119	0.1775
Asia	363	0.0837	0.0558	-0.0019	0.2723
Japan	363	0.0419	0.0352	-0.0076	0.2025
China	363	0.0192	0.0219	0.0001	0.1543
ASEAN4	363	0.0135	0.0171	0.0000	0.1564
Log of hourly wage rate					
lower secondary edu.	363	13.8202	0.3008	12.9414	14.5591
upper secondary edu.	363	13.8921	0.3017	13.1645	14.9157
tertiary edu.	363	14.1004	0.2579	13.5935	14.8955