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ABSTRACT

Applying a common empirical approach to comparable industry-level data on production, trade, and labor markets for Japan and South Korea, this paper aims to investigate the impacts of outsourcing on different sectors of the labor market focusing on differences in educational attainment. While outsourcing measures used in previous studies only take account of the outsourcing of intermediate inputs and do not capture the outsourcing of the final production stage (assembly), this paper, utilizing the *Asian International Input-Output Tables*, incorporates the outsourcing of assembly, taking into account the growing importance of the international fragmentation of production in Asia.

The main findings can be summarized as follows. First, 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. Second, 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. Third, both in Japan and Korea, the international outsourcing of assembly has a significant impact on skill upgrading, particularly in the electrical machinery sector.

JEL Classifications: F14, F16, F23

Keywords: Outsourcing, labor demand, skill upgrading, Japan, Korea, manufacturing, Asian International Input-Ouput Tables

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. 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 South Korea. As explained in the traditional Heckscher-Ohlin framework, the relative demand for unskilled labor will decrease and the relative demand for skilled labor will increase when unskilled-labor intensive processes are outsourced to unskilled-labor abundant countries (usually low-income countries). Moreover, taking account of the difference in wage levels and stages of economic development between Japan and Korea, it is expected that international outsourcing affects domestic labor markets in Japan and Korea differently, though both countries are important players in international outsourcing in East Asia. In this paper, using industry level data, we investigate this impact from a comparative perspective.

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

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

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. More recently, Tanaka and Nakazawa (2007) have focused on the destination impacts of outsourcing and found that outsourcing to lower income countries was positively associated with skilled workers' share in wage bills. Thus, for Japan, several studies have produced empirical results which are consistent with the Heckscher-Ohlin theory.

However, for Korea, this issue has not yet been adequately examined. Moreover, as pointed out by Hijzen, Görg and Hine (2005), the outsourcing measures used in previous studies do not capture trilateral trade-type outsourcing. In other words, the traditional outsourcing measures, focusing on imports of intermediate inputs, ignore the possibility of the outsourcing of final production stages such as assembly, and the data do not capture outsourcing when products are not re-imported, but exported to third countries. 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 then exported to a third country such as the United States and European countries. In this case, although Japan and Korea outsource the final assembly stage to other Asian countries, the traditional measure cannot capture this type of outsourcing. In this paper, utilizing the *Asian International*

Input-Output Tables, we incorporate such type of outsourcing to take account of the growing importance of the international fragmentation of production in Asia.

The remainder of the paper is organized as follows. In Section 2, 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 3, we conduct econometric analyses to investigate the impact of international outsourcing on labor markets in Japan and Korea. Section 4 estimates the number of employees affected by the change in outsourcing between 1995 and 2000 using the estimated elasticities. Section 5, finally, presents our conclusions.

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

2.1 Trends in Labor Markets

We begin with an overview of labor market trends in Japan. According to various labor statistics, 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 sector.[2] Looking at the shares of each educational group calculated using the JIP Database 2006, the proportion of employees with lower secondary education decreased from 47 percent to 13 percent in the manufacturing sector

[2] 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).

and from 25 percent to 7 percent in the service sector during the period from 1980 to 2002.[3] During the same period, the share of the number of employees with tertiary education increased from 13 percent to 29 percent in the manufacturing sector and from 24 percent to 47 percent in the service sector. As for the share of the number of employees with upper secondary education, this increased from 41 percent to 58 percent in the manufacturing sector and slightly decreased from 50 percent to 47 percent in the service sector.

Figure 1 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 1(a) to 1(d). The different panels in Figure 1 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.[4,5] 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.[6] As mentioned by Sasaki and Sakura (2005), continuing

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[3] For details of the JIP Database 2006, see the Appendix. The shares are calculated excluding part-time and self-employed workers.

[4] 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.

[5] 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.

[6] As is widely known, the enrollment rate in tertiary education rapidly increased during Japan's high-speed

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.

INSERT Figure 1

Next, let us move on to recent trends in the South 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. According to these statistics, 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

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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 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 share, since data on wage rates for each job type were not available.

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 percent in 1983 and gradually decreased to 11.3 percent in 2006. The share of employees with tertiary education rapidly increased from only 6.7 percent in 1980 to 33.7 percent in 2006. The share of employees with upper secondary education increased from 21.8 percent in 1980 to a peak of 44.4 percent in 2001 and has been declining slightly since. Nonetheless, employees with upper secondary education accounted for the largest share with 42.2 percent in 2006.

Figures 2(a) to 2(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.

INSERT Figure 2

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 1).[7] 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 percent to 54 percent 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 percent to 58 percent (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.

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 1

The data on the changes in labor input quantities described above imply that the reductions in the quantity of unskilled labor input (i.e., those with secondary education)

[7] 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.

have been greater than those in the quantity of skilled labor input (i.e., those with tertiary education) in Japan. 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 1 and 2. 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.

2.2 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 using information on imported inputs from input-output tables. 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> $z_i^N = \frac{m_{ii}}{Y_i}$ (1)

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

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

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 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:

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

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 i 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.

However, as pointed out by Hijzen, Görg and Hine (2005), there are two main drawbacks in measuring outsourcing this way. First, we have to ignore the possibility of the 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 are exported to third countries. Therefore, utilizing the *Asian International Input-Output Tables 1990, 1995, and 2000* published by the Institute of Developing Economies, we construct a measure of outsourcing of the final production stage. The *Asian International Input-Output Tables* provide information on input-output structure at the 76-78 industry-level for major Asian economies (Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, Korea, Japan) and the United States. For example, the input-output tables provide the value of intermediate inputs which were imported from Japan and used to produce final goods in China. Therefore, using such information, our measure of outsourcing of the final production stage (assembly) to Asian countries is calculated as follows. First, narrow outsourcing of assembly to Asian countries is:

$$z_i^{NA} = \sum_{c \in Asia} \frac{x_{iic}}{X_{ic}} \frac{X_{ic}}{Y_i} \qquad (5)$$

where x_{iic} is intermediate inputs which are exported from Japan's (or Korea's) industry i to country c and used in industry i in country c, X_{ic} is industry i's total exports from Japan (or Korea) to country c, and Y_i is output in industry i in Japan (or Korea). We should note that

Asian countries include Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, and Korea in the case of Japan's exports, while Asian countries include Japan and all these countries except Taiwan in the case of Korea's exports.[8] Similarly, broad outsourcing of assembly to Asian countries is:

$$z_i^{BA} = \sum_{c \in Asia} \frac{\sum_{j=1}^{N} x_{ijc}}{X_{ic}} \frac{X_{ic}}{Y_i} \qquad (6)$$

where x_{ijc} is intermediate inputs which are exported from Japan's (or Korea's) industry i to country c and used in industry j (all manufacturing industries) in country c.

Utilizing the *Asian International Input-Output Tables* for 1990, 1995, and 2000 as benchmarks, we construct time series for the measures of assembly outsourcing in a similar way as the outsourcing measures for imported intermediate inputs. We observe the share of Japan's (or Korea's) exports used as intermediate inputs in other Asian countries in industry i, x_{iic}/X_i, in 1990, 1995, and 2000, while we observe exports in relation to domestic output every year. We use a liner interpolation of x_{iic}/X_i based on the 1990, 1995, 2000 values in order to obtain values of z_i^{NA} for 1991-1994 and 1996-1999. For 1988 and 1989, we use the x_{iic}/X_i for the year 1990. For 2001-2004, we use the x_{iic}/X_i for the year 2000. Similarly, we observe the share of exports by Japan's (or Korea's) industry i used as intermediate inputs in other Asian countries in industry j, x_{ijc}/X_i, in 1990, 1995, and 2000 and the ratio of exports to domestic output every year. Again, using linear interpolation, we obtain values of x_{ijc}/X_i for every year.

[8] As the trade data we used for Korea are taken from the UN COMTRADE data, Korean imports from and exports to Taiwan are not included in our analysis.

Table 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 in relation to the industry's total 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 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).[9] 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,

[9] Comparing our Table 2 with Table 1 in Ekholm and Hakkala (2006), the shares of imported inputs in total output 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 percent to 0.85 percent in all industries in the case of Japan, while the corresponding shares are in the range from 4.0 percent to 4.2 percent 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 percent to 0.18 percent, 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.

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 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.

As for exported intermediate goods to Asian countries, the level of outsourcing of assembly shows a significant increase between 1990 and 2000 in the cases of both Japan and Korea. Particularly, the outsourcing of assembly in the Korean electrical machinery sector has increased remarkably.

INSERT Table 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, 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.[10]

Figure 3 shows narrow outsourcing to major regions for Japan and Korea in 1990, 1995, 2000, and 2004 in the manufacturing sector.[11] 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 4 and 5 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 4), although narrow outsourcing has increased in every industry, the most conspicuous

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[10] 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 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.

[11] The trends of the narrow and broad measures of outsourcing to major regions for Japan in all industries are mostly consistent with the trends in manufacturing shown in Figure 3.

increase can be seen in the electrical machinery industry. The outsourcing measure for the electrical machinery industry rapidly 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 5), 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, 4, and 5, outsourcing to China shows a rapid increase since 1990 in many industries in both Japan and Korea.[12]

INSERT Figures 3, 4, and 5

[12] Looking at broad outsourcing to different regions, we can see a similar trend as in the narrow outsourcing to different regions shown in Figures 3, 4, and 5.

3. Econometric Analysis

3.1 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.[13] For Korea, 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:

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

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

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. 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)

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, NA, BA*) 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 (equation 6) is estimated using Zellner's method for seemingly unrelated regression equations (SUR). A full set of year dummies is included in order to capture economy-wide technological change over time. 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.[14]

3.2 Estimation Results for Japan

Tables 3 and 4 report the elasticities derived from the regression results for Japan.[15] 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.[16] For each skill group, we carry out two sets of estimations: specification (1) is based on the assumption that quality-adjusted wages are

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

[15] 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.

[16] 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 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.

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.[17]

INSERT Tables 3 and 4

Table 3 shows the elasticities focusing on the narrow measure of outsourcing. According to the top panel of Table 3, 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 0.7-0.8 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 1.0 percent and the estimated elasticity is statistically significant. The results in the top panel of Table 3 strongly indicate that overall narrow outsourcing tends to shift labor demand away from workers with upper secondary education towards workers with tertiary education. Moreover, a one percentage-point increase in the outsourcing of assembly increases the demand for workers with tertiary education by 0.7-0.8 percent, although the impact on the demand for workers with secondary education is not statistically significant.

[17] 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.

In the second and the third panels of Table 3, 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 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 percent (on average, 55 persons) and increases the demand for workers with lower secondary education and tertiary education by 0.07 percent (on average, 30 persons) and 0.04 percent (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 3, 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 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 3, 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. Moreover, in the case of broad measure of outsourcing, outsourcing of assembly also shifts labor demand away from workers with upper secondary education towards workers with tertiary education.

According to our results in Tables 3 and 4, 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.[18]

3.3 Econometric Results for Korea

Tables 5 and 6 report the elasticities derived from the regression results for Korea.[19] 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 5 and 6

Table 5 shows the elasticities with the narrow measure of outsourcing. According to the top panel of Table 5, unlike in the case of Japan, total outsourcing does not have significant effects on the demand for workers in Korea. However, outsourcing of assembly

[18] 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 3 and 4 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.

[19] 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.

to Asian countries has a significant negative impact on the demand for labor with lower secondary education and a significant positive impact on the demand for labor with tertiary education. In particular, a one percentage-point increase in the outsourcing of assembly decreases the demand for workers with lower secondary education by 5 percent, while a one percentage-point increase in the outsourcing of assembly increases the demand for workers with tertiary education by 1.7-1.9 percent. The impact of outsourcing of assembly in Korea is much larger than that in Japan.

Although total outsourcing does not have significant impacts, outsourcing to China has a significant negative elasticity for workers with lower secondary education and a significant positive elasticity for workers with tertiary education (the third panel of Table 5). 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 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 6 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 5.

4. Estimated Impacts of International Outsourcing on Labor Demand

Our regression analysis so far provides evidence that in the case of Japan, international outsourcing has a negative impact on the demand for workers with secondary education but a positive impact on the demand for workers with tertiary education. In particular, outsourcing to Asia has the strongest effect of skill upgrading, i.e., shifting demand away from less-skilled workers towards skilled workers. Therefore, focusing on the total international outsourcing and the 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 3 and 4. The calculation of the estimate is summarized in Table 7. As shown in the upper panel of Table 7, 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. 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 7. 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 59,796 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 13 percent 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 percent (narrow measure) and 22 percent (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 7. As already seen in Figure 4, the increase in outsourcing is most conspicuous in the electrical machinery sector.[20] 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 7, we find that more than half of the labor demand change induced by outsourcing to Asia is driven by the electrical machinery sector alone.

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[20] Looking at the data, 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.

In addition to the impact of the outsourcing of intermediate inputs, we can estimate the number of employees affected by the change in outsourcing of assembly to Asian countries. Table 8 shows the estimated impact of assembly outsourcing in the case of Japan. As shown in the upper panel of Table 8, the actual change in broad outsourcing of assembly to Asian countries was associated with a reduction in the demand for workers with upper secondary education by 10,498 workers and with an increase in the demand for workers with tertiary education by 4,046 workers. Adding these impacts to the impacts of intermediate inputs outsourcing shown in Table 7, the estimated reduction in the number of workers with upper secondary education induced by broad outsourcing accounts for approximately 15 percent of the actual reduction. In the case of the electrical machinery sector, the estimated reduction induced by broad outsourcing (of intermediate inputs and assembly) to Asia is more substantial, accounting for approximately 30 percent of the actual reduction. Moreover, the actual increase in the number of workers with tertiary education induced by broad outsourcing (of intermediate inputs and assembly) to Asia accounts for approximately 66 percent of the actual increase, which is a significant contribution to the skill upgrading in the Japanese electrical machinery sector.

Similarly, we can calculate an estimate of the number of employees affected by the change in outsourcing for the same period in the case of Korea, using the estimated elasticities shown in Tables 5 and 6. The estimated impacts of broad outsourcing to different Asian regions and of assembly outsourcing to Asia are summarized in Table 9.[21] According to our estimates in the upper panel of Table 9, the actual change in broad

[21] The total number of workers by industry is taken from the Korean Input-Output Tables published by the Bank of Korea. The number of workers for each educational group is estimated using the employment share of each educational group taken from the *Basic Survey of Wage Structure* by the Ministry of Labor.

outsourcing to China was associated with a reduction in the demand for workers with lower secondary education by 26,008 workers. As the actual reduction in the number of workers with lower secondary education was 387,526 persons during the period from 1995 to 2000, the estimated reduction induced by broad outsourcing to China accounts for approximately 7 percent of the actual reduction. As already described above, the overall impact of outsourcing to all countries on labor demand is not statistically significant in Korea because the different impacts of outsourcing to different regions offset each other. However, if outsourcing to China increases while outsourcing to Japan decreases in the future, labor demand might shift towards workers with tertiary education.

Similar to the case of Japan, in Korea, too, skill upgrading induced by outsourcing (of intermediate inputs and assembly) is more substantial in the electrical machinery sector (the lower panel of Table 7). The estimated reduction in workers with lower secondary education induced by broad outsourcing of assembly accounts for approximately 33 percent of the actual reduction. On the other hand, the estimated increase in workers with tertiary education induced by broad outsourcing of assembly accounts for approximately 54 percent of the actual increase.

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 South 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, 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.

Second, 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.

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.

Moreover, utilizing the *Asian International Input-Output Tables*, we estimated the impact of the outsourcing of the final assembly stage on domestic labor demand, which had not been captured in previous studies on international outsourcing. Although the impact in Japan of the outsourcing of final assembly may not be very great, as shown in Table 8, we were able to confirm that traditional measures of outsourcing cannot capture the outsourcing of assembly and therefore underestimate the impact on labor demand. However, in Korea, the outsourcing of assembly to Asia has significantly contributed to the shift in

the domestic labor demand towards workers with tertiary education. In addition, we found that both in Japan and Korea, international outsourcing (of intermediate inputs and of assembly) has a significant impact on skill upgrading particularly in the electrical machinery sector.

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/]. We should note that Korea's imports from and exports to Taiwan are not included.

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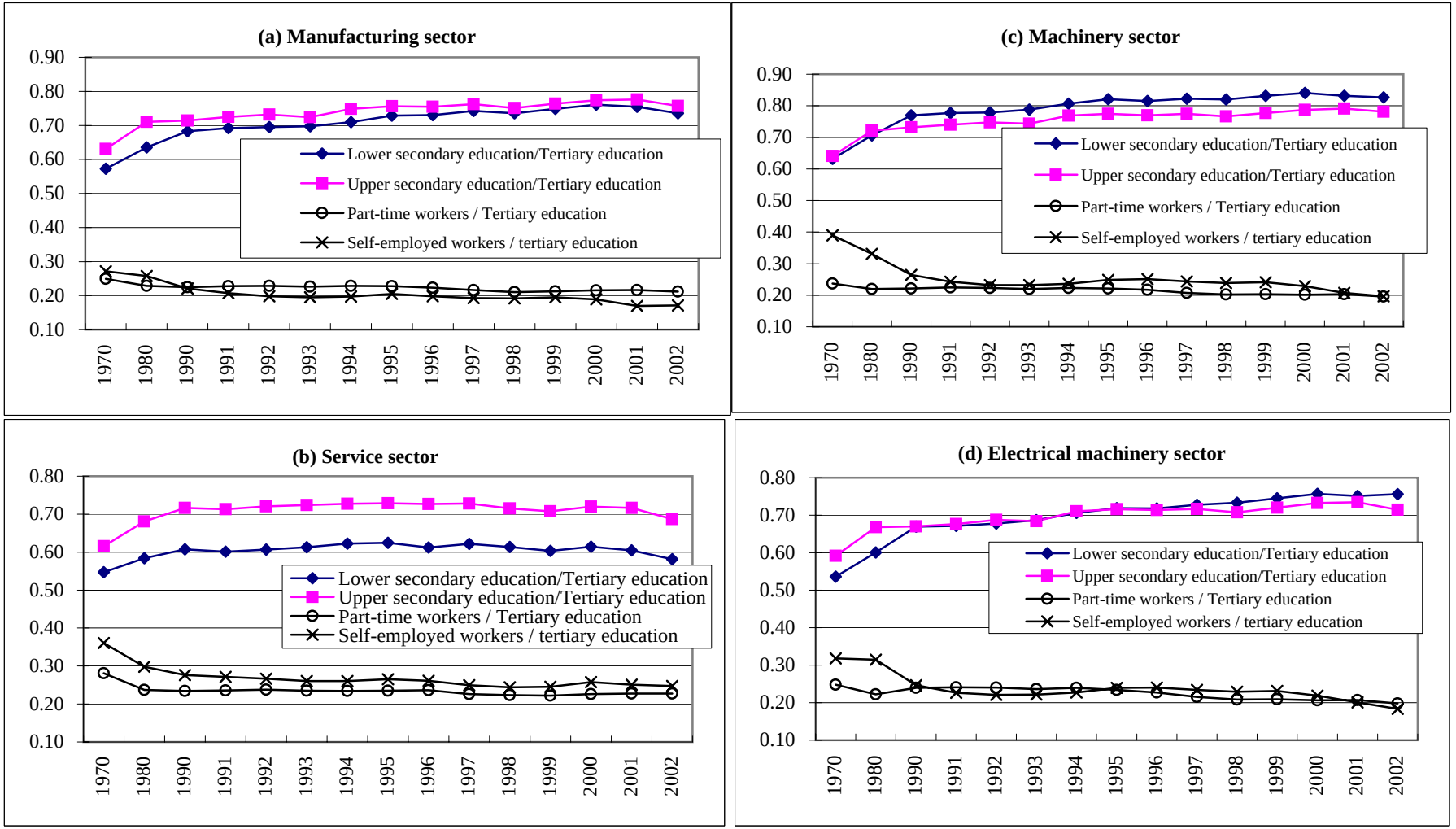

Figure 1. Nominal Wage Rate Trends for Different Educational Groups: Japan

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.

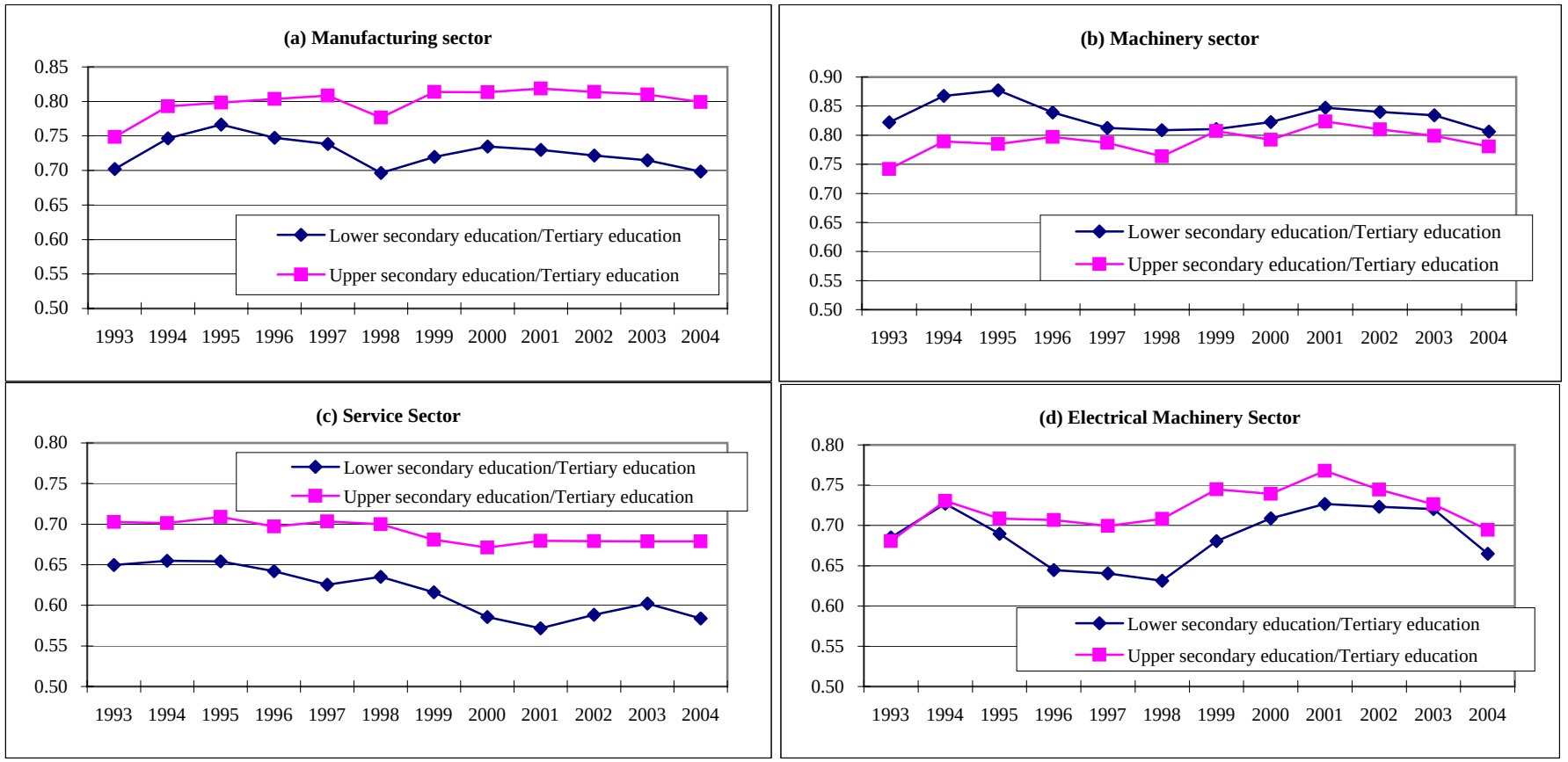

Figure 4. Nominal Wage Rate Trends for Different Educational Groups: Korea

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

Table 1. Wage Share by Educational Attainment

	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

† 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 2. International Outsourcing in 1990, 1995, and 2000:
Imported Inputs and Exported Intermediate Goods as a Percentage Share of Output

(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 inputs within mfg.		0.29	0.18	0.17	0.19	0.02	8.97
Exported intermediate goods to Asia as a percentage share of output in manufacturing							
	Narrow		0.41	0.69	0.68	0.28	68.83
	Broad		0.84	1.30	1.72	0.88	103.63
Exported intermediate goods to Asia as a percentage share of output in the electrical machinery industry							
	Narrow		1.42	2.41	1.87	0.45	31.83
	Broad		1.76	2.99	4.05	2.29	130.06

(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 inputs within mfg.		n.a.	0.11	0.15	0.65	0.55	500.04
Exported intermediate goods to Asia as a percentage share of output in manufacturing							
	Narrow		0.06	0.09	0.14	0.08	121.63
	Broad		0.15	0.22	0.38	0.24	162.18
Exported intermediate goods to Asia as a percentage share of output in the electrical machinery industry							
	Narrow		0.87	0.92	2.48	1.61	184.20
	Broad		1.19	1.30	5.43	4.24	356.43

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.

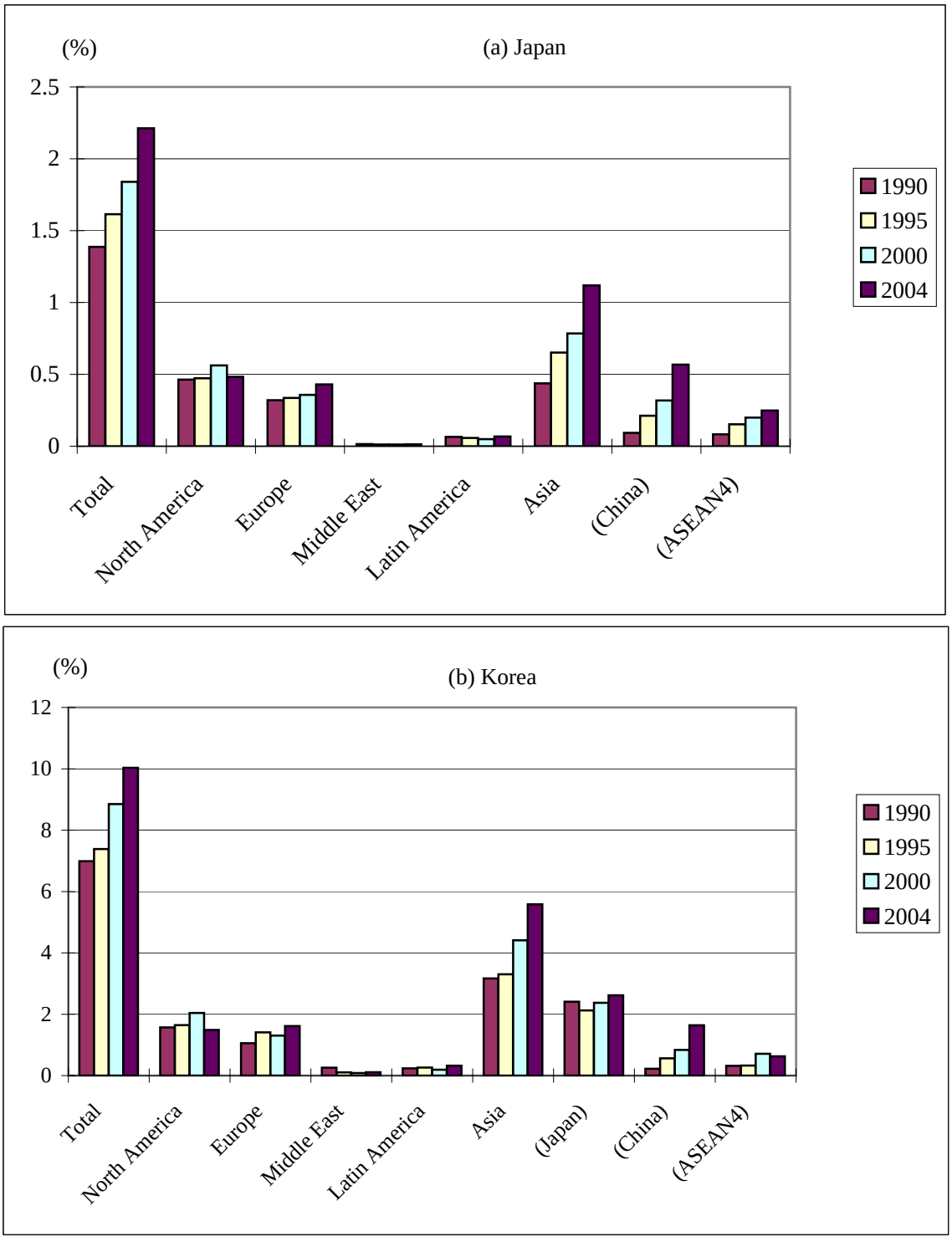

Figure 3. Narrow Outsourcing to Different Regions: Japan and Korea
(All Manufacturing Industries Except Energy-Related Industries)
Sources: Authors' calculations based on the JIP Database 2006, Japan's Input-Output Tables, Balance of Payment Statistics, Korean Input-Output Tables, and UN Comtrade data.

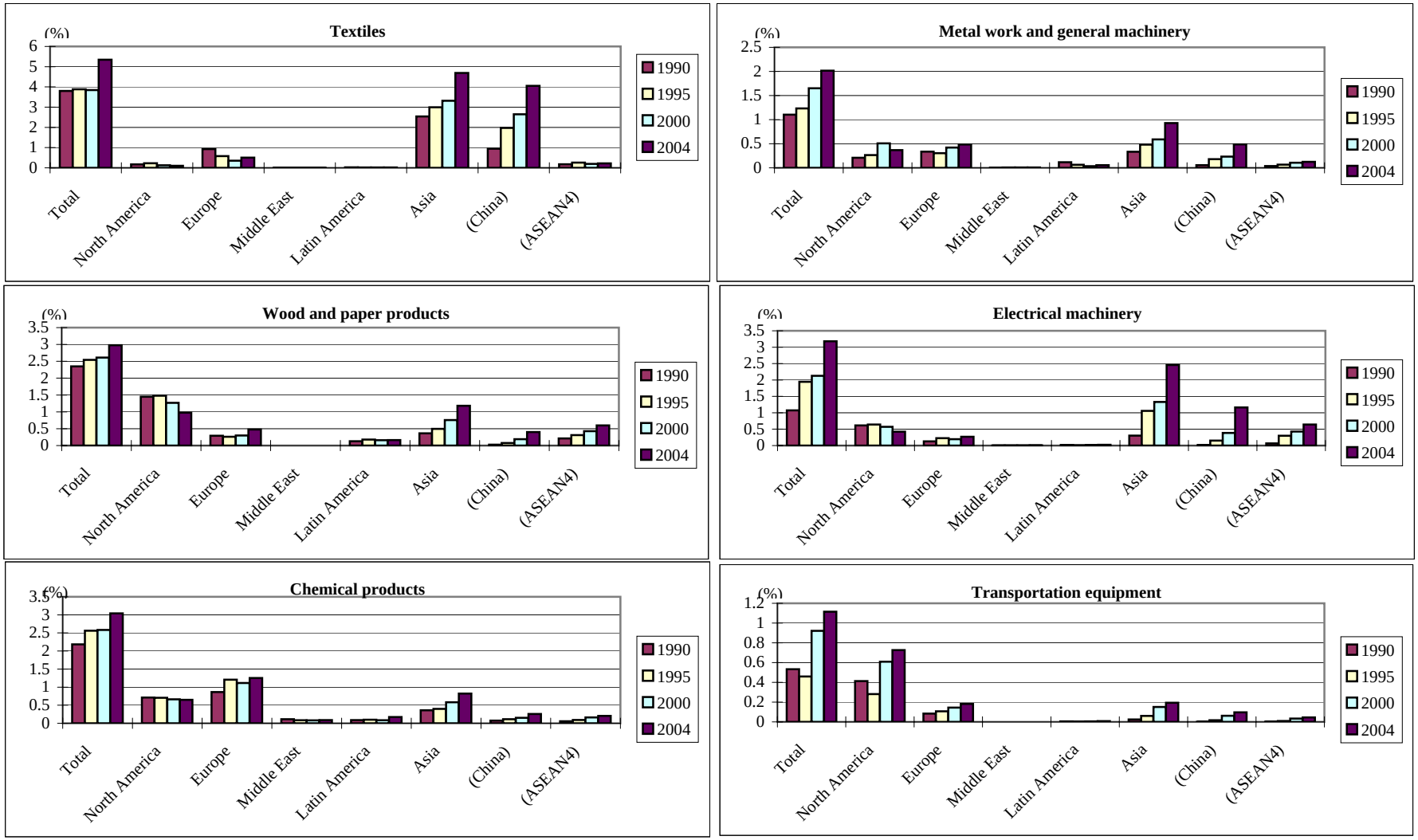

Figure 4. Japan's Narrow Outsourcing to Different Regions (by Industry)

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

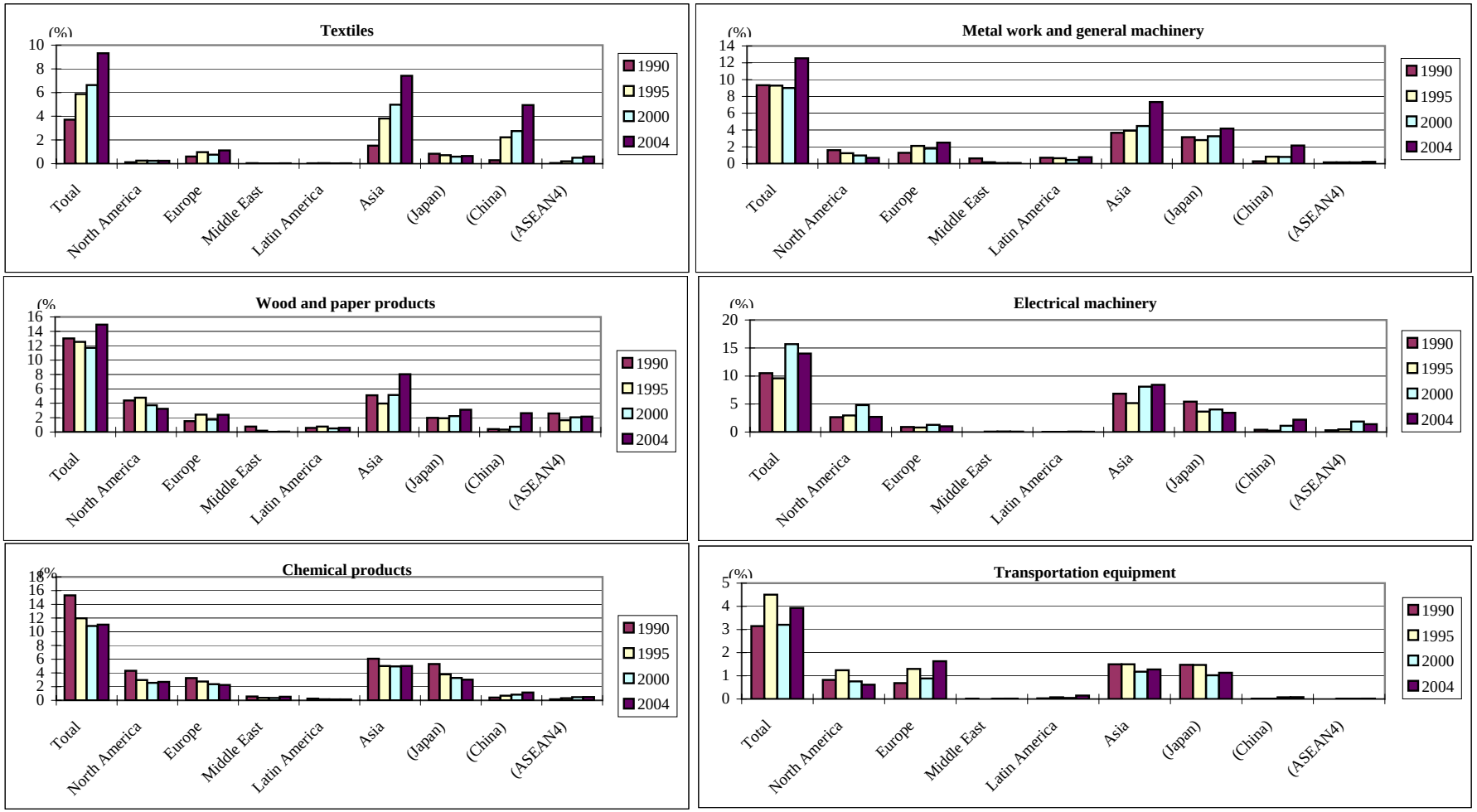

Figure 5. Korea's Narrow Outsourcing to Different Regions (by Industry)

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

Table 3. Elasticities Calculated from Estimations of Translog Cost Functions: Narrow Measure of Outsourcing, Japan

		Changes in: Capital		Value added		R&D		Outsourcing Total		Outsourcing of assembly Asia		MNEshare		Wages Lower sec.		Upper sec.		Tertiary	
Lower sec. edu.	(1)	0.298	***	0.049	***	0.575	***	0.627		-0.804		0.070	***						
		(0.032)		(0.010)		(0.219)		(0.427)		(0.780)		(0.022)							
	(2)	0.301	***	0.045	***	0.551	**	0.421		-0.712		0.066	***	-0.161		-0.213		0.374	***
		(0.032)		(0.010)		(0.218)		(0.430)		(0.776)		(0.022)		(0.233)		(0.263)		(0.128)	
Upper sec. edu.	(1)	-0.167	***	-0.023	***	-0.170	*	-0.763	***	-0.167		-0.051	***						
		(0.013)		(0.004)		(0.088)		(0.172)		(0.314)		(0.009)							
	(2)	-0.163	***	-0.024	***	-0.167	*	-0.674	***	-0.147		-0.046	***	-0.074		0.149		-0.075	
		(0.013)		(0.004)		(0.086)		(0.171)		(0.308)		(0.009)		(0.092)		(0.131)		(0.068)	
Tertiary edu.	(1)	0.114	***	0.011	***	-0.056		0.985	***	0.811	**	0.047	***						
		(0.014)		(0.004)		(0.097)		(0.190)		(0.347)		(0.010)							
	(2)	0.105	***	0.015	***	-0.046		0.956	***	0.717	**	0.043	***	0.237	***	-0.135		-0.101	
		(0.014)		(0.004)		(0.095)		(0.186)		(0.338)		(0.009)		(0.081)		(0.123)		(0.091)	

		Changes in: Capital		Value added		R&D		Outsourcing NA		EUR		ASIA		MNEshare		Wages 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: Capital		Value added		R&D		Outsourcing NA		EUR		China		ASEAN4		MNEshare		Wages 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. Elasticities Calculated from Estimations of Translog Cost Functions: Broad Measure of Outsourcing, Japan

		Changes in: Capital		Value added		R&D		Outsourcing Total		Outsourcing of Assembly Asia		MNEshare		Wages Lower sec.		Upper sec.		Tertiary	
Lower sec. edu.	(1)	0.269	***	0.029	***	0.825	***	2.145	***	0.571	*	0.041	**						
		(0.031)		(0.009)		(0.207)		(0.221)		(0.320)		(0.021)							
	(2)	0.270	***	0.029	***	0.813	***	2.109	***	0.557	*	0.040	*	-0.649	***	0.319		0.331	***
		(0.031)		(0.009)		(0.208)		(0.228)		(0.320)		(0.021)		(0.220)		(0.239)		(0.124)	
Upper sec. edu.	(1)	-0.152	***	-0.013	***	-0.304	***	-1.114	***	-0.423	***	-0.035	***						
		(0.012)		(0.004)		(0.080)		(0.086)		(0.124)		(0.008)							
	(2)	-0.147	***	-0.015	***	-0.313	***	-1.133	***	-0.392	***	-0.032	***	0.111		-0.009		-0.102	*
		(0.012)		(0.004)		(0.079)		(0.086)		(0.121)		(0.008)		(0.084)		(0.118)		(0.063)	
Tertiary edu.	(1)	0.106	***	0.005		0.030		0.661	***	0.405	***	0.038	***						
		(0.015)		(0.004)		(0.097)		(0.104)		(0.149)		(0.010)							
	(2)	0.096	***	0.009	**	0.053		0.720	***	0.359	**	0.032	***	0.209	***	-0.185		-0.024	
		(0.014)		(0.004)		(0.094)		(0.102)		(0.145)		(0.009)		(0.079)		(0.114)		(0.088)	

		Changes in: Capital		Value added		R&D		Outsourcing NA		Outsourcing EUR		Outsourcing ASIA		MNEshare		Wages 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: Capital		Value added		R&D		Outsourcing NA		EUR		China		ASEAN4		MNEshare		Wages 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 5. Elasticities Calculated from Estimations of Translog Cost Functions: Narrow Measure of Outsourcing, Korea

		Changes in: Capital		Value added		R&D		Outsourcing Total		Outsourcing of Assembly Asia		MNEshare		Wages Lower sec.		Upper sec.		Tertiary	
Lower sec. edu.	(1)	0.119	*	0.296	***	0.042		0.003		-5.392	***	25.826							
		(0.072)		(0.034)		(1.118)		(0.301)		(1.297)		(117.8)							
	(2)	0.192	***	0.242	***	-0.319		-0.125		-5.033	***	115.97		0.017		0.274	*	-0.291	**
		(0.069)		(0.034)		(1.064)		(0.287)		(1.238)		(113.2)		(0.143)		(0.145)		(0.126)	
Upper sec. edu.	(1)	-0.119	***	-0.059	***	-0.545		-0.002		1.022	**	-94.54	**						
		(0.028)		(0.013)		(0.428)		(0.115)		(0.496)		(45.09)							
	(2)	-0.110	***	-0.052	***	-0.684		-0.048		0.731		-110.6	**	0.104	*	-0.084		-0.020	
		(0.027)		(0.013)		(0.419)		(0.113)		(0.489)		(44.52)		(0.055)		(0.097)		(0.073)	
Tertiary edu.	(1)	0.122	**	-0.088	***	0.872		0.002		1.703	*	139.66	*						
		(0.050)		(0.023)		(0.774)		(0.209)		(0.898)		(81.58)							
	(2)	0.060		-0.067	***	1.328	*	0.158		1.957	**	109.44		-0.183	**	-0.033		0.216	*
		(0.047)		(0.022)		(0.721)		(0.195)		(0.837)		(76.24)		(0.079)		(0.121)		(0.124)	

		Changes in: Capital		Value added		R&D		Outsourcing NA		Outsourcing EUR		Outsourcing ASIA		MNEshare		Wages 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: Capital		Value added		R&D		Outsourcing NA		EUR		Japan		China		ASEAN4		MNEshare		Wages 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		68.61							
		(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	**	49.97		-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 6. Elasticities Calculated from Estimations of Translog Cost Functions: Broad Measure of Outsourcing, Korea

		Changes in: Capital		Value added		R&D		Outsourcing Total		Outsourcing of Assembly Asia		MNEshare		Wages Lower sec.		Upper sec.		Tertiary	
Lower sec. edu.	(1)	0.116		0.308	***	0.083		0.185		-3.207	***	33.15							
		(0.072)		(0.034)		(1.113)		(0.190)		(0.712)		(117.4)							
	(2)	0.193	***	0.256	***	-0.305		0.227		-3.222	***	123.02		0.034		0.261	*	-0.295	**
		(0.069)		(0.034)		(1.057)		(0.181)		(0.677)		(112.5)		(0.142)		(0.145)		(0.126)	
Upper sec. edu.	(1)	-0.119	***	-0.062	***	-0.553		-0.054		0.643	**	-95.86	**						
		(0.028)		(0.013)		(0.427)		(0.073)		(0.273)		(45.03)							
	(2)	-0.111	***	-0.055	***	-0.702	*	-0.083		0.473	*	-111.9	**	0.099	*	-0.079		-0.021	
		(0.027)		(0.013)		(0.418)		(0.071)		(0.269)		(44.43)		(0.055)		(0.097)		(0.073)	
Tertiary edu.	(1)	0.124	**	-0.090	***	0.859		-0.028		0.955	*	137.25	*						
		(0.050)		(0.024)		(0.773)		(0.132)		(0.495)		(81.57)							
	(2)	0.061		-0.071	***	1.350	*	-0.006		1.245	***	107.22		-0.186	**	-0.034		0.220	*
		(0.047)		(0.023)		(0.719)		(0.123)		(0.461)		(76.11)		(0.079)		(0.121)		(0.124)	

		Changes in: Capital		Value added		R&D		Outsourcing NA		Outsourcing EUR		Outsourcing ASIA		MNEshare		Wages 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: Capital		Value added		R&D		Outsourcing NA		EUR		Japan		China		ASEAN4		MNEshare		Wages 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 7. 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	0.627	0.226	3,238	-0.38%	2,288,373	1,445,508	-842,865	-36.8%
	Broad	2.145	0.906	44,488	-5.28%	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	-0.763	0.226	-10,194	2.20%	5,924,006	5,460,713	-463,293	-7.8%
	Broad	-1.114	0.906	-59,796	12.91%	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	0.985	0.226	5,299	4.20%	2,383,392	2,509,664	126,272	5.3%
	Broad	0.661	0.906	14,282	11.31%	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	0.627	0.181	299	-0.34%	263,338	175,511	-87,828	-33.4%
	Broad	2.145	2.349	13,269	-15.11%	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	-0.763	0.181	-1,474	1.29%	1,066,191	951,938	-114,253	-10.7%
	Broad	-1.114	2.349	-27,892	24.41%	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	0.985	0.181	937	2.92%	524,383	556,422	32,039	6.1%
	Broad	0.661	2.349	8,144	25.42%	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.

Table 8. Implied Changes in the Demand for Workers and Actual Increases in International Outsourcing in the Japanese Manufacturing Sector, Impact of Outsourcing of Assembly to Asia: 1995-2000

<Impact of assembly outsourcing to Asian countries>

		Estimated elasticity	Change in assembly 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: All manufacturing sectors									
Lower secondary education									
Asia	Narrow	-0.804	-0.001	19	0.00%	2,288,373	1,445,508	-842,865	-36.8%
	Broad	0.571	0.419	5,476	-0.65%	2,288,373	1,445,508	-842,865	-36.8%
Upper secondary education									
Asia	Narrow	-0.167	-0.001	10	0.00%	5,924,006	5,460,713	-463,293	-7.8%
	Broad	-0.423	0.419	-10,498	2.27%	5,924,006	5,460,713	-463,293	-7.8%
Tertiary education									
Asia	Narrow	0.811	-0.001	-20	-0.02%	2,383,392	2,509,664	126,272	5.3%
	Broad	0.405	0.419	4,046	3.20%	2,383,392	2,509,664	126,272	5.3%

		Estimated elasticity	Change in assembly 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: Electrical machinery									
Lower secondary education									
Asia	Narrow	-0.804	-0.535	1,134	-1.29%	263,338	175,511	-87,828	-33.4%
	Broad	0.571	1.051	1,580	-1.80%	263,338	175,511	-87,828	-33.4%
Upper secondary education									
Asia	Narrow	-0.167	-0.535	951	-0.83%	1,066,191	951,938	-114,253	-10.7%
	Broad	-0.423	1.051	-4,738	4.15%	1,066,191	951,938	-114,253	-10.7%
Tertiary education									
Asia	Narrow	0.811	-0.535	-2,277	-7.11%	524,383	556,422	32,039	6.1%
	Broad	0.405	1.051	2,232	6.97%	524,383	556,422	32,039	6.1%

Source: Authors' calculation.

Table 9. Implied Changes in Demand for Workers and Actual Increase in International Outsourcing in the Korean 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)
Korea									
Lower secondary education									
Japan	Broad	3.928	0.248	8,916	-2.30%	916,603	529,077	-387,526	-42.3%
China	Broad	-4.684	0.606	-26,008	6.71%	916,603	529,077	-387,526	-42.3%
ASEAN4	Broad	4.880	0.458	20,500	-5.29%	916,603	529,077	-387,526	-42.3%
Assembly	Broad	-3.207	0.159	-4,667	1.20%	916,603	529,077	-387,526	-42.3%
Upper secondary education									
Japan	Broad	0.026	0.248	146	-0.03%	2,246,463	1,739,751	-506,712	-22.6%
China	Broad	0.057	0.606	772	-0.15%	2,246,463	1,739,751	-506,712	-22.6%
ASEAN4	Broad	-2.150	0.458	-22,135	4.37%	2,246,463	1,739,751	-506,712	-22.6%
Assembly	Broad	0.643	0.159	2,294	-0.45%	2,246,463	1,739,751	-506,712	-22.6%
Tertiary education									
Japan	Broad	-2.512	0.248	-5,974	17.58%	960,244	926,272	-33,972	-3.5%
China	Broad	2.850	0.606	16,579	-48.80%	960,244	926,272	-33,972	-3.5%
ASEAN4	Broad	0.478	0.458	2,105	-6.20%	960,244	926,272	-33,972	-3.5%
Assembly	Broad	0.955	0.159	1,456	-4.28%	960,244	926,272	-33,972	-3.5%

		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)
Korea: Electrical machinery sector									
Lower secondary education									
Japan	Broad	3.928	0.088	236	-0.86%	68,087	40,735	-27,352	-40.2%
China	Broad	-4.684	1.598	-5,098	18.64%	68,087	40,735	-27,352	-40.2%
ASEAN4	Broad	4.880	2.073	6,887	-25.18%	68,087	40,735	-27,352	-40.2%
Assembly	Broad	-3.207	4.128	-9,012	32.95%	68,087	40,735	-27,352	-40.2%
Upper secondary education									
Japan	Broad	0.026	0.088	10	-0.01%	417,246	342,827	-74,419	-17.8%
China	Broad	0.057	1.598	379	-0.51%	417,246	342,827	-74,419	-17.8%
ASEAN4	Broad	-2.150	2.073	-18,593	24.98%	417,246	342,827	-74,419	-17.8%
Assembly	Broad	0.643	4.128	11,077	-14.88%	417,246	342,827	-74,419	-17.8%
Tertiary education									
Japan	Broad	-2.512	0.088	-363	-3.05%	163,977	175,903	11,926	7.3%
China	Broad	2.850	1.598	7,471	62.64%	163,977	175,903	11,926	7.3%
ASEAN4	Broad	0.478	2.073	1,625	13.63%	163,977	175,903	11,926	7.3%
Assembly	Broad	0.955	4.128	6,462	54.18%	163,977	175,903	11,926	7.3%

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 machines
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 Equipment
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
lower secondary edu.2	750	0.1809	0.0762	0.0501	0.4592
upper secondary edu.2	750	0.4924	0.0466	0.3094	0.6255
tertiary edu.2	750	0.2694	0.0936	0.0771	0.4891
Part-time2	750	0.0311	0.0261	0.0010	0.1549
Self-employed2	750	0.0263	0.0379	0.0000	0.2581
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