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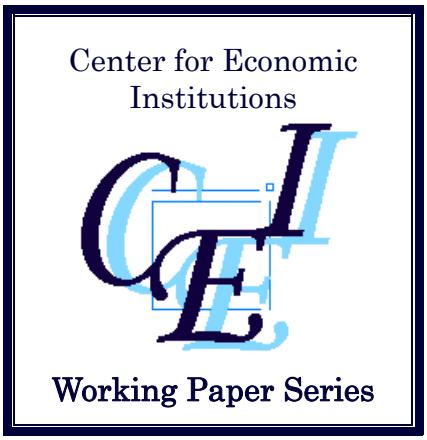

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The Impact of Outsourcing on the Japanese and South Korean Labor Markets: International Outsourcing of Intermediate Inputs and Assembly in East Asia

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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, this paper, utilizing the *Asian International Input-Output Tables*, incorporates the outsourcing of assembly.

The econometric results indicate 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 both in Japan and Korea. Moreover, the international outsourcing of assembly has a significant impact on skill upgrading, particularly in the Korean electrical machinery sector.

JEL Classifications: F14, F16
Keywords: Outsourcing, labor demand, skill upgrading, Japan, Korea, manufacturing, Asian International Input-Output Tables

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1. Introduction

In East Asia, the international division of labor has made significant progress in the last decade. The production of individual commodities within an industry is 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. Since there are 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 work by Feenstra and Hanson (1996a, 1996b, 1999) has been followed by Falk and Koebel (2002), Strauss-Kahn (2004), Hijzen et al. (2005), Ekholm and Hakkala (2006), and others. In the case of Japan, this issue has been investigated by Sakurai (2000),

Ito and Fukao (2005a, 2005b), Sasaki and Sakura (2005), and Yamashita (2006). Although the studies by Sakurai (2000) and Ito and Fukao (2005a), using 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) 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 et al. (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. In Section 4, we estimate 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 and Korea. According to various labor statistics, in both countries, 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.[1] Table 1 provides some summary statistics for labor markets in

[1] 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).

Japan and Korea. The first column of Table 1 shows the wage shares of employees with lower secondary, upper secondary, and tertiary education in 2000, while the other columns show the average annual change in the wage share, in labor input, and in the nominal wage rate of each education group. In both countries, we can see similar trends of an increase in the wage share of workers with tertiary education and a decrease in the wage share of workers with lower secondary education. However, the increase in the wage share of workers with upper secondary education in manufacturing is much smaller in Korea than in Japan. Moreover, the wage share of workers with tertiary education is much higher in Korea.

Although, as shown in Table 1, relative employment increased in favor of workers with tertiary education, the nominal wage of workers with tertiary education rose much slower than that of workers with lower or secondary education in the manufacturing sector in the 1990s. However, after 2000, the wage gap between workers with tertiary education and workers with lower or upper secondary education expanded both in Japan and Korea.[2,3]

The decrease in wage rates for unskilled employees (those with secondary education) relative to

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Part-time and self-employed workers are excluded from our analysis because of the unavailability of information on the education level of these workers. For Japan, we mainly rely on labor statistics taken from the JIP Database 2006, which is described in more detail in the Appendix. For Korea, labor data are taken from the *Economically Active Population Survey* by the Korean National Statistical Office and the *Basic Statistics Survey of Wage Structure* by the Ministry of Labor. For more a detailed description of labor market trends in Korea and Japan, see Ahn et al. (2008).

[2] Previous studies such as Sakurai (2004) and OECD (1996) show that until the first half of the 1990s there was 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.

[3] Looking at annual wage data, we find that the wage gap in Korea has been broadly expanding since the mid-1990s, both in manufacturing and in services.

wage rates for skilled employees (those with tertiary education) in recent years may reflect a shift in demand towards skilled labor.[4] As mentioned by Sasaki and Sakura (2005), the continuing increase in the supply of workers with tertiary education in Japan and Korea 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 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) have been greater than those in the quantity of skilled labor input (i.e., those with tertiary education). Moreover, in both Japan and Korea, the nominal wage of skilled labor has also risen faster than that of unskilled labor in recent years. 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.

[4] As is widely known, the enrollment rate in tertiary education increased rapidly during Japan's high-speed growth era. Moreover, under the seniority wage system, workers with long experience in a company receive a higher wage and, consequently, wages for elder workers tend to be higher even though they did not receive more formal education. Japanese labor statistics (for example, Ministry of Health, Labour and Welfare, 2004) indicate that both the average age and the average duration of service of workers with lower education are higher than those of workers with higher education. As a result, it is sometimes observed that younger employees with tertiary education hold less skilled jobs receiving a lower wage, or that they receive a lower wage even though they hold skilled jobs. Therefore, educational attainment may not be the best measure of workers' skill levels. In 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 et al. (2005), using information on employees' occupations, found that international outsourcing had a strong negative impact on the demand for unskilled labor in 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 shares, since data on wage rates for each job type were not available.

2.2 Measurement of Outsourcing

A number of recent studies, using a variety of data sources, 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 et al. (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 the 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 domestic output in industry i.

We use direct information about an industry's 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:

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

where M_i is total imports in industry i. We observe the share of imported 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 linear interpolation of m_{ii}/M_i based on the 1990, 1995, and 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:

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

We observe industry i's use of imported intermediate inputs in industry j as the 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 et al. (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* for 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.[5] 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.[6]

Table 2 shows the trends in international outsourcing for Japan and Korea during the period from 1990 to 2000. 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

[5] 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.

[6] We observe the shares of Japan's (or Korea's) exports used as intermediate inputs in other Asian countries in industry i and j, *xiic/Xi* and *xijc/Xi* respectively, in 1990, 1995, and 2000, while we observe exports in relation to domestic output every year. We use a linear interpolation of *xiic/Xi* and *xijc/Xi* based on the 1990, 1995, and 2000 values in order to obtain values of z_i^{NA} and z_i^{BA} for every year.

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). Thus, we found that international outsourcing in the Japanese manufacturing sector increased during the 1990s, though Campa and Goldberg (1997) found that Japanese manufacturing industries experienced a reduction in international outsourcing during the period from 1974 to 1993, while the United States and the United Kingdom experienced rapid increases in industry import penetration and imported input use during the same period. The contrast implies that there was a change in the trend in international outsourcing in Japan in the 1990s.[7]

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.[8] Japan and Korea show

[7] Calculating the narrow and broad outsourcing measures for 1980 for Japan, we confirmed 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 attributable to the appreciation of the yen 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.

[8] 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 in 1996. Although this may be a strong assumption, it will not substantially affect the outsourcing measures for manufacturing industries because the share of imported

similar regional distributions: Outsourcing to Asia, particularly to China, has increased conspicuously since 1990. In the case of Japan, the most conspicuous 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, 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.[9,10]

3. Econometric Analysis

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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 in the Extended Input-Output Tables published by the Ministry of Economy, Trade and Industry annually until 2000 and for the years 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.

[9] For more detailed analyses on outsourcing and regional trade patterns, see Ahn et al. (2008).

[10] 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.

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 the UN COMTRADE database in the case of Korea. Utilizing the JIP Database 2006 allows us to examine the issue for the 52 manufacturing sectors for the period from 1988 to 2002 in the case of Japan. For Korea, we examine the issue for the 34 manufacturing sectors for the period from 1993 to 2003.[11]

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 which has been widely employed in the literature on the effects of outsourcing on the skilled-unskilled wage differential or skill upgrading. As in Berman et al. (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:

[11] We follow the JIP Database 2006 industry classification (108 industries including 52 manufacturing industries) for Japan and the SNA industry classification (78 industries including 34 manufacturing industries) for Korea.

$$\ln C_i(w,x,z) = \beta_i + \sum_{j=1}^{S}\alpha_j \ln w_{ij} + \frac{1}{2}\sum_{j=1}^{S}\sum_{s=1}^{S}\gamma_{js}\ln w_{ij}\ln w_{is} + \sum_{k=1}^{K}\phi_k \ln x_{ik}$$
$$+ \frac{1}{2}\sum_{j=1}^{S}\sum_{k=1}^{K}\delta_{jk}\ln w_{ij}\ln x_{ik} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K}\phi_{kl}\ln x_{ik}\ln x_{il} + \frac{1}{2}\sum_{r=1}^{R}\sum_{t=1}^{R}\kappa_{rt}z_{ir}z_{it} \qquad (7)$$
$$+ \sum_{r=1}^{R}\kappa_r z_{ir} + \frac{1}{2}\sum_{j=1}^{S}\sum_{r=1}^{R}\lambda_{jr}z_{ir}\ln w_{ij} + \frac{1}{2}\sum_{k=1}^{K}\sum_{r=1}^{R}\lambda_{kr}z_{ir}\ln x_{ik}$$

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:

$$\theta_{ij} = \alpha_j + \sum_{s=1}^{S}\gamma_{js}\ln w_{is} + \sum_{k=1}^{K}\delta_{jk}\ln x_{ik} + \sum_{r=1}^{R}\lambda_{jr}z_{ir} \qquad (8)$$

(j=1, …., S; s=1, …., S; k=1, …, K; 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} captures 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 8) 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. Time-invariant industry-specific effects are controlled for by including industry dummies.[12] Because the sum of labor cost shares equals 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:

[12] Following Hijzen et al. (2005) and Ekholm and Hakkala (2006), we estimate the system of share equations rather than estimating a single cost share equation. Moreover, we control for industry-specific time-invariant effects by including industry dummies rather than by taking first differences. Like Hijzen et al. (2005), we believe that estimating the system simultaneously will yield more efficient results than single equation estimation when the disturbances are correlated across equations. Also, as shown by Griliches and Hausman (1986), first-differencing can exacerbate the errors in variables problem.

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

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

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

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.[13]

3.2 Estimation Results

Tables 3 and 4 report the elasticities derived from the regression results focusing on the narrow measure of outsourcing for Japan and Korea.[14] 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 (and Japan in the case of Korea).[15] Outsourcing to regions

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

[14] Although the results of the broad outsourcing are mostly consistent with those of narrow outsourcing presented in Tables 3 and 4, we only report the elasticities derived from narrow outsourcing. The results of estimating the system of equations using pooled iterated SUR (pooled ISUR), derived elasticities for all the explanatory variables, and summary statistics for variables used in our regression analysis may be obtained from the authors upon request.

[15] In our definition, NA excludes Mexico, EUR includes Eastern Europe and Russia, and ASIA includes

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 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. Although the results of specification (2) are mostly consistent with those of specification (1), we report the results of specification (1).[17]

INSERT Tables 3 and 4

According to panel (a) of Table 3, in the case of Japan, 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

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the area from Pakistan to the east. ASEAN 4 refers to Indonesia, Malaysia, the Philippines, and Thailand.

[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 elasticities 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 those results using outsourcing measures distinguishing between imports from different regions rather than imports from low- and high-income countries.

[17] Specification (2) may suffer from an endogeneity problem in that industry wages may be affected by the industry's wage cost shares for different workers. Moreover, estimated coefficients of the industry-specific wage levels are not statistically significant in many cases.

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 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 0.8 percent, although the impact on the demand for workers with secondary education is not statistically significant.

In panels (b) and (c) 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 the 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.[18]

According to panel (a) of Table 4, unlike in the case of Japan, total outsourcing does not have

[18] As for the elasticity with respect to R&D, which is not shown 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 et al. (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, 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.

significant effects on the demand for workers in Korea. However, outsourcing of assembly 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 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 (panel (c) of Table 4). 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.

According to our results in Tables 3 and 4, outsourcing to China in particular has 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 for both Japan and Korea. In the case of Japan, total outsourcing shifts labor demand away from workers with intermediate education, which is consistent with the findings of Ekholm and Hakkala (2006) but not those of Hijzen et al. (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 et al. (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 while outsourcing to the ASEAN 4 countries tends to have 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 in the future, semi-skilled workers might be substituted by workers embodied in imported intermediates from China.[19]

[19] 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

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 impact of outsourcing on the demand for workers with tertiary education, 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.[20]

The calculation of the estimate is summarized in Table 5. As shown in the upper panel of the table, in the case of Japan, the actual change in narrow outsourcing to all countries in the manufacturing sector during the period is 0.226 percentage points, and the actual change in outsourcing to Asia is 0.134 percentage points. Similarly, the actual changes in outsourcing to China and ASEAN 4 are positive, though the actual change of outsourcing of assembly to Asia was negative but small in the case of Japan. According to our estimates using these values, the actual change in outsourcing to all countries is associated with an increase in the demand for workers with tertiary

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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 Table 3 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.

[20] Although we calculated the impact of outsourcing (using both the narrow and the broad definition) on the demand for workers in all the skill groups, we do not show all the results here due to space constraints. The results may be obtained from the authors upon request.

education by 5,299 workers, while the actual change in outsourcing to Asia is associated with an increase in the demand for workers with tertiary education by 12,338 workers. Outsourcing to China has the largest impact on demand for workers with tertiary education, which is associated with an increase by 12,655 workers. As for the outsourcing of assembly to Asia, its actual change was negative, which implies that the outsourcing of assembly to Asia decreased the demand for workers with tertiary education by 20 workers.[21]

In the case of Korea, we do not report the estimate of the number of employees affected by the change in outsourcing in the cases where estimated elasticities were not significant. The actual change in outsourcing to China is associated with an increase in the demand for workers with tertiary education by 9,774 workers, while the actual change in outsourcing to Japan is associated with a reduction in the demand for such workers by 7,022. 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. Unlike in the case of Japan, outsourcing of assembly to Asia actually increased for the period in the case of Korea, being associated with an increase in the demand for workers with tertiary education by 848 workers.

In the case of Japan, the actual number of workers with tertiary education in manufacturing

[21] However, the broad measure of outsourcing of assembly to Asia actually increased by 0.42 percentage points and the increase is estimated to be associated with an increase in the demand for workers with tertiary education by 4,046 workers.

increased by 126,272 during the period (from 2.38 million in 1995 to 2.51 million in 2000), while it decreased by 33,972 (from 0.96 million in 1995 to 0.93 million in 2000) in the case of Korea. Therefore, although it may be difficult to judge whether the positive impact of outsourcing on the demand for workers with tertiary education is large or not, we may say that it is somewhat significant. In the case of outsourcing from Japan to Asia, the implied increase in the demand for workers with tertiary education is 12,338 workers, which accounts for approximately 10 percent of the actual increase in the total number of employees with tertiary education during the period.[22] In the case of Korea, outsourcing to China is associated with an increase by 9,774 workers with tertiary education, although the actual number decreased by 33,972 workers.

Furthermore, we conduct a similar calculation for the electrical machinery industry where the increase in outsourcing to Asia was conspicuous for both Japan and Korea during the period from 1995 to 2000 (the lower panel of Table 5). The actual change in outsourcing to Asia is associated with an increase in the demand for workers with tertiary education by 5,517 workers in the case of Japan. Comparing this figure with that in the upper panel of Table 5, we find that nearly half of the labor demand change induced by outsourcing to Asia is driven by the electrical machinery industry alone. Similarly, in Korea, too, skill upgrading induced by outsourcing is substantial in the electrical machinery sector. In particular, a significant increase in the demand for workers with tertiary education is induced by the increase in outsourcing of assembly to Asia, which is in contrast with the

[22] When we use the broad measure of outsourcing, the impact is much larger, accounting for 22 percent of the actual increase in the total number of employees with tertiary education.

case of Japan.

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, the relative wage shares of workers with different levels of 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, 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. In the case of Korea, the outsourcing of assembly to Asia has significantly contributed to the shift in the domestic labor demand towards workers with tertiary education. Thus, 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, the impact in Japan of the outsourcing of assembly was not very great. Possible explanations for the small impact of the outsourcing of assembly on skill upgrading in Japan include the following. First, the industry classification is relatively more disaggregated for Japan than for Korea. For example, in the case of Japan, semiconductor devices and electronic parts are classified into two different industries while they are classified into one industry in the case of Korea. Moreover, motor vehicle parts and accessories form one industry in the case of Japan but not in the case of Korea. Although the narrow measure of outsourcing is thought to better represent fragmentation than the broad measure which includes imported inputs from all industries, it may not be without problems because it is entirely based on the way industries are classified.[23] In fact, when we focus on the broad measure of outsourcing, the increase was greater for Japanese manufacturing than for Korean manufacturing (an increase of 0.419 percentage points versus 0.159 percentage points from 1995 to 2000). A better industry grouping or even the development of a new measure of outsourcing which comes much closer to the essence of fragmentation is an issue that deserves further attention. Second, affiliates of Japanese firms in East Asia may be less dependent than their Korean counterparts on

[23] Hijzen et al. (2005: 865, fn. 5) also mention this point.

imported parts from their home country, because the former tend to have longer experience in operating abroad and tend to be more advanced in developing local procurement networks in the region.

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, we found that both in Japan and Korea, international outsourcing 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/en/database/d05.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 the 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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Table 1. Wage Share in 2000 and Annual Percentage Change by Educational Attainment

	Wage share 2000 (%)	Average annual change (%)					
		1990†-2000			2000-2002*		
		Wage share	Labor input	Wage rate	Wage share	Labor input	Wage rate
(a) Japan							
Mfg.	100.0						
LS	14.0	-4.67	-5.60	2.78	-8.98	-12.54	-1.45
US	54.3	0.70	-1.05	2.38	-0.37	-4.91	-1.17
TR	31.6	3.66	2.19	1.48	4.48	-1.06	-0.21
Services	100.0						
LS	6.1	-4.95	-4.40	1.75	-7.76	-7.85	-3.87
US	41.6	-0.95	0.04	1.50	-2.49	-2.56	-3.32
TR	52.3	2.80	4.71	0.87	3.17	0.84	-1.00
(b) Korea							
Mfg.	100.0						
LS	14.2	-5.57	-5.05	11.03	-7.04	-11.52	7.64
US	51.8	0.32	0.62	12.00	-2.31	-8.52	8.75
TR	33.9	4.38	6.42	9.90	6.48	-2.54	9.35
Services	100.0						
LS	8.0	-4.83	-1.15	7.78	-11.45	-15.90	7.93
US	27.6	-2.60	1.05	9.09	-4.88	-11.69	8.40
TR	64.4	2.71	7.01	10.19	3.52	-5.91	8.03

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

* For Korea, the wage share data are for the year 2004.

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

Table 2. International Outsourcing in 1990, 1995, and 2000

(a) Japan

Measure		1990 (%)	1995 (%)	2000 (%)	Change 1990-2000 (% points)	(%)
Imported inputs as as percentage share of output						
Manufacturing	Narrow	1.39	1.61	1.84	0.45	32.62
	Broad	4.25	4.26	5.17	0.92	21.66
Services	Narrow	0.32	0.37	0.39	0.07	22.31
	Broad	1.41	1.27	1.32	-0.10	-6.80
Services inputs within mfg.		0.18	0.17	0.19	0.02	8.97
Exported intermediate goods to Asia as a percentage share of output						
Manufacturing	Narrow	0.41	0.69	0.68	0.28	68.83
	Broad	0.84	1.30	1.72	0.88	103.63
Electrical machinery	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		1990 (%)	1995 (%)	2000 (%)	Change 1990-2000 (% points)	(%)
Imported inputs as as percentage share of output						
Manufacturing	Narrow	6.99	7.38	8.85	1.86	26.68
	Broad	15.90	15.85	17.74	1.83	11.52
Services	Narrow	0.65	0.74	1.75	1.10	169.31
	Broad	2.51	2.66	4.18	1.68	66.82
Services inputs within mfg.		0.11	0.15	0.65	0.55	500.04
Exported intermediate goods to Asia as a percentage share of output						
Manufacturing	Narrow	0.06	0.09	0.14	0.08	121.63
	Broad	0.15	0.22	0.38	0.24	162.18
Electrical machinery	Narrow	0.87	0.92	2.48	1.61	184.20
	Broad	1.19	1.30	5.43	4.24	356.43

Note: Energy-related industries are excluded.

Sources: Input-Output Tables 1990, 1995, 2000 for Japan and Korea; JIP database 2006, Korea SNA data.

Table 3. Elasticities Calculated from Estimations of Translog Cost Functions: Japan

Panel (a)	Changes in Outsourcing to: All countries	Assemly to Asia	MNEshare
Lower secondary	0.627	-0.804	0.070 ***
	(0.427)	(0.780)	(0.022)
Upper secondary	-0.763 ***	-0.167	-0.051 ***
	(0.172)	(0.314)	(0.009)
Tertiary	0.985 ***	0.811 **	0.047 ***
	(0.190)	(0.347)	(0.010)

Panel (b)	Changes in Outsourcing to: NA	EUR	ASIA	MNEshare
Lower secondary	2.935 ***	2.742	-3.580 ***	0.075 ***
	(0.924)	(1.972)	(1.114)	(0.022)
Upper secondary	-0.418	-1.876 **	-0.886 *	-0.049 ***
	(0.376)	(0.801)	(0.453)	(0.009)
Tertiary	-1.100 ***	1.664 *	3.871 ***	0.041 ***
	(0.399)	(0.852)	(0.481)	(0.009)

Panel (c)	Changes in Outsourcing to: NA	EUR	China	ASEAN4	MNEshare
Lower secondary	2.544 ***	2.658	-10.26 ***	3.443	0.073 ***
	(0.906)	(1.904)	(1.567)	(3.261)	(0.021)
Upper secondary	-0.368	-2.030 **	0.819	-3.448 **	-0.049 ***
	(0.376)	(0.790)	(0.650)	(1.353)	(0.009)
Tertiary	-0.942 **	1.998 **	5.007 ***	4.070 ***	0.043 ***
	(0.396)	(0.832)	(0.685)	(1.426)	(0.009)

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: Korea

Panel (a)	Changes in Outsourcing to: All countries	Assemly to Asia	MNEshare
Lower secondary	0.003	-5.392 ***	25.826
	(0.301)	(1.297)	(117.8)
Upper secondary	-0.002	1.022 **	-94.54 **
	(0.115)	(0.496)	(45.09)
Tertiary	0.002	1.703 *	139.66 *
	(0.209)	(0.898)	(81.58)

Panel (b)	Changes in Outsourcing to: NA	EUR	ASIA	MNEshare
Lower secondary	2.117	-2.524 **	-0.193	2.646
	(1.519)	(1.278)	(0.804)	(121.3)
Upper secondary	0.650	-0.090	-0.450	-73.62
	(0.571)	(0.481)	(0.302)	(45.62)
Tertiary	-2.402 **	1.734 **	0.863	119.74
	(1.027)	(0.864)	(0.543)	(82.00)

Panel (c)	Changes in Outsourcing to: NA	EUR	Japan	China	ASEAN4	MNEshare
Lower secondary	-0.461	-1.563	5.643 ***	-5.903 ***	2.601	68.61
	(1.526)	(1.242)	(1.514)	(1.542)	(1.786)	(117.9)
Upper secondary	0.841	-0.185	-0.353	-0.011	-1.824 ***	-71.49
	(0.594)	(0.483)	(0.589)	(0.600)	(0.695)	(45.88)
Tertiary	-1.097	1.288	-2.965 ***	3.729 ***	1.373	74.77
	(1.042)	(0.848)	(1.034)	(1.053)	(1.220)	(80.58)

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

Table 5. Implied Changes in Demand for Workers with Tertiary Education: 1995-2000

	Estimated elasticity	Change in outsourcing (% points)	Implied change in labor	Estimated elasticity	Change in outsourcing (% points)	Implied change in labor
(a) Manufacturing total						
Outsourcing:	Japan			Korea		
to All countries	0.985	0.226	5,299	not significant		
to Asia	3.871	0.134	12,338	not significant		
to Japan	n.a.	n.a.	n.a.	-2.965	0.247	-7,022
to China	5.007	0.106	12,655	3.729	0.273	9,774
to ASEAN4	4.070	0.046	4,471	not significant		
of Assembly to Asia	0.811	-0.001	-20	1.703	0.052	848
(b) Electrical machinery						
Outsourcing:	Japan			Korea		
to All countries	0.985	0.181	937	not significant		
to Asia	3.871	0.272	5,517	not significant		
to Japan	n.a.	n.a.	n.a.	-2.965	0.369	-1,792
to China	5.007	0.234	6,152	3.729	0.870	5,322
to ASEAN4	4.070	0.127	2,708	not significant		
of Assembly to Asia	0.811	-0.535	-2,277	1.703	1.564	4,366

n.a. = not applicable.