IMPACT OF INTERNATIONAL TRADE ON WAGE INEQUALITY IN JAPANESE MANUFACTURING INDUSTRIES

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Abstract

This paper empirically analyzed the impact of international trade on the wage inequality between skilled and unskilled workers in Japanese manufacturing industries. This analysis is the first empirical research at the industry level, which employs the harmonized dataset of Japan's export, import, industry, and wages. The hypothesis for the analysis was that international trade, either import or export, would raise the wage gap between skilled and unskilled workers. The regression results showed that the hypothesis was not supported and that imports hurt unskilled workers at large firms while imports favored unskilled workers in small firms. The Japanese data were found inconsistent with the "Stolper-Samuelson-like" effects.

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1. INTRODUCTION

This paper analyzes the impact of international trade on wage inequality between skilled and unskilled workers in Japanese manufacturing industries.[1] The paper employs a specific-factors model to examine whether data of Japanese manufacturing industries supports the "Stolper-Samuelson-like effects". There has been little research on the effect of international trade on the skill-based wage gap in Japan. An analysis at industry level is important because small changes in wages at the aggregate level may mask a large change at industry level. This analysis is the first empirical research at the industry level, which employs the harmonized dataset of Japan's trade, industry, and wages. The sections of statistics and literature review provide background of the analysis. Following the theoretical model, an empirical specification is presented. Analysis on the results comes next, followed by conclusions.

2. STATISTICAL FACTS

Statistics show the wage inequality between different skill groups and its change in Japan. Tables 1 and 2 show the changes in relative monthly salary of workers with advanced degree during 1988-2002 period.[2] College graduates receive higher salaries than high school graduates, but the salary gap between senior high school graduates and advanced degree holders is stable over time for male workers. The gap is larger and growing for female workers. The relative salaries of female workers with four-year university degree have been increasing.

[1] Educational attainment is used as a proxy for "skill" in this analysis. Certain skills can be obtained through on-the-job training (OJT) and experience at a workplace. However, it is important to focus on formal education because skills that are generally applicable to any workplaces can only be obtained at school. OJT and experience tend to generate more firm-specific skills. Cline (1997) finds that most of the previous studies define "skilled" and "unskilled" workers either (1) as non-production versus production workers in manufacturing industries, or (2) in education distinctions, such as more educated than high school or less. He concludes the latter definition is usually considered superior, because skilled workers are often included in the production worker's category and vice versa.

[2] The relative salary income is based on nominal monthly salary, and not controlled for workers' tenure or age. Fringe benefits are not included in the relative salary income. The nominal income of workers with senior high school education is indexed as 100.

Total employment in manufacturing industries decreased 3.5% from 798 million in 1988 to 770 million in 1995. The skill composition of employment also changed. The share of workers with a junior high school education dropped from 29.7% in 1988 to 19.5% in 1995. On the other hand, the share of workers with senior high school education increased from 52.8% to 56.8%, workers with some college education increased from 4.2% to 6.8%, and workers with a university degree increased from 13.3% to 18.9%. Senior high school graduates have the largest share in employment in Japanese manufacturing industries.

Table 3 shows the growth in trade values and the changes in the relative wage of unskilled workers. Trade significantly grew during the period of 1988-1995. On average, imports measured in nominal value increased more than 50% from 15,761 billion yen in 1988 to 23,733 billion yen in 1995. Imports decreased in non-ferrous metal (18% decline) and steel (11% decline) industries but increased in other industries. A decline in export value is observed in six industries: food, textile, apparel, wood, print, and steel. However, an increase in export value in machinery industries overrode the decline.

The left half of Table 3 shows the fixed-weight average ratio of the average hourly wage high school graduates to the average hourly wage of university graduates for cells defined by industry and education category.[3] The fixed weight for each cell is the cell's average share of total employment over the period of 1988-1995. These figures are weighted relative average value of labor income, adjusted by CPI, with regard to the number of worker-hours (number of workers times number of working hours) basis. On average, unskilled workers received about 56% of labor income that skilled workers received. The inequality varies across industries. It is the largest in the food and apparel industries, where unskilled workers earned about only half that skilled workers did. The wage inequality is

[3] The relative wage of unskilled workers shown in Table 3 grew between 1988 and 1995, contrary to the findings in Tables 1 and 2. Major difference between Table 3 and Tables 1 and 2 includes that the relative wage in Table 3 is (1) adjusted by CPI, (2) calculated to obtain per actual working hour wage based on monthly salary and bonus, (3) weighted by the average share of total employment over the period of 1988-1995, and that (4) data of male and female workers are aggregated.

the smallest in the beverage, print, metal, and general machinery industries in 1988, where unskilled workers received more than 60% of the wages that skilled workers did. The wage inequality in 1995 is the smallest in chemical industry. By comparing the relative wages in 1988 and in 1995, four out of twenty industries experienced a decline in the relative wage of unskilled workers, while the rest experienced an increase in the relative wage.

The Stolper-Samuelson theorem predicts that the relative wage of unskilled workers would decline because Japan exports skilled-labor-intensive commodities and imports unskilled-labor-intensive products. As seen in the tables, however, an overview of changes in wage inequality and changes in trade at each industry does not present a clear relationship. The change in the relative wage is, in general, much smaller than the change in international trade. For example, the relative wage grew 7.59% in the beverage industry while import and export increased 79.6% and 113.24% respectively. Some industries, on the other hand, recorded larger growth in the relative wage in spite of small growth or even decline in trade. Food, chemical, and steel industries are examples of these. It requires regression analysis to confirm whether an increase in trade hurts unskilled workers.

The changes in relative labor income of university graduates exhibited in Tables 1 and 2 were rather small. Table 1 shows that the relative salary of male university graduates in manufacturing industry grew from 119.19 to 120.72 during the period of 1988-1995. Table 2 shows that the relative wage of female university graduates grew from 137.21 to 143.14 during the same period. The growth rates are only 1.3% for male workers and 4.3% for female workers. The change in relative wage of university graduates in each manufacturing industry exhibited in Table 3 is much larger. It is possible that small changes in relative wage at the aggregate level mask a large change at the industry level. It is necessary to analyze the impact of trade on relative wages at the industry level to obtain more precise results.

3. LITERATURE

Existing literature analyze how trade affects wage inequality between workers with different skill levels. A group of literature, such as Murphy and Welch (1991), Katz and Murphy (1992), Borjas, et al. (1997), Haskel (2000), and Goux and Maurin (2000), compares the impact of trade and the impact of technological changes on relative wages of skilled workers through the changes in their relative demand and relative supply.[4] They find that international trade is an element that increased the relative demand for skilled workers, increasing their relative wage, in the US and in France. Another group of literature, such as Slaughter and Swagel (1997), Borjas, et al. (1997), Jean (2000), Slaughter (2001), Krishna, et al. (2001), and Hasan, et al. (2003), explain links through which international trade with developing countries contributed to rising wage inequality between skilled and unskilled workers. The links are (1) the Stolper-Samuelson theorem, (2) the factor content of trade, and / or (3) a change in the elasticity of labor demand.

Some existing empirical studies analyze the correlation between international trade and the wages in the Japanese labor market.[5] Higuchi (1989) empirically investigates how external demand shocks affect the inter-industry wage disparities among different skills and age groups, but he does not estimate the effect of the exogenous shock (such as international trade) on wage inequality between different skill groups. Tachibanaki, et al. (1998) find that the correlation between the change in export ratio and the change in wage gap among production and non-production workers was negative and statistically significant. Their analysis does not classify workers by education attainment and other characteristics of workers. Rebick (1999) estimates how much international trade affects wages of different components of the labor markets. His approach has two major weaknesses. One is that he

[4] Extensive literature reviews on the topic include Deardorff and Hakura (1994), Cline (1997), and Freeman (2003).
[5] Tomiura (2002) analyzes the impact of imports on employment in Japanese manufacturing industries.

does not present a theory on how trade affected wages. The other is that, while his analysis covers the period 1965-1990, his dataset includes only 6 annual observations. Sakurai (2000) uses the factor content of trade approach and measures the impact of international trade on the relative wages between skilled and unskilled workers in manufacturing industries. He does not classify workers according to education attainment and other characteristics of workers. Higuchi (2001) estimates the impact of exports and imports on wage levels in each manufacturing industry at the 2-digit SIC level. He concludes that international competition, either through importing or exporting, lowers wages, on average, but he does not show whether the relative wages of workers with higher education increased. As shown above, there has been relatively little research on the effect of international trade on the wage inequality between different skill groups in manufacturing industries.

4. MODEL

The model used in this paper is based on Feenstra and Hanson (2003). It is a specific-factors model with two countries, three factors, and two industries. The specific-factors model can represent the heterogeneity in Japanese labor markets better than the standard Heckscher-Ohlin framework. The model is valid to observe the 'Stolper-Samuelson-like' effects among skilled and unskilled workers when a fixed factor exists. The production factors in the model are unskilled labor, skilled labor, and capital, and capital is assumed to be sector-specific.[6]

[6] Other assumptions for the model include:
1) Goods markets are perfectly competitive and production technology is homogeneous both at home and abroad. The change of the price of imported goods is exogenous.
2) Domestic products and imports are perfect substitutes.
3) No change in labor supply for both skilled and unskilled workers. It is also assumed that unskilled workers cannot become skilled workers. This assumption is appropriately applicable to the Japanese labor market because it is not common that workers with high school education go to college and become skilled workers while they continue working.
4) Production factors are fully employed.
5) Workers are perfectly mobile across domestic industries, but immobile across skill groups. Workers are not mobile across countries, either.

There are three industries in a country: industry 1 produces an unskilled-labor intensive intermediate good (good 1), industry 2 produces a skilled-labor intensive intermediate good (good 2), and final good industry domestically assembles using intermediate goods. Intermediate goods are tradable: good 1 is importable and good 2 is exportable. Let $x_1<0$ denote the imports of good 1, and $x_2>0$ denote the exports of good 2.

It is assumed that each intermediary good is produced using unskilled labor (L), skilled labor (H), and capital (K), with concave and linearly homogeneous production functions. The production functions of the intermediary goods are expressed as:

$$y_i = f_i(L_i, H_i, K_i),\ i = 1,2.$$

The production function of the final goods is given by $y_m = f_m(y_1 - x_1, y_2 - x_2)$, and is also concave and linearly homogeneous. The production process of the final goods is a bundling activity using the available amounts of good 1 and good 2. It is assumed that the bundling activity does not need labor and capital inputs.

It is assumed that the production factors, that is, unskilled labor, skilled labor, and capital, are fully employed. The total factor usage in the manufacturing industry is expressed as: $L_1 + L_2 = L,\ H_1 + H_2 = H,\ K_1 + K_2 = K$.

The optimal output in the manufacturing industry is obtained by solving the following maximization problem. With an assumption of perfect competition, the value of output from the final good, plus net trade, will be maximized subject to the resource constraints:

$$Y = F(L, H, K, p_m, p) \equiv \max_{x_i, L_i, H_i, K_i} p_m y_m + p x_1 + x_2$$

subject to

$$y_i = f_i(L_i, H_i, K_i),\ i = 1,2$$

$$y_m = f_m(y_1 - x_1, y_2 - x_2)$$

$$L_1 + L_2 = L,\ H_1 + H_2 = H,\ K_1 + K_2 = K$$

where p_m is the price of the final good, and p is the price of good 1 (importable good). The function $F(L,H,K,p_m,p)$ is linearly homogeneous in prices, so it can be alternatively written as $Y = p_m F(L,H,K,1,p/p_m)$.

We can make use of a cost function that is dual to the production function mentioned above, because we want to think of labor as being optimally adjusted in response to changes in factor prices. A short-run cost function is obtained when the level of capital is fixed. The cost function is defined as:

$$C(w,q,Y,p/p_m) = \min_{L,H} wL + qH$$
subject to
$$Y = p_m F(L,H,\overline{K},1,p/p_m)$$

where w is the wage of unskilled labor and q is the wage of skilled labor. We can also define cost functions for industries 1 and 2. Each type of labor must be optimally chosen in industries 1 and 2 when it is optimally chosen for the overall manufacturing industries. Thus, the cost functions are defined as:

$$C_i(w,q,Y_i) = \min_{L_i,H_i} wL_i + qH_i$$
subject to
$$y_i = f_i(L_i,H_i,\overline{K}_i),\ i = 1,2$$

Since the production functions of intermediary goods are assumed to be linearly homogeneous, the cost function mentioned above will be homogeneous of degree one in Y_i. This means that the cost function can be rewritten as

$$C_i(w,q,Y_i) = Y_i c_i(w,q),$$

where $c_i(w,q,r)$ is the unit-cost function, which is equal to marginal cost.

Choosing good 2 as the numeraire and setting the price of good 1 as p, the zero-profit conditions for industries 1 and 2 can be written as:

$$\begin{aligned} p &= c_1(w,q) \\ 1 &= c_2(w,q) \end{aligned}.$$

Totally differentiating these unit-cost functions, the change of p is decomposed of change in factor prices and cost-share of factors:

$$\hat{p} = \theta_{1L}\hat{w} + \theta_{1H}\hat{q}$$
$$0 = \theta_{2L}\hat{w} + \theta_{2H}\hat{q}$$
$$\therefore \hat{p} = (\theta_{1L} - \theta_{2L})\hat{w} + (\theta_{1H} - \theta_{2H})\hat{q}$$

where $\hat{p},\hat{w},\hat{q}$ means the percentage change in import price of good 1, the percentage change in factor prices, respectively, and where θ_{ij} is the cost-share of factor j in industry i, with $\sum_j \theta_{ij} = 1$.

We assume that capital has equal cost shares in the two industries. With the assumption of equal cost shares of capital, the total cost shares of labor also becomes equal. Therefore, we get $(\theta_{1L} - \theta_{2L}) = -(\theta_{1H} - \theta_{2H})$. Thus, using the above equation, we can obtain:

$$\hat{p} = (\theta_{1L} - \theta_{2L})(\hat{w} - \hat{q}).$$

Industry 1 is assumed to be unskilled-labor intensive, and thus we get $(\theta_{1L} - \theta_{2L}) > 0$. A decrease in the price of the imported intermediate good leads to a decrease in the relative wage of unskilled labor, $(\hat{w} - \hat{q}) = \hat{p}/(\theta_{1L} - \theta_{2L}) < 0$. This means that the effect consistent with the Stolper-Samuelson theorem holds for the model with two mobile factors.

5. REGRESSION SPECIFICATION

a. Hypothesis

The hypothesis for the regression analysis is drawn from the model: international trade, either import or export, will enlarge the wage gap between skilled and unskilled workers in Japan. This is compatible with the 'Stolper-Samuelson-like' effect because Japan is a relatively skilled-labor-abundant country, exporting skilled-labor-intensive goods and importing unskilled-labor-intensive goods.

b. Variables

This analysis uses a simple ordinary least squares (OLS) regression. The dependent variable is the change in the fixed-weight average ratio of the average hourly wage high school graduates to the average hourly wage of four-year university graduates for 57 cells defined by industry and firm size category.[7] The fixed weight for each cell is the cell's average share of total employment over the period of 1988-1995.[8]

A set of three different dependent variables is used to compare the impact of international trade on different relative wages. The first is the change in relative wage of unskilled workers to skill workers using data of all workers. The second and the third are the change in relative wages of unskilled workers at large firms and at small firms, respectively. A specific-factors model does not predict difference between large and small firms. However, the difference between large and small firms may affect the results because institutional differences between those are prominent in Japanese manufacturing industries. The effects of international trade on the wage gap between skilled and unskilled workers will be different between large and small firms. One hypothesis is that small firms are more responsive to international trade while large firms protect their workers from changes in business environment. This hypothesis expects to find the 'Stolper-Samuelson-like' effects at small firms larger than those at large firms.

Explanatory variables in this analysis include the change in the import ratio, the change in the export ratio, and the change in industry characteristics to control non-trade-related changes in each industry. Industry characteristics variables used here are industry sales (a proxy of market size of an industry), the capital-labor ratio (a proxy of the technological advancement status of an industry), the ratio of female workers[9], the ratio of

[7] Graduates of junior colleges (two-year college) and colleges of technology (koto senmon gakko) are included neither with high school graduates nor with university graduates.
[8] This methodology is similar to Katz and Murphy (1992).
[9] Female workers ratio variable is necessary to control for the effect of the wage gap between male and female

sales share of large firms (a proxy of the status of non-competitive structure of an industry), the average age of workers, the relative average tenure of unskilled workers[10], and unionization ratio. Table 4 shows definitions and predicted coefficient signs of each explanatory variable.

The coefficients of trade variables will be negative. The Stolper-Samuelson theorem predicts that the relative wage of unskilled workers would decline after trade because Japan exports skill-labor-intensive commodities. The capital labor ratio will have a negative coefficient because demand for skilled workers will increase relative to demand for unskilled workers. The female worker ratio will also have a negative coefficient since most of female workers do not have advanced skills. Variables of relative average tenure and unionization ratio will have positive coefficients, assuming that the wage increases with longer tenure and that activities of labor unions are in favor of unskilled workers. Signs of the industrial sales variable and the large firms sales share variable are not determined. The coefficients will be negative if firms pay more to skilled workers when they have larger sales.

c. Data

The analysis uses a dataset that covers 19 industries for 8 years from 1988 through 1995. The cross-sectional data in each year is pooled to create a quasi-panel dataset. Surveyed workers and firms in each industry are different every year. However, it is legitimate to pool annual data because characteristics in each industry remain same during the analysis period.

Labor data is taken from the Basic Survey of Wage Structure (hereafter as "BSWS") provided by the Ministry of Health, Labor and Welfare; industry data taken from the Census of Manufacturers (hereafter as "CM") provided by the Ministry of Economy, Trade and Industry; trade data taken from Trade Statistics (hereafter as "TS") provided by the

workers. It is predicted that the skilled / unskilled wage gap is larger when the female worker ratio is larger.

[10] Relative average tenure variable is necessary to control for the effect of the wage profile of unskilled workers relative to skilled workers.

Tariff and Customs Bureau, Ministry of Finance; labor union membership data taken from the Basic Survey of Labor Unions (hereafter as "BSLU") provided by the Ministry of Health, Labor and Welfare. All of these data are published annually, and this study uses data from 1988 through 1995. The CM gives information on each industry at the 4-digit standard industry category (SIC) level. However, the BSWS provides wage data only at the 2-digit SIC level. Thus, this study provides analysis using aggregated data at the 2-digit SIC level. Table 5 shows detailed definitions of the labor data. Monetary terms such as cash earnings or sales are real value of 1995 price adjusted by CPI.

Values of import and export, and unionization ratio at 2-digit level used in this analysis are obtained by matching different official statistics. First, import penetration ratio and export ratio are obtained by matching the CM and the TS. The TS is classified based on Harmonized Commodity Description and Coding System for tariff classification purpose, and it goes down to the 9-digit level of product disaggregation. However, the product classification of the TS does not automatically match the industry classification of the CM. There is no official concordance between the TS and the CM. To match the TS and the CM, this analysis employs the same methodology introduced by Tomiura and Uchida (2001). A certain product category code is first matched with corresponding industry category codes of the Input-Output Table. Then the industry codes of the Input-Output Table are matched with corresponding industry codes of the CM. Tomiura and Uchida (2001) provide a concordance between the TS and the CM for imports. The concordance for exports is originally produced for this analysis.

The unionization ratio is also originally created for this analysis. The BSLU provides unionization ratio only at 1-digit level. To obtain unionization ratio at 2-digit level, an original dataset is created by combining the labor union membership provided by the BSLU with the employment at firms with 4 or more employees provided by the CM.

d. Limitation

This analysis cannot cover every aspect in Japanese labor market, partly due to limited data availability caused by strict privacy protection by the Japanese government. The limitation of this analysis is summarized as follows. First, this analysis does not examine whether trade disproportionately affects skilled workers or unskilled workers, because the wages are measured in relative terms. Second, this analysis does not cover the impact of trade on wages of workers in firms where there are less than 10 employees, because the datasets on workers do not include this data. Finally, this analysis substantially uses data of male workers. The BSWS datasets miss much data on female workers with a university degree. Data on female workers with a university degree (i.e., wages, working hours, tenure, and number of workers in a sector) are available only in some industries and only recently: they are available in three industries (print, chemical, and electric machinery) for the period between 1992 and 1995 only. This analysis is still of value in spite of these limitations because empirical analysis on the impact of trade on wage inequality in Japanese labor market has not been studied before.

6. ANALYSIS

a. Regression results

As shown below, the results show that overall fit of regression is very low. The value of adjusted R-squared is 0.0888 at best for the regression for all workers. The value is lower than the overall fit of regressions in existing empirical studies while the regression specifications are not the same.[11]

[11] For example, Baldwin and Cain (2000) regress the change in trade ratio with the change in factor share of skilled and unskilled workers in manufacturing industries during 1986-1992 period. The value of R-squared is around 0.2.

Table 6. Change in the hourly wage based on monthly salary of workers with senior high school education relative to workers with a university degree, regressed by changes in industrial variables.

		All workers			Large firm only			Small firms only		
		Coef.		S.E.	Coef.		S.E.	Coef.		S.E.
Changes in	Export ratio	0.483		0.445	0.245		0.229	0.383		0.337
	Import ratio	0.163		0.132	-0.047		0.068	0.190	*	0.100
	Unionization ratio	-0.378	*	0.201	-0.046		0.103	-0.284	*	0.152
	Female worker ratio	-0.135		0.276	-0.157		0.142	-0.167		0.209
	Capital-labor ratio	-0.004		0.003	-0.003		0.002	-0.002		0.002
	Large firm sales ratio	0.005		0.310	0.011		0.160	0.088		0.235
	Relative avg tenure	0.119	***	0.030	0.131	***	0.042	0.133	**	0.062
Constant		0.007	**	0.003	0.001		0.001	0.004	*	0.002
Number of obs.		133			133			133		
Adjusted R-squared		0.0888			0.0663			0.0365		

* significant at 10% level
** significant at 5% level
*** significant at 1% level

These results are not consistent with the predictions of the theoretical model. The model predicted that the coefficients of trade variables would be negative and that trade would increase the wage gap between skilled and unskilled workers. The coefficient of the export ratio variable is positive while it is statistically insignificant for all cases. The coefficient of the import ratio variable is positive for all workers and for small firms. It is statistically significant for small firms, while it is negative and statistically insignificant for large firms. A hypothesis that the 'Stolper-Samuelson-like' effects at small firms would be larger than those at large firms is rejected.

The signs of coefficients of other variables are the same as predicted. A variable that increases the wage gap between skilled and unskilled workers is the change in unionization ratio. The coefficient of the unionization ratio is negative in all cases, and is statistically significant in cases for all workers and for small firms. The result means that firms in highly unionized industry are more protective for skilled workers than for unskilled

workers in terms of wage. The coefficient of the relative average tenure variable is positive and statistically significant in all regressions. This means that seniority wage system is prominent in Japanese manufacturing firms, and the finding is consistent with the stylized facts in Japanese labor markets.

b. Alternative set of dependent variables

The workers' income in the above analysis consists of monthly salary that includes various allowances. In Japan, however, determination of salary and allowances are structured and especially lacks downward flexibility. Amount of bonus payment is decided, on the other hand, upon an annual negotiation between firm management and its labor union according to the profit of the firm and performance of the individual workers.[12] Therefore, bonus should be included in the income variable to reflect the difference in wages.

Table 7. Change in the hourly wages based on monthly salary and bonus of workers with senior high school education relative to workers with a university degree, regressed by changes in industrial variables.

		All workers			Large firm only			Small firms only		
		Coef.		S.E.	Coef.		S.E.	Coef.		S.E.
Changes in	Export ratio	0.278		0.445	0.199		0.230	0.347		0.353
	Import ratio	0.229	*	0.132	-0.044		0.068	0.233	**	0.105
	Unionization ratio	-0.333	*	0.200	-0.002		0.104	-0.316	**	0.159
	Female worker ratio	-0.154		0.276	-0.185		0.143	-0.174		0.219
	Capital-labor ratio	-0.005		0.003	-0.003		0.002	-0.003		0.003
	Large firm sales ratio	0.026		0.310	-0.013		0.160	0.135		0.246
	Relative avg tenure	0.124	***	0.030	0.112	***	0.042	0.170	***	0.065
Constant		0.007	**	0.003	0.001		0.001	0.005	**	0.002
Number of obs.		133			133			133		
Adjusted R-squared		0.104			0.0561			0.0626		

* significant at 10% level
** significant at 5% level
*** significant at 1% level

The fit of overall regression becomes improved in the cases for all workers and for small firm workers, while the value of adjusted R-squared is still low. The coefficient of the

[12] Bonus is usually equivalent to the salary of several months, and paid in June and in December.

import ratio variable in the regression of all workers becomes statistically significant. The hypothesis that the 'Stolper-Samuelson-like' effects at small firms would be larger than those at large firms is again rejected. Signs of the coefficients of trade-related variables, unionization ratio, and relative average tenure variable are the same as the previous regressions. The coefficients of the relative average tenure remain statistically significant for all three cases.

One contrast that appears in the previous regression and the alternative regression is the effect of the ratio of sales by large firms to the total sales in an industry. This ratio is a measurement of concentration ratio of large firms, and a larger concentration ratio indicates that large firms can gain economic rents in the non-competitive industry. In industries with a larger concentration ratio, the relative wage of unskilled workers at large firms decreases and that in small firms increases. It is a puzzle that the relative wage of unskilled workers at large firms declines when the industrial sales grow.

These regression results mentioned above do not support the hypothesis that an increase in international trade would increase the relative wages of skilled workers. Instead, they show that international trade would contribute to a decline in the relative wages of skilled workers. One factor that contributes to the results is that Japan has not experienced the kind of decline in relative wage of unskilled workers. As shown in Table 4, the wage gap between skilled and unskilled workers in manufacturing industries on average decreased in spite of the growth in international trade during the analysis period.

One remained question is why the wage gap between groups with different education attainment seems to be shrinking. In spite of the existence of the wage gap between skilled and unskilled workers, Japanese employment and personnel management system that do not allow large labor mobility across firms may have a distribution effect in favor of unskilled workers. Further exploration on labor market institution in Japanese

manufacturing industry is needed to reveal why the wage gap between skilled and unskilled workers has been stable.

7. CONCLUSION

This paper presented an empirical analysis on the impact of international trade on wage inequality between skilled and unskilled workers. There has been relatively little research on the topic in Japanese manufacturing industries, partly because of the difficulty in matching data among statistics of trade, wages, and industry. This paper contributed to the empirical literature because it was the first empirical research that used a harmonized dataset of Japan's trade, industry, and wages.

This paper employed a specific-factors model because the model could reflect the heterogeneity in Japanese labor markets. The hypothesis for the empirical analysis was that international trade, either import or export, would raise the wage gap between skilled and unskilled workers. The hypothesis was compatible with the 'Stolper-Samuelson-like' effects because Japan is a relatively skilled-labor-abundant country, exporting skilled-labor-intensive goods, and importing unskilled-labor-intensive goods.

The regression results showed that both the import ratio and the export ratio would increase the relative wage of unskilled workers. The results did not support the prediction of the model. Instead, they showed that international trade contributed to a decline in the relative wages of skilled workers. Furthermore, the coefficients of the import ratio variables showed that imports hurt the relative wage of unskilled workers at large firms while imports favored unskilled workers at small firms. The hypothesis that the 'Stolper-Samuelson-like' effects at small firms would be larger than those at large firms was rejected. The model did not anticipate these results because the model did not distinguish the size of firms. Further exploration on labor market institution in Japanese manufacturing industry is needed to reveal why the wage gap between skilled and unskilled workers has been stable.

Table 1. Change in relative monthly salary of skilled workers in manufacturing industries (male)

Year	Senior high school	Junior college	4-year university
1985	100	103.27	119.32
1986	100	102.23	119.81
1987	100	103.10	120.35
1988	100	101.80	119.19
1989	100	100.30	120.01
1990	100	99.94	120.21
1991	100	99.01	120.34
1992	100	98.40	120.77
1993	100	97.79	122.28
1994	100	96.84	120.37
1995	100	97.16	120.72
1996	100	95.79	120.86
1997	100	96.96	120.25
1998	100	98.67	122.32
1999	100	98.18	120.66
2000	100	97.05	120.06
2001	100	98.21	121.21
2002	100	99.02	121.48

Source: Basic Survey of Wage Structure (Ministry of Health, Labor and Welfare) – manufacturing industry average

Table 2. Change in relative monthly salary of skilled workers in manufacturing industries (female)

Year	Senior high school	Junior college	4-year university
1985	100	111.97	134.29
1986	100	112.69	135.54
1987	100	111.26	136.95
1988	100	111.90	137.21
1989	100	111.96	143.23
1990	100	112.43	144.41
1991	100	112.03	142.88
1992	100	112.29	142.35
1993	100	112.54	141.97
1994	100	111.94	143.48
1995	100	111.67	143.14
1996	100	111.28	143.09
1997	100	112.17	140.79
1998	100	114.05	151.00
1999	100	114.37	146.47
2000	100	111.87	142.71
2001	100	113.33	144.63
2002	100	115.24	147.26

Source: Basic Survey of Wage Structure (Ministry of Health, Labor and Welfare) – manufacturing industry average

Table 3. Comparison of relative wages and trade in 1988 and 1995

		Relative wages (unskilled/skilled)			Imports (billion Yen)			Exports (billion Yen)		
SIC	SECTOR	1988	1995	**Change**	1988	1995	**Growth**	1988	1995	**Growth**
12	Food	0.5029	0.6831	**35.83%**	2,120.57	3,152.85	**48.7%**	212.08	163.44	**-22.93%**
13	Beverage	0.6069	0.6530	**7.59%**	290.41	521.58	**79.6%**	23.18	54.07	**133.24%**
14	Textile	0.5254	0.5799	**10.37%**	921.67	1,179.57	**28.0%**	644.45	624.36	**-3.12%**
15	Apparel	0.5014	0.5402	**7.75%**	561.67	1,206.03	**114.7%**	62.49	39.88	**-36.18%**
16	Wood	0.5406	0.6610	**22.28%**	589.00	1,008.60	**71.2%**	9.95	6.90	**-30.61%**
17	Furniture	0.5809	0.6084	**4.72%**	130.26	258.30	**98.3%**	43.46	45.96	**5.74%**
18	Paper	0.5690	0.6256	**9.95%**	422.04	489.58	**16.0%**	217.14	245.41	**13.02%**
19	Print	0.6380	0.6302	**-1.22%**	54.41	85.31	**56.8%**	54.80	39.52	**-27.88%**
20	Chemical	0.5621	0.7065	**25.68%**	1,754.64	2,147.78	**22.4%**	2,150.61	3,194.20	**48.53%**
22	Plastic	0.5500	0.6217	**13.05%**	105.25	201.48	**91.4%**	244.52	375.21	**53.45%**
23	Rubber	0.5220	0.5440	**4.23%**	175.53	289.62	**65.0%**	397.18	499.79	**25.84%**
25	Ceramic	0.5810	0.6006	**3.36%**	225.35	301.05	**33.6%**	443.52	599.02	**35.06%**
26	Steel	0.5198	0.6255	**20.34%**	642.52	573.87	**-10.7%**	1,949.80	1,634.96	**-16.15%**
27	Non-ferrous	0.5440	0.5398	**-0.78%**	2,110.80	1,722.17	**-18.4%**	437.70	629.02	**43.71%**
28	Metal	0.6219	0.6062	**-2.52%**	153.52	297.23	**93.6%**	499.69	550.48	**10.17%**
29	General Machinery	0.6439	0.6328	**-1.73%**	698.00	1,095.81	**57.0%**	4,905.32	6,747.27	**37.55%**
30	Electric Machinery	0.5164	0.6745	**30.61%**	1,532.33	4,628.34	**202.0%**	10,114.15	13,349.64	**31.99%**
31	Transportation Machinery	0.5707	0.6067	**6.31%**	920.64	1,604.92	**74.3%**	9,162.84	9,626.58	**5.06%**
32	Precision Machinery	0.5763	0.6359	**10.33%**	333.29	702.00	**110.6%**	1,201.49	1,432.52	**19.23%**
	All	0.5609	0.6205	**10.63%**	15,761.02	23,733.40	**50.6%**	32,774.37	39,858.24	**21.61%**

Table 4. Explanatory variables

Variables *	Definition	Predicted coefficient sign
Import ratio	Ratio of value of imports to the value of sales of output in domestic market in an industry.	Negative
Export ratio	Ratio of value of exports to the sales of output in domestic market in an industry.	Negative
Industry sales of output	Total annual sale of products at plants in the survey, aggregated according to industries and firm sizes. A plant's sales amount includes sales to another plant that belongs to the same company and the amount of products self-consumed at the plant.	Undetermined
Capital labor ratio	Amount of capital is calculated as the accumulated physical investment in the recent 4 years, including the current year, discounted by a depreciation rate. Physical investment in a year is the total amount of annual investment on land, buildings, and equipments. The denominator of the ratio is the number of employment in an industry.	Negative
Ratio of female workers	Ratio of female workers to all workers in an industry. This ratio excludes the workers with university degree because their data are not available in many industries. The value is calculated as a weighted average value with regard to the number of worker-hours.	Negative
Ratio of sales share of large firms	Ratio of sales by large firms to the total sales in an industry. This ratio is a measurement of concentration ratio of large firms.	Undetermined
Relative average tenure	Average tenure of unskilled workers relative to skilled workers in an industry. The tenure variable shows average tenure year of the workers in a specific category because only aggregated data are available. This value is also calculated as a weighted average value with regard to the number of worker-hours.	Positive
Unionization ratio	Ratio of labor union members to all workers in an industry.	Positive

* Changes in these variables are used in regressions as explanatory variables.

Table 5. Definitions of data

Salary	A monthly pre-tax salary paid for June in the survey year, which is calculated according to employment contracts or office rules. The salary is a cash payment and includes basic payment, a function allowance, a commuting allowance, a family allowance, and an overtime allowance. *
Working hours	Monthly working hours consisting of actual working hours based on employment contracts or office rules and overtime working hours.
Tenure	Number of years for a worker kept to be employed at a company from the recruitment to the date of the survey.
Education attainment	Highest certificate or a degree a worker has already completed. If a worker obtains a higher degree during the working years, the higher degree is applied. "Junior high school" indicates that the worker completed 9 years of schooling. "Senior high school" shows that the worker finished 12 years of schooling. "Junior college" indicates that the worker finished approximately 14 years of schooling by attending a junior college or a college of technology. "University" means that the worker completed 16 years of schooling or more by attending undergraduate or higher programs.
Worker / Employee	A "worker" in the BSWS is defined as one of the following: (i) an employee without agreed employment period, (ii) an employee with a fixed employment period more than a month, or (iii) an employee with a fixed employment period within a month or employed on a daily basis, who was employed more than 17 days each in April and in May. The definition of an "employee" in the CM is broader than a "worker" in BSWS. In addition to the categories in the BSWS, self-employees and their family members who are engaged in their business without payments are also regarded as employees in the CM. The difference in the definition of a worker can be ignored because workers in very small companies with less than 10 employees are excluded in this analysis.
Firm size	Size of a plant measured by the number of employees, classified into three categories: small (10-99), medium (100-999), and large (1000 or more).
Union membership	Number of employees who are members of labor unions in an industry. A member works at either a public enterprise or a private firm.

(Note) * The itemized components of the salary are not reported and they are not separable.

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