Chapter 2

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CHAPTER 2

Trade Liberalization and the Wage Skill Premium in Korean Manufacturing Plants: Do Plants' R&D and Investment Matter?

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This paper examines the effects of output and input tariff reductions on within-plant wage skill premium in Korean manufacturing plants. We find evidence that output tariff reduction interacts differently with plants' R&D and investment behaviors, respectively, to affect wage skill premium. More specifically, output tariff reduction increases wage skill premium mostly in R&D-performing plants while reducing it mostly in plants making positive facility investments. While there is weak evidence that input tariff reduction increases wage skill premium, no such interactive effects are found. One story behind our results is that, although both R&D and facility investments may respond to changes in profit opportunities due to output tariff reductions, R&D raises the relative demand for the skilled workers while facility investment, an activity of increasing production capacity, raises the relative demand for the unskilled workers.

Keywords: trade liberalization, skill premium, wage inequality, R&D, investment
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1. Background and Objective

For the past several decades, the impact of globalization on wage inequality between skilled and unskilled workers (wage skill premium) has drawn much attention in the academic and policy circles. Earlier studies based on the traditional Heckscher-Ohlin theory were generally skeptical to the view that trade is an important cause for the rising wage inequality. Recent theories, however, highlight several new mechanisms—interaction between skill-biased technological progress (SBTC) and trade (Wood, 1995, Thoenig and Verdier 2003, Bustos 2007, 2011), complementarity between imported capital goods and skilled workers (Acemoglu, 2003), or trade-induced compositional change in firm's product portfolio (Verhoogen, 2008), for example—by which trade liberalization increases wage skill premium. Although there are a growing number of empirical studies finding that globalization increases wage skill premium[1], whether and how globalization increases wage skill premium is an issue which deserves further scrutiny.

In this paper, we examine empirically the effect of trade liberalization on within-plant wage inequality between skilled and unskilled workers[2] utilizing plant-level dataset in the Korean manufacturing sector. As in Amiti & Davis (2012) and Amiti & Cameron (2012)[3], we examine separate roles of output and input tariffs and consider possibly differential effects among plants. The latter approach is broadly in line with the spirit of the recent heterogeneous firm trade theories which predict differential

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1 See Goldberg & Pavcnik (2007) for an extensive review of the related literature.

2 Our focus on within-plant wage skill premium is motivated by Hahn & Park (2012), which shows that around half of the increase in the aggregate share of the skilled employment and wages is accounted for by the within-plant effect in Korean manufacturing during the period of our analysis.

3 While Amiti & Cameron (2012) focus on the effects on within firm wage inequality between skilled and unskilled workers as in this paper, Amiti & Davis (2012) analyze the effects on between-firm wage inequality.

responses of firms to trade liberalization depending on the firm characteristics.

In this paper, we focus on plants' R&D and investment behavior as the key plant characteristics determining the effect of import tariff reductions on within-plant wage skill premium. So, our paper can be broadly related to the literature examining the possible interaction between trade and SBTC as a mechanism through which trade affects wage skill premium. While there is a growing interest in this subject, empirical studies which examine this mechanism explicitly are surprisingly scant.[4]

The following is a brief sketch of the story that explains our focus on plant's R&D and investment behavior. According to the well-known heterogeneous firm trade theories, such as those developed and reviewed by Amiti & Davis (2012), trade liberalization or reductions of trade costs increases the revenue and profit of firms with higher productivity while decreasing them with lower productivity. The increase (decrease) of the revenue and profit, or the prospect of it, will enhance (reduce) the incentive to do R&D[5] and/or to make investments in production facilities since these are basically investment activities motivated by profit opportunities. However, the effect of import tariff reductions on within-plant wage skill premium might differ depending on firms' behaviors in R&D and facility investment in response to import tariff reductions. Above all, R&D itself is likely to be a skilled-labor-intensive activity. Thus, if a firm increases R&D activity in response to trade liberalization, it will increase the relative demand for the skilled workers, leading to an increase of the wage skill premium when wages are determined at the firm level. Furthermore, R&D might be aimed at more skill-intensive products or processes under the increased

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[4] Bustos (2007, 2011) are a few exceptions.

[5] Costantini & Melitz (2008) and Aw, *et al.* (2011) theoretically analyze this mechanism in the context of heterogeneous firms and trade.

import competition.[6] Alternatively, if a firm decides to increase its production capacity by investing in equipment and production lines given existing technologies, it is likely to increase relative demand for the production or unskilled workers. So, firms that increase production capacities in response to trade liberalization may experience a reduction in wage skill premium.[7] So, our analysis allows for differential effects of tariff reductions among plants engaged in R&D, plants making facility investments, and those that do neither. We find evidence consistent with the above conjecture. We think that this is a novel feature of our paper.

As mentioned above, we are interested in estimating the separate effects of output and input tariff reductions on wage skill premium as in Amiti & Cameron (2012). We think that conducting similar analyses for Korea's case is a meaningful exercise *per se*. Amiti & Cameron (2012) find that the reduction in intermediate input tariffs *lowers* wage skill premium in Indonesian manufacturing while they find no significant effect from the output tariff reductions. Their interpretation of the wage-inequality-reducing effect of input tariff reductions is as follows. As Indonesian manufacturing plants import more skill-intensive intermediate inputs mostly from developed countries, the reduction in input tariffs induces firms to switch from in-house production of skill-intensive intermediate inputs to importing, which decreases the relative demand for the skilled labor within firm. They give no detailed explanations on the insignificant effect from output tariff reductions.

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[6] Thoenig & Verdier (2003) theoretically show that firms respond to globalization by engaging in "defensive innovation", i.e., by biasing the direction of their innovations towards skilled-labor-intensive technologies.

[7] It is well known that only a small fraction of plants are engaged in R&D and a much higher fraction of plants, although not all plants, are making positive investments at a point in time. This pattern is also observed for Korean manufacturing, as we will show below. Thus, focusing on R&D alone in response to trade liberalization might not be sufficient to understand the effect of import tariff reductions on within-plant wage skill premium and might lead to an omitted variable bias problem.

In our view, however, there is no guarantee that similar results will be found for Korea or in other countries or contexts. First and foremost, we expect that the reduction of output tariffs widens wage skill premium mostly in R&D-doing plants and narrows wage skill premium mostly in plants expanding their production capacity. Next, regarding the effect of input tariff reductions, we think that the expected effect of the reduction in input tariffs is ambiguous for empirical and theoretical grounds. Amiti & Cameron's interpretation of their own results is based on the observation that Indonesia is a skill-scarce country which imports intermediate inputs from skill-abundant developed countries. However, the source-country composition of Korea's intermediate input imports is different from that of Indonesia'. Although high-income countries account for a major share of Korea's intermediate input imports during the period from 1992-2003, the share of low-income countries has steadily risen, from 22 to 32 percent.

More importantly, in our view, the effect of the reduction in intermediate input tariffs is likely to be theoretically ambiguous even if imported intermediate inputs are typically more skill-intensive than domestically produced ones. The relative-cost-based choice between in-house production and importing of intermediate inputs, as explained by Amiti & Cameron, is one mechanism. However, there could be another mechanism through which the reduction in input tariffs affect within-firm wage skill premium. As theoretically shown by Amiti & Davis (2012), for example, when there are increasing returns from a greater number of input varieties, the increase in the number of available intermediate inputs caused by input tariff reductions decreases the marginal cost of production for firms which import intermediate inputs, which increases their revenues and profits. If, again, the increase in profit opportunity strengthens the incentive to do R&D, the input tariff reductions are expected to increase, rather than decrease, the wage skill premium within plants.[8] So, the combined effect is ambiguous. Under this story, which we think is very plausible, the effect of input tariff reductions on within-plant wage skill premium is an empirical matter.

This paper is organized as follows. In the next section, we explain our data and present trends in wages and employments of skilled and unskilled workers in the aggregate manufacturing. We also review trends in the average tariff rate. In section III, we explain estimation strategy and provide summary statistics in the key variables in our regressions. In section IV, we provide our main empirical results. The final section concludes.

2. Data

In our empirical analyses, we will utilize two data sources. The first one is the "Mining and Manufacturing Census" conducted by the KNSO (Korea National Statistical Office) during 1992~2003. This census data covers all plants with five or more employees in the mining and manufacturing sectors. For each year, the numbers of and the wage bills paid to production and non-production workers are available at plant-level in this survey. We construct within-plant wage inequality between production and non-production workers by dividing average wage of non-production workers by that of production workers. This data also provide information about various plant characteristics: status of R&D, investment and export,

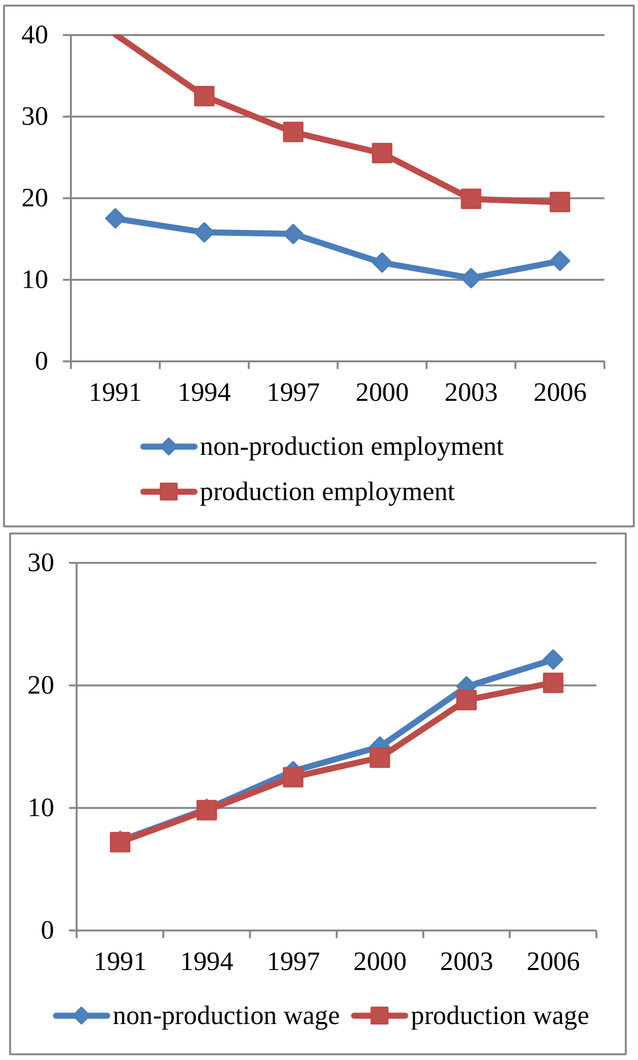
[8] We must acknowledge that, unlike Indonesia analyzed by Amiti & Cameron (2012), plant-level intermediate input imports data are not available for Korea. So, the results of this paper are not directly comparable to their paper.

size (measured by the level of total employment), skill intensity (measured by the ratio of the number of non-production workers to that of production workers).

Finally, yearly import tariff data comes from the KCS (Korea Customs Service) at the 10-digit level with HS code system. They provide data on the value of applied tariff and import for each HS category and the output tariff can be directly calculated by dividing the value of applied tariff by the value of import. This tariff data with HS code system has been converted to 141 Korea's Input-Output industry codes to calculate average industry-level output tariffs using the matching table provided by the Bank of Korea. We combine these industry-level output tariffs with the Korea's Input-Output table in 2000 to calculate the input tariffs for the corresponding industry.

Figure 1 shows the trends in average wage and employment of production and non-production workers in Korean manufacturing sector from 1991 to 2006, calculated from Mining and Manufacturing Census. First of all, the relative wage of non-production workers has risen slightly, if at all, over the period. Next, although the employments of both production and non-production workers have declined secularly, the pace of the decline was more pronounced for the employment of production workers. In this paper, we use non-production and production workers as proxies for skilled and unskilled workers, respectively. Then, trends shown in figure 1 suggest that the relative demand for skilled workers have been rising in Korean manufacturing for the past two decades.

Figure 1: Employment and Wage of Production and Non-production Workers



3. Empirical Specification

In order to investigate how (both input and output) tariff reduction and its interaction with R&D, investment and export activity affect within-plant wage inequality, we run the following regression:

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\begin{aligned}
\ln(w_s/w_u)_{p,i,t} = {} & \alpha_p + \alpha_t + \beta_1 * \text{output tariff}_{i,t} + \beta_2 * \text{input tariff}_{i,t} \\
& + \beta_3 * \text{output tariff}_{i,t} * CH_{i,t} + \beta_4 * \text{input tariff}_{i,t} * CH_{i,t} \\
& + \Gamma' X_{p,i,t} + \varepsilon_{p,i,t}
\end{aligned} \tag{1}
$$

where the dependent variable is the skilled wage premium, measured by the log of the ratio of the average wage of non-production workers to that of production workers (w_s/w_u). The output and input tariffs are measured at 141 input-output industry-level. *CH* denotes three different channels that can interact with trade liberalization: R&D, physical investment and export activity of each plant. *X* represents a vector of plant-specific characteristics such as size, total factor productivity and skill intensity. α_p and α_t are plant-fixed and year-fixed effect, respectively.

The coefficient β_1 has the meaning of the effect of output tariff on the within-plant skilled wage premium for the plants with *CH* = 0: for example, the effect of output tariff on the wage premium without doing any R&D activity. The coefficient on the interaction term, β_3, represents the heterogeneous response of R&D-doing plants in response to output tariff reduction: if output tariff reduction lead to increase the demand for the skilled-labor of the R&D-doing plants (and therefore widen the skilled wage premium), we expect that β_3 would be estimated to be significantly negative. This interpretation can be applied to other different channels: investment and export activity.

Likewise, β_2 measures the effect of input tariff on the skilled wage premium for the plants with *CH* = 0. If input tariff reduction affects the skilled wage premium of, for example, R&D-doing firms differentially, β_4 would be significantly different from zero.

The basic statistics of the key variables used in this paper are summarized in Table 1 and 2. In Table 1, we can see that both output and input tariffs show decreasing trend although the rate of decrease is not substantial.[9] In Table 2, the average skilled wage premium in our sample is 1.151 with substantial heterogeneity across plants. On average, R&D, investment and export activities are implemented by 8.4%, 48.6% and 12.9% of plants, respectively.

Table 1: Korea's Output Tariffs and Input Tariffs: 1992~2003

	Output Tariff		Input Tariff	
Year	Mean (1)	Std. Dev. (2)	Mean (3)	Std. Dev. (4)
1992	0.109	0.083	0.053	0.023
1993	0.092	0.077	0.046	0.02
1994	0.089	0.084	0.043	0.02
1995	0.111	0.16	0.05	0.035
1996	0.094	0.085	0.044	0.023
1997	0.092	0.077	0.043	0.025
1998	0.094	0.079	0.042	0.022
1999	0.088	0.069	0.044	0.019
2000	0.087	0.071	0.044	0.02
2001	0.084	0.069	0.043	0.021
2002	0.086	0.072	0.043	0.021
2003	0.086	0.081	0.041	0.022
1992~2003	0.091	0.084	0.044	0.022

Note: Table reports the means and standard deviations of output and input tariffs across 141 industries. Input tariffs are constructed using 2000 input-output table provided by the Bank of Korea.

[9] Korea's major tariff reform took place in 1984 and 1989 (See Cheung & Ryu, 2003). In each year, the average output tariffs for manufacturing goods were reduced to around 20% and 15%. It would be ideal to include these early periods in our sample. But unfortunately, detailed tariff data are not available for these reform periods.

Table 2: Summary Statistics of Other Variables

	Observation	Mean	Std. Dev.	Min	Max
Skilled wage Premium	509,211	1.151	0.676	0.02	107.143
R&D Dummy	742,585	0.084	0.278	0	1
Investment Dummy	706,503	0.486	0.5	0	1
Export Dummy	633,506	0.129	0.335	0	1
Ln(TFP)	737,558	0.194	0.4	-11.905	15.787
Size	742,574	2.544	0.92	0.693	10.219
Skill Intensity	742,346	0.223	0.228	0	1

Note: Skilled wage premium is defined by the ratio of the average wage of non-production workers relative to that of production workers. Export, R&D and Investment dummies take the value of 1 if the value of export, R&D and investment are positive, respectively and the value of 0 otherwise. TFP is measured using the chained-multilateral index number approach as developed in Good (1985) and Good, *et al.* (1997). Size is the natural logarithm of employment and skill intensity is the ratio of the number of non-production workers to that of production workers.

4. Empirical Results

4.1. Main results

We first estimate equation (1) with plant fixed effects and Table 3 shows the results. In all specifications, we include plant-specific characteristics of size, TFP and skill intensity, all of which are statistically different from zero at 1% level. It shows that the skilled wage premium is higher when the size is larger, the productivity is lower and the skill intensity is lower. These results are almost identical to the case of Indonesia as shown in Amiti & Cameron (2012).[10]

[10] Amiti & Cameron (2012) did not include TFP level in their regressions. But our empirical results do not change in any material way when we drop TFP variable in our analyses.

Table 3: Fixed Effects Estimation Results

	(1)	(2)	(3)	(4)	(5)
Output tariff	-0.040*		-0.024	-0.062**	-0.059**
	(0.022)		(0.023)	(0.028)	(0.029)
Input tariff		-0.249**	-0.226**	-0.221*	-0.057
		(0.098)	(0.104)	(0.127)	(0.140)
Output tariff * R&D			-0.076*	-0.103**	-0.105**
			(0.043)	(0.044)	(0.049)
Input tariff * R&D			0.135	0.216	0.16
			(0.193)	(0.201)	(0.222)
Output tariff * INV				0.073***	0.076***
				(0.026)	(0.028)
Input tariff * INV				0.006	-0.045
				(0.118)	(0.129)
Output tariff * EXP					-0.022
					(0.056)
Input tariff * EXP					-0.138
					(0.221)
R&D			0.008	0.007	0.011
			(0.008)	(0.008)	(0.010)
INV				-0.004	-0.002
				(0.005)	(0.006)
EXP					0.018*
					(0.010)
Size	0.126***	0.126***	0.125***	0.128***	0.133***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Ln(TFP)	-0.066***	-0.066***	-0.066***	-0.066***	-0.067***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Skill Intensity	-0.345***	-0.345***	-0.346***	-0.342***	-0.383***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Constant	-0.269***	-0.259***	-0.257***	-0.266***	-0.279***
	(0.009)	(0.010)	(0.010)	(0.011)	(0.012)
Year Effect	Yes	Yes	Yes	Yes	Yes
Plant Effect	Yes	Yes	Yes	Yes	Yes
Number of Plants	157,409	157,409	157,409	155,275	143,589
Number of Observations	506,376	506,376	506,376	478,424	413,072
R-Squared	0.026	0.026	0.026	0.027	0.028

Note: Robust standard errors clustered at the plant level are in parentheses. *, **, and *** denote that the estimated coefficients are significant at 10%, 5% and 1% level, respectively.

In columns (1) ~ (3) of the table, we include either output/input tariffs or both. When we include output or input tariff separately, both coefficients on these variables are estimated to be significantly negative. This means that the reductions of both output and input tariffs are associated with the increase of the skilled wage premium, which is in sharp contrast with the main findings from the Indonesian data by Amiti & Cameron (2012). In the case of Korea, it seems that trade liberalization (in terms of both output and input) leads plants to increase the demand for skilled-labor. Then what are the important channels through which trade liberalization affect the demand for skilled-labor?

As explained in section 2, the interaction of trade liberalization and R&D might be an important channel that explains this skilled wage premium in the Korean context. To explore this, in column (3) of Table 3 we include the interaction term of output tariff and R&D dummy and we find that its coefficient is estimated to be significantly negative. This suggests that trade liberalization, as measured by output tariff reduction, had an effect of increasing skilled wage premium within R&D-performing plants. This result is supportive of the view that trade liberalization, in interactions with skill-biased technological change, contributed to the increase in the skilled wage premium. We do not find, however, any significant effect of the reduction in intermediate input tariffs on within-plant skilled wage premium, which is in contrast with the results by Amiti & Cameron (2012).

As explained in section 2, if trade liberalization affect skilled wage premium of R&D-doing plants differently, it would be a natural empirical question to ask whether investment-doing plants also respond differently to trade liberalization. Thus, in column (4) of Table 3, we additionally include the interaction term of investment with trade liberalization. After adding investment-related variables, the coefficient on output tariff becomes significantly negative again which means that even the plants without any R&D and physical investment increase the demand for skilled labor. In addition, the coefficient on the interaction of R&D with output tariff becomes larger in its absolute value and more significant. R&D-performing plants further increase the demand for skilled labor. However, the coefficient of the interaction of investment dummy with output tariff is estimated to be positively significant. This means that the plants with physical investment respond in the opposite direction compared to the plants with R&D investment. The investment-performing plants increase their demand for unskilled-labor and their skilled wage premium decreases. To the extent that R&D activity is associated with higher demand for human capital (or skilled labor) and physical investment with lower demand for skilled labor, this positive sign of the estimated coefficient on the interaction of investment with output tariff is not surprising.

In column (5) of the table, we include export-related variables in the regression additionally. None of the coefficients on the interaction terms of export with output and input tariffs are significant but the coefficients on the interactions terms of R&D and investment remain to be significant and have the same sign as in column (4).

As an alternative specification, we estimate equation (1) in the five-year differences. Taking five-year differencing would reduce the problems of measurement errors and any concern of unit roots that may exist in a levels equation. The dependent variable is the log difference of skilled wage premium and output tariff, input tariff and other plant characteristics (size, productivity and skill intensity) are also differenced at five-year interval. For R&D, investment and export dummies, we take the initial year's value.[11] Table 4 reports the estimation results of this specification which are very similar to those in Table 3 with fixed effects. R&D-doing plants and physical investment-doing plants respond differently to output tariff reduction in the opposite direction in terms of skilled wage premium.

Table 4: Alternative Specification: Five-year Differences

	-1	-2	-3
△ Output tariff	-0.037	-0.132**	-0.134**
	(0.038)	(0.059)	(0.059)
△ Input tariff	-0.011	0.404	0.460*
	(0.167)	(0.273)	(0.278)
△ Output tariff * $R\&D_{t0}$	-0.184*	-0.256**	-0.258**
	(0.109)	(0.115)	(0.117)
△ Input tariff * $R\&D_{t0}$	0.323	0.344	0.386
	(0.453)	(0.468)	(0.471)
△ Output tariff * INV_{t0}		0.163**	0.161**
		(0.074)	(0.074)
△ Input tariff * INV_{t0}		-0.605*	-0.557
		(0.338)	(0.342)
△ Output tariff * EXP_{t0}			0.028
			(0.117)
△ Input tariff * EXP_{t0}			-0.352
			(0.378)
$R\&D_{t0}$	-0.017**	-0.018**	-0.018***
	(0.007)	(0.007)	(0.007)
INV_{t0}		-0.010**	-0.011**
		(0.005)	(0.005)
EXP_{t0}			0.003
			(0.006)
△ Size	0.099***	0.099***	0.100***
	(0.004)	(0.004)	(0.004)
△ Ln(TFP)	-0.059***	-0.058***	-0.058***
	(0.005)	(0.005)	(0.005)
△ Skill Intensity	-0.409***	-0.405***	-0.405***
	(0.014)	(0.014)	(0.014)
Year Effect	Yes	Yes	Yes
Number of Observations	74,110	70,403	70,403
R-Squared	0.028	0.028	0.028

[11] The reason why we take the initial year's values for these dummy variables instead of taking five-year differences is due to the convenience of the interpretation. If we mechanically take five year differences of these dummies then they will have the values of -1, 0 or 1 whose coefficients are difficult to be interpreted.

4.2.Endogeneity Issue

As in other empirical studies focusing on the effects of tariff reduction, we may address the concern of the potential endogeneity of trade liberalization if politically powerful industries are able to successfully lobby government for trade protection. However, in the previous literature, the degree of endogeneity of tariff reduction seems to vary depending on the specific country and the sample period that is being analyzed. For example, in the case of Indonesia, Amiti & Cameron (2012) used instrumental variable approach in order to treat this endogeneity issue but it turns out that the endogeneity problems is not that severe. On the other hand, Topalova & Khandelwal (2011), which analyzed the effect of industry level output and input tariffs on plant's total factor productivity using Indian plant data, provided several evidences on the exogeneity of tariff reduction in India and did not treat the endogeneity issue explicitly.

In this subsection, we follow the methodologies in Topalova & Khandelwal (2011) in order to check whether Korea's tariff reduction should be treated as endogenous in our sample. Before we proceed, it would be worthwhile to note that in Korea two major tariff reform took place in 1984 and 1988 before our sample period of 1992~2003 as mentioned in section 2. Moreover, during our sample period, there were several international events under which any political consideration in favor of some industries is unlikely to play an important role in determining tariff endogenously: the end of the Uruguay round in 1994, the establishment of the WTO in 1995, Korea's accession to OECD in 1996 and the IMF-supported program for Korea starting from 1997 after the financial crisis.

Nevertheless, we first follow Topalova & Khandelwal (2011) to test whether tariff reductions are correlated with politically important characteristics by regressing the changes in output and input tariffs over 1992~2003 on various industrial characteristics in 1992. These industrial characteristics include average wage, production worker share, capital/labor ratio, shipment and employment. The results are shown in Table 5. In panel A, the correlation between changes in output tariff and these characteristics are reported and there exist no statistical correlation between output tariff and any of the industrial characteristics. In panel B, with the only exception of significantly positive correlation between changes in input tariff and shipment, none of the other industry characteristics is correlated with input tariff reduction.

Table 5: Initial Industrial Characteristics and Subsequent Tariff Change

Ln(wage)	Production Worker Share	Capital/Labor Ratio	Ln(shipment)	Ln(employment)
(1)	(2)	(3)	(4)	(5)
Panel A: Regression of Changes in output tariff on ….				
0,002	-0,035	0,000	0,004	0,004
(0,004)	(0,025)	(0,001)	(0,003)	(0,005)
Panel B: Regression of Changes in input tariff on …				
0,002	0,002	0,000	0.003***	0,002
(0,002)	(0,016)	(0,001)	(0,001)	(0,002)

Note: Each cell represents a separate regression of either changes in output tariffs (panel A) or changes in input tariffs (panel B) during 1992~2003 on the variable in the column heading in 1992. The number of observation in each regression is 141 industries. Robust standard errors are in parentheses. *, **, and *** denote that the estimated coefficients are significant at 10%, 5% and 1% level, respectively.

The second way to check the endogeneity of tariff reduction is to investigate whether tariffs were adjusted in response to industry's skilled wage premium. If this were the case, the current level of skilled wage premium would be able to predict future measures of tariff. In Panel A and B of Table 6, we regress the changes in output and input tariffs from t to t+1 on the skilled wage premium at time t. For the whole sample period (1992~2003) and before and after the Korean financial crisis (1992~1996 and 1998~2003), the correlations between current skilled wage premium and future changes in tariffs are indifferent from zero.

Table 6: Current Wage Premium and Subsequent Tariff Change

Period	1992~2003	1992~1996	1998~2003
	(1)	(2)	(3)
Panel A: Regression of Changes in output tariff from *t* to *t*+1 on …			
Skilled wage	-0,009	-0,051	-0,003
premium at t	(0,007)	(0,034)	(0,007)
Observations	1.183	332	755
Panel B: Regression of Changes in input tariff from *t* to *t*+1 on …			
Skilled wage	0,001	-0,003	0,002
premium at t	(0,002)	(0,005)	(0,003)
Observations	1.183	332	755

Note: The table regresses either changes in output tariffs (panel A) or changes in input tariffs (panel B) from t to t+1 on industry-level skilled wage premium in period t. Industry-level skilled wage premium is calculated as a real shipment-weighted average of plant-level skilled wage premium. All regressions include industry and year fixed effects. Robust standard errors are in parentheses. *, **, and *** denote that the estimated coefficients are significant at 10%, 5% and 1% level, respectively.

Overall then, we conclude that Korea's tariff reduction at least during our sample period does not suffer endogeneity problem as in the case of Indian data investigated by Topalova & Khandelwal (2011).

5. Summary and Policy Implications

In this paper we examine the effects of output and input tariff reductions on within-plant wage skill premium in Korean manufacturing plants during the periods of 1992~2003. Our empirical results can be summarized as follows. First, both output and input tariff reductions are associated with the increase of the skilled wage premium unlike the case of Indonesia. Second, trade liberalization, as measured by output tariff reduction, had an effect of increasing skilled wage premium within R&D-performing plants. This result is supportive of the view that trade liberalization, in interactions with skill-biased technological change, contributed to the increase in the skilled wage premium. But there is no significant effect of the reduction in intermediate input tariffs on within-plant skilled wage premium. Third, for investment-performing plants output tariff reduction had an effect of decreasing skilled wage premium. These may reflect that while R&D activity is associated with higher demand for human capital (or skilled labor) physical investment is associated with higher demand for unskilled labor.

The results found in this study suggest that trade liberalization brings about not only benefits but also costs: increased disparity between skilled and unskilled workers in the labor market outcomes. So, a country liberalizing its trade should also consider strengthening general social protection scheme in order to make the benefits from liberalized trade more equally shared among economic agents. Strengthening general social protection scheme is considered to be a better approach than strengthening the trade adjustment assistance (TAA) program, which targets only at displaced workers by FTA-related increased import competition. More generally, the relationship between TAA and general social protection scheme should be more carefully examined and discussed. Another policy implication from this study is that we can maximize the benefits from trade liberalization and make it more politically supported when trade liberalization is pursued as a part of a broader growth strategy. Given the interdependence of trade, innovation, and income distribution, as shown in this study, key elements of such growth strategy should at least include trade policy, innovation policy and redistribution policies. Establishing an effective policy governance scheme for such a strategy is likely to be an important issue.

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Appendix

Table A1: Fixed Effects Estimation Results with Industry Fixed Effects

	(1)	(2)	(3)	(4)	(5)
Output tariff	-0.051** (0.025)		-0.043* (0.025)	-0.081*** (0.030)	-0.068** (0.031)
Input tariff		-0.192 (0.131)	-0.150 (0.135)	-0.157 (0.154)	0.086 (0.165)
Output tariff * R&D			-0.078* (0.043)	-0.103** (0.045)	-0.103** (0.049)
Input tariff * R&D			0.195 (0.194)	0.263 (0.202)	0.173 (0.223)
Output tariff * Investment				0.074*** (0.026)	0.075*** (0.028)
Input tariff * Investment				0.022 (0.118)	-0.038 (0.129)
Output tariff * Export					-0.036 (0.056)
Input tariff * Export					0.015 (0.226)
R&D dummy			0.006 (0.008)	0.005 (0.009)	0.010 (0.010)
Investment dummy				-0.005 (0.005)	-0.003 (0.006)
Export dummy					0.012 (0.010)
Size	0.125*** (0.002)	0.125*** (0.002)	0.124*** (0.002)	0.128*** (0.002)	0.132*** (0.003)
Ln(TFP)	-0.066*** (0.003)	-0.067*** (0.003)	-0.067*** (0.003)	-0.067*** (0.003)	-0.067*** (0.003)
Skill Intensity	-0.345*** (0.008)	-0.345*** (0.008)	-0.346*** (0.008)	-0.342*** (0.008)	-0.383*** (0.009)
Constant	-0.279*** (0.009)	-0.272*** (0.012)	-0.270*** (0.012)	-0.279*** (0.012)	-0.301*** (0.014)
Year Effect	Yes	Yes	Yes	Yes	Yes
Plant Effect	Yes	Yes	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes	Yes	Yes
Number of Plants	157,409	157,409	157,409	155,275	143,589
Number of Observations	506,376	506,376	506,376	478,424	413,072
R-Squared	0.026	0.026	0.026	0.027	0.028

Note: Robust standard errors clustered at the plant level are in parentheses. *, **, and *** denote that the estimated coefficients are significant at 10%, 5% and 1% level, respectively.

Table A2: Alternative Specification: Five-year Differences with Industry Fixed Effects

	(1)	(2)	(3)
ΔOutput tariff	-0.046 (0.040)	-0.135** (0.062)	-0.136** (0.062)
ΔInput tariff	-0.166 (0.204)	0.210 (0.300)	0.251 (0.302)
ΔOutput tariff * $R\&D_{t0}$	-0.204* (0.110)	-0.271** (0.116)	-0.272** (0.118)
ΔInput tariff * $R\&D_{t0}$	0.384 (0.459)	0.397 (0.474)	0.452 (0.477)
ΔOutput tariff * INV_{t0}		0.157** (0.074)	0.155** (0.074)
ΔInput tariff * INV_{t0}		-0.536 (0.340)	-0.490 (0.344)
ΔOutput tariff * EXP_{t0}			0.026 (0.120)
ΔInput tariff * EXP_{t0}			-0.367 (0.390)
$R\&D_{t0}$	-0.016** (0.007)	-0.017** (0.007)	-0.018** (0.007)
INV_{t0}		-0.010** (0.005)	-0.010** (0.005)
EXP_{t0}			0.003 (0.006)
ΔSize	0.100*** (0.004)	0.100*** (0.004)	0.101*** (0.004)
ΔLn(TFP)	-0.063*** (0.006)	-0.062*** (0.006)	-0.062*** (0.006)
ΔSkill Intensity	-0.410*** (0.014)	-0.405*** (0.014)	-0.405*** (0.014)
Year Effect	Yes	Yes	Yes
Industry Effect	Yes	Yes	Yes
Number of Observations	74,110	70,403	70,403
R-Squared	0.031	0.031	0.031

Note: Robust standard errors are in parentheses. *, **, and *** denote that the estimated coefficients are significant at 10%, 5% and 1% level, respectively.