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TRADE POLICY AND THE LABOR MARKET: EVIDENCE FROM KOREA

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ABSTRACT

This dissertation investigates the effect of trade liberalization in a trading partner country on labor market outcomes, and the export wage premium. The first chapter studies the impact of trade liberalization in China on the firm-level skilled labor employment share in Korea. The second chapter examines the existence of the export wage premium. The third chapter explores the response of partner-country tariffs on productivity. My findings highlight the importance of partner-country trade liberalization in enhancing firm performance via productivity and share of skilled labor, and the existence of the export wage premium in Korea.

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DISSERTATION

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1. Trade Policy and the Labor Market

The impacts of trade on labor markets have been widely studied. For example, Bernard and Jensen (1997), Verhoogen (2008), and Hahn and Park (2011) have shown that exporters have greater skill intensity than non-exporters. Similarly, Goldberg and Pavcnik (2007), and Bustos (2012, forthcoming), among others, have shown that trade liberalization leads to increases in skill intensity. Pavcnik (2002), Amiti and Konings (2007), and Topalova and Khandelwal (2011) demonstrate that trade liberalization enhances firm productivity. Finally, Bernard and Jensen (1997), Hahn (2005), Schank et al. (2007), Frías et al. (2011), and Krishna et al. (2011) investigate the existence of export wage premium. However, only few studies such as Trefler (2004), Lileeva and Trefler (2010), Bustos (2011), and Bustos (2012, forthcoming) look at the causal effects of a trading partner's trade liberalization on labor market outcomes-- firm productivity, technology adoption and demand for skill. My dissertation builds on the empirical literature studying the role of the trade liberalization in a trading partner country in enhancing share of skilled labor in firm-level employment, firm productivity, and the export wage premium. In each of my three chapters, outlined in the greater detail in the subsequent paragraphs, I argue that one of the sources of an increase in the skilled labor employment share and the firm-level productivity gain is trade liberalization in a trading partner-country. Also, I argue that there exists the export wage premium. My empirical research leads to three main findings. First, share of skilled labor in firm-level employment is negatively associated with Chinese tariffs and that this impact of tariffs is larger in magnitude for firms below the median size than for other firms. Second, exporting firms pay higher wages than non-exporting firms, and most of it seems to work through the firm size channel rather than through differences in worker characteristics between exporters and non-exporters. Finally, a reduction in China's tariffs induces Korean firms above median size to increase their total factor productivity.

The first chapter studies the impact of trade liberalization in the main trading partner country (namely, China) on the share of skilled labor in total employment in Korea. Using firm-level data for the period 2002-2009, I find that the share of skilled labor in firm-level employment is negatively associated with Chinese tariffs and that this impact of tariffs is larger in magnitude for firms below the median size than for other firms. To figure out the movement of skilled labor, I decompose the change in the share of skilled labor and find that the skilled labor share in employment is associated with labor reallocation between firms, but not skill upgrading within firms. Also, data show that exporters have a higher demand for skilled labor than non-exporters and that there is positive correlation between technology and the share of skilled labor. Further results point to the magnified effect when the firm size distribution is constructed using profit than by sales, sales per worker, and employment.

The second chapter, coauthored with Devashish Mitra, Lourenço Paz and Jeongeun Shin, investigates the existence of the export wage premium, which is the difference in the average wage between an exporting and a non-exporting firm. Using firm-level data from Korea, this chapter also examines whether this happens through firm size or worker characteristics. The findings indicate that a one-percent increase in sales leads to a 0.092 percent increase in the wage rate and that exporting firms pay about 11.5–14.8 percent higher wages than non-exporting firms. Most of it seems to work through the firm size channel rather than through differences in worker characteristics between exporters and non-exporters. Furthermore, this chapter examines the impact of trade liberalization in Korea as well as in China and find that it reduces wages in Korea.

The third chapter examines the impact of partner-country, namely China, tariffs on Korean firm-level productivity for the period 2005-2009. In the trade policy and labor markets literature, it is well-known that productivity gains can be achieved as a result of scale effect and/or selection effect. When a trading partner country reduces its output tariff on the imports of a final good, the home country exports more of that good to the partner. Similarly, a reduction in a variable trade cost induces some firms, who did not export before a tariff reduction in a partner country, to enter into the export market. The data shows that the rates at which total factor productivity, spending on technology, number of exporting firms, and exports grow are increasing in firm size. To test the hypothesis that output tariff liberalization in a partner country enhances the firm-level productivity, a two-stage approach has been employed. In the first stage, TFP at the firm level is calculated by using Levinsohn and Petrin (2003) methodology. The TFP has been estimated separately for different industries. In the second stage, I regress firm-level TFP on lagged China-tariff; firm-level control variables and some other effects like year, industry and firm effects. My main results show that a reduction in China's tariffs induces Korean firms above median size to increase their productivity. Also, I find that the effect of any given tariff reductions is highest in the uppermost quartile of the firm-size distribution.

To conclude, my findings highlight the importance of partner-country trade liberalization in enhancing firm performance via productivity and share of skilled labor, and the existence of the export wage premium in Korea. The first chapter studies the impact of trade liberalization in China on the firm-level skilled labor employment share in Korea. The second chapter examines the existence of the export wage premium. The third chapter explores the response of partner-country tariffs on productivity.

2. Skill, Technology and Trade Liberalization: Evidence from Korean Firm-Level Data

2.1. Introduction

The standard Heckscher-Ohlin trade model states that each country will export the good that uses its abundant factor intensively. This predicts that trade opening in skill-scarce developing countries leads to a reduction in the skill premium. Since the 1980s, the integration of developing countries in the world economy has coincided with the increase in the skill premium [Pavcnik (2003), Topalova (2005) and Goldberg and Pavcnik (2007)]. These trends contradict the H-O prediction. Thus, the recent literature has proposed various alternative mechanisms through which trade liberalization can raise the relative demand for skill in both the developed and the developing world. However, there is little empirical evidence regarding the causal effects of tariff reduction in a trading partner country on the share of skilled workers in total employment. In this study, I explore the effects of a trading partner's tariffs on the share of skilled labor and allow that relationship to vary by firm size.

While we are interested in the mechanisms through which trade liberalization can raise the relative demand for skilled labor, we want to focus on some models in the trade and labor literature. First, trade liberalization may alter the returns to available technologies and lead to skill-biased technological change (Acemoglu, 2003 and Ekholm and Midelfart, 2005). When technology is skill biased, productivity is positively correlated with its skill intensity, and hence, the most productive firms (exporters) tend to be relatively skill intensive. Moreover, a reduction in a trading partner's tariffs induces the most productive firms to adopt skill-intensive production technologies, and to thus upgrade the skill level (Bustos, 2012). Notice that more productive firms are bigger in size in terms of output, revenue and profit (Melitz, 2003). Second, exporters employ more skilled workers to produce higher quality products to compete in the world market (Verhoogen, 2008). When there is a reduction in a variable iceberg-type trade cost (i.e., a reduction in a trading partner's tariffs), some firms who did not export before would start to export. Third, multiproduct firms may specialize in skill-intensive products if they face higher demand as a result of the reduction in trade cost, which will also enhance the share of skilled labor. However, if the firms are heterogeneous and face difficulties in changing their technology or any other factors in the production process, then we might observe an increase in the share of skilled labor due to labor reallocation across firms.

In the case of Korea, the following facts further motivate this study. First, Korea has seen a surplus in trade with China, its largest trading partner, while big economies, such as the United States and the EU, have seen their trade deficits with China broaden since the beginning of the 2010s. Korea's exports to China have grown from $23.75 billion in 2002 to $86.70 billion in 2009, which are about 14.6% and 23.8% of Korea's world exports respectively. Second, the overall trend in the share of skilled workers has increased from 2002 to 2009. Third, during the period from 2002 to 2009, China gradually reduced tariffs, non-tariff measures, licenses and quotas. Between 2001 and 2008, the simple average applied Most Favored Nation (MFN) tariff declined on average by 7 percentage points with a wide variation in tariff changes across manufacturing industries.

I analyze recent Korean firm level data from 2002 to 2009 to find the effects of Chinese tariffs on the share of skilled labor in total employment. The main feature of this data set is that it includes information about spending on technology (ST), export status, workers' professions and other common firm-level characteristics. The data show that the share of skilled labor in total employment is higher in exporters than in non-exporters and higher with more spending on technology.

First, I decompose the changes that occur in the share of skilled labor within and between industries to analyze the possible sources of the increase in the skilled labor share. This is important because the increase in the relative demand for skilled labor could result from labor reallocation from less skill-intensive industries to more skill-intensive industries, as predicted by the H-O model. However, I find that the majority of the increase in the relative demand of skilled labor comes from labor reallocation across firms within an industry rather than between industries. The finding that the movement of skilled labor from less skill-intensive firms to more skill-intensive firms leads me to conduct a cross-sectional analysis. To investigate the effects of trade liberalization on the skilled labor share through the technology adoption channel, I also look at the relationship between the share of skilled labor and exporting status as well as the share of skilled labor and spending on technology. I find that exporters have a higher demand for skilled labor than non exporters and that there is positive correlation between spending on technology and demand for skilled labor, which suggests that new technologies are more skill-intensive.

Using Korean firm-level data, I examine the impact of Chinese MFN tariffs on the share of skilled labor. I find that firms facing a reduction in the Chinese tariff below the median size increase their share of skilled labor faster than those above the median size. These effects are magnified when the firm size distribution is constructed by using profit than by sales, sales per worker, and employment. In particular, the estimates imply that a one percentage point decline in Chinese tariffs leads to a 0.51 percentage point increase in the skilled labor employment share in

Korea if the firms are below the median size, and a 0.15 percentage point increase in the skilled labor employment share if the firms are above the median size.

One possible reason that smaller firms increase the share of skilled labor faster than bigger firms due to the reduction of Chinese tariffs is that the movement of skilled workers occurs across firms rather than through the upgrading of skills within firms. Here, we may expect that the reductions in tariffs of a trading partner country force smaller firms to increase the share of skilled labor; otherwise, they have to exit the market. In the group of smaller firms (i.e., firms below median size), who survives as a result of trade liberalization increases the share of skilled labor via productivity. Note that bigger firms already have a higher share of skilled workers and spending on technology, and they are exporters. Even if they do not increase the share of skilled workers, they are more likely to survive since they are already more productive and participate in the exporting market. Moreover, data show some evidence of shifting skilled labor from larger firms to smaller firms.

As explained in the literature review that follows, there are some papers that empirically look at the effect of trade on the demand for skill. To my knowledge, Bustos (2012, working paper) is the first paper that studies the effect of trading partner's tariff reduction on the demand for skilled workers. My work is closer to this paper as both projects look at the impact of trade liberalization in a trading partner country on labor market outcomes. This paper finds that a reduction in Brazil's tariff induces the most productive Argentinean firms to enhance skills, while the least productive ones decline. In her study, the increase in the relative demand for skilled workers comes from skill upgrading within firms, while it comes from employment reallocation across firms in my study. This could be one reason why I observe a slightly different result from Bustos- that is, in my paper, no matter what size, all Korean firms increase the share of skilled workers due to the impact of China's tariff reduction, and the increase in smaller firms (less productive firms) is higher than in bigger firms.

Structurally, section 2.2 presents a brief overview of the literature. Section 2.3 presents the descriptions of the data, while section 2.4 reports the preliminary evidence. Similarly, section 2.5 discusses the empirical strategy followed by section 2.6, which presents the empirical results. The final two sections aim to check the robustness of the results (section 2.7), and conclude my discussion of the study (section 2.8).

2.2. The Literature

2.2.1. The Theoretical Foundation

The famous explanation in the trade and labor literature for the increase in the relative demand of skilled workers in a developed country is the 'skill-biased technological change' (SBTC). The main reasons that guided economists to favor the SBTC explanation are as follows. First, skill upgrading has been observed mainly within industries, which contradicts the traditional Heckscher-Ohlin (HO) theory. Second, skill upgrading not only occurred in developed countries but also in developing countries, which is again against the prediction of the HO theory. Recently developed models of 'trade in tasks', or 'offshoring' (Feenstra and Hanson (1996), Feenstra and Hanson (2001), Antras, Garicano and Rossi-Hansberg (2006) and Grossman and Rossi-Hansberg (2008)) make trade induced 'within' industry skill upgrading possible. Trade in tasks explain why both developed and developing countries can experience skill upgrading after trade liberalization, with the reason being that newly traded tasks to developing countries tend to be more skilled intensive work than those that used to be in developing countries.

The literature on trade and labor has proposed several channels through which trade liberalization can affect the demand for skill. First, trade liberalization may alter the returns to available technologies and lead to a skill-biased technological change (Acemoglu, 2003 and Ekholm and Midelfart, 2005). When technology is skill biased, productivity is positively correlated with its skill intensity, and hence, most productive firms (exporters) tend to be relatively skill intensive. Moreover, a reduction in a trading partner's tariffs induces the most productive firms to adopt skill-intensive production technologies, and to thus upgrade the skill (Bustos (2012, working paper)). Bustos develops a model where firms are heterogeneous in productivity and face fixed exporting costs, as in Melitz (2003), by introducing two kinds of technologies: high and low. This model also predicts that the most productive firms use the high technology and export, the medium productivity firms use the low technology and export, and the low productive firms use the low technology and serve only in the domestic market. Notice that more productive firms are bigger in size in terms of output, revenue and profit (Melitz, 2003). In addition, trade liberalization may upgrade within firm technology, as in Bustos (2011), which can increase a firm's relative employment of skilled labor.

Second, exporters employ more skilled workers to produce higher quality products to compete in the world market (Verhoogen, 2008). When there is a reduction in a variable iceberg-type trade cost (i.e., a reduction in a trading partner's tariffs), some firms will start to export who did not export before. Third, multiproduct firms may specialize in skill-intensive products if they face higher demand as a result of a reduction in trade cost, which will also enhance the share of skilled labor.

Similarly, one explanation comes from Stoyanov (2013). He extends Melitz (2003) heterogeneous firms model by introducing endogenous technology choice with firm-specific factor prices and survival probability. This model states that trade liberalization increases the incentives for exporters to adopt more productive and more capital-intensive technology, and it contributes to industry-wide productivity gain.

Although we have reasons to believe that the trade liberalization will increase the relative demand of skilled labor, as mentioned in above models, it does not necessarily mean that we should observe skill upgrading within firms. If the firms are heterogeneous and face difficulties in changing their technology or any other factors of the production process, then we will observe an increase in the share of skilled labor due to the labor reallocation across firms.

The above discussion leads me to test the following hypothesis:

A reduction in a trading partner's tariff induces the most productive firms to adopt skill-intensive production technologies.

2.2.2. The Empirical Evidence

In the literature on trade and labor, there is substantial empirical evidence showing the impact of trade liberalization on wage inequality in developing countries. For instance, Feenstra and Hanson (1996, 1997) and Goldberg and Pavcnik (2007) test the effect of trade liberalization on wages and find the skill premium effect. In particular, Feenstra and Hanson (1996, 1997) develop and test a model that predicts concurrent increases in skill premium in both developed and developing countries when they open up to trade. The model incorporates trade in intermediate inputs and capital movements. Goldberg and Pavcnik (2007) find that the increase in skill premium in Latin American countries can be reconciled with the standard Heckscher-Ohlin framework if unskilled-labor-intensive industries were relatively more protected prior to trade liberalization.

Bustos (2012, forthcoming) studies the effect of trade liberalization in a trading partner country on skill upgrading using Argentinean firm-level data (1992-1996). She finds that the reductions in Brazil's tariffs induce the most productive Argentinean firms to upgrade the share of skilled labor, while the least productive ones downgrade. The paper also documents a series of facts that support the following views: that increase in skill intensity is not only explained by the movement of labor across industries or firms but also by skill upgrading within firms; that exporters upgrade skill faster than non-exporters; and that firms upgrading skill also upgrade technology.

In the presence of technological choices, the seminal paper by Bustos (2011) develops a model of trade with heterogeneous firms and shows that the increase in revenues produced by trade integration can induce exporters to upgrade technology. Using Argentinean firm level data (1992-1996), the paper estimates the impact of partner country Brazil's trade liberalization on technology upgrading and finds that higher reductions in Brazil's tariffs raise spending on technology faster.

Bernard and Jensen (1997) find that exporters have greater skill intensity than non-exporters in the U.S., so a reallocation of market shares towards exporters can increase the relative demand for skilled workers. Similarly, another explanation comes from Verhoogen (2008), in which it is argued that increased trade with developed countries can induce exporters in developing countries to raise product quality and wages. The paper finds that exchange rate devaluation in Mexico leads the most productive firms to increase the export share of sales and wages relative to less productive firms.

Using parametric and semi-parametric approaches, Pavcnik(2003) examines whether plant-level measures of capital and investment, the use of imported materials, foreign technical assistance, and patented technology affect the relative demand for skilled workers. Using Chilean manufacturing plant level data, the paper finds that demand for skilled workers can be attributed to capital deepening. Three other technology measures disappear after controlling for unobserved plant characteristics.

Hahn and Park (2011) examine the role of exports in skill upgrading by using Korean manufacturing data from 1990 to 1998 and find that a large part of the increase in the non-production employment share was due to the “within” effect rather than the “between” effect. For instance, the “within” component contributed 1.007 percentage points per year in the increase of non production workers, while the “between” component contributed 0.754 percentage points per year. Here, most of the “within” changes were accounted for by the skill-upgrading of exporters, especially those exporters who are large and R&D active.

Harrigan and Reshef (2012, working paper) propose a model that explains why trade liberalization raises skill premium in both rich and poor countries by assuming that skill intensity and productivity are positively correlated. This model takes into consideration both trade between identical countries and countries with different factor endowments (Yeaple (2005), Bustos (2011) and Vannoorenberghe (2011) analyze trade between identical countries only). Because of the positive correlation between skill intensity and productivity, opening to trade shifts up the relative demand for skill, and skill-intensive firms expand their export opportunity. On the other hand, low-skill firms exit by facing import competition.

A few studies like Trefler (2004), Lileeva and Trefler (2010), Bustos (2011), and Bustos (2012, forthcoming) look at the effect of a trading partner’s tariff reductions associated with bilateral trade agreement between the countries on productivity, technology adoption and demand for skill. None of the existing literature takes into consideration trade liberalization in a trading partner country that is not associated with bilateral trade agreement between the two partner countries.

2.2.3. Korea is Different: Labor market and over-education

South Korea has been facing an over-supply of individuals with baccalaureate, and probably associate degrees. University and college graduates are having problems getting the kinds of professional and managerial jobs they expect (Linking higher education and economic development, Chapter 4: South Korea, Pundy Pillay, 2010). This over-education problem in a labor market causes a low skill premium in Korea.

2.3. Context and Data

2.3.1. Trade between Korea and China

This sub-section describes the trade liberalization policies launched in China after its accession to the WTO in December 2001, and the trade relationship between Korea and China. During the study period of 2002-2009, China gradually reduced tariffs, non-tariff measures, licenses and quotas. Between 2001 and 2008, the simple average applied MFN tariff declined on average by 7 percentage points with a wide variation in tariff changes across manufacturing industries. Import quotas were eliminated in 2005.

While big economies such as the United States and the EU have seen their trade deficits with China widen over the 2010’s decade, Korea has seen its trade surplus with China, the largest trading partner, grow from $6.35 billion in 2002 to $32.45 billion in 2009. Korea’s exports to China have grown from $23.75 billion in 2002 to $86.70 billion in 2009 as shown in Figure 2.1. These exports are about 14.6% and 23.8% of Korea’s world exports respectively.[1]

[1] The data I use in this paragraph come from the website of Korean Economic Institute of America, http://www.keia.org/pagefullwidth/bilateral-trade-database.

Amazingly, there has not been a big change in the composition of Korea's exports to China. Korea's major exports to China are high-tech manufactured products such as electronics, machinery, plastics, organic chemicals and optical devices. Korea initially utilized the Chinese market as an export platform to the US and the EU, but over time, mainly after China's accession to a WTO, Korea has begun to take advantage of opportunities in China's own domestic market.

2.3.2. Firm-Level Data

The Korean firm-level data used in the paper are derived from "Workplace Panel Surveys" (WPS) that cover the period 2002-2009. The data are collected and maintained by Korea Labor Institute (KLI), a government-funded policy research institution. The surveys are conducted on stratified samples from the entire population with at least 30 employees in Korea except for the first two years.[2] The population of firms is recorded on the "Workplace Demographics Survey" published by the National Statistical Office. Firms in the samples represent actual size, industry and regional distribution of firms in the population. The firms in the sample cover about 12 percent of employees in 2002 and 4 percent of employees in 2005 out of 3,392,865 and 3,450,893 employees in manufacturing sector, respectively. Note that the surveys are not conducted in the years 2004 and 2006 and that firms between the periods 2002-2003 and 2005-2009 are not identifiable.[3]

The analysis attempted in this paper restricts the focus mainly to single-plant firms in the manufacturing sector. The reason to restrict attention to single-plant firms is that only for such firms can we get fully consistent employment and financial information.[4] Note that the firms are not identified over the whole period 2002-2009 in the data, so a balanced panel cannot be

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[2]The surveys do not restrict the size of employment in first two years.
[3] The firm identification code numbers for the period 2005-09 are different from the period 2002-03.
[4] The data I use in this study also consist of some multiple-plant firms (1 firm in 2005, 10 firms in 2007, and 4 firms in 2008) that provide plant-level employment and financial information. For these firms, I use the information on employment and finance based on one of their plants.

constructed.[5] Thus, I end up with a pooled cross-sectional data of 3,510 manufacturing firms after deleting some missing observations. In fact, there are 880 common firms with 1,194 firms for 2002 and 882 firms for 2003 for the period 2002-2003. Similarly, there are 159 common firms with 493 firms for 2005, 458 firms for 2007, 280 firms for 2008 and 423 firms for 2009 for the period 2005-2009.[6]

The WPS survey provides rich information on financial and employment status in a given firm. It includes sales, profits, wage bill,[7] technological cost, export ratio[8], composition of workers and number of employees in each category. The technological cost includes spending on several dimensions of technology, namely information technology (IT) (i.e., computer, server, software and outsourcing of IT) (for years 2002 and 2003), property rights, copyrights and R&D (for years 2005, 2007 and 2009).[9] Note that firms can upgrade their production technology in many ways: by investing in research and development, purchasing foreign/new technology and capital goods that enhance the new technologies or adopting other means of innovation. In this study, I use spending on technology as the level of technology rather than depending on the estimation of residuals from the production function. Based on the survey, employees are classified into various groups in terms of occupation, such as manager, special staff (professional worker), research and technical staff[10], office staff, service staff, sales staff, agricultural skilled staff, production craft worker and elementary occupational workers. For this study, I take production craft workers and elementary occupational workers as a proxy of unskilled workers

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[5]Firms are identified over periods 2002-2003 and 2005-2009 separately.
[6] There are 320 common firms between the 2005 and 2007 surveys, 269 between 2007 and 2008 and 181 between 2005 and 2008.
[7]The wage bill includes wages and other compensation to employees such as bonuses and contribution to pension funds.
[8] The export ratio information is not included in the 2005 and 2008 surveys.
[9] For the year 2008, the survey does not provide information about technological cost.
[10] Research and technical workers are classified only for years 2002, 2003 and 2005. This category is not classified for the years 2007-2009.

and other workers are a proxy of skilled workers.[11] The sales, profit, and spending on technology and all nominal variables expressed in Korean Won are deflated using industry-specific 2005 base year producer price indices (PPI) obtained from the Economic Statistics System (ECOS) of the Bank of Korea (BOK). Sales, sales per worker, profit, spending on technology and employment are expressed in logarithms in the regressions.

Summary statistics of the main variables are presented in Table 2.1. From this table we see that there is a decrease in the number of observations for sales, profits, the export dummy, export share and spending on technology, which are due to either missing data or negative reported values. Another important characteristic of this sample is the existence of dispersion in firm size across all measures.

2.3.3. Tariff Data

To construct the output tariffs for Korea and its largest trading partner country, China, I map the HS02[12] product level tariffs from the World Trade Organization (WTO) into the Korean Standard Industrial Classification (KSIC) at the two digit level.[13] They consist of the MFN tariff rates. Industry-level input tariffs are built as the weighted average of output tariffs, in which the weights are the industry intermediate input consumption shares from Korea's input-output table. Changes in Korean tariffs and Chinese tariffs capture trade liberalization in Korea and China, respectively. For my analysis, I use lag tariffs by assuming that skill composition effects of tariff changes might take some time to show up.

[11] Skilled agricultural, forestry and fishing workers are available only for years 2005 (4 firms), 2007 (5 firms) and 2008 (1 firm). Because of very few observations in this category, I ignore this category.

[12] They provide the HS96 version for year 2001.

[13] The concordance table used for this conversion is available upon request. Industry names and codes themselves are in Table 2.2.1.

As explained in section 2.2, the trade liberalization in China should end up affecting the share of skilled labor in Korea. Even though the degree to which the reduction in Chinese tariffs is not large, the average tariff rates keep declining throughout the period from 2001 to 2007 and there are small increases from 2007 to 2008, as shown in Figure 2.2. As shown in Table 2.2.1, across all three tariffs (Korean output tariffs, Chinese output tariffs and Korean input tariffs) and across almost all products, we see declines during the period 2001-08. We can also see that there are considerable cross industry variations in all tariffs. For instance, the difference in Chinese tariffs between the most protected industry, tobacco, and the least protected industry, the printing industry, is 32 percentage points. The simple correlations among the three tariffs are presented in Table 2.2.2. We see that the Korean output and intermediate input tariffs are highly correlated, whereas the Chinese import tariff is less correlated with them but is still above 0.52.

2.4. Preliminary Evidence

2.4.1. The Relative Share of Skilled Labor

Even though the share of skilled labor decreases from year 2002 to 2003 and from year 2007 to 2009, it increases from 2003 to 2007. Overall, the trend of the share of skilled workers increases from 2002 to 2009, as shown in the Figure 2.3.[14] Data reveal that exporting firms use more highly skilled workers than non-exporting firms, while firms with higher spending on technology have more highly skilled workers. Over the 2002-2009 period, the share of high skilled jobs was about 45% on average in the exporting firms and about 41% on average in the non-exporting firms. Similarly, that share was about 47% and 36% in firms with and without spending on technology, respectively. Table 2.3 presents the industry level share of skilled labor

[14] Since the surveys do not provide sampling weights, I use an un-weighted sample to construct the trend of the share of skilled labor.

and the rank of skill intensity across the twenty-four manufacturing industries where we see significant cross industry variations. The most skill-intensive industry, beverages, and the least skill-intensive industry, casting of metals, have about 70% and 19.5% of skilled labor, respectively.

2.4.2. Decomposition of the Change in the Share of Skilled Workers

Following Bernard and Jensen (1997), I first construct a measure to capture the size of skilled labor relative to unskilled labor: the share of skilled labor in total employment. Then I decompose the changes in skilled labor employment share into between industries/firms and within industry/firm to analyze the possible sources of the increase in the share of skilled labor. The decomposition is conducted by using the following basic formula:

$$\Delta\left(\frac{L^s}{L}\right)_t = \left(\frac{L^s}{L}\right)_t - \left(\frac{L^s}{L}\right)_{t-1} = \sum_j \overline{\left(\frac{L_j^s}{L_j}\right)} \Delta\left(\frac{L_j}{L}\right)_t + \sum_j \overline{\left(\frac{L_j}{L}\right)} \Delta\left(\frac{L_j^s}{L_j}\right)_t \qquad (2.1)$$

where j = industry, firm; when j stands for industry, (L^s/L) is the share of skilled labor, (L_j/L) is the share of labor employed in industry j, (L^s_j/L_j) is skill intensity in industry j, a bar over a term denotes a time average of respective terms and the symbol Δ before a term denotes a change from time t to $t\text{-}1$. The first term on the right hand side of the equation above measures the change in skill intensity in between industries due to a change in the industrial composition of employment, while the second term (skilled biased technical change effects) reports the change in skill intensity within an industry. At the industry level, the within effect can be either changes across the firms in the same industry or changes within the firm itself. In the literature, the first term is called the “between” effect and the second term is called the “within” effect. A positive “between” effect implies that there have been employment shifts toward industries or firms whose average skill level is relatively higher. On the other hand, a net positive “within” effect results from an increase in share of skilled workers, or skill upgrading, in industries or firms with higher than average employment shares. In general, the “between” movements are primarily associated with the reallocation of employment across industries or firms which is caused by shift in product demand. Of course, it is also possible to observe these changes because of technological changes and other factors. Conversely, the changes in the “within” component have been attributed to changes in technology within an industry or a firm rather than a change in product demand.

Table 2.4.1 reports the within and between decompositions of the firm-level change in share of skilled labor during the periods 2002-2003 and 2005-2009, respectively.[15] In both periods, “within” effects are negative, “between” effects are positive and total effects are positive. In particular, the results show that a 0.13 percent per year increase in the share of skilled labor over the period 2002 -2003 and a 0.17 percent per year increase in the share of skilled labor over the period 2005-2009 are explained by the “between” component. This suggests that the firm-level skill demand is caused by employment reallocation--that is, the movement of skilled labor from less skill intensive firms to more skill intensive firms (positive “between” effect).

I also look at the decomposition of the change in the employment share of skilled labor by firm for each industry separately. Table 2.4.2 reports the industry-wide within and between effects where most of the industries have positive total effects with positive “between” effects for both of the given periods. I look at the decomposition of the change in the employment share of skilled labor by two-digit industry; results are presented in Table 2.4.3. The findings, from Table

[15] The decomposition here only takes a panel of firms, a sub sample of the given data. Since the panel id is only identified in two different periods, namely 2002- 2003 and 2005-2009, I have done a decomposition of change of the share of skilled labor for the two periods separately. Except for this decomposition, I use whole repeated pooled cross section data and/or unbalanced panel data set for the rest of the econometric analysis in this study.

2.4.3, show that the aggregate changes are negative, that either one of the between and within effect is negative or that both are negative.

Table 2.4.4 presents the share of skilled labor in total employment for firms above and below median size in manufacturing sector by year. This table shows that the share of skilled labor for firms above median size significantly decreases from 0.404 in 2002 to 0.334 in 2003 and from 0.451 in 2005 to 0.414 in 2009. On the other hand, even though the share of skilled labor for firms below median size marginally decreases from 0.482 in 2002 to 0.481 in 2003, it marginally increases from 0.390 in 2005 to 0.393 in 2009. These results show some evidence of shifting skilled labor from larger firms to smaller firms.

These results allow me to draw the conclusion that the increase in the share of skilled workers could be mainly driven by employment reallocation towards more skill-intensive firms, holding skill intensity within a firm constant.[16] Also, data show some evidence of shifting skilled labor from larger firms to smaller firms. The finding that the increase in the share of skilled labor is explained by employment reallocation across firms indicates that changes in production technology in more skill-intensive firms are the main source of the increase in the share of skilled labor. As explained in section 2.2, some less skill-intensive firms might face difficulties in changing their technology or any other factors of the production process. Hence, the next sub-sections focus on the relationship between skilled labor employment share and technology, as well as between skilled labor employment share and export status, to confirm that the trade liberalization in a trading partner country increases the share of skilled labor through the technology adoption channel.

[16] The decrease in share of skilled labor in each sector/firm (negative 'within' effect) here could be because of shifting skilled labor from the manufacturing sector to the service sector. According to OECD Social, Employment and Migration Working Paper no. 61, in the mining and manufacturing sector, the growth rate of employment has decreased from -0.9 in 2003 to -1.6 in 2006. On the other hand, in business, personal and public services, it has increased from 3.4 in 2003 to 4.7 in 2006.

2.4.3. Technology and Share of Skilled Labor

In this subsection I explore the relationship between spending on technology and the share of skilled labor by estimating the following regression using OLS.

$$\frac{L_{ijt}^{s}}{L_{ijt}} = \beta_0 + \beta_1 \log ST_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \qquad (2.2)$$

where L_{ijt}^{s} and L_{ijt} are skilled workers and total employment in firm *i* that belongs to industry *j* in year *t*, respectively. Similarly, log ST_{ijt} is log of spending on technology in firm *i* that belongs to industry *j* in year *t*, α_j is an industry dummy, α_t is a year dummy, and ε_{ijt} is the error term. Since some firms do not provide information on spending on technology in surveys, we can run this regression only in the sub-sample of total numbers firms.[17]

Estimation results are presented in Table 2.5. These results show that firms that increase spending on technology or spending on technology per worker faster also increase the share of skilled labor faster. Also, firms with spending on technology increase the share of skilled labor faster than firms without spending on technology. The estimated coefficient, 0.064, in column 4, implies that a 1 percent rise in spending on technology relative to average spending on technology is associated with a 0.064 percent rise in share of skilled labor. Unobserved time-trend shocks and industry characteristics are controlled by using time and industry dummies. This positive correlation between technology and share of skilled workers reported in table 2.5, suggests that firms that have more spending on technology are more skill intensive.

2.4.4. Export Status and Share of Skill

[17] For the year 2008, the survey does not provide spending on technology. Also, some firms in other years miss the information on spending on technology.

In this subsection I investigate the differences in the share of skilled workers between exporters and non exporters by estimating the following regression by OLS.

$$\ln Y_{ijt} = \beta_0 + \beta_1 EXP_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{2.3}$$

where Y_{ijt} is the firm's characteristics such as share of skilled labor, sales, profit, employment, ST and ST per worker that belongs to industry j in year t and Exp_{ijt} is a dummy variable that takes the value of 1 if the firm exported in year t.

Table 2.6 reports the results showing the differences between exporters and non-exporters. The estimated coefficient 0.03 in column (1) states that exporters have a 3 percentage point higher share of skilled labor than non-exporters. In other words, from column (2), we can say that exporters have a 2.5 percent higher share of skilled labor than non-exporters. Similarly, columns 3, 4 and 5 report that exporters are 0.646 - 1.484 log points bigger than non-exporters in terms of employment, sales and profit. In addition, they have a 2.5 percent higher degree of ST per worker and a 0.140 log point higher degree of ST.

The patterns in the estimated results reported in table 2.6 suggest that exporting is associated with the production function that consists of both more technology and more skill intensity. If firms start to export as a result of a decrease in a variable iceberg-type trade cost, they will start to enjoy skill-intensive production technologies.

2.5. Empirical Strategy

2.5.1. Cross-Sectional Patterns in the Data

As mentioned in section 2.2, the differences in productivity form various groups of firms: the most productive firms use high technology and export; the medium productivity firms use low technology and export; and the low productivity firms use low technology and only serve in the domestic market. In addition to productivity, there are several sources of heterogeneity across industries or firms. However, I consider only the productivity in this study. In this subsection, I seek to figure out the approximate cutoff points of productivity differences by looking at sizable variation in the share of exporters, in the share of skilled labor employment and in spending on technology across the groups of firms. As proxies for unobserved productivity, I take the sizes of profit, sales, sales per worker and employment separately to analyze the firm-size distribution.[18]

Towards that end, I look at the average differences in the outcomes--probability to export, concentration of skilled workers, and technology intensity--across quartiles of the firm-size distribution with respect to the first size quartile. Some of these estimation results are not conclusive about these cutoffs.[19] However, skilled labor share, probability of exporting, export share, and spending on technology are higher in the third and fourth quartiles than in the first two.[20] This suggests that the approximate productivity cutoff point to use high technology is the median of firm-size distribution.[21] On an average, firms above median size use high technology and firms below median size use low technology. To confirm, I estimate the average differences in outcomes between above and below median size by using the following equation:

$$Y_{ijt} = \beta_0 + \beta_1 Big_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{2.4}$$

where *i* indexes firms, *j* indexes 2-digit KSIC industries, *t* indexes years, Y_{ijt} stands for firm characteristics (export status, skilled labor employment share, and spending on technology), and

[18] A more productive firm will be bigger in terms of output and revenues, and earn higher profits than a less productive firm (Melitz (2003)).
[19] When firm-size distributions are constructed by profit, and sales, firms that belong to third size quartile have higher share of skilled labor than firms that belong to fourth quartile. On the other hand, probability of exporting, export share, and spending on technology increase with firm size. Tables of estimation results are available upon request.
[20] When firm-size distribution is constructed by employment, the skilled labor share is lower in the third and fourth quartiles than in the first two.
[21] When firm size distribution is constructed by profit, firms above median size have share of skilled labor: 0.49, share of exporting firms: 0.78 and log of ST: 0.43 on an average. Similarly, firms below median size have share of skilled labor: 0.40, share of exporting firms: 0.53 and log of ST: 0.10 on an average.

Big_{ijt} represents a dummy variable taking the value of 1 when firm *i* belongs to above median size in time *t*. So, β_1 corresponds to the differences in average outcomes for firms above median size relative to firms below median size.

Estimation results are presented in Tables 2.7.1 to 2.7.4. Table 2.7.1 presents the estimated results when firm-size distribution is constructed by size of profit, while tables 2.7.2, 2.7.3 and 2.7.4 show the results by size of sales, sales per worker and employment, respectively. The results in tables 2.7.1, 2.7.2 and 2.7.3 show that the skilled labor share, probability of exporting, export share and spending on technology are higher for firms above median size than for firms below median size. The results shown in table 2.7.4 differ. Though the probability of exporting, export share and spending on technology are higher for firms above median size as in previous tables, skilled labor employment share is lower for firms above median size. The potential reason for this difference could be that when manufacturing firms are bigger in terms of employment, they might have more unskilled labor share or little room to increase skilled labor.

2.5.2. Econometric Specification

Through the mechanisms highlighted above, such as association of exporting with more skill-intensive production technologies, increased export revenues inducing firms to cross a size demarcation above which such production functions are more profitable or other channels related to the enlargement of exports and number of exporters, tariff reductions in a trading partner country can increase the share of skilled labor. Regardless of these mechanisms, in this section, I estimate the causal effect of a trading partner country's tariffs on the share of skilled labor.

As I mentioned in section 2.5.1, I report the results that are obtained when firms are classified into two groups: above and below median size. For this study, based on the nature of the data, we can take the median as an appropriate cutoff to identify the causal effects of a partner country's tariff reduction on the share of skilled labor. The data reveal that 78% firms above the median size and 53% firms below the median size export when firm-size distribution is constructed by profit.[22]

Estimations are done using two different methods: a random effects model and a pooled regression model. The use of the panel data allows for modeling of heterogeneity across firms.[23] In the panel context, the common and fundamental question is the choice between fixed effects (FE) and random effects (RE). The following reasons lead me to use the RE model instead of the FE model. First, I believe that although there is some correlation between omitted variables and explanatory variables like Chinese tariffs and firm size dummies, it is negligible. Second, the data reveal that 'between variation' plays a leading role in the change in the share of skilled labor compared to 'within variation' in all variables used in the regression analysis. Third, the share of skilled labor moves across firms, from less skill-intensive to more skill-intensive firms, rather than skill upgrading within them.[24] A general formulation of a random effects model can be expressed as:

$$y_{ijt} = \alpha + \beta X_{ijt} + \mu_i + \varepsilon_{ijt} \quad , \tag{2.5}$$

$$\mu_i \sim IID(0, \sigma_\mu^2) \text{ and}$$

$$\varepsilon_{ijt} \sim IID(0, \sigma_\varepsilon^2).$$

where β measures a partial effect of X_{ijt} across years t for a firm i that belongs to industry j, α stands for the intercept term and μ_i stands the random parameters that capture firm's individual

[22] If the firm size distribution is constructed by sales, 78% of firms above the median size and 53% of firms below median size export; if the firm size distribution is constructed by employment, 73% of firms above the median size and 53% of firms below median size export and if the firm size distribution is constructed by sales per worker, 75% of firms above the median size and 56% of firms below median size export.

[23] Though firms between the periods 2002-2003 and 2005-2009 are not identifiable, when I use a random effects model in this study, I use as one set of unbalanced panels.

[24] To support this argument, I also estimate the causal effect of a trading partner country's tariffs on the share of skilled labor by using firm fixed effects, and the results are interpreted in the result section.

effect and are assumed to be independently and identically distributed (IID) over firms. Specifically, in this context, the following equation is estimated by using a random effects model:

$$\frac{L^s_{ijt}}{L_{ijt}} = \beta_0 + \beta_1 tariffC_{j(t-1)} + \beta_2 Big_{ijt} + \delta(tariffC_{j(t-1)} * Big_{ijt}) + \alpha_j + \alpha_t + \mu_i + \varepsilon_{ijt} \qquad (2.6)$$

where *i* denotes firms, *j* denotes 2-digit KSIC industries and *t* denotes years. Similarly, $tariffC_{j(t-1)}$ stands for China's average MFN tariffs for industry *j* at time *t-1* and Big_{ijt} represents a dummy variable taking the value of "1" when firms are above median size. Industry effects are added to equation (2.6) to address time invariant factors at the industry level that affect employment composition like the share of skilled workers. The year effects are included in the empirical specification to account for economy-wide shocks that affect employment composition, technology and the export decision.

Similarly, I estimate the effect of China's tariffs on the skilled labor employment share for firms below and above median size by using pooled cross-sectional data through the following equation:

$$\frac{L^s_{ijt}}{L_{ijt}} = \beta_0 + \beta_1 tariffC_{j(t-1)} + \beta_2 Big_{ijt} + \delta(tariffC_{j(t-1)} * Big_{ijt}) + \alpha_j + \alpha_t + \varepsilon_{ijt} \qquad (2.7)$$

where *i* denotes firms, *j* denotes 2-digit KSIC industries and *t* denotes years; $tariffC_{j(t-1)}$ represents China's average MFN tariffs for industry *j* at time *t-1* and Big_{ijt} stands for a dummy variable taking the value of "1" when firms are above median size.

2.5.3. Endogeneity of Trade Policy

Two sides of identification make trade liberalization in China likely to be exogenous with respect to the change in the Korean firm-level share of skilled labor between 2002 and 2009. First, the Chinese decision to join the WTO was motivated by the domestic reform agenda and willingness to become a market economy. Note that China has been a member of the WTO since December 11, 2001. Once a country becomes a member of the WTO, it has to apply its MFN tariffs to all other members of the WTO. There are also nine free trade agreements between China and its trading partners signed during the period of 2002 to 2009, which are given in Appendix A. These agreements guide the reduction in MFN tariffs over the given period. Thus, the reductions in MFN tariffs in China are anticipated without accounting for trade relations with Korea.

Second, even though the bilateral trade volume between Korea and China accounted for about 22 percent of Korea's total trade, it is only about 7 percent of China's overall trade in 2009. These figures imply that China's most favored nation import tariffs are unlikely to be driven by Korean industry characteristics.

2.6. Results

In tables 2.8.1 to 2.8.4, I present the estimation results of equation (2.6) that show the impact of Chinese output tariffs on the share of skilled labor in total employment for firms below and above median size by using a random effects model. In particular, table 2.8.1 reports these results when the firm-size distribution is constructed by using profit. In column (1), the baseline specification, we see that one percentage point decline in Chinese tariffs leads to a 0.513 percentage point increase in the share of skilled labor if the firms are below the median size, while there will be a 0.12 (0.513-0.393) percentage point increase if the firms are above the median size. In column (2), we see that effect to firms below and above the median size expand slightly from 0.513 to 0.529 percentage points and 0.120 to 0.143 percentage points, respectively, once we control for the Korean output import tariff. In column (4), we see that there are similar effects to the firms both below and above the median size, as in columns (1) and (2), once we control for the Korean input import tariff. In columns (3) and (5), I present results once we additionally controlled for the interaction of the Korean output import tariff and the above median size dummy as well as the Korean input import tariff and above median size dummy, respectively. The point estimations in these two columns also support the explanations that have been made in columns (1), (2) and (4). Thus, the regression results, presented in table 2.8.1, provide strong evidence that the firms below median size have a stronger effect of Chinese tariff reduction on an increase in the share of skilled labor compared to the firms above median size.[25]

Tables 2.8.2, 2.8.3 and 2.8.4 also present the impact of Chinese tariffs on the share of skilled labor for the firms below and above median size. These tables depart from table 2.8.1 only in the construction of the firm-size distribution. Table 2.8.2 presents the estimated results when firm-size distribution is constructed by size of sales, while tables 2.8.3 and 2.8.4 show the results by size of sales per worker and employment, respectively. When the firm-size distribution is constructed by sales, the coefficients in the first row (estimation of β_1, which measures the average effect of China's tariff on the share of skilled workers for firms below median size) in table 2.8.2 are negative in sign and statistically significant. Though the coefficients of interaction of the Chinese tariff and the above median size dummy are not statistically significant in columns (3) and (5), signs of the coefficients are positive. Also, in all specifications, the size of the coefficient of interaction term is smaller than the size of the respective coefficient of Chinese output tariffs in magnitude. Thus, regression results, presented in table 2.8.2, also provide some evidence that firms below median size have a stronger effect of Chinese tariff reduction on the share of skilled labor compared to firms above median size.

[25] In the use of unbalanced panel, one possible bias could arise due to attrition. Since firms are not identified over periods 2002-2003 and 2005-2009, attrition bias is not addressed in this study.

When the firm-size distributions are constructed by sales per worker and employment, the coefficients in the first row are negative in sign and statistically significant except for some outliers: columns (3) and (5) of table 2.8.3. Though the coefficients of the interaction of the Chinese output tariff and the above median size dummy in the third row are not statistically significant, signs are positive. From these two tables, we again conclude that there is also some weak evidence that firms below median size have a stronger effect of the Chinese output tariff on the share of skilled labor compared to firms above median size. Note that the baseline specification is not jointly controlled by the Korean output import tariff and the Korean input import tariff due to the strong multicollinearity between the two.

In section 2.5, I offer some arguments about why a random effects model is more appropriate than a fixed effects model in the use of panel data to explain the causal effects of China's tariff on the share of skilled labor. Out of these, one comes from the decomposition of change in share of skilled labor, which includes movements of skilled labor from less skill-intensive firms to more skill-intensive firms. However, to support this argument, I also use a fixed effects model instead of a random effects model, and estimation results are presented in tables 2.9.1 (using panel data for period 2002 to 2003) and 2.9.2 (using panel data for period 2005 to 2009).[26] From both tables, we see that the coefficients of China's tariff and the coefficients of interaction of China's tariff and above median size dummy are not statistically significant. This implies that firm fixed effects do not play any role to explain the impact of China's tariffs on the share of skilled labor. Hence, the results from tables 2.9.1 and 2.9.2 are consistent with the results from the decomposition of change in the share of skilled labor.

[26] Here, I put the results only when firm size distribution is constructed by profit. When firm size distribution is constructed by sales, sales per worker, and employment, the pattern of results are similar to in tables 2.9.1 and 2.9.2. (Other tables are available upon request).

When the estimations are done by using a pooled regression model, results are presented in tables 2.10.1 to 2.10.4. These tables show the estimation results of equation (2.7) that look at the impact of Chinese output tariffs on the share of skilled labor in total employment for firms below and above median size, as in tables 2.8.1 to 2.8.4. In particular, table 2.10.1 reports the results on when firm-size distribution is constructed by profit. In column (1), the baseline specification, we see that one percentage point decline in Chinese tariffs leads to a 0.621 percentage point increase in the share of skilled labor if the firms are below the median size and a 0.152 (0.469-0.621) percentage point increase in share of skilled labor if the firms are above the median size. In column (2), we see that the effect on the firms below median size shrinks a little from 0.621 to 0.617 percentage points, while the firms above median size expand a little from 0.152 to 0.174 percentage points once we control for the Korean output import tariff. The Korean output import tariff reduction is positively associated with the skilled labor share. In column (4), we see that the effects to the firms both below and above the median size shrink from 0.621 to 0.603 percentage points and 0.152 to 0.138 percentage points, respectively, once we control for the Korean input import tariff. In columns (3) and (5), I present results once we additionally control for the interaction of the Korean output import tariff and the above median size dummy as well as the Korean input import tariff and above median size dummy, respectively. Though the coefficients of the interactions of the Chinese tariff and the above median size dummy are not statistically significant, signs are positive. Also, in both specifications, the size of the coefficient of the interaction term is smaller than the size of the respective coefficient of Chinese output tariffs in magnitude. Thus, the regression results, presented in table 2.10.1, provide some evidence that firms below median size have a stronger effect of Chinese tariff reduction on an increase in the share of skilled labor compared to firms above median size.

Tables 2.10.2, 2.10.3 and 2.10.4 also present the impact of Chinese tariffs on the share of skilled labor for firms below and above median size. These tables depart from table 2.10.1 only in the construction of the firm-size distribution. Table 2.10.2 presents the estimated results when firm-size distribution is constructed by size of sales, while tables 2.10.3 and 2.10.4 show the results by size of sales per worker and employment, respectively. When firm-size distributions are constructed by sales and sales per worker, the coefficients in the first row are negative in sign and are statistically significant except for some outliers: columns (3) and (5) of table 2.10.3. Though the coefficients of the interaction of the Chinese output tariff and the above median size dummy in the third row are not statistically significant, their signs are positive. From these two tables, we conclude that there is also some weak evidence that firms below median size have a stronger effect of the Chinese output tariff on the share of skilled labor compared to firms above median size. When the firm-size distribution is constructed by employment, the coefficients in the first row are negative, and the coefficients of the interaction of the Chinese output tariff and the above median size dummy in the third row are positive. Though they are not statistically significant, the size of the coefficient of the interaction term is smaller than the size of the respective coefficient of the Chinese output tariff in magnitude. Thus, this table has still maintained some support for the finding that firms below median size have a stronger effect of the Chinese tariff on the share of skilled labor compared to firms above median size.

In sum, the analysis in this section suggests that declines in Chinese output tariffs on Korean exports were associated with increases in the share of skilled labor in Korean manufacturing firms and that degrees of increasing vary with the sizes of firms by firm-size distribution. In other words, smaller Korean manufacturing firms hire a larger proportion of skilled to unskilled labor compared to bigger firms in the response of reduction in the Chinese tariff.

2.7. Robustness Check

A potential concern with the results is that the predicted value of the share of skilled labor could lie outside the range [0,1] since the dependent variable is in fractional form. To address this concern, I estimate the equation (2.7) by using a fractional logit model [Papke and Wooldridge (1996)]. Table 2.11 presents the estimation results.[27] As expected, from Table 2.11 we see that firms below median size have a stronger effect of Chinese tariff reduction on the share of skilled labor compared to firms above median size. The estimation results slightly differ from Table 2.10.1 only in the sizes of respective coefficients. Hence, these results are robust with that estimated by using OLS (see Tables 2.10.1 and 2.11).

2.8. Conclusion

In this paper, I have used Korean firm-level data to investigate the effect of trade liberalization in a trading partner country on the share of skilled labor in total employment. To shed light on the possible determinants of the increase in the skilled labor share, I have decomposed the increase in the share of skilled labor in changes within and across firms/sectors. To investigate the effects of trade liberalization on the skilled labor share through the technology adoption channel, I have also looked at the relationship between the share of skilled workers and exporting status, as well as between share of skilled workers and spending on technology.

[27] Here I use firm size distribution constructed by profit. Results are robust to using fractional logit for all proxies of sizes: profit, sales, sales per worker and employment instead of OLS. Tables that use firm size distribution by sales, sales per worker and employment are available upon request.

The main finding of the paper is that firms facing a reduction of Chinese tariff below median size increase the share of skilled labor faster than above median size. This effect is magnified when the firm-size distribution is constructed using profit than by sales, sales per worker and employment. I have also seen that the share of skilled labor is associated with labor reallocation between firms but not skill upgrading within firms. Finally, the results in the paper reveal that there is a positive correlation between technology and the share of skilled labor that suggests that new technologies are more skill-intensive and that exporting is associated with the production function that consists of both more technology and more skill intensity.

3. Export Wage Premium: Firm-Level Evidence from Korea

3.1. Introduction

Most of us who have participated in some kind of labor market or the other know from experience that wages vary quite a bit within the same profession. We also know that not always can these variations be explained away by variations in skill, experience, ability or certain other fundamental visible worker characteristics. Thus, wages for the same type of workers could vary across firms. The literature has provided different explanations for this phenomenon. One explanation is that firms have to provide fair wages. More precisely, a low wage paid by a highly profitable firm to its workers is viewed as unfair, in response to which workers do not exert their full effort. What is viewed as fair wage is increasing in a firm's profits. This will lead to higher wages paid by the relatively large, profitable, and productive firms. A second explanation is that some workers searching for jobs might just get lucky to be matched up with relatively more productive firms that also in turn are more profitable. With Nash bargaining between the firm and its workers, the wages will turn out to be higher in the more productive firms. A third explanation in the literature comes from the fact that the quality of matches is better in the more productive and profitable firms since it is in the interest of these firms to spend more in the screening of applicants.

While we are interested in the aforementioned models of heterogeneous wages in general, more specifically we want to focus on the trade aspects of such models. In particular, we are interested in whether exporting firms pay higher wages than non-exporting firms. And, if so, whether exporters pay higher wages because they employ higher quality workers needed to produce higher quality products to compete in the world market (as in Verhoogen, 2008) or because they are the relatively larger and more profitable firms in their industry, and thus have to pay higher wages due to fairness considerations (Amiti and Davis, 2012 and Egger and Kreickemeier, 2009) or a part of their surplus is bargained away by workers or because they invest more in the screening of applicants which leads to better matches (Helpman et al., 2008).

In this paper, we also analyze the impact of trade policy variables on wages. Both fair-wage based theories as well as search or screening based theories would argue that trade liberalization (tariff cuts) would have different impacts on different kinds of firms. Some of the least productive firms would be wiped out by trade liberalization while the slightly more productive firms will still exist but will lose profits from the decline in their domestic market share. These firms will not be productive enough to find it profitable to jump the fixed costs of exporting. However, larger firms will benefit from bigger markets abroad due to reciprocal trade liberalization. When a country's own tariff is liberalized it is quite possible that profits and in turn wages fall across the board in a country. Finally, we are also interested in how partner country tariffs affect wages as partner country tariffs affect a firm's ability to export.

Using firm-level data from South Korea, we examine the existence of the export wage premium, which is the difference in the average wage between an exporting and a non-exporting firm. We investigate whether this happens through firm size or worker characteristics. We also look at the impact of tariffs in Korea as well as in its largest trading partner, namely China. We find that a one-percent increase in sales leads to a 0.092 percent increase in the wage rate and that exporting firms pay about 11.5–14.8 percent higher wages than non-exporting firms. Most of it seems to work through the firm size channel rather than through differences in worker characteristics between exporters and non-exporters. Trade liberalization in Korea as well as in

China seems to reduce wages in Korea. We cannot identify the effects of input tariffs separately from output tariffs as they are highly correlated.

As explained in the literature review that follows, there are some papers that empirically look at the issue of trade within a fair wage framework or a screening framework married with the Melitz model (such as Amiti and Davis, 2012 for Indonesia and Krishna, Poole and Senses, 2012 and Helpman, Itskhoki, Redding and Muendler, 2012 for Brazil). There is also a paper by Hahn (2005) that focuses on the export wage premium in Korea. While our paper is similar in spirit to Hahn's, we go a fair bit beyond it in two respects. First, we look at the impact of policy variables on the wages paid. These policy variables include output and intermediate input import tariffs and the tariffs imposed by the largest trading partner, namely China. Second, our estimates use more recent data, which offers a wide variety of size controls apart from the employment level control used by Hahn. The latter is important because our findings suggest that the employment level when used as a size control does not do very well in identifying the impact of firm size on wages. Finally, it is worth mentioning that, as discussed above, some of our results are common to the fair-wage framework as well as the search/screening framework, married to the Melitz model. Since we do not have matched employer-employee data for Korea, we will not be able to empirically differentiate between the two types of theories.

The remainder of the paper is organized as follows. Section 3.2 presents a brief overview of the theoretical models and their testable predictions that are examined in this paper. In section 3.3, we discuss the empirical specifications used to assess such predictions. The data used is described in section 3.4. Section 3.5 presents the empirical results. We offer some conclusions in section 3.6.

3.2. Related Literature and Relevant Hypotheses

We first discuss the hypotheses from the theoretical literature that we are able to test using our data on Korean plants. Next, we present a brief review of the empirical literature on the exporter wage premium that is related to our study.

3.2.1. Theoretical Models and Testable Predictions

The theoretical models discussed here are based upon the Melitz (2003) heterogeneous firm model, in which monopolistically competitive firms have heterogeneous productivity and face a fixed cost of production every period. If a firm exports, it will also incur an additional per period fixed export cost and a variable iceberg-type trade cost that is proportional to the volume exported.[28] In equilibrium, the existence of fixed costs causes high marginal cost firms to not operate since they make negative profits. Among the firms that find profitable to operate and serve domestic markets, not all of them find profitable to export due to the export fixed cost. Nevertheless, the Melitz (2003) model does not allow for different wages across firms, and thus there is no exporter wage premium. But, there are two types of extensions of this model with ex ante homogeneous workers that deliver within industry wage heterogeneity. The first type is related to fair wage considerations, such as Amiti and Davis (2012) and Egger and Kreickemeier (2009, 2010, and 2012). The second type considers the existence of labor market frictions such as Helpman et al. (2008).

The fair wage mechanism used in Amiti and Davis (2012) is based on the Akerlof (1982) idea that if workers perceive their wages as being unfair, they will not exert effort. That is why firms are willing to comply with workers' demand that their wages be directly linked to their profitability. As a result, firms optimally choose wages taking into account their impact on profitability. In the Amiti and Davis (2012) model, the fair wage constraint implies that (average)

[28] This variable trade cost includes both transportation costs and partner country tariffs.

wages and economic profits should be positively correlated. This leads to the first testable hypothesis.

Hypothesis 1: *Firm-level average wages are increasing in firm-level profits.*

The constant mark-up pricing rule based upon the firm productivity level of the original Melitz (2003) model, also present in the Amiti and Davis (2012) model, makes firm productivity to be a sufficient statistic for profits, sales, and employment level. Hence revenues, employment size, and profits are positively related. As a consequence, we should also observe a positive relationship between sales, employment size, and average wages. This leads to our second testable hypothesis.

Hypothesis 2: *Firm-level average wages are increasing in firm sales and employment.*

Firms' profits increase when they engage in exporting, and due to the fair wage mechanism, higher profits lead to higher wages, i.e. workers employed in exporting firms receive a wage premium, namely the exporting wage premium. This leads to the third testable hypothesis.

Hypothesis 3: *Exporting firms pay higher average wages than non-exporting firms.*

Recall that the wage premium comes from larger profits. Suppose two firms have the same profits, but only one of these firms' exports. Then, according to the fair-wage mechanism there should be no difference in the wages paid. So, when profits, sales, or employment are controlled for, there should be no exporting wage premium in the Amiti and Davis (2012) model. This leads to Hypothesis 4.

Hypothesis 4: *There is no difference between average wages paid by exporting and non-exporting firms when profits, sales, or employment levels are controlled for.*

Besides the fair wage mechanism, the Amiti and Davis (2012) model extends Melitz (2003) to incorporate trade in intermediate goods (similarly to Kasahara and Lapham, 2007). Thus, in addition to the domestic varieties of intermediate inputs, a firm can access additional varieties of intermediates produced abroad by paying a fixed and a variable import cost. By having access to a larger variety of intermediate inputs firms can have a lower marginal cost at any given wage. And this boosts their sales and profits. So, a firm imports intermediate inputs as long as its additional profits outweigh the costs of importing inputs.

The comparative statics involving tariff changes in this type of heterogeneous firm model is conducted under the assumption of symmetric countries and symmetric tariff changes. Nonetheless, Demidova and Rodriguez-Clare (2011) provide a small open economy version of the Melitz (2003) which allows for unilateral tariff changes. In this case, a unilateral output or input tariff reduction leads to a trade deficit. Thus, the real exchange rate has to depreciate to restore the trade balance equilibrium. This means that the domestic wage level vis-á-vis the foreign wage has to decrease. Since wages change uniformly across all firms, this does not affect the exporter wage premium. On the one hand, the wage reductions enhance profits and output of all domestic firms, while the exporters specifically benefit much more since their new lower cost/price increase their sales abroad. On the other hand the decrease in tariff reduces the revenues and profits from selling at domestic markets due to stronger foreign competition in the case of output tariffs or due to stronger competition from domestic producers that import intermediate input in the case of an intermediate input tariff decline. The resulting effect of these two mechanisms depends on the firm exposure to international trade. For non-exporters (and non-importers) the increased competition in the domestic market effect is stronger. This leads to Hypothesis 5.[29]

Hypothesis 5: *A decrease in both input and output import tariffs decreases the wages at all firms that are not engaged in any form of international trade, namely in exporting and in importing intermediate inputs.*

The firms that are marginal exporters or are marginal importers of intermediate inputs also suffer from a reduction in domestic sales, but neither the sales abroad nor the lower marginal cost due to imported intermediate inputs are enough to counterbalance the profit reduction from the decrease in domestic sales arising out of the greater competition they face. This leads to the sixth testable hypothesis.

Hypothesis 6: *A decrease in input or output import tariffs reduces the wages at all firms that are marginal importers of intermediate inputs or exporters of final goods.*

Nevertheless, if firms are larger exporters (or larger importers of intermediate inputs), the increase in foreign (or domestic) sales due to the change in tariffs is large enough to more than counterbalance the decrease in domestic sales due to the greater competition induced by the change in tariffs, as is stated in Hypothesis 7.

Hypothesis 7: *A decrease in input or output import tariffs increases the wages paid by large importers of intermediate inputs and exporters.*

A change in a trade partner's import tariff on final goods has an effect similar to that of a change in a country's own import tariff. This happens because balanced trade requires that any increase in exports to a trade partner due to the trade partner's reduction in its tariff be counterbalanced by an increase in imports from the trade partner through an exchange rate appreciation. This leads to Hypothesis 8 for firms not engaged in trade and for marginal

[29] Hypotheses 5 through 8 come from Amiti and Davis (2012) Proposition 4.

exporters and importers (of intermediate inputs), and Hypothesis 9 for larger exporters of output or importers of intermediate inputs.

Hypothesis 8: *A decrease in a trade partner's output import tariff decreases wages paid by all firms that are not engaged in trade and all firms that are marginal exporters and importers of intermediate inputs.*

Hypothesis 9: *A decrease in a trade partner's output import tariff increases the wages paid by large importers of intermediate inputs and exporters.*

The second type of extension of the Melitz model consists of adding job search with labor market frictions. This prevents workers outside a firm from being perfect substitutes of the firm's current employees. As a consequence, the currently employed workers have some bargaining power in the determination of wages. And in that case as well wage becomes related to the firm's profit. An important paper of this strand is Helpman et al. (2008), in which workers are ex ante homogeneous but they exhibit a different firm-specific ability draw, which is also called firm-worker match quality. Firms can infer this ability through the use of a costly screening technology that allows them to hire workers with firm-specific ability above some threshold. As a result, in equilibrium firms with higher profits (and revenues) will sample more workers and have higher firm-specific ability cutoffs. Thus they hire more productive workers and pay higher wages than firms with lower profits in the same industry. Because workers are ex-ante homogeneous these higher wages paid by exporters can be interpreted as the exporting wage premium. This model also generates Hypotheses 1 through 4.

Both reductions in domestic output import tariffs and in trade partners' output import tariffs affect the firm revenues in a similar fashion to that in Amiti and Davis (2012). Hence, Hypotheses 5 through 8 for changes in output tariffs are also generated by Helpman et al (2008).

So far we have focused on models of ex ante homogeneous workers. But, there is another class of models in which workers are ex ante heterogeneous. In these models, the wage paid by exporting firms is also higher than the wages of firms serving only domestic markets. This is so because exporters employ more skilled workers. One explanation for such behavior can be found in Bustos (2011). She presents a model where access to foreign markets leads exporters to adopt new technologies that require more skilled workers. Another explanation comes from Verhoogen (2008). In his model, the exported goods must be of better quality. This increase in the quality of output requires hiring relatively more skilled workers who earn higher wages. So once the skill composition of labor used is controlled for, the exporting wage premium should not exist. Assessing this type of explanation in detail is beyond the scope of our paper and thus it is not further discussed here.

3.2.2. Literature Review

The seminal paper of Bernard and Jensen (1995) studied the behavior of exporting and non-exporting plants using U.S. manufacturing data. They found that average wages were higher in exporting plants than in non-exporting plants of all size categories. Furthermore, the exporter wage premium remained positive and statistically significant even after introducing additional controls such as capital per worker, size of plant, plant age, and region, industry, and year effects. Since then, many papers have studied this phenomenon both theoretically and empirically, and found that this phenomenon happens in both developed and developing countries.[30]

Hahn (2005) is an empirical paper that used Korean manufacturing plant level data from 1990-1998 to investigate the differences between exporters and importers. The exporting wage premium was estimated by means of a regression of the plant average wage on a dummy variable

[30] For a comprehensive literature review about the export wage premium (including papers not directly linked to ours), see Schank et al. (2007).

indicating if the firm exported and other controls. Hahn (2005)'s results implied that the average wage of exporters is higher than of non-exporters, i.e. the export status dummy was positive and statistically significant as predicted by Hypothesis 3. Furthermore both production and non-production workers wages were higher in exporters, however, the premium for non-production workers was larger. The export dummy's sign and statistical significance did not change when region and industry effects were added to the estimated specification. But when plant size measured as employment level was included in the empirical model, the coefficient of the export dummy decreased in magnitude and lost statistical significance. So the wage premium found by Hahn seems to be a size premium and not an exporting wage premium.

There are some other papers that have also looked at the exporter wage premium but used employer-employee matched data such as Schank et al. (2007) for Germany, Frías et al. (2011) for Mexico, and Krishna et al. (2011) for Brazil. The latter also looked at the impact of trade on wages.

Schank et al. (2007) and Frías et al. (2011) find that the exporting wage premium become smaller but does not disappear when matched firm-worker (spell) fixed effects and both observable as well as unobservable characteristics of workers and plants are accounted for. This result supports Hypothesis 3. Furthermore, Frías et al. (2011) found that only a third of this wage premium could be attributed to changes in labor skill composition, therefore their results do not support Hypothesis 4.

Krishna et al. (2011) use Brazilian employer-employee matched data to empirically examine the effect of tariffs on average wages during the Brazilian trade liberalization episode (1987–1998). They find that a decline in trade protection is associated with an increase in the average wages of exporting firms relative to non-exporting firms. This effect is found to be stronger for large exporters, as predicted by Hypothesis 7 above. When their econometric specification accounts for compositional effects (workers characteristics) and firm-worker specific effects, like Schank et al. (2007), they find that larger wages paid by exporters come from higher innate ability of workers and worker-firm match quality. This means that there is indeed an exporter wage premium as predicted by Hypothesis 3.

3.3. Econometric Specification

In this section we describe the econometric specifications to be estimated using Korean plant level pooled cross-section data to assess Hypotheses 1 through 9 that were discussed in the previous section. To investigate Hypotheses 1-4 predictions, we employ the following empirical specification,

$$\log(\bar{w}_{ijt}) = \alpha + \beta_1 size_{ijt} + \beta_2 export_{ijt} + \delta_j + \theta_t + \epsilon_{ijt} \ , \qquad (3.1)$$

where $\bar{w}_{ijt}$ is the average wage paid by firm *i* that belongs to industry *j* in year *t*, $export_{ijt}$ is an indicator variable that is "1" if firm *i* exported in year *t*, and "0" otherwise; $size_{ijt}$ is a proxy variable for the economic size of the firm, such as natural logarithm (ln) of sales, profits, and employment level; $\boldsymbol{\delta}_j$ is a vector of industry effects, $\boldsymbol{\theta}_t$ is a vector of year effects, and ϵ_{ijt} is the error term. Hypotheses 1 and 2 predict a positive sign for β_1. When the *size* variable is omitted, Hypothesis 3 predicts $\beta_2 > 0$. Conversely, when *size* is included in the specification, Hypothesis 4 predicts $\beta_2 = 0$.

Industry effects are added to equation (3.1) to address time invariant factors at the industry level that affect wages, like compensating differentials. The year effects are included in the empirical specification to account for economy-wide shocks such as business cycle and exchange rate fluctuations that affect both wages and the export decision. An important econometric issue related to our empirical specification is that the average wage differs across firms belonging to different industries, since different industries are concentrated in different cities. We believe that these issues are alleviated significantly by the use of industry and year effects. Also, the use of industry and year effects makes the within-industry variation the source of identification of the estimated coefficients, as posited by the theoretical models discussed earlier. Accordingly, we clustered the standard errors at the industry level.

Moreover, firms may require different mixes of full time and part-time workers, production and non-production workers, and worker skill. Thus, to examine the possibility that higher wages are due to the fact that larger or exporting firms employ workers with different characteristics, we estimate an augmented version of equation (3.1) that incorporates worker characteristics like share of males and share of production workers (included in the $characteristics_{ijt}$ vector) as follows.

$$\log(\overline{w}_{ijt}) = \alpha + \beta_1 size_{ijt} + \beta_2 export_{ijt} + \gamma characteristics_{ijt} + \delta_j + \theta_t + \epsilon_{ijt} \qquad (3.2)$$

The third empirical specification to be estimated examines Hypotheses 5-9, which predict that the effect of tariffs on average wage depends on the firm's exposure to international trade. We follow Amiti and Davis (2012) and use two variables to indicate the firm exposure to international trade. To capture the level effect of exports, like in the case of equations (3.1) and (3.2) above we use a dummy variable that is "1" if a firm is an exporter, and "0" else, or alternatively the share of export revenues in total sales. For the interaction effect of trade, we also need information on firm-level input imports in addition to the information on its levels of exports. Unfortunately, the information regarding firm-level imports of intermediate inputs is not available in our dataset, but since both exports of a firm's products and its intermediate input imports are usually positively correlated with size or productivity (according to all of the relevant theories described above), we interact all the tariff variables with firm size or productivity proxy variables, as shown in the following equation:

$$\log(\overline{w}_{ijt}) = \alpha + \beta_1 size_{ijt} + \beta_2 export_{ijt} + (\beta_3 + \beta_4 size_{ijt})\tau_{jt} + (\beta_5 + \beta_6 size_{ijt})\tau_{jt}^{int} + (\beta_7 + \beta_8 size_{ijt})\tau_{jt}^{*} + \delta_j + \theta_t + \epsilon_{ijt}\ , \quad (3.3)$$

where τ_{jt} is the tariff imposed by Korea on imported goods from industry *j* in year *t*, τ_{jt}^{int} is the tariff imposed by Korea on imported intermediate inputs used by industry *j* in year *t*, τ_{jt}^{*} is a vector of Korea's trade partner import tariffs imposed on Korean industry *j* products in year *t*. We use tariffs lagged by one year for our analysis as employment effects of tariff changes might take some time to show up.

Hypotheses 5, 6, and 8 predict $\beta_3 > 0$, $\beta_5 > 0$, and $\beta_7 > 0$, respectively. Now, Hypothesis 7 predicts $\beta_3 + \beta_4 size_{ijt} < 0$ and $\beta_5 + \beta_6 size_{ijt} < 0$ whenever $size_{ijt}$ is sufficiently large. Similarly, Hypotheses 9 predicts $(\beta_7 + \beta_8 size_{ijt}) < 0$ if $size_{ijt}$ is sufficiently large.

The last empirical specification, equation (3.4), is an augmented version of equation (3.3) in which we added controls for workers characteristics. As discussed earlier, we also expect Hypotheses 5 through 9 to hold here.

$$\log(\overline{w}_{ijt}) = \alpha + \beta_1 size_{ijt} + \beta_2 export_{ijt} + (\beta_3 + \beta_4 size_{ijt})\tau_{jt} + (\beta_5 + \beta_6 size_{ijt})\tau_{jt}^{int} + (\beta_7 + \beta_8 size_{ijt})\tau_{jt}^{*} + \gamma \text{characteristics}_{ijt} + \delta_j + \theta_t + \epsilon_{ijt} \quad (3.4)$$

A final concern is that the import tariffs across industries may be correlated with some industry characteristics present in the error term. In other words, some characteristics of the industry (e.g. market concentration, share of unskilled workers) are taken into account when setting tariffs. This possibility has received a great deal of attention in the literature on the political economy of trade protection both theoretically basis (Grossman and Helpman, 1994, and Mitra, 1999) and empirically (Trefler, 1993, Goldberg and Maggi, 1999, Gawande and Bandyopadhyay, 2000, Mitra et al., 2002, and Karacaovali, 2011). This means that if some of these characteristics also influence the wage, the current tariff level becomes an endogenous variable. For instance, a higher wage in a given industry might induce its workers to lobby against trade liberalization. Given these factors are likely to be time invariant, the industry effects will take care of them.

3.4. Data Description

In this section, we first describe the survey used to collect the South-Korean firm-level data and provide the descriptive statistics of the sample used in our empirical exercise. Next, we present the source of the tariff data used and provide some background information about the tariff changes that happened over the period under study.

3.4.1. Firm-Level Data

The Korean firm-level data used in this paper come from the Workplace Panel Surveys conducted by the Korea Labor Institute (KLI), a government-funded policy research body. These cross-section surveys are conducted on stratified samples from the entire population of firms with at least one employee in Korea for the first two years. The population of the firms is listed on the “Workplace Demographics Survey” issued by the National Statistical Office. Firms are sampled by the KLI to replicate actual industry, size and regional distribution of firms in the population, to arrive at a truly representative sample.

For our analysis in this paper, we restrict focus on firms in the manufacturing sector for the years 2002, 2003, and 2007, in which the export share variable is available.[31] Notice that the firms are not identified in the data, so a panel cannot be constructed. Of these manufacturing firms, we restrict attention mainly to single-plant firms since only for such firms we can get fully consistent employment and financial information.[32] Thus we end up with a pooled cross-sectional data of 2,063 manufacturing firms.

In particular, the surveys for the early two years have 880 firms in common with 1,194 firms for 2002 and 882 firms for 2003, and the survey for the year 2007 consist of 460 firms. After dropping firms due to missing values in the key variables used, the final data set consists of 986 firms for 2002, 714 firms for 2003 and 363 firms for 2007. Table 3.1 presents the distribution of firms across the twenty-four manufacturing industries. The firms in our sample comprise around 12 percent of employees out of the entire population of manufacturing firms' employees (3,392,865) for 2002.

The Workplace Panel Survey provides information on the firms' financial status such as sales, profits, wage bill, export ratio as well as on their personnel characteristics—for instance, number of employees according to gender, labor contract, and occupation. The sales, profit, wage and all nominal variables expressed in Korean Won are deflated using industry-specific 2005 base year producer price indices (PPI) obtained from the Economic Statistics System (ECOS) of the Bank of Korea (BOK). We construct the measure of wage rate by dividing wage

[31] The minimum size requirement for the sampling of firms for the last year 2007 is 30 employees.

[32] The data we use in this paper also have some multiple-plant firms (10 firms in 2007). The information on employment and finance is based on one of their plants. As for the 2002 and 2003 surveys, it is hard to know exactly whether information on employment and finance is consistent since unlike the last three years surveys, the early two years do not include the question to clarify whether financial information is based on a plant or the whole firm. But we can comfortably assume that information on employment and finance is consistent in the early two years since any plant of any multiple-plant firm did not respond to financial questions such as sales and profits. Only headquarters of firms which could be multiple-plant firms and single-plant firms could provide consistent information in 2002 and 2003.

bill by the number of employees for each firm.[33] Wage rate, sales, sales per worker, profit and employment are used in logarithms in the regressions.

Summary statistics of the main variables are presented in Table 3.2. From this table we see that there is a decrease in the number of observations for profits, export dummy and export share, which are due to either missing data or negative reported values. Another important characteristic of our sample is the existence of dispersion in form size across all measures.

3.4.2. Tariff Data

The data on the output tariffs of Korea and its largest trading partner, China, are obtained from the World Trade Organization (WTO). They consist of the Most Favored Nation (MFN) tariff rates at the HS02 product level. We then converted these tariffs to the Korean Standard Industrial Classification (KSIC) at the two digit level.[34] Industry-level input tariffs are built as the weighted average of output tariffs, in which the weights are the industry intermediate input consumption shares from the Korea's input-output table.

As shown in Table 3.3, across all three tariffs and virtually across all products (barring two exceptions), we see declines during the period 2002-07. The dispersion in Korean tariffs went up from the year 2002 to the year 2005 but has been falling since. We can also see that there are significant cross industry variations in tariffs. The difference in tariffs between the most protected industry, food production and processing, and the least protected industry, printing industry, is 36.66 percentage points. The simple correlations among the three tariffs are presented in Table 3.4. We see that the Korean output and intermediate input tariffs are highly correlated, whereas Chinese import tariff is less correlated with them, but it still above 0.59.

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[33]The wage bill includes not only wages but also other compensation to employees such as bonuses and contribution to pension funds.

[34] The concordance table used for this conversion is available upon request. Industry names and codes themselves are in Table 3.2.

3.5. Results

In Table 3.5, we present the regression results that show the impact of firm size and productivity on wages paid. In column (1), we see that a one-percent increase in sales leads to a 0.092 percent increase in the wage rate. In column (2), we see that this figure shrinks from 0.092 to 0.081 once we control for worker characteristics. While the share of production workers is negatively associated with the wage rate, the share of permanent workers and that of male workers in the overall work force of the firm are positively related to the wage. The results with profits in place of sales are also qualitatively similar. From columns (3) and (4), we see that a one-percent increase in profits is associated with around a 0.04 percent increase in the wage rate. The impact of the shares of production workers, permanent workers and male workers remain unchanged relative to column (2). In the theoretical models discussed earlier, the determinant of firm size in equilibrium is productivity. Using sales per worker as a proxy for productivity in columns (5) and (6), we find that more productive firms pay more. A firm that is one percent more productive relative to another firm pays a 0.15-0.17 percent higher wage. The addition of worker characteristics variables again leads to qualitatively similar results. Finally, in columns (7) and (8) we use employment as a measure of firm size and find that it is again positively related to the wage rate. However, the coefficients of employment are not statistically significant. Thus, the regression results presented in Table 3.5 provide fairly strong evidence for Hypotheses 1 and 2. Also, we show that this evidence is robust to controlling for worker characteristics variables available in our dataset as well as industry and year effects.

In Table 3.6, we introduce the export dummy, as in equation (3.2), which takes the value "1" if the firm exports and "0" otherwise. This export dummy is introduced in place of the size or productivity variable in some columns and also in addition to them in other columns. From columns (1) and (2) we see that exporting firms pay about 11.5–14.8 percent higher wages than non-exporting firms, with the lower figure for the case where we control for worker characteristics. In other words, exporting firms hire workers with the more expensive visible characteristics. However, these characteristics explain only a small part of the higher wage rates paid by exporting firms. The impact of worker characteristics remains virtually unchanged relative to what we observed in Table 3.5.

With the size variables incorporated in the model in addition to the export dummy, we find the impact of the size variables to be the same in sign and similar in magnitude to what we saw in Table 3.5. The sign of the export dummy variable remains preserved even after controlling for productivity (as proxied by sales per worker). Nevertheless, the export dummy turns statistically insignificant, except when the size control is employment, where both with and without worker characteristics as right-hand side variables, we see that exporting firms pay a higher wage, with magnitudes similar to those observed in columns (1) and (2). Notice that although insignificant in most of the cases, the null hypothesis that the export dummy and the size/productivity proxy variable are jointly equal to zero is rejected in all specifications. The magnitude of the exporter dummy coefficient decreases once we control for worker characteristics along with profits, providing support for the Verhoogen-type hypothesis that exporting firms might need to hire workers with more costly skills or characteristics. Thus there is strong support for Hypothesis 3 but only mixed support for Hypothesis 4. There also seems to be some indication that the impact of exports on the wage is through the size variable in that exporting firms in general are bigger in size and are more profitable, leading to higher wages.

In Table 3.7 when we replace the export dummy variable with the export share variable, nowhere is this alternative export variable significant. Even the signs switch between positive and negative depending on whether controls are used and which control variables are used. Since a continuous change in the level of exports is not able to identify the impact of exports on wages, from now on, for the most part, we will stick to the export dummy as our export variable.

We now present results for regressions based on equation (3.4), where the tariff variables and their interactions with alternative firm size and productivity variables are included. In Table 3.8 we present the estimation results using the Korean output import tariff. Across all columns, the partial derivative of the log of wage with respect to the tariff remains positive virtually almost at all firm sizes. A small exception is column (1) where the derivative is negative at the minimum size but just at slightly above the minimum size the derivative turns positive. Across all columns, this derivative becomes more and more positive as firm size or productivity increases. In other words, with trade liberalization wages decline for firms of all sizes and productivity levels. These results go against Hypotheses 5, 6, and 7. It is quite possible that foreign competition cuts into the market share of all firms leading to a decline in profits across the board and, in turn, in the wages paid to workers. The fact that wages paid by the larger and more productive firms face a bigger negative effect from trade liberalization might be because those are the firms that are really in competition with foreign firms in that they could be the firms that produce the relatively higher quality varieties produced for the relatively higher income people. One of the assumptions of the theoretical models based upon the Melitz (2003) framework is that firm productivity (and cost) distributions are the same in all countries. Korea's productivity distribution could be quite different from distributions in its trading partners, which might be leading to the results we are getting. It is also important to note that dropping the export variable in these regressions does not qualitatively change the coefficients of the tariff interaction and level terms.

The specification estimates reported in Table 3.9 use Korean intermediate input import tariff in lieu of output import tariffs. These results are qualitatively the same as those from Table 3.8 and there is again no support for Hypotheses 4, 5, 6, and 7. Note that we cannot throw in both output and input tariffs at the same time due to the strong multicollinearity between the two which prevents the identification of the effects of these two variables separately. This also means input tariffs will be capturing the same effect as output tariffs. It is interesting to note that in all columns of Tables 3.8 and 3.9, the export dummy coefficient has a positive sign and is statistically significant between 1 and 10 percent in four of the sixteen cases. The impact of size and productivity are positive throughout, thus still maintaining some support for Hypotheses 1 through 4.

In Table 3.10, in addition to the Korean output import tariff and its interaction with size/productivity variables, we introduce the Chinese tariff imposed on Korean goods and its interaction with firm size and productivity variables. The partial derivative of the log of wage with respect to the Chinese tariff also turns out to be positive across all firm sizes in columns (1) and (2). Thus, Chinese trade liberalization reduces wages across Korean firms of all sizes. It is possible that Chinese trade liberalization makes Chinese firms more productive through the procompetitive effect as well as through cheaper and better imported inputs. This, in turn, will lead to a fall in the market share of Korean firms in the world market, in turn leading to a decline in their profits and therefore in the wages they pay to their workers. In the next four columns the coefficients of the Chinese tariff and its interaction with the size/productivity variable are both insignificant. Once employment is used as a size variable we see that the results are reversed in that the partial derivative of the log of wage with respect to the Chinese tariff becomes negative. Both the Chinese tariff and its interaction with employment are statistically significant. We cannot rely on these two columns with employment as the size control since it has on all previous occasions as well as this time done very poorly in identifying the effect of firm size on wage. The results for Chinese tariffs seem to be no different if we use the export share in place of the export dummy (Table 3.11). We also tried dropping the export variable and the impact of the Chinese tariff column by column replicates qualitatively what we saw in Table 3.10. Overall, there seems to be no real support for Hypotheses 8 or 9.

Note that the export dummy coefficient in Table 3.10 has a positive sign throughout and is significant at the 1–10 percent levels in two of the eight columns. The size/productivity variable is significant throughout except in the case of employment. Finally note that the size variable and the export dummy are jointly significant except in column 4. In most cases, it seems that the export status matters for the wage through its impact on size or its positive relationship with productivity.

3.6. Conclusion

In this paper we have used firm-level data from South Korea to investigate the existence of the export wage premium, which is the difference in the average wage between an exporting and a non-exporting firm. We have examined whether this happens through firm size or worker characteristics. We have also looked at the impact of tariffs in Korea as well as in its largest trading partner, namely China.

Our findings indicate that a one-percent increase in sales leads to a 0.092 percent increase in the wage rate and that exporting firms pay about 11.5–14.8 percent higher wages than non-exporting firms. Most of the export wage premium seems to work through the firm size channel rather than through differences in worker characteristics between exporters and non-exporters. Interestingly, our estimates using employment level as a firm size control do not do well in identifying the impact of firm size on wages, which is in contrast with one of the characteristics of heterogeneous firm models that employment level, sales and profits could be used interchangeably as a firm size control. We also have found that trade liberalization in Korea as well as in China seem to reduce wages in Korea. Unfortunately, we cannot identify the effects of input tariffs separately from output tariffs as they are highly correlated.

4. Productivity, Firm Size and Trade Liberalization in a Partner Country: Evidence from Korean Firm-Level Data

4.1. Introduction

Total Factor Productivity (TFP) has been widely used to measure efficiency in all sectors since it was introduced by Solow (1957). Even though earlier studies focused on industry-level productivity, recent studies have looked at firm–level productivity due to greater availability of firm-level data.

In the international trade literature, empirical studies have focused mainly on the impact of trade liberalization on productivity and find that a reduction in both input and output tariff enhances productivity. Reductions in output tariffs can enhance productivity by inducing import competition, whereas cheaper imported inputs can produce productivity gains via learning, variety, and quality effects (Amiti and Konings, 2007). But, there still remains a gap in this literature. The effects of reductions in output tariffs in a trading partner country on total factor productivity have not been studied so far. I am going to explore this relationship in this study.

Productivity gains can be achieved as a result of economies of scale. When a trading partner country reduces its output tariff on the imports of a final good, the home country exports more of that good to the partner. This creates a scale effect that raises productivity. In addition, productivity gains can take place through the channels of the 'selection effect' and 'technology adoption' as in the seminal papers by Melitz (2003) and Bustos (2011), respectively. A reduction in a variable trade cost induces some firms, who did not export before a tariff reduction in a partner country, to enter into the export market. Also, trade liberalization in a partner country can increase productivity by the adoption of more advanced technologies as in Bustos (2011).

In this paper, I study the impacts of China's tariffs on Korean firm-level productivity. To answer the proposed question, I am going to use Korean firm-level data derived from "Workplace Panel Surveys" (WPS) that cover the period 2005-2009. The data set based on stratified sampling and collected in separate years, consists of the years 2005, 2007, 2008 and 2009. The surveys cover all Korean firms which have 30 or more employees. Firms in the sample represent actual size, industry and geographical distribution of firms in the population recorded in the "Workplace Demographics Survey" issued by the National Statistical Office in Korea. The analysis drawn in the paper restricts focus mainly to single-plant firms in the manufacturing sector. The reason to restrict attention to single-plant firms is that only for such firms can we get fully consistent employment and financial information. Thus I end up with an unbalanced 4-year panel of 1652 observations. The data on the output tariffs of Korea and its trading partner countries China, USA, the EU and Japan are obtained from the World Trade Organization (WTO). The WTO provides the Most Favored Nation (MFN) tariff rates at the HS02 product level which I have converted to the Korean Standard Industrial Classification (KSIC) at two digit level.

To test the hypothesis that output tariff liberalization in a partner country enhances the firm-level productivity, I employ a two-stage approach. In the first stage, I calculate TFP at the firm level by using Levinsohn and Petrin (2003) methodology. The TFP has been estimated separately for different industries.[35] In the second stage, I regress firm-level TFP on lagged China-tariff; firm-level control variables and some other effects like year and industry effects.

To investigate the effects of reductions in output tariffs in a trading partner country on total factor productivity, I first regress Korean firm-level TFP on the Chinese tariff and firm-

[35]In some industries there is not enough number of observations to estimate TFP by using LP method. To capture as many as more observations in a sample, I estimate TFP in a group of such similar industries.

level controlled variables. Firm-level controls include share of male workers, share of regular workers and share of workers above fifty year in total employment; age and foreign ownership. I also used industry and year effects in all specifications. The results show some evidence that trade liberalization in China has led to productivity gains to Korean manufacturing firms. Precisely, I find that a one percentage point tariffs reduction in leads to a 0.92 percent increase in the TFP relative to the average. While I am interested in how the impact of China's tariffs on TFP varies by firm sizes, I find that firms above median size increase TFP as a result of a reduction in China's tariffs. Moreover, results show that firms in the fourth quartile in Korea have stronger effect of Chinese tariffs to increase their TFP than firms in the third quartile.

The rest of the paper is organized as follows. Section 4.2 provides the literature review. Section 4.3 describes an overview of trade policy in China. Section 4.4 describes Korean firm-level data and the tariff data. In Section 4.5, I outline the empirical strategy for identifying and estimating the effects of trade liberalization on total factor productivity. Section 4.6 presents the empirical results and also checks the robustness of them. Section 4.7 concludes.

4.2. The Literature

4.2.1. The Theoretical Foundation

Many studies in the area of productivity and trade liberalization have found that lower output tariffs in a home country have enhanced productivity due to 'import competition' effects. They all draw on the theoretical models like Krugman (1979) and Helpman and Krugman (1985) where increase in the productivity arises due to scale effect. When there is trade liberalization in a trading partner country, domestic firms would increase exports, expand production scale and move down the cost curve (i.e., scale effect). There is also another mechanism, the selection effect, to gain the productivity. In this mechanism, some firms exit, and market reallocates releasing factors of production towards the surviving firms. Since firms are symmetric in Krugman's model, selection takes place on a purely random basis.

Melitz (2003) model incorporates the selection effect by introducing firm heterogeneity. Since firms have different levels of production capability, more productive firms generate higher revenues and will be more likely to enter the export market profitable as a result of an exposure to trade. The more productive firms will expand by drawing resources from unproductive firms, and this forces the least productive firms to exit. This reallocation of market shares then leads to average productivity gain. Also, some firms who did not export before trade liberalization in a trading partner country would start to export after trade liberalization in a partner country due to a reduction in a variable trade cost.

Trade liberalization can enhance productivity by the adoption of more advanced technologies. According to Bustos (2011), more productive firms get higher revenues that can induce exporters to invest in new technologies. Only the firms with higher revenues are able to pay the fixed costs to enter the export market profitable as a result of a reduction in tariffs in a partner country. Aw et al. (2011) develop a dynamic structural model by incorporating a producer's decision to invest in R&D and participate in the export market, and productivity. This model shows that producer's decision to invest in R&D and export is positively correlated with future productivity. Hence, when an access to the export market increases as a result of a reduction of tariffs in a partner country, firms observe an increase in productivity from larger market size and investments in exporting and innovation.

The above discussion leads me to test the following hypothesis:

A tariff reduction in a trading partner country raises firm-level productivity

4.2.2. The Empirical Evidence

Empirical studies in trade policy and the labor market have explored the impact of trade liberalization on productivity based on the above mentioned models and mechanisms in the context of different countries. Pavcnik (2002) shows that productivity in the traded goods sectors increased by up to 10 percent than in the non-traded goods sectors in Chile due to trade liberalization. Trefler (2004) shows that industries in Canada and the US that experienced the largest tariff cuts enjoyed labor productivity gains by 14 percent. This paper finds that the US-Canada free trade agreement resulted in a reduction of plant scale in terms of employment and the numbers of plants in a short-run. In a long-run, labor productivity continues to increase, and at least half of that comes from the exit and/or contraction of lower productive plants. As a result, this noticeable long-run labor productivity gains make up the short-term losses. Moreover, the paper points to the increase in productivity due to the reallocation of market shares towards more efficient firms.

Using Indonesian plant-level manufacturing census data for the period 1991-2001, Amiti and Konings (2007) look over the effects of tariffs on final goods and intermediate inputs on productivity. The main finding of the paper is that a reduction of tariffs on both final and intermediate goods raises productivity. Moreover, the reduction of input tariffs is at least twice as much as those from cutting output tariffs. Lower output tariffs can increase industry's productivity by inducing tougher import competition, and cheaper imported inputs can raise productivity via learning, variety, and quality effects.

Topalova and Khandelwal (2011) examine India's trade reform to develop a causal link between a reduction in tariffs and a firm productivity, and find that tariff liberalization increases firm-level productivity. Such a gain by a reduction of output tariff is approximately ten times more than by a reduction of input tariff. Also, the paper shows that a reduction in tariff is correlated with contemporaneous productivity level which proves that trade policies are endogenous to productivity levels. Fernandes (2007) also confirms that there is positive impact of a tariff reduction on productivity by analyzing Columbian manufacturing plant-level data.

In a sense, my study is closer to Trefler (2004), Farnandes (2007), Amiti and Konings (2007), and Topalova and Khandelwal (2011). All of these studies use information about tariff reduction rather than particular episode of trade liberalization to examine the effect of trade liberalization on productivity.

My work is also related to Yu (2011, working paper) that studies the impact of a reduction of tariff on imported inputs and final goods on firms' productivity using Chinese firm-level data. As far as I know, this is the first work focusing on the role of processing trade on productivity gains in Chinese firms. The main finding of the paper is that output tariff reduction has a greater effect on productivity than input tariff reduction. This finding significantly differs from that of a number of previous studies such as Amiti and Konings (2007) and Topalova and Khandelwal (2011). The reason might be processing trade in China enjoys zero tariffs on imported inputs. Other studies on output tariffs and productivity include Levinsohn (1993), Harrison (1994), Tybout and Westbrook (1995), Gaston and Trefler (1997), Krishna and Mitra (1998) and Head and Ries (1999).

There are fewer empirical studies examining the impact of a reduction in a partner country's tariffs as a result of bilateral trade agreement between partners. Trefler (2004), Lileeva and Trefler (2010), Bustos (2011), and Bustos (2012, forthcoming) focus on the impact of a trading partner's tariff reduction through bilateral trade agreement between partners on labor market outcomes such as labor productivity, technology adoption, and demand for skill. But, the effects of reductions in output tariffs in a trading partner country on total factor productivity have not been studied so far. I am going to explore this relationship in this study.

4.3. China's Tariff Reduction

Tariff reduction in China started before its entry into WTO in December 2001. The average nominal tariff has been reduced by 26 percentage points (from 43 percent to 17 percent) over the period 1992-1999. Though China committed to reduce industrial average tariffs to 9.4 percent by 2005 to join the WTO, it had been achieved in 2004. Moreover, since then the government has gradually reduced tariffs, non-tariffs measures, licenses and quotas. Between 2004 and 2008, applied Chinese MFN tariffs declined on average by 1 percentage point with a wide variation in tariff change across manufacturing industries.

4.4. The Data

4.4.1. Firm-Level Data

Korean firm-level data covering the period 2005-2009 used in this study are derived from “Workplace Panel Survey” (WPS). The data are collected, edited and maintained by Korea Labor Institute (KLI), a government-funded policy research institute. The data set, based on stratified sampling and collected in separate years, consist of the years 2005, 2007, 2008[36] and 2009. The surveys cover the entire population of firms with 30 or more employees in Korea. Firms in the samples represent actual size, industry and regional distribution of firms in the population recorded on the “Workplace Demographics Survey” issued by the National Statistical Office. The analysis attempted in this paper restricts the focus mainly to single-plant firms in the

[36] Even though the survey for the year 2008 is little different in terms of variables from other three years, I use all four years (2005, 2007, 2008 and 2009) in the study.

manufacturing sector. The reason for restricting attention to single-plant firms is that only for such firms can we get fully consistent information on employment and finance.[37] Thus I end up with an unbalanced 4-year panel of 1652 observations.

In particular, the surveys include 159 common firms across all four years with 492 firms for 2005, 458 firms for 2007, 280 firms for 2008 and 422 firms for 2009. The firms in the sample comprise about 4 percent of employees out of the entire population 3,450,893 employees in Korean manufacturing sectors in 2005.

The WPS provides rich information on financial and employment status in a given firm. It includes composition of labor, capital[38], material, sales, profit, spending on technology[39], wage bill[40] and export ratio[41]. Based on the survey, employees are classified into various groups such as professional workers, managerial workers, sales workers, production workers, male workers and regular workers. The capital, material, sales, profit, spending on technology and all other variables expressed in Korean Won are deflated using industry-specific 2005 base year producer price indices (PPI) obtained from the Economic Statistics System (ECOS) of the Bank of Korea (BOK). Summary statistics of all variables used in the study are presented in Table 4.1. The table shows that there is a decrease in the number of observations for log of TFP, sales, capital, materials, the export dummy, export share, age, spending on technology, and foreign ownership dummy, which are due to either missing data or negative values. Another important characteristic of this sample is the existence of dispersion in firm size across all measures.

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[37]The data used for the study also consist of some multiple-plant firms (1 firm in 2005, 10 firms in 2007, and 4 firms in 2008) that provide plant-level employment and financial information. For these firms, I use employment and financial information based on one of their plants.
[38]A tangible asset at the beginning of the year is taken as a proxy of capital for that year.
[39]Spending on technology includes property-right, copy-right, software and developmental costs, and is provided only for years 2005, 2007 and 2009.
[40]The wage bill includes wages and other compensation to employees such as bonuses and contribution to pension funds.
[41]The export ratio is included only in the years 2007 and 2009 surveys.

4.4.2. The Tariff Data

To construct the output tariffs for Korea and its main trading partners China, the USA, the EU and Japan, I map the HSO2 product level tariffs from the WTO into the Korean Standard Industrial Classification (KSIC) at two-digit level, as in Mitra and Shin (2012).[42] They consist of the MFN tariff rates. Industry-level input tariffs are built as the weighted average of output tariffs, in which the weights are the industry intermediate input consumption shares from Korea's input-output table.[43] Tariffs used in this analysis are lagged by one year by assuming that overall firm effects including employment and financial effects of tariff changes might take some time to show up.

Changes in Korean output tariffs and its partners' tariffs capture trade liberalization in Korea and its partners, respectively. Among Korea's main trading partners namely China, the US, the EU and Japan, only China has some changes in tariffs over the period 2004-2008.[44] That's a one reason why I choose China as a trading partner country to see the effect of a tariff reduction in a trading partner country on total factor productivity. The second reason is that China is the largest trading partner for Korea.[45] As shown in Table 4.2, even though the degree to which the reduction in China's tariff is not large, the average tariff rates in most of industries decline during the period 2004-08. We can also see that there are significant cross industry variations in all three tariffs. All tariffs I use are in decimal fractions in the regressions.

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[42]Industries names and codes are presented in Table 4.2.The concordance table used for this conversion is available upon request.
[43]Input tariffs are calculated using 2005, 2007 and 2008 Korean Input-Output tables which are obtained from the Economic Statistics System (ECOS) of the central bank in Korea (the Bank of Korea). Specifically, the 2005 I-O table is used for 2004 and 2005, the 2007 I-O table is used for 2006 and 2007, and the 2008 I-O table is used for 2008.
[44]China reduced about 1 percentage point tariff from 2004 to 2008. Other countries reduced even less than 0.1 percentage point tariff.
[45]The bilateral trade volume between Korea and China accounted for about 22 percent of Korea's total trade in 2009.

4.5. Empirical Strategy

4.5.1. Economic Specification

To test the hypothesis that a tariff reduction in a trading partner country raises the firm-level productivity, I will apply a two-stage approach. In the first stage, TFP at the firm level will be calculated by using the Levinsohn and Petrin (2003) method. In this methodology, I use intermediate inputs to proxy the unobservable productivity variable. This approach allows me to correct the simultaneity bias in the choice of inputs, while ordinary least square estimates of production functions are biased and lead to biased estimates of productivity. In the second stage, I will regress firm-level TFP on lagged Chinese tariff, firm-level control variables and some other effects such as industry and year effects.

4.5.1.1. Productivity

Consider the Cobb-Douglas production function,

$$Y_{it} = A_{it} L_{it}^{\beta_l} K_{it}^{\beta_k} Q_{it}^{\beta_q} \tag{4.1}$$

where Y_{it} stands for output for the firm *i* at time *t* and A_{it} stands for productivity for the firm *i* at time *t*. Similarly, L, *K* and *Q* stand for labor, capital and intermediate input, respectively. Taking the natural logarithm of the above equation yields:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_q q_{it} + w_{it} + \varepsilon_{it} \tag{4.2}$$

where lower caps *y, l, k* and *q* indicate respective logged values. w_{it} represents firm-level TFP and is unobservable to the econometrician but observable to the firm while ε_{it} is a classical error term. After rearranging the terms, we get

$$va_{it} = \beta_l l_{it} + \beta_k k_{it} + w_{it} + \varepsilon_{it} \tag{4.3}$$

where $va_{it} = y_{it} - \beta_q q_{it}$ represents the natural logarithm of the value added.

Estimating above equation (4.1) or equation (4.2) using OLS will lead to biased coefficients of labor and capital since the decision on input choice for each firm will be correlated with its productivity. On average, the coefficient for labor is overestimated and the coefficient for capital is underestimated when those are estimated by OLS. In order to obtain consistent estimates of the input coefficients β_l and β_k, I will employ the Levinsohn and Petrin (2003) methodology. Then, I will use these estimates obtained from Levinsohn and Petrin (2003) method to derive the natural logarithm of the TFP for each firm using the following equation:

$$\log TFP_{it} = va_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} \tag{4.4}$$

where β_l hat and β_k hat are estimated coefficients for labor and capital by using Levinsohn and Petrin (LP) method, respectively. After estimating *log TFP*, I normalize it by its average.

4.5.1.2. Tariff Reduction in a Partner Country and Productivity

To explore the effects of tariff reductions in a trading partner country (namely, China) on TFP, I first examine the average effect of reductions in Chinese output tariffs on Korean firm-level TFP by estimating the following regression:

$$\log TFP_{it}^{j} = \beta_0 + \beta_1 tariffC_{j(t-1)} + \beta_2 X_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{4.5}$$

where *i* stands firms, *j* stands two-digit KSIC industries, *t* stands years. The left hand side variable $\log TFP_{it}^{j}$ is the log of total factor productivity of firm *i* in industry *j* at year *t*. Similarly, $tarifffC_{j(t-1)}$ on the right hand side is China's tariff that vary across two-digit KSIC industries, and is lagged by one year. β_1 is the main coefficient of interest what I expect to be negative as based on the discussion made in the Section 4.2. X_{ijt} include other firm controls such as share of male workers, share of regular workers, share of workers above fifty year in total employment, age of the firms, and foreign ownership dummy variable. These control variables will capture the fact that firms with higher share of male workers, with higher share of regular workers, who are older, and who are owned by foreign owners tend to be more productive. Finally, α_j and α_t are two-digit industry effects and time effects while ε_{ijt} is a classical error term.

Then, I analyze how this impact varies by firm sizes. Firms in different quartiles of the firm size distribution by employment are considered as different sizes of firms. In order to see the impact of a reduction in China's tariffs on TFP varies by firm sizes, I estimate the following equation:

$$\log TFP_{it}^{j} = \beta_0 + \beta_1 tariffC_{j(t-1)} + \beta_2 Big_{it} + \beta_3 (tariffC_{j(t-1)} xBig_{it}) + \beta_4 X_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \qquad (4.6)$$

where Big_{it} is a dummy variable taking the value of 1 when firm *i* belongs to above median size at year *t* and 0 otherwise. The third term $tariffC_{j(t-1)}xBig_{it}$ is an interaction of $tariffC_{j(t-1)}$ and Big_{it}.

I also estimate the following equation to look at the impact of a reduction in China's tariffs on TFP for firms in different quartiles of the firm-size distribution:

$$\log TFP_{it}^{j} = \beta_0 + \sum_{r=1}^{4} \beta_{\tau}^{r} (tariffC_{j(t-1)} xQ_{ijt}^{r}) + \sum_{r=2}^{4} \delta^{r} Q_{ijt}^{r} + \beta_1 X_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \qquad (4.7)$$

where Q^{r}_{ijt} are dummy variables that takes the value of 1 when firm *i* belongs to quartile *r* of the firm-size[46] distribution at year *t* and 0 otherwise.

4.5.2. Endogeneity of Trade Policy

China's tariff reduction is likely to be exogenous with respect to the change in Korean firm-level productivity over the period 2005-2009. First, the Chinese decision to join the WTO was motivated by its domestic reform agenda and willingness to become a market economy. Note that China has been a member of the WTO since 11 December 2001. Once a country becomes a member of the WTO, it has to apply its MFN tariffs to all other members of the WTO. There are also four free trade agreements between China and its trading partners signed during

[46]Firm size is based on log of employment and is calculated separately for different years. Probability of exporting, exports and spending on technology have been increased with an increase in the size of quartiles (see Table 4.3).

this period. These agreements guide the reduction in MFN tariffs over the given period. Thus, the reductions in MFN tariffs in China are anticipated without accounting for trade relations with Korea. Second, even though the bilateral trade volume between Korea and China accounted for about 22 percent of Korea's total trade, it was only about 7 percent of China's overall trade in 2009.[47] These figures imply that China's MFN import tariffs are unlikely to be driven by Korean industry characteristics. Moreover, the Chinese tariff used in the regression analysis is lagged by one year.

4.6. The Results and the Robustness Checks

4.6.1. Basic Results

4.6.1.1. Firm Sizes and Total Factor Productivity

In this sub-section, I test the hypothesis that bigger firms have higher productivity, higher spending on technology and higher probability of exporting using the equation:

$$Y_{ijt} = \sum_{r=2}^{4} \delta^r Q_{ijt}^r + \alpha_j + \alpha_t + \varepsilon_{ijt} \qquad (4.8)$$

where i indexes firms, j indexes two-digit KSIC industries and t indexes years. Similarly, Y_{ijt} are firm characteristics (TFP, spending on technology and export status) and Q_{ijt}^r are dummy variables taking the value of 1 when firm i belongs to quartile r of the firm-size distribution at year t and 0 otherwise. So, δ^r provides the differences in average outcomes for a firm in quartile r relative to a firm in the first quartile. Table 4.4 presents the estimated results of equation (4.8). This shows that TFP, probability of exporting and spending on technology increase with firm size.

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[47] A similar explanation is applied by Bustos (2011) to claim the exogeneity of Brazil's tariffs reduction for the demand of skill in Argentinean manufacturing firms.

4.6.1.2. Export Status and Total Factor Productivity

To examine the effect of exporting on log of TFP, I estimate the following equation:

$$\log TFP_{it}^{j} = \beta_0 + \beta_1 EXP_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{4.9}$$

where Exp_{ijt} is a export dummy variable that takes the value of 1 if the firm exported at year *t* and 0 otherwise. Table 4.5 presents the estimated results. Column (2) shows that exporters have a 2.4 percent higher TFP relative to the average TFP compared to non-exporters. Also, the TFP increases with increasing exports; and the point estimation result in column (6) shows that a 1 percent increase in exports causes a 0.002 percent increase in TFP relative to the average.

4.6.1.3. Spending on Technology and Total Factor Productivity

I also investigate the effect of spending on technology on TFP by estimating the following regression using OLS:

$$\log TFP_{it}^{j} = \beta_0 + \beta_1 \log ST_{ijt} + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{4.10}$$

where $\log ST_{ijt}$ denotes log of spending on technology of firm *i* which belongs to industry *j* at year *t*. Estimated results are again presented in Table 4.5 (Columns 3 and 4). Column (4) shows that a 1 percent increase in spending on technology causes a 0.04 percent increase in TFP relative to its average.

4.6.2. Main Results

A tariff reduction in a trading partner country can increase the firm-level productivity in a home country through the mechanisms pointed out in the Section 4.2 (i.e., The Literature). Highlighted mechanisms include the channels related to an expansion of production scale as a result of increase in exports, related to the expansion of exporters as in Melitz (2003) and related to the increase in investment in technology as in Bustos (2011). Thus, in this section I emphasis on identifying the causal effect of a tariff reduction in a trading partner country on the total factor productivity.

4.6.2.1. China's Tariff Reduction and Total Factor Productivity

In table 4.6, I present the estimated results of equation (4.5) that show the impact of Chinese output tariffs on firm-level productivity. Column (2) shows the point estimation for the baseline specification. In columns (3)-(8), I present results once we additionally controlled for Herfindahl index[48] , age, foreign ownership dummy, Korean output tariff, Korean input tariff, and both Korean input and output tariffs, respectively. In only two specifications, when the baseline regression includes either the foreign ownership dummy variable or both Korean input and output tariffs, coefficients are statistically significant. The point estimate in column (5) is -0.652 and implies that one percentage point reduction in China's tariffs leads to 0.92 percent increase in TFP relative to the average. Even though the coefficients of China's tariffs are not statistically significant in some specifications, the signs are negative in all specifications with robust standard errors that are clustered at the two-digit industry level. Hence the results presented in table 4.6 provide some evidence that a reduction in China's tariffs induces firms to gain productivity in Korea.

4.6.2.2. China's Tariff Reduction, Firm Size and Total Factor Productivity

In this subsection, I look at the effects of tariff reductions in a partner country on TFP by firm sizes. First, I determine how this impact varies for firms below and above the median size of the firm-size distribution. To see this difference, I estimate equation (4.6).

Estimated results are presented in Table 4.7. Column (1) includes no control variables while the rest of the columns add the controls mentioned in the previous sections. The first row reports estimation results of the average effect of China's tariffs on the TFP for firms below

[48]The Herfindahl index is a measurement of the size of firms in an industry and captures the amount of competition among them.

median size while the third row reports the estimation results of the differential effect of the firms above median size. The average total effect for the group above median size is given by the sum of coefficients in the first and third rows. Although coefficients in the first row are not statistically significant, joint tests of China's tariffs and the interaction of China's tariffs and the above median size indicator are statistically significant in all specifications. The estimated coefficients in the baseline specification, reported in column (2), are 0.251 and -1.300 in the first and third rows, respectively. These coefficients imply that one percentage point reduction in China's tariffs leads to a 1.85 percent increase in TFP relative to the average for firms above median size. The rest of the columns show that estimation results are robust with other controls such as age, the Herfindahl index, the foreign ownership dummy variable, Korean output tariffs, Korean input tariffs, and both Korean output and input tariffs as shown in the Table 4.7. All specifications include a dummy variable indicating whether a firm is above median size, year effects and two-digit industry effects. Thus, the estimation results in the Table 4.7 conclude that firms above median size increase TFP as a result of a reduction in China's tariffs.

Second, I investigate how the impact of China's tariffs on TFP varies by firms in different quartiles. To see these variations, I estimate equation (4.7). Estimated results of this equation are presented in Table 4.8. The coefficients of an interaction of Chinese tariffs and the fourth quartile dummy in the fourth row are negative and statistically significant in all specifications. Although coefficients of an interaction of Chinese tariffs and the third quartile dummy in the third row are not statistically significant except in column (4), signs are negative, and sizes are smaller in magnitude compared to the corresponding coefficients in the fourth row. Similarly, coefficients of an interaction of Chinese tariffs and the second quartile dummy in the second row are insignificant, signs are negative except in columns (1) and (2), and sizes are smaller in magnitude compared to the corresponding coefficients in the third row. Thus there is strong evidence that bigger firms have stronger effect of trade liberalization in a trading partner country to increase their TFP than smaller firms. In particular, firms in the fourth quartile in Korea have stronger effect of Chinese tariffs to increase their TFP than firms in third quartile.

Taken together, the above results indicate that the average effect of a reduction in China's tariffs induces firms above median size to increase the firm-level total factor productivity in the manufacturing sector. Moreover, firms in the fourth quartile have stronger effect partner-country tariffs reduction to increase their total factor productivity than firms in the third quartile. Hence, most productive firms increase total factor productivity in response to a tariff reduction in a trading partner country.

4.7. Conclusion

In this paper I study the effect of a tariff reduction in a trading partner country (namely, China) on firm-level total factor productivity using Korean firm-level data from 2005 to 2009. Productivity gains can take place through the channels of the economy of scale, selection effect and adoption of technology. I start by documenting that the rates at which total factor productivity, spending on technology, number of exporting firms, and exports grow are increasing in firm size. The results show that a reduction in China's tariffs induces Korean firms above median size to increase their productivity. Also, I find that the effect of any given tariff reductions is highest in the uppermost quartile of the firm-size distribution.

The previous literature has studied the impact of trade liberalization on total factor productivity but there still remains a gap in this literature. The effects of reductions in output tariffs in a trading partner country on total factor productivity have not been studied so far. I try to fill this gap in the literature by examining the impact of Chinese tariffs on firm-level TFP in Korea.

Appendix

Appendix A: China's Free Trade Agreements

China's Free Trade Agreements (FTAs) and Closer Economic Partnership Arrangements (CEPA):2002-2009

S.N.	Name of FTA/CEPA	Agreement date	Effective date
1	China-ASEAN FTA	November 2002	
2	Mainland-Hong Kong CEPA	June 2003	
3	Mainland-Macau CEPA	October 2003	
4	China-Chile FTA	November 2005	October 2006
5	China-Pakistan FTA	November 2006	July 2007
6	China-New Zealand FTA	April 2008	October 2008
7	China-Singapore FTA	October 2008	
8	China-Peru FTA	April 2009	

Free Trade Agreements (FTAs) under Negotiation: 2002-2009

S.N.	Name of the proposed FTA	Negotiation Start Date
1	China-GCC (Golf Cooperation Council) FTA	April 2005
2	China-Australia FTA	May 2005
3	China-Iceland FTA	April 2008
4	China-Norway FTA	September 2008
5	China-Costa Rica	January 2009

Free Trade Agreements (FTAs) under Consideration: 2002-2009

S.N.	Name of the FTA under consideration	Negotiation Start Date
1	China-India regional trade agreement joint feasibility study	2003
2	China-Korea FTA joint feasibility study	November 2004

Figures and Tables

Figure 2.1: Korea's Exports to China over the Period 2002-2009

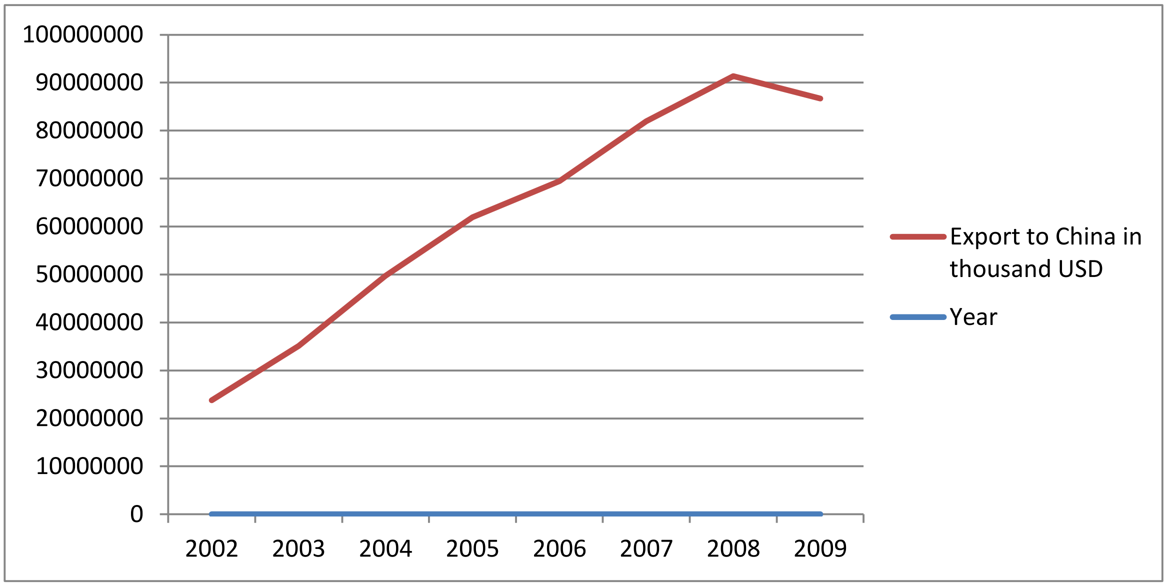

Figure 2.2: Average MFN Output Tariffs in China over the Period 2001-2008

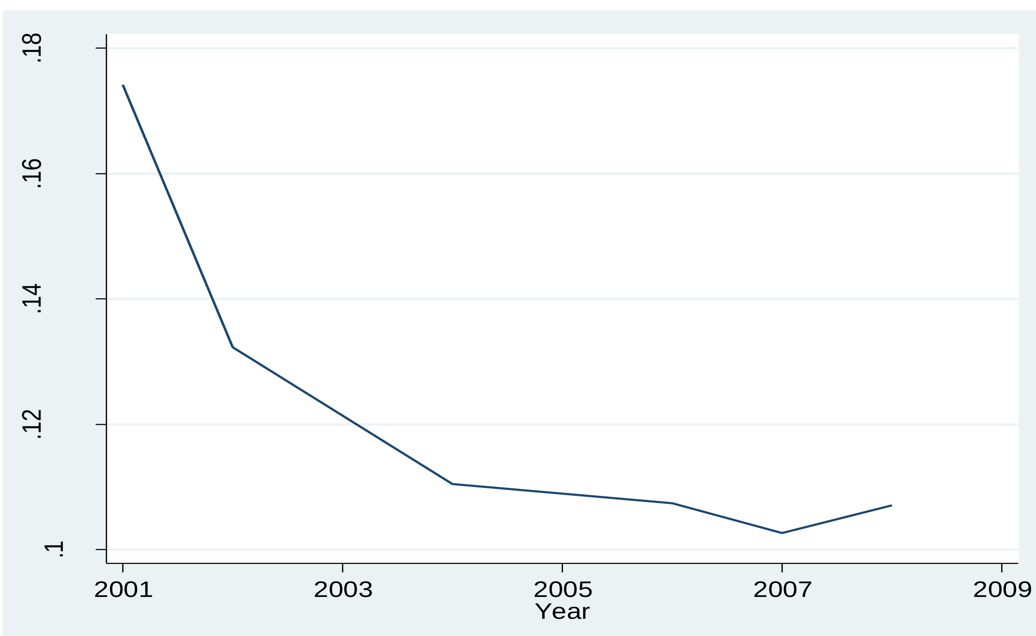

Figure 2.3: Trend of Skilled Workers in Korea over the Period 2002-2009

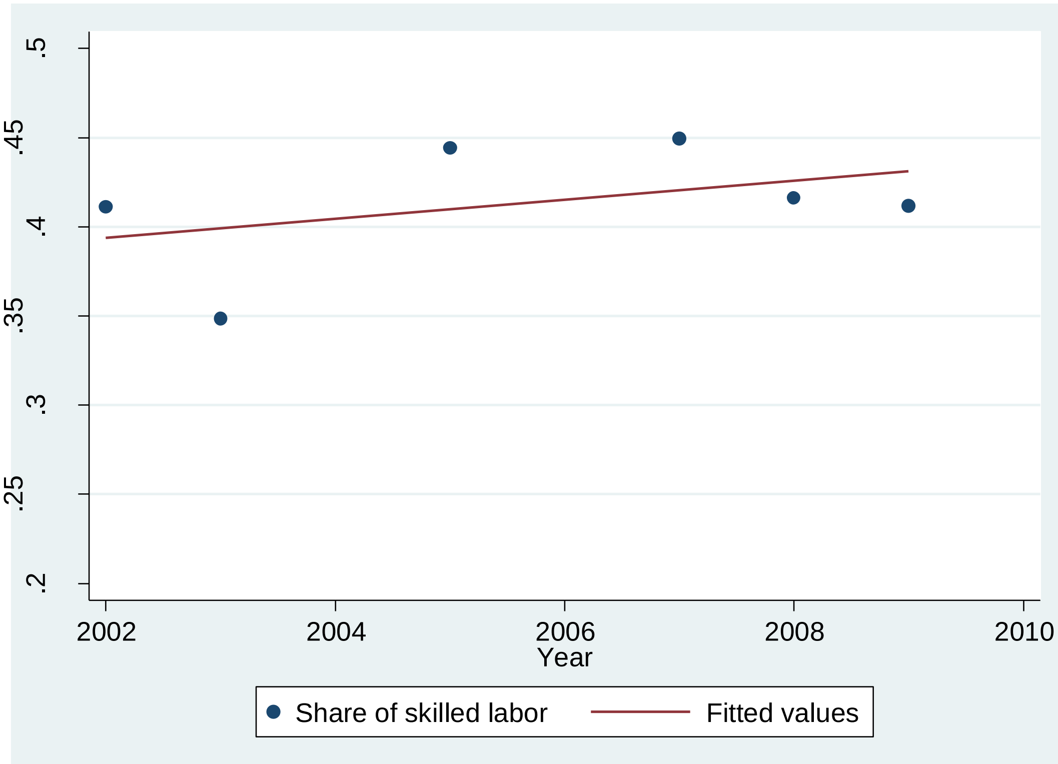

Table 2.1: Summary Statistics

Variables	Observations	Mean	Std. Dev	Min	Max
Share of skilled labor	3510	0.427867	0.273293	0	1
Chinese import tariff	3510	0.132377	0.064877	0.027684	0.51881
Korean output import tariff	3510	0.09486	0.091951	0	0.43431
Korean input import tariff	3510	0.086737	0.06453	0.019823	0.316564
ln (Sales)	2885	24.38113	1.874358	15.58747	30.2211
ln (Profit)	2367	21.5705	2.176726	13.74598	29.83114
ln(Employment)	3510	4.789351	1.138225	1.098612	10.65608
ln(Sales per worker)	2885	19.50296	1.316353	11.80328	26.4598
Above med. Size dummy (by sales)	2885	0.498094	0.500083	0	1
Above med. Size dummy (by profit)	2367	0.497254	0.500098	0	1
Above med. Size dummy (by employment)	3510	0.498576	0.500069	0	1
Above med. Size dummy (by sales per worker)	2885	0.49948	0.500086	0	1
Export dummy	2729	0.627703	0.483506	0	1
Export share	2729	0.231458	0.293656	0	1
ln(Spending on technology)	2280	0.246897	0.544452	0	5.375215
ln(Spending on technology per worker)	2280	0.100569	0.262163	0	3.34478
Spending on technology dummy	2280	0.849561	0.357579	0	1

Note: All monetary values are in Korean Won deflated by industry-specific producer price indices (PPI), where 2005 is the base year. The average tariff variables are weighted by the number of firms in each industry, in order to portray the average tariff faced by the average firm in our sample. Spending on technology is normalized by its average.

Table 2.2.1: Industry, Average Tariff and Change in Tariff

Industry Code	Industry Name	Korean Output tariff		Chinese Output tariff		Korean Input tariff	
		Average	Change	Average	Change	Average	Change
10	Production and processing of food	0.3884	-0.0606	0.1997	-0.0924	0.2869	-0.0332
11	Beverages	0.2016	-0.0014	0.3081	-0.2927	0.1965	-0.0126
12	Tobacco	0.3301	-0.0029	0.3522	-0.1867	0.1660	-0.0741
14	Apparel, clothing accessories and fur products	0.1208	0.0020	0.1862	-0.0770	0.1220	-0.0793
13	Manufacture of other textiles	0.0889	-0.0011	0.1282	-0.1033	0.0806	-0.0068
15	Leather, bags and Footwear	0.0791	-0.0010	0.1526	-0.0389	0.1161	0.0779
16	Wood products	0.0628	-0.0022	0.0580	-0.0490	0.0640	-0.0056
17	Pulp and paper	0.0194	-0.0663	0.0791	-0.0902	0.0362	-0.0521
18	Printed books, newspapers, pictures and other products of the printing industry	0.0137	-0.0109	0.0323	-0.0214	0.0312	-0.0311
19	Cork, coal and oil refinement	0.0780	-0.0030	0.0724	-0.0121	0.0722	-0.0049
20	Manufacture of basic chemicals	0.0697	-0.0153	0.0741	-0.0292	0.0711	-0.0129
21	Medical materials and medications	0.0421	-0.0050	0.0542	-0.0426	0.0797	-0.0126
22	Rubber and plastics	0.0723	-0.0072	0.1142	-0.0673	0.0718	-0.0110
23	Non-metal and mineral	0.0710	-0.0019	0.1241	-0.0381	0.0698	-0.0079
24	Casting of metals	0.0432	-0.0260	0.0816	-0.0191	0.0465	-0.0227
25	Tools, implements, base metal products	0.0682	-0.0004	0.1093	-0.0191	0.0539	-0.0178
26	Electronic parts, computer, television image and musical instruments	0.0512	-0.0009	0.0976	-0.0879	0.0551	-0.0024
27	Optical, precision, medical or surgical instruments and apparatus	0.0657	0.0007	0.1039	-0.0422	0.0630	-0.0006
28	Electrical Machinery	0.0699	0.0019	0.1080	-0.0628	0.0595	-0.0104
29	Machinery and mechanical appliances	0.0613	-0.0032	0.0978	-0.0560	0.0600	-0.0084
30	Cars and railway or tramway locomotives	0.0779	-0.0001	0.1915	-0.1811	0.0674	-0.0207
31	Other transportation equipments	0.0378	-0.0001	0.0974	-0.0285	0.0567	0.0033
32	Furniture	0.0434	-0.0126	0.1107	-0.1300	0.0666	-0.0141
33	Miscellaneous manufactured articles	0.0739	-0.0048	0.2018	-0.0237	0.0638	-0.0125

Note: Change in tariff= tariff in 2008- tariff in 2001

Table 2.2.2: Correlation Between Korean Output and Intermediate Input Tariffs and Chinese Import Tariffs Imposed on Korean Goods

	Output import tariff	Input import tariff	Chinese import tariff
Output import tariff	1		
Input import tariff	0.9781	1	
Chinese import tariff	0.5203	0.5522	1

Table 2.3: Share of Skilled Labor by Industry

Industry code	Industry name	Average share of skill	Rank of share of skill
10	Production and processing of food	0.383	16
11	Beverages	0.703	1
12	Tobacco	0.490	8
14	Apparel, clothing accessories and fur products	0.666	5
13	Manufacture of other textiles	0.254	23
15	Leather, bags and Footwear	0.510	7
16	Wood products	0.270	22
17	Pulp and paper	0.318	18
18	Printed books, newspapers, pictures and other products of the printing industry	0.684	2
19	Cork, coal and oil refinement	0.682	3
20	Manufacture of basic chemicals	0.556	6
21	Medical materials and medications	0.678	4
22	Rubber and plastics	0.310	19
23	Non-metal and mineral	0.300	21
24	Casting of metals	0.195	24
25	Tools, implements, base metal products	0.475	9
26	Electronic parts, computer, television image and musical instruments	0.440	11
27	Optical, precision, medical or surgical instruments and apparatus	0.439	12
28	Electrical Machinery	0.392	15
29	Machinery and mechanical appliances	0.471	10
30	Cars and railway or tramway locomotives	0.302	20
31	Other transportation equipments	0.437	13
32	Furniture	0.423	14
33	Miscellaneous manufactured articles	0.355	17

Table 2.4.1: Decomposition of the Change in the Employment Share of Skilled Labor by Firm

	2002-2003			2005-2009		
	Within	Between	Total	Within	Between	Total
Firms	-0.001	0.132	0.131	-0.009	0.178	0.169

Table 2.4.2: Decomposition of the Change in the Employment Share of Skilled Labor by Firm: Industry Wide

	2002-2003				2005-2009			
Industry Code	Within	Between	Total	No. of firms	Within	Between	Total	No. of firms
10	0.022	0.129	0.151	61	0.043	0.137	0.180	58
11	-0.049	0.559	0.510	9				
12	-0.181	0.002	-0.179	4				
13	-0.010	0.071	0.061	71	-0.030	0.142	0.112	43
14	0.012	0.173	0.185	33	-0.023	0.287	0.264	23
15	-0.050	0.115	0.065	18	0.056	0.204	0.260	7
16					-0.054	-0.402	-0.456	3
17					0.009	0.017	0.026	28
18					0.008	-0.103	-0.095	14
19					-0.024	-0.007	-0.031	3
20	-0.005	0.149	0.144	134	0.058	0.271	0.329	39
21	0.053	0.133	0.186	22	0.083	0.370	0.453	1
22	-0.005	0.104	0.099	35	0.014	0.233	0.247	78
23	-0.025	0.042	0.017	38	0.004	-0.008	-0.004	7
24	0.023	-0.042	-0.019	55	-0.002	0.053	0.051	28
25	-0.019	0.096	0.077	46	0.022	-0.026	-0.004	63
26	0.005	0.233	0.238	94	-0.043	0.230	0.187	177
27	-0.120	-0.050	-0.170	12	-0.040	-0.049	-0.089	14
28	-0.011	0.034	0.023	39	0.003	0.239	0.242	45
29	0.012	0.059	0.071	57	-0.032	0.193	0.161	83
30	0.002	0.081	0.083	51	0.002	0.021	0.023	64
31	-0.015	0.245	0.230	15	-0.081	0.157	0.076	10
32	-0.010	0.298	0.288	8	-0.051	0.159	0.108	6
33	0.020	0.050	0.070	11	0.037	-0.057	-0.020	33

Table 2.4.3: Decomposition of the Change in the Employment Share of Skilled Labor by Industry

	2002-2003			2005-2009		
	Within	Between	Total	Within	Between	Total
Industries at 2-digit	-0.047	-0.015	-0.062	-0.041	0.01	-0.031

Table 2.4.4: Share of Skilled Labor in Total Employment by Size and Year

	2002-2003		2005-2009	
	2002	2003	2005	2009
Firms Above Median Size	0.404	0.334	0.451	0.414
Firms Below Median Size	0.482	0.481	0.390	0.393

Table 2.5: Technology and Share of Skilled Labor

	(1)	(2)	(3)	(4)	(5)	(6)
	Skilled Labor Share	Skilled Labor Share	Skilled Labor Share	Log of Skilled Labor Share	Log of Skilled Labor Share	Log of Skilled Labor Share
Log of ST	0.094***			0.064***		
	(0.018)			(0.012)		
Log of ST per worker		0.260***			0.172***	
		(0.030)			(0.019)	
ST Dummy			0.091***			0.066***
			(0.026)			(0.017)
Constant	0.409***	0.412***	0.337***	0.322***	0.325***	0.269***
	(0.005)	(0.005)	(0.026)	(0.003)	(0.003)	(0.017)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,280	2,280	2,280	2,280	2,280	2,280
R-squared	0.138	0.159	0.122	0.138	0.157	0.123

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All the regressions are estimated by OLS.

Table 2.6: Export Status and Share of Skilled Labor

	(1) Skilled Labor Share	(2) Log of Skilled Labor Share	(3) Log of Sales	(4) Log of Profit	(5) Log of Employment	(6) Log of ST per worker	(7) Log of ST
Export Dummy	0.030*	0.025*	1.364***	1.484***	0.646***	0.025***	0.140***
	(0.018)	(0.012)	(0.136)	(0.159)	(0.086)	(0.009)	(0.022)
Constant	0.397***	0.311***	24.137***	21.233***	4.629***	0.024*	0.050**
	(0.013)	(0.009)	(0.084)	(0.097)	(0.048)	(0.012)	(0.020)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,729	2,729	2,475	2,026	2,729	2,113	2,115
R-squared	0.104	0.103	0.190	0.171	0.155	0.115	0.105

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. All the regressions are estimated by OLS.

Table 2.7.1: Cross Sectional Patterns in the Data (Size by Profit)

	(1) Skilled Labor Share	(2) Log of Skilled Labor Share	(3) Export Dummy	(4) Export Share	(5) Log of ST	(6) Log of ST per Worker
Above median size dummy (by Profit)	0.067***	0.044***	0.250***	0.110***	0.307***	0.044***
	(0.017)	(0.012)	(0.028)	(0.025)	(0.031)	(0.014)
Constant	0.373***	0.298***	0.464***	0.062***	-0.028	0.015
	(0.012)	(0.008)	(0.020)	(0.014)	(0.029)	(0.014)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,367	2,367	2,026	2,026	1,849	1,848
R-squared	0.125	0.122	0.141	0.126	0.206	0.170

All regressions include year and industry dummies. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Coefficients in the first row report differences in outcomes of the firms belonging to above median size by profit w.r.t. firms belonging to below median size by profit. All the regressions are estimated by OLS.

Table 2.7.2: Cross Sectional Patterns in the Data (Size by Sales)

	(1) Skilled Labor Share	(2) Log of Skilled Labor Share	(3) Export Dummy	(4) Export Share	(5) Log of ST	(6) Log of ST per Worker
Above median size dummy (by Sales)	0.081***	0.054***	0.262***	0.111***	0.299***	0.037***
	(0.017)	(0.011)	(0.034)	(0.028)	(0.027)	(0.012)
Constant	0.364***	0.293***	0.409***	0.071***	-0.044	0.010
	(0.011)	(0.007)	(0.023)	(0.016)	(0.026)	(0.011)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,885	2,885	2,475	2,475	2,255	2,253
R-squared	0.130	0.127	0.143	0.121	0.202	0.159

All regressions include year and industry dummies. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Coefficients in the first row report differences in outcomes of the firms belonging to above median size by sales w.r.t. firms belonging to below median size by sales. All the regressions are estimated by OLS.

Table 2.7.3: Cross Sectional Patterns in the Data (Size by Sales per Worker)

	(1) Skilled Labor Share	(2) Log of Skilled Labor Share	(3) Export Dummy	(4) Export Share	(5) Log of ST	(6) Log of ST per Worker
Above median size dummy (by Sales/worker)	0.129***	0.085***	0.207***	0.092***	0.210***	0.051***
	(0.021)	(0.013)	(0.039)	(0.022)	(0.028)	(0.010)
Constant	0.341***	0.277***	0.445***	0.084***	0.007	0.003
	(0.012)	(0.008)	(0.027)	(0.013)	(0.025)	(0.012)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,885	2,885	2,464	2,464	2,253	2,253
R-squared	0.159	0.156	0.116	0.110	0.169	0.163

All regressions include year and industry dummies. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Coefficients in the first row report differences in outcomes of the firms belonging to above median size by sales per worker w.r.t. firms belonging to below median size by sales per worker. All the regressions are estimated by OLS.

Table 2.7.4: Cross Sectional Patterns in the Data (Size by Employment)

	(1) Skilled Labor Share	(2) Log of Skilled Labor Share	(3) Export Dummy	(4) Export Share	(5) Log of ST	(6) Log of ST per Worker
Above median size dummy (by Employment)	-0.046***	-0.032***	0.215***	0.100***	0.267***	-0.002
	(0.014)	(0.010)	(0.027)	(0.026)	(0.030)	(0.013)
Constant	0.425***	0.333***	0.419***	0.084***	-0.037	0.031**
	(0.013)	(0.009)	(0.013)	(0.014)	(0.033)	(0.012)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,510	3,510	2,729	2,729	2,280	2,280
R-squared	0.108	0.106	0.129	0.112	0.191	0.154

All regressions include year and industry dummies. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Coefficients in the first row report differences in outcomes of the firms belonging to above median size by employment w.r.t. firms belonging to below median size by employment. All the regressions are estimated by OLS.

Table 2.8.1: Effect of Chinese Tariff on Share of Skilled Labor (Size by Profit – RE)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.513**	-0.529**	-0.518**	-0.521**	-0.486**
	(0.237)	(0.237)	(0.237)	(0.239)	(0.239)
Above median size dummy (by Profit)	-0.017	-0.016	-0.016	-0.017	-0.019
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Lag of Chinese import tariff*Above median size dummy	0.393***	0.386***	0.359**	0.392***	0.311*
	(0.143)	(0.144)	(0.158)	(0.143)	(0.161)
Lag of Korean import tariff		0.306	0.277		
		(0.529)	(0.547)		
Lag of Korean import tariff*Above median size dummy			0.040		
			(0.129)		
Lag of Korean input tariff				0.108	-0.003
				(0.508)	(0.537)
Lag of Korean input tariff*Above median size dummy					0.158
					(0.186)
Constant	0.496***	0.376*	0.380*	0.465***	0.477***
	(0.067)	(0.221)	(0.223)	(0.160)	(0.163)
Observations	2,367	2,367	2,367	2,367	2,367
R-squared	0.124	0.124	0.124	0.124	0.124
Number of clusters	1380	1380	1380	1380	1380

All regressions include year effects, industry effects and random effects. Robust standard errors in parentheses are clustered at firm-level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of profit. All the regressions are estimated by OLS.

Table 2.8.2: Effect of Chinese Tariff on Share of Skilled Labor (Size by Sales – RE)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.512**	-0.501**	-0.427**	-0.507**	-0.404*
	(0.211)	(0.210)	(0.214)	(0.212)	(0.215)
Above median size dummy (by Sales)	0.011	0.011	0.008	0.011	0.001
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Lag of Chinese import tariff*Above median size dummy	0.328**	0.331**	0.200	0.327**	0.143
	(0.145)	(0.145)	(0.164)	(0.145)	(0.164)
Lag of Korean import tariff		-0.203	-0.314		
		(0.477)	(0.476)		
Lag of Korean import tariff*Above median size dummy			0.217*		
			(0.124)		
Lag of Korean input tariff				-0.064	-0.291
				(0.470)	(0.480)
Lag of Korean input tariff*Above median size dummy					0.412**
					(0.179)
Constant	0.484***	0.564***	0.560***	0.502***	0.506***
	(0.059)	(0.201)	(0.202)	(0.149)	(0.149)
Observations	2,885	2,885	2,885	2,885	2,885
R-squared	0.128	0.128	0.129	0.128	0.130
Number of clusters	1,534	1,534	1,534	1,534	1,534

All regressions include year effects, industry effects and random effects. Robust standard errors in parentheses are clustered at firm-level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of sales. All the regressions are estimated by OLS.

Table 2.8.3: Effect of Chinese Tariff on share of Skilled Labor (Size by Sales per Worker – RE)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.375*	-0.362*	-0.313	-0.363*	-0.305
	(0.212)	(0.211)	(0.211)	(0.212)	(0.212)
Above median size dummy (by Sales per worker)	0.074***	0.073***	0.071***	0.074***	0.067***
	(0.023)	(0.024)	(0.024)	(0.023)	(0.025)
Lag of Chinese import tariff*Above median size dummy	0.124	0.134	0.041	0.126	0.006
	(0.146)	(0.147)	(0.162)	(0.146)	(0.163)
Lag of Korean import tariff		-0.305	-0.451		
		(0.478)	(0.513)		
Lag of Korean import tariff*Above median size dummy			0.165		
			(0.167)		
Lag of Korean input tariff				-0.188	-0.354
				(0.460)	(0.498)
Lag of Korean input tariff*Above median size dummy					0.277
					(0.234)
Constant	0.445***	0.566***	0.590***	0.499***	0.509***
	(0.058)	(0.203)	(0.207)	(0.147)	(0.148)
Observations	2,885	2,885	2,885	2,885	2,885
R-squared	0.156	0.155	0.156	0.156	0.157
Number of clusters	1534	1534	1534	1534	1534

All regressions include year effects, industry effects and random effects. Robust standard errors in parentheses are clustered at firm-level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of sales per worker. All the regressions are estimated by OLS.

Table 2.8.4: Effect of Chinese Tariff on Share of Skilled Labor (Size by Employment – RE)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.399*	-0.384*	-0.423**	-0.369*	-0.402**
	(0.206)	(0.203)	(0.202)	(0.205)	(0.204)
Above median size dummy (by Employment)	-0.081***	-0.082***	-0.081***	-0.081***	-0.078***
	(0.024)	(0.024)	(0.025)	(0.024)	(0.026)
Lag of Chinese import tariff*Above median size dummy	0.149	0.152	0.225	0.150	0.210
	(0.153)	(0.154)	(0.157)	(0.153)	(0.155)
Lag of Korean import tariff		-0.290	-0.222		
		(0.472)	(0.499)		
Lag of Korean import tariff*Above median size dummy			-0.109		
			(0.136)		
Lag of Korean input tariff				-0.402	-0.319
				(0.377)	(0.424)
Lag of Korean input tariff*Above median size dummy					-0.121
					(0.192)
Constant	0.527***	0.640***	0.636***	0.640***	0.633***
	(0.055)	(0.199)	(0.199)	(0.123)	(0.126)
Observations	3,510	3,510	3,510	3,510	3,510
R-squared	0.106	0.105	0.105	0.107	0.106
Number of clusters	1782	1782	1782	1782	1782

All regressions include year effects, industry effects and random effects. Robust standard errors in parentheses are clustered at firm-level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Firm size is measured as the log of employment. All the regressions are estimated by OLS.

Table 2.9.1: Effect of Chinese Tariff on Share of Skilled Labor (Size by Profit – FE, 2002-03)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.425	-0.404	-0.389	-0.420	-0.406
	(0.331)	(0.335)	(0.336)	(0.339)	(0.344)
Above median size dummy (Profit)	-0.024	-0.026	-0.027	-0.024	-0.026
	(0.034)	(0.034)	(0.034)	(0.034)	(0.036)
Lag of Chinese import tariff*Above median size dummy	0.233	0.243	0.206	0.234	0.201
	(0.205)	(0.205)	(0.221)	(0.205)	(0.239)
Lag of Korean import tariff		-0.231	-0.276		
		(0.625)	(0.694)		
Lag of Korean import tariff*Above median size dummy			0.070		
			(0.264)		
Lag of Korean input tariff				-0.068	-0.116
				(0.902)	(1.001)
Lag of Korean input tariff*Above median size dummy					0.077
					(0.387)
Constant	0.518***	0.538***	0.540***	0.524***	0.526***
	(0.057)	(0.078)	(0.080)	(0.093)	(0.097)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1,502	1,502	1,502	1,502	1,502
R-squared	0.006	0.006	0.006	0.006	0.006
Number of id	938	938	938	938	938

All regressions include year fixed effects and firm fixed effects. Robust standard errors in parentheses are clustered at the firm-level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of profit. All the regressions are estimated by OLS.

Table 2.9.2: Effect of Chinese tariff on share of skilled labor (Size by Profit – FE, 2005-09)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.805	-0.976	-1.043	-0.998	-1.009
	(0.982)	(0.984)	(0.979)	(1.021)	(1.016)
Above median size dummy (Profit)	-0.014	-0.017	-0.023	-0.011	-0.012
	(0.055)	(0.055)	(0.056)	(0.056)	(0.056)
Lag of Chinese import tariff*Above median size dummy	0.076	0.100	0.247	0.044	0.068
	(0.359)	(0.358)	(0.419)	(0.362)	(0.414)
Lag of Korean import tariff		1.680	1.871		
		(2.289)	(2.246)		
Lag of Korean import tariff*Above median size dummy			-0.114		
			(0.170)		
Lag of Korean input tariff				0.581	0.605
				(0.645)	(0.682)
Lag of Korean input tariff*Above median size dummy					-0.029
					(0.250)
Constant	0.527***	0.405**	0.396**	0.505***	0.504***
	(0.112)	(0.188)	(0.185)	(0.114)	(0.115)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	865	865	865	865	865
R-squared	0.006	0.006	0.007	0.007	0.007
Number of id	442	442	442	442	442

All regressions include year fixed effects and firm fixed effects. Robust standard errors in parentheses are clustered at the firm-level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of profit. All the regressions are estimated by OLS.

Table 2.10.1: Effect of Chinese Tariff on Share of Skilled Labor (Size by Profit)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.621***	-0.617***	-0.594**	-0.603***	-0.535**
	(0.216)	(0.215)	(0.231)	(0.204)	(0.199)
Above median size dummy (by Profit)	0.002	0.005	0.005	0.003	-0.002
	(0.033)	(0.032)	(0.032)	(0.033)	(0.030)
Lag of Chinese import tariff*Above median size dummy	0.469*	0.443*	0.384	0.465*	0.293
	(0.258)	(0.251)	(0.313)	(0.256)	(0.272)
Lag of Korean import tariff		1.526***	1.439***		
		(0.354)	(0.393)		
Lag of Korean import tariff*Above median size dummy			0.082		
			(0.130)		
Lag of Korean input tariff				-0.436	-0.633
				(0.669)	(0.755)
Lag of Korean input tariff*Above median size dummy					0.318
					(0.251)
Constant	0.503***	-0.118	-0.098	0.630**	0.646***
	(0.052)	(0.171)	(0.176)	(0.229)	(0.227)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Observations	2,367	2,367	2,367	2,367	2,367
R-squared	0.129	0.130	0.130	0.129	0.130

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Firm size is measured as the log of profit. All the regressions are estimated by OLS.

Table 2.10.2: Effect of Chinese Tariff on Share of Skilled Labor (Size by Sales)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.535**	-0.533**	-0.464*	-0.517**	-0.400*
	(0.195)	(0.204)	(0.234)	(0.188)	(0.204)
Above median size dummy (by Sales)	0.032	0.033	0.034	0.033	0.027
	(0.030)	(0.029)	(0.029)	(0.030)	(0.028)
Lag of Chinese import tariff*Above median size dummy	0.361	0.353	0.232	0.355	0.149
	(0.232)	(0.228)	(0.274)	(0.231)	(0.242)
Lag of Korean import tariff		0.967***	0.850***		
		(0.271)	(0.294)		
Lag of Korean import tariff*Above median size dummy			0.167		
			(0.125)		
Lag of Korean input tariff				-0.407	-0.595
				(0.396)	(0.464)
Lag of Korean input tariff*Above median size dummy					0.387
					(0.236)
Constant	0.477***	0.083	0.091	0.595***	0.588***
	(0.042)	(0.128)	(0.130)	(0.140)	(0.133)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Observations	2,885	2,885	2,885	2,885	2,885
R-squared	0.132	0.132	0.133	0.132	0.133

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of sales. All the regressions are estimated by OLS.

Table 2.10.3: Effect of Chinese Tariff on Share of Skilled Labor (Size by Sales per Worker)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.433*	-0.429*	-0.400	-0.402*	-0.348
	(0.224)	(0.228)	(0.255)	(0.216)	(0.233)
Above median size dummy (by Sales per worker)	0.077*	0.078*	0.078*	0.078*	0.074*
	(0.040)	(0.040)	(0.039)	(0.041)	(0.039)
Lag of Chinese import tariff*Above median size dummy	0.378	0.367	0.299	0.374	0.242
	(0.283)	(0.279)	(0.341)	(0.281)	(0.321)
Lag of Korean import tariff		0.538	0.417		
		(0.330)	(0.286)		
Lag of Korean import tariff*Above median size dummy			0.095		
			(0.136)		
Lag of Korean input tariff				-0.785**	-0.921**
				(0.347)	(0.394)
Lag of Korean input tariff*Above median size dummy					0.246
					(0.236)
Constant	0.426***	0.206	0.236**	0.655***	0.661***
	(0.043)	(0.136)	(0.112)	(0.112)	(0.109)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Observations	2,885	2,885	2,885	2,885	2,885
R-squared	0.161	0.162	0.162	0.162	0.162

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of sales per worker. All the regressions are estimated by OLS.

Table 2.10.4: Effect of Chinese Tariff on Share of Skilled Labor (Size by Employment)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.375	-0.372	-0.389	-0.330	-0.331
	(0.287)	(0.243)	(0.236)	(0.309)	(0.314)
Above median size dummy (by Employment)	-0.080**	-0.079**	-0.079**	-0.080**	-0.080**
	(0.030)	(0.031)	(0.030)	(0.030)	(0.030)
Lag of Chinese import tariff*Above median size dummy	0.258	0.245	0.278	0.255	0.258
	(0.181)	(0.190)	(0.199)	(0.178)	(0.205)
Lag of Korean import tariff		1.242***	1.289***		
		(0.401)	(0.406)		
Lag of Korean import tariff*Above median size dummy			-0.044		
			(0.065)		
Lag of Korean input tariff				-1.115	-1.112
				(0.652)	(0.685)
Lag of Korean input tariff*Above median size dummy					-0.004
					(0.111)
Constant	0.503***	0.003	-0.006	0.826***	0.825***
	(0.069)	(0.198)	(0.199)	(0.235)	(0.236)
Year Dummies	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes
Observations	3,510	3,510	3,510	3,510	3,510
R-squared	0.109	0.110	0.110	0.110	0.110

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of employment. All the regressions are estimated by OLS.

Table 2.11: Effect of Chinese Tariff on Share of Skilled Labor (Size by Profit- Fractional Logit)
Dependent Variable: Skilled Labor Share

	(1)	(2)	(3)	(4)	(5)
Lag of Chinese import tariff	-0.680***	-0.682***	-0.657***	-0.660***	-0.584***
	(0.240)	(0.233)	(0.253)	(0.225)	(0.216)
Above median size dummy (by Profit)	-0.000	0.002	0.003	-0.000	-0.004
	(0.034)	(0.033)	(0.033)	(0.034)	(0.031)
Lag of Chinese import tariff*Above median size dummy	0.509*	0.482*	0.426	0.506*	0.330
	(0.267)	(0.260)	(0.327)	(0.264)	(0.282)
Lag of Korean import tariff		1.597***	1.520***		
		(0.365)	(0.407)		
Lag of Korean import tariff*Above median size dummy			0.076		
			(0.135)		
Lag of Korean input tariff				-0.446	-0.650
				(0.698)	(0.791)
Lag of Korean input tariff*Above median size dummy					0.320
					(0.262)
Observations	2,367	2,367	2,367	2,367	2,367

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1. Firm size is measured as the log of profit. All the regressions are estimated by fractional logit model.

Table 3.1: Number of Firms per Industry

Industry code	Industry name	Number of firms	Share in the total number of firms (%)
10	Production and processing of food	155	7.51
11	Beverages	20	0.97
12	Tobacco	7	0.34
14	Apparel, clothing accessories and fur products	86	4.17
13	Manufacture of other textiles	169	8.19
15	Leather, bags and Footwear	37	1.79
16	Wood products	1	0.05
17	Pulp and paper	12	0.58
18	Printed books, newspapers, pictures and other products of the printing industry	5	0.24
19	Cork, coal and oil refinement	1	0.05
20	Manufacture of basic chemicals	297	14.40
21	Medical materials and medications	44	2.13
22	Rubber and plastics	101	4.90
23	Non-metal and mineral	82	3.97
24	Casting of metals	114	5.53
25	Tools, implements, base metal products	121	5.87
26	Electronic parts, computer, television image and musical instruments	278	13.48
27	Optical, precision, medical or surgical instruments and apparatus	37	1.79
28	Electrical Machinery	108	5.24
29	Machinery and mechanical appliances	157	7.61
30	Cars and railway or tramway locomotives	134	6.50
31	Other transportation equipment	37	1.79
32	Furniture	22	1.07
33	Miscellaneous manufactured articles	38	1.84
Total		2,063	100

Table 3.2: Summary Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
ln(Wage rate)	2063	17.102	0.811	9.384	21.852
ln(Sales)	2063	24.416	1.922	20.040	30.221
ln(Sales per worker)	2063	19.512	1.379	14.946	26.460
ln(Profit)	1711	21.608	2.243	13.746	29.831
ln(Employment)	2063	4.904	1.134	1.099	10.656
Outuput import tariff	2063	0.095	0.087	0.000	0.389
Intermediate Input import tariff	2063	0.088	0.060	0.021	0.284
Chinese import tariff	2063	0.123	0.056	0.028	0.393
Export dummy	2056	0.670	0.470	0.000	1.000
Export share	2056	0.244	0.297	0.000	1.000
Share of production workers	2063	0.438	0.303	0.000	0.989
Share of permanent workers	2063	0.876	0.195	0.000	1.000
Share of male workers	2063	0.723	0.235	0.000	1.000

Note: All monetary values are in Korean Won deflated by industry-specific producer price indices (PPI), where 2005 is the base year. The average tariff variables are weighted by the number of firms in each industry, in order to portray the average tariff faced by the average firm in our sample.

Table 3.3: Industry, Average Tariff and Change in Tariff

Industry Code	Industry Name	Output import tariff		Input import tariff		Chinese import tariff	
		Average	**Change**	**Average**	**Change**	**Average**	**Change**
10	Production and processing of food	0.382	-0.0147	0.281	-0.0045	0.196	-0.0333
11	Beverages	0.202	-0.0009	0.193	0.0023	0.314	-0.1605
12	Tobacco	0.330	-0.0019	0.177	-0.0681	0.348	-0.0867
14	Apparel, clothing accessories and fur products	0.121	0.0006	0.132	-0.0693	0.192	-0.0562
13	Manufacture of other textiles	0.089	-0.0015	0.081	-0.0060	0.131	-0.0620
15	Leather, bags and Footwear	0.079	-0.0014	0.103	0.0704	0.151	-0.0160
16	Wood products	0.063	-0.0031	0.065	-0.0058	0.057	-0.0234
17	Pulp and paper	0.025	-0.0500	0.041	-0.0393	0.077	-0.0422
18	Printed books, newspapers, pictures and other products of the printing industry	0.015	-0.0104	0.034	-0.0250	0.030	-0.0062
19	Cork, coal and oil refinement	0.079	-0.0030	0.073	-0.0053	0.071	-0.0029
20	Manufacture of basic chemicals	0.073	-0.0148	0.074	-0.0126	0.071	-0.0069
21	Medical materials and medications	0.041	0.0030	0.080	-0.0098	0.048	-0.0038
22	Rubber and plastics	0.075	-0.0072	0.074	-0.0097	0.110	-0.0199
23	Non-metal and mineral	0.071	-0.0012	0.071	-0.0062	0.122	-0.0122
24	Casting of metals	0.044	-0.0186	0.048	-0.0166	0.079	-0.0034
25	Tools, implements, base metal products	0.068	-0.0001	0.055	-0.0121	0.107	-0.0045
26	Electronic parts, computer, television image and musical instruments	0.051	-0.0007	0.055	-0.0020	0.091	-0.0316
27	Optical, precision, medical or surgical instruments and apparatus	0.066	0.0027	0.063	-0.0030	0.099	-0.0082
28	Electrical Machinery	0.070	0.0023	0.060	-0.0078	0.102	-0.0185
29	Machinery and mechanical appliances	0.061	-0.0014	0.060	-0.0052	0.093	-0.0161
30	Cars and railway or tramway locomotives	0.078	0.0001	0.070	-0.0030	0.188	-0.0870
31	Other transportation equipment	0.038	0.0006	0.055	-0.0061	0.095	-0.0089
32	Furniture	0.044	-0.0097	0.068	-0.0079	0.111	-0.0686
33	Miscellaneous manufactured articles	0.075	-0.0033	0.065	-0.0109	0.200	-0.0072

Note: Change in tariff= tariff in 2007-tariff in 2002

Table 3.4: Correlation between Korean Output and Intermediate Input Tariffs and Chinese Import Tariffs Imposed on Korean Goods

	Output import tariff	Input import tariff	Chinese import tariff
Output import tariff	1		
Input import tariff	0.977	1	
Chinese import tariff	0.593	0.616	1

Table 3.5: Effect of Firm Size on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Sales)	0.092***	0.081***						
	(0.013)	(0.015)						
ln(Profit)			0.068***	0.060***				
			(0.012)	(0.014)				
ln(Sales per worker)					0.169***	0.146***		
					(0.012)	(0.015)		
ln(Employment)							0.023	0.035
							(0.022)	(0.024)
Share of production workers		-0.194***		-0.193**		-0.091		-0.215***
		(0.064)		(0.069)		(0.062)		(0.063)
Share of permanent workers		0.322*		0.439**		0.196		0.300*
		(0.163)		(0.168)		(0.152)		(0.165)
Share of male workers		0.544***		0.575***		0.455***		0.681***
		(0.148)		(0.150)		(0.147)		(0.127)
Observations	2,063	2,063	1,711	1,711	2,063	2,063	2,063	2,063
R-squared	0.173	0.199	0.164	0.194	0.202	0.217	0.131	0.169

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.6: Effect of Firm Size and Export Dummy on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Export dummy	0.146***	0.114**	0.015	0.004	0.041	0.033	0.020	0.014	0.142***	0.099**
	(0.045)	(0.044)	(0.040)	(0.035)	(0.039)	(0.036)	(0.038)	(0.036)	(0.042)	(0.039)
ln(Sales)			0.090***	0.081***						
			(0.014)	(0.015)						
ln(Profit)					0.065***	0.058***				
					(0.012)	(0.013)				
ln(Sales per worker)							0.168***	0.146***		
							(0.014)	(0.016)		
ln(Employment)									0.006	0.023
									(0.021)	(0.022)
Share of production workers		-0.192***		-0.191***		-0.192**		-0.089		-0.208***
		(0.061)		(0.064)		(0.069)		(0.062)		(0.064)
Share of permanent workers		0.272		0.321*		0.440**		0.197		0.298*
		(0.160)		(0.163)		(0.168)		(0.153)		(0.163)
Share of male workers		0.653***		0.543***		0.571***		0.453***		0.654***
		(0.135)		(0.149)		(0.151)		(0.147)		(0.135)
Observations	2,056	2,056	2,056	2,056	1,706	1,706	2,056	2,056	2,056	2,056
R-squared	0.136	0.171	0.173	0.199	0.165	0.193	0.202	0.216	0.136	0.172

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.7: Effect of Firm Size and Export Share on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Export share	0.026	0.013	-0.126	-0.114	-0.084	-0.067	-0.098	-0.092	0.007	-0.015
	(0.077)	(0.068)	(0.081)	(0.066)	(0.096)	(0.081)	(0.071)	(0.064)	(0.072)	(0.061)
ln(Sales)			0.096***	0.085***						
			(0.013)	(0.014)						
ln(Profit)					0.071***	0.062***				
					(0.011)	(0.013)				
ln(Sales per worker)							0.173***	0.150***		
							(0.013)	(0.015)		
ln(Employment)									0.022	0.036
									(0.021)	(0.022)
Share of production workers		-0.188***		-0.185***		-0.187**		-0.080		-0.212***
		(0.061)		(0.065)		(0.070)		(0.063)		(0.064)
Share of permanent workers		0.256		0.307*		0.427**		0.180		0.296*
		(0.159)		(0.162)		(0.167)		(0.151)		(0.164)
Share of male workers		0.686***		0.546***		0.578***		0.458***		0.682***
		(0.127)		(0.145)		(0.149)		(0.144)		(0.129)
Observations	2,056	2,056	2,056	2,056	1,706	1,706	2,056	2,056	2,056	2,056
R-squared	0.130	0.167	0.175	0.200	0.165	0.194	0.203	0.217	0.131	0.169

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.8: Effect of Firm Size, Export Dummy and Output Tariff on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export dummy	0.014	0.002	0.037	0.028	0.020	0.013	0.140***	0.094**
	(0.040)	(0.034)	(0.038)	(0.035)	(0.038)	(0.036)	(0.043)	(0.040)
Output tariff	-5.280***	-3.220**	0.271	1.295	-1.611	0.298	0.013	0.272
	(1.658)	(1.455)	(1.564)	(1.520)	(1.340)	(1.208)	(0.789)	(0.811)
ln(Sales)	0.066***	0.061***						
	(0.017)	(0.018)						
ln(Sales)*Output tariff	0.255***	0.200***						
	(0.064)	(0.059)						
ln(Profit)			0.057***	0.051**				
			(0.018)	(0.019)				
ln(Profit)*Output tariff			0.083	0.064				
			(0.070)	(0.070)				
ln(Sales per worker)					0.152***	0.137***		
					(0.019)	(0.020)		
ln(Sales per worker)*Output tariff					0.147**	0.077		
					(0.064)	(0.058)		
ln(Employment)							-0.016	-0.007
							(0.028)	(0.029)
ln(Employment)*Output tariff							0.244	0.338**
							(0.146)	(0.158)
Share of production workers		-0.190***		-0.196***		-0.091		-0.207***
		(0.065)		(0.070)		(0.062)		(0.065)
Share of permanent workers		0.311*		0.440**		0.196		0.309*
		(0.164)		(0.168)		(0.154)		(0.167)
Share of male workers		0.549***		0.587***		0.463***		0.676***
		(0.145)		(0.149)		(0.146)		(0.138)
Observations	2,056	2,056	1,706	1,706	2,056	2,056	2,056	2,056
R-squared	0.176	0.202	0.167	0.197	0.204	0.218	0.138	0.175

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.9: Effect of Firm Size, Export Dummy and Input Tariff on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export dummy	0.013	0.000	0.037	0.027	0.018	0.011	0.141***	0.095**
	(0.040)	(0.034)	(0.038)	(0.035)	(0.038)	(0.037)	(0.042)	(0.039)
Input tariff	-5.547**	-2.205	0.617	2.371	-1.834	1.183	1.550	2.000
	(2.572)	(2.517)	(2.216)	(2.266)	(1.713)	(1.762)	(2.222)	(2.254)
ln(Sales)	0.063***	0.061***						
	(0.018)	(0.019)						
ln(Sales)*Input tariff	0.319***	0.225*						
	(0.112)	(0.111)						
ln(Profit)			0.056***	0.052**				
			(0.019)	(0.019)				
ln(Profit)*Input tariff			0.106	0.068				
			(0.087)	(0.084)				
ln(Sales per worker)					0.147***	0.136***		
					(0.020)	(0.022)		
ln(Sales per worker)*Input tariff					0.222**	0.104		
					(0.087)	(0.078)		
ln(Employment)							-0.001	0.005
							(0.037)	(0.037)
ln(Employment)*Input tariff							0.079	0.231
							(0.399)	(0.397)
Share of production workers		-0.190***		-0.197***		-0.091		-0.210***
		(0.065)		(0.069)		(0.063)		(0.064)
Share of permanent workers		0.316*		0.444**		0.199		0.310*
		(0.161)		(0.168)		(0.153)		(0.165)
Share of male workers		0.548***		0.580***		0.459***		0.669***
		(0.146)		(0.149)		(0.147)		(0.140)
Observations	2,056	2,056	1,706	1,706	2,056	2,056	2,056	2,056
R-squared	0.176	0.202	0.166	0.196	0.204	0.218	0.137	0.173

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.10: Effect of Firm Size, Export Dummy, Output Tariff and Chinese Import Tariff on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export dummy	0.014	0.002	0.039	0.029	0.022	0.014	0.139***	0.092**
	(0.040)	(0.034)	(0.037)	(0.034)	(0.038)	(0.036)	(0.043)	(0.040)
Output tariff	-13.740***	-11.462***	-6.147**	-4.980	-5.921**	-4.109	-5.855***	-5.223***
	(2.956)	(3.113)	(2.901)	(3.041)	(2.496)	(2.711)	(1.719)	(1.688)
Chinese import tariff	3.032	4.164	-1.804	-0.649	-6.115	-5.073	-1.911	-0.890
	(4.165)	(4.305)	(3.715)	(3.559)	(3.925)	(4.215)	(2.065)	(1.715)
ln(Sales)	0.095***	0.093***						
	(0.024)	(0.024)						
ln(Sales)*Output tariff	0.402***	0.358***						
	(0.094)	(0.099)						
ln(Sales)*Chinese import tariff	-0.003*	-0.004*						
	(0.002)	(0.002)						
ln(Profit)			0.071**	0.068**				
			(0.028)	(0.028)				
ln(Profit)*Output tariff			0.157	0.151				
			(0.095)	(0.100)				
ln(Profit)*Chinese import tariff			-0.170	-0.200				
			(0.171)	(0.167)				
ln(Sales per worker)					0.147***	0.135***		
					(0.022)	(0.024)		
ln(Sales per worker)*Output tariff					0.137	0.084		
					(0.104)	(0.111)		
ln(Sales per worker)*Chinese import tariff					0.000	0.000		
					(0.002)	(0.002)		
ln(Employment)							0.046	0.063
							(0.043)	(0.040)
ln(Employment)*Output tariff							0.535***	0.663***
							(0.171)	(0.147)
ln(Employment)*Chinese import tariff							-0.007	-0.008**
							(0.004)	(0.003)

Table 3.10: Effect of Firm Size, Export Dummy, Output Tariff and Chinese Import Tariff on Wage Rate (Continued)

Share of production workers		-0.190***		-0.197***		-0.088		-0.210***
		(0.061)		(0.068)		(0.062)		(0.063)
Share of permanent workers		0.284*		0.424**		0.173		0.284*
		(0.163)		(0.169)		(0.155)		(0.165)
Share of male workers		0.549***		0.587***		0.462***		0.677***
		(0.146)		(0.151)		(0.147)		(0.140)
Observations	2,056	2,056	1,706	1,706	2,056	2,056	2,056	2,056
R-squared	0.181	0.206	0.171	0.200	0.207	0.221	0.143	0.180

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3.11: Effect of Firm Size, Export Share, Output Tariff and Chinese Import Tariff on Wage Rate

Dependent Variable: Log Wage Rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export share	-0.121	-0.114*	-0.085	-0.073	-0.096	-0.095	0.001	-0.022
	(0.079)	(0.065)	(0.094)	(0.078)	(0.072)	(0.065)	(0.072)	(0.062)
Output tariff	-13.414***	-11.170***	-5.933*	-4.805	-5.576**	-3.812	-5.972***	-5.272***
	(2.879)	(3.032)	(2.886)	(3.024)	(2.421)	(2.641)	(1.758)	(1.700)
Chinese import tariff	3.473	4.521	-1.446	-0.384	-5.922	-4.930	-1.655	-0.679
	(4.288)	(4.439)	(3.861)	(3.672)	(3.958)	(4.253)	(2.246)	(1.859)
ln(Sales)	0.105***	0.100***						
	(0.022)	(0.023)						
ln(Sales)*Output tariff	0.391***	0.346***						
	(0.095)	(0.099)						
ln(Sales)*Chinese import tariff	-0.004*	-0.004*						
	(0.002)	(0.002)						
ln(Profit)			0.079***	0.074**				
			(0.027)	(0.027)				
ln(Profit)*Output tariff			0.152	0.147				
			(0.096)	(0.099)				
ln(Profit)*Chinese import tariff			-0.184	-0.211				
			(0.176)	(0.171)				
ln(Sales per worker)					0.155***	0.143***		
					(0.022)	(0.023)		
ln(Sales per worker)*Output tariff					0.122	0.070		
					(0.103)	(0.110)		
ln(Sales per worker)*Chinese import tariff					0.000	-0.000		
					(0.002)	(0.002)		
ln(Employment)							0.063	0.076*
							(0.042)	(0.039)
ln(Employment)*Output tariff							0.581***	0.696***
							(0.184)	(0.154)
ln(Employment)*Chinese import tariff							-0.007	-0.008**
							(0.004)	(0.004)

Table 3.11: Effect of Firm Size, Export Share, Output Tariff and Chinese Import Tariff on Wage Rate (Continued)

Share of production workers		-0.185***		-0.192**		-0.079		-0.214***
		(0.062)		(0.069)		(0.063)		(0.063)
Share of permanent workers		0.272		0.410**		0.157		0.282
		(0.162)		(0.168)		(0.154)		(0.166)
Share of male workers		0.553***		0.594***		0.468***		0.705***
		(0.143)		(0.149)		(0.144)		(0.132)
Observations	2,056	2,056	1,706	1,706	2,056	2,056	2,056	2,056
R-squared	0.182	0.208	0.171	0.201	0.208	0.222	0.138	0.178

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors clustered at the industry level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.1: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ln (TFP)	1001	0.9999997	0.8407671	-1.226486	2.165521
Import tariff (China)	1652	0.1074023	0.0402324	0.027684	0.306667
Import tariff (Korea)	1652	0.0878227	0.087284	0	0.379953
Import tariff (US)	1652	0.0293004	0.0539043	0	2.041667
Import tariff (EU)	1652	0.0392129	0.0261969	0	0.396667
Import tariff (Japan)	1652	0.0223839	0.0367603	0	0.12592
Input tariff (Korea)	1652	0.0774515	0.0615531	0.019823	0.283875
Share of nonprod. Workers	1652	0.4936958	0.2747493	0	1
Share of male workers	1652	0.7016805	0.2356401	0	1
Share of age50 above workers	1652	0.0022193	0.0052512	0	0.111111
Share of regular workers	1652	0.6764267	0.2211208	0	1
Herfindahl Index	1652	0.2919727	0.2195363	0	1
Age	1372	17.77332	12.56268	0	93
Age squared	1372	473.5969	681.8614	0	8649
Foreign ownership dummy	1372	0.1661808	0.3723785	0	1
ln (Sales)	1070	24.12884	1.564723	21.21052	28.74404
ln(Value Added)	1035	22.28294	1.672779	16.60461	28.19412
ln(Employment)	1652	4.611434	1.092764	1.098612	9.405332
ln(Material Cost)	1068	23.91021	1.56773	20.80104	28.27414
ln(Capital)	1043	22.74147	1.777243	17.66891	27.60907
Export dummy	880	0.5409091	0.498607	0	1
ln(Exports)	657	13.6518	1.63E+11	0	27.88942

Note: All monetary values are in Korean Won deflated by industry-specific producer price indices (PPI), where 2005 is the base year. The average tariff variables are weighted by the number of firms in each industry, in order to portray the average tariff faced by the average firm in our sample.

Table 4.2: Industry, Average Tariff and Change in Tariff

Industry Code	Industry Name	Output import tariff (Korea)		Input import tariff (Korea)		Output import tariff (China)	
		Average	Change	Average	Change	Average	Change
10	Production and processing of food	0.3774	-0.0063	0.2801	0.0092	0.1784	0.0006
11	Beverages	0.2012	0.0000	0.1874	0.0089	0.2605	-0.0344
12	Tobacco	0.3293	0.0000	0.1336	-0.0610	0.3067	0.0000
13	Manufacture of other textiles	0.0888	-0.0015	0.0787	-0.0010	0.1023	-0.0147
14	Apparel, clothing accessories and fur products	0.1210	0.0006	0.1073	-0.0646	0.1663	-0.0141
15	Leather, bags and Footwear	0.0792	-0.0015	0.1203	0.0828	0.1446	-0.0038
16	Wood products	0.0621	-0.0031	0.0623	-0.0023	0.0461	-0.0036
17	Pulp and paper	0.0001	-0.0002	0.0214	-0.0033	0.0588	-0.0111
18	Printed books, newspapers, pictures and other products of the printing industry	0.0111	-0.0088	0.0220	-0.0012	0.0277	0.0000
19	Cork, coal and oil refinement	0.0770	0.0000	0.0707	0.0001	0.0699	0.0000
20	Manufacture of basic chemicals	0.0649	-0.0004	0.0669	0.0005	0.0687	-0.0024
21	Medical materials and medications	0.0397	0.0032	0.0752	0.0029	0.0450	0.0023
22	Rubber and plastics	0.0700	-0.0003	0.0683	-0.0001	0.1006	-0.0063
23	Non-metal and mineral	0.0708	-0.0012	0.0676	-0.0013	0.1161	-0.0026
24	Casting of metals	0.0367	-0.0038	0.0406	-0.0024	0.0782	-0.0013
25	Tools, implements, base metal products	0.0681	-0.0001	0.0494	-0.0036	0.1054	-0.0006
26	Electronic parts, computer, television image and musical instruments	0.0511	-0.0006	0.0544	-0.0003	0.0813	-0.0152
27	Optical, precision, medical or surgical instruments and apparatus	0.0658	0.0030	0.0625	0.0043	0.0953	0.0008
28	Electrical Machinery	0.0700	0.0023	0.0568	-0.0014	0.0951	-0.0029
29	Machinery and mechanical appliances	0.0604	0.0008	0.0578	-0.0009	0.0860	-0.0018
30	Cars and railway or tramway locomotives	0.0779	0.0001	0.0646	-0.0165	0.1523	-0.0370
31	Other transportation equipments	0.0376	0.0006	0.0548	0.0102	0.0909	0.0005
32	Furniture	0.0401	-0.0021	0.0639	-0.0079	0.0797	-0.0242
33	Miscellaneous manufactured articles	0.0723	0.0024	0.0600	-0.0008	0.1966	0.0001

Note: Change in tariff= tariff in 2008 - tariff in 2004

Table 4.3: Export Status and Spending on Technology by Quartile

	Share of exporting firms	Average amount of exports	Average amount of ST
1st size quartile	0.445	9.947969	18.03359
2nd size quartile	0.465	12.11551	18.12464
3rd size quartile	0.577	14.12072	18.7279
4th size quartile	0.679	16.94018	19.2988

Note: Average amount of exports and ST are in Korean Won deflated by industry-specific producer price indices (PPI), where 2005 is the base year.

Table 4.4: Firm Characteristics and Firm Size

	ln (TFP)	Export Status	ln (Export Amount)	ln(ST)
2nd size quartile	0.014*	0.019	1.799	0.036
	(0.008)	(0.078)	(2.094)	(0.047)
3rd size quartile	0.039**	0.168***	4.519***	0.218**
	(0.017)	(0.045)	(1.090)	(0.078)
4th size quartile	0.083**	0.246***	7.167***	0.405***
	(0.033)	(0.063)	(1.432)	(0.090)
Constant	-1.041***	0.315***	7.260***	-0.001
	(0.017)	(0.042)	(1.115)	(0.050)
Year effect	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Observations	1,001	880	657	664
R-squared	0.986	0.167	0.204	0.230

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** indicates significant at 1%, ** significant at 5%, * significant at 10%. Firm size is measured as the log of employees for each year separately.

Table 4.5: Effect of Export Dummy as well as Spending on Technology on TFP

Dependent Variable: Log TFP

	(1)	(2)	(3)	(4)	(5)	(6)
Export dummy	0.199**	0.024*				
	(0.090)	(0.013)				
ln(ST)			0.160**	0.041***		
			(0.075)	(0.012)		
ln(Export)					0.009*	0.002**
					(0.004)	(0.001)
Constant	0.883***	-1.005***	0.969***	-1.009***	0.884***	-1.011***
	(0.238)	(0.010)	(0.231)	(0.008)	(0.239)	(0.011)
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	No	Yes	No	Yes	No	Yes
Observations	622	622	643	643	622	622
R-squared	0.015	0.984	0.016	0.985	0.015	0.984

All regressions include year and industry effects. Robust standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.6: Effect of Chinese Import Tariff on TFP

Dependent Variable: Log TFP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chinese output tariff lag1	-0.434	-0.471	-0.729	-0.679	-0.652*	-0.580	-0.520	-0.616*
	(0.318)	(0.334)	(0.438)	(0.419)	(0.359)	(0.363)	(0.320)	(0.348)
Share of male workers		0.052**	0.051**	0.061***	0.055***	0.052**	0.052**	0.052**
		(0.021)	(0.021)	(0.020)	(0.019)	(0.021)	(0.021)	(0.021)
Share of age50 above workers		-2.489	-2.531	-1.525	-1.415	-2.507	-2.495	-2.511
		(2.572)	(2.587)	(2.223)	(2.128)	(2.591)	(2.575)	(2.594)
Share of regular workers		-0.027**	-0.029**	-0.025*	-0.033**	-0.028**	-0.027**	-0.028**
		(0.013)	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
Age				0.001				
				(0.002)				
Age square				-0.000				
				(0.000)				
Herfindahl Index			0.058					
			(0.040)					
Foreign ownership dummy					0.051**			
					(0.020)			
Korean output tariff lag1						-3.577		-3.539
						(2.282)		(2.295)
Korean input tariff lag1							0.153	0.114
							(0.238)	(0.235)
Observations	1,001	1,001	1,001	855	855	1,001	1,001	1,001
R-squared	0.985	0.985	0.985	0.985	0.985	0.985	0.985	0.985

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.7: Effect of Chinese Import Tariff and Firm Size Dummy (Above Median Size Dummy) on TFP

Dependent Variable: Log TFP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chinese output tariff lag1	0.294	0.251	0.123	0.009	0.166	0.121	0.196	0.081
	(0.443)	(0.471)	(0.575)	(0.506)	(0.533)	(0.475)	(0.443)	(0.449)
above median size dummy	0.185***	0.187***	0.190***	0.186***	0.188***	0.186***	0.187***	0.186***
	(0.046)	(0.048)	(0.049)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)
Ouput tariff (China)_lag1*above med. size dummy	-1.269***	-1.300***	-1.337***	-1.291***	-1.337***	-1.286***	-1.302***	-1.287***
	(0.405)	(0.417)	(0.429)	(0.418)	(0.415)	(0.419)	(0.419)	(0.420)
Share of male workers		0.064***	0.070***	0.063***	0.065***	0.065***	0.064***	0.064***
		(0.018)	(0.017)	(0.018)	(0.017)	(0.018)	(0.018)	(0.018)
Share of age50 above workers		-0.835	-0.314	-0.864	-0.169	-0.816	-0.845	-0.823
		(1.087)	(0.965)	(1.116)	(0.823)	(1.129)	(1.093)	(1.135)
Share of regular workers		-0.020	-0.018	-0.022	-0.023	-0.022	-0.020	-0.021
		(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.014)	(0.014)
Age			0.001					
			(0.002)					
Age square			-0.000					
			(0.000)					
Herfindahl index				0.053				
				(0.041)				
Foreign ownership dummy					0.039**			
					(0.017)			
Korean output tariff lag1						-3.846		-3.801
						(2.425)		(2.457)
Korean input tariff lag1							0.173	0.129
							(0.259)	(0.257)
Observations	1,001	1,001	855	1,001	855	1,001	1,001	1,001
R-squared	0.986	0.986	0.987	0.986	0.987	0.986	0.986	0.986

All regressions are estimated by OLS and include a constant and year and industry effects. Standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.8: Effect of Chinese Import Tariff and Firm Size Dummy (Quartile Dummy) on TFP

Dependent Variable: Log TFP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Chinese output tariff lag1*1st size quartile	0.493	0.392	0.087	0.096	0.165	0.264	0.357	0.244
	(0.535)	(0.574)	(0.690)	(0.679)	(0.549)	(0.551)	(0.541)	(0.521)
Chinese output tariff lag1*2nd size quartile	0.055	0.014	-0.057	-0.048	-0.234	-0.108	-0.019	-0.126
	(0.370)	(0.398)	(0.548)	(0.485)	(0.415)	(0.397)	(0.363)	(0.369)
Chinese output tariff lag1*3rd size quartile	-0.347	-0.405	-0.598	-0.604*	-0.634	-0.518	-0.440	-0.537
	(0.301)	(0.331)	(0.370)	(0.346)	(0.440)	(0.344)	(0.342)	(0.355)
Chinese output tariff lag1*4th size quartile	-1.604***	-1.723***	-1.992***	-1.923***	-1.956***	-1.831***	-1.757***	-1.851***
	(0.288)	(0.311)	(0.406)	(0.384)	(0.353)	(0.288)	(0.295)	(0.276)
Share of male workers		0.072***	0.078***	0.073***	0.071***	0.072***	0.072***	0.072***
		(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Share of age50 above workers		-0.335	0.153	0.300	-0.387	-0.323	-0.339	-0.326
		(0.809)	(0.743)	(0.671)	(0.847)	(0.857)	(0.813)	(0.861)
Share of regular workers		-0.021	-0.022	-0.025	-0.022	-0.022	-0.021	-0.022
		(0.015)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Age			0.001					
			(0.002)					
Age square			-0.000					
			(0.000)					
Foreign ownership dummy				0.031*				
				(0.016)				
Herfindahl index					0.051			
					(0.044)			
Korean output tariff lag1						-3.753*		-3.731*
						(2.014)		(2.038)
Korean input tariff lag1							0.107	0.063
							(0.238)	(0.230)
Observations	1,001	1,001	855	855	1,001	1,001	1,001	1,001
R-squared	0.987	0.987	0.988	0.988	0.987	0.987	0.987	0.987

All regressions are estimated by OLS and include a constant, year and industry effects, and second, third and fourth quartile dummies. Standard errors in parentheses are clustered at the two-digit industry level. *** p<0.01, ** p<0.05, * p<0.1.

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