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Evaluating Stolper-Samuelson: Trade Liberalization & Wage Inequality in India

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Abstract: This paper tests the predictions of the Stolper-Samuelson Theorem in India after it underwent major trade reform in 1991. Using industry level tariff data, the paper empirically examines trade liberalization's effect on the wages of high-skilled labor relative to low skilled labor within firms. The study finds empirical evidence to support growing wage differentials within firms, which contradict the predictions of the Stolper-Samuelson Theorem. Additionally, when controlling for firm size and the effects of the global financial crisis, these results remain robust. Finally, the paper explores training and welfare and R&D's effect on the wage differentials within firms, finding a direct relationship between training and welfare expenditures and executive compensation but no significant impact of R&D expenditure.

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1. Introduction

In 1776 the "father" of modern economics, Adam Smith, was the first to hypothesize about the economic gains from International Trade. In his famous publication, *The Wealth of Nations,* Smith explains that trade occurs on the basis of a countries ability to produce a certain amount of a good. Since Smith's theory of Absolute Advantage, there have been numerous models presented by economists to portray the basis in which countries will engage in trade. Each subsequent trade theory has been widely accepted and eventually superseded by new models that provide more accurate explanations of trade movements between nations. Within this century alone, major trade theory has taken several shifts as the leading theoretical models failed to live up to their empirical counterparts when predicting the relative wages among skill groups, occupations and sectors.

The Stolper-Samuelson Theorem is the basis for the analysis of International trade used in this paper. Using firm level data, this paper tests the Stolper-Samuelson Theorem's ability to explain wage movements across skill groups in India after the country underwent dramatic trade reform. The years following India's market liberalization offers the perfect window to conduct this analysis since India's major economic policy favored protecting domestic markets from foreign goods.

As a low middle income country, India has a relative factor abundance of low-skilled labor, and relative scarcity of high-skilled labor relative to the rest of the world. Using OLS, I use tariff levels as a proxy for relative openness of an industry in order to analyze market liberalization's effect on the wages of high-skilled labor relative to low-skilled labor. At the firm level, executive compensation is used to proxy for the payments given to high-skilled labor, and firm payments given to all other non-executive employees represent the payments to low-skilled labor.

Section 2 gives further theoretical analysis of the Stolper-Samuelson Theorem in the context of India, a low skill abundant country. Section 3 presents the empirical literature related to the trade liberalization and wage inequality. Section 4 provides historical background of India's market liberalization and breakdown of India's labor markets Section 5 explains the data and methodology used in this paper, where Section 6 presents the results and robustness checks of our specifications. Section 7 summarizes and concludes.

2. Theoretical Background of Stolper-Samuelson

2.1 Pre-Stolper-Samuelson Trade Theories

In Smith's theory of Absolute Advantage, if Country A can produce a larger quantity of Good X, using the same amount of resources as Country B, then Country A is said to have the absolute advantage in the production of the good. Therefore, Country A and Country B should engage in trade of Good X, where Country A will export Good X to Country B.

In his 1887 book, *On the Principles of Political Economy and Taxation*, David Ricardo presents his theory of Comparative Advantage, a stark improvement from the theory of Absolute Advantage. Ricardo's model demonstrates that countries should engage in trade on the basis of differences in technology or resource endowment. Consider a two country (Country A and B), two good (Good X and Y) model, where man-hours are the resource used in the production of both goods. Before any trade decision takes place, both countries need to decide how many man-hours it wishes to allocate towards the production of Goods X and Y. Each country can either devote all of its resources to the production of Good X or Y (or Autarky), or devote a fraction of its resources towards production of Good X and the rest to produce Good Y. Since the country is aware of the amount of man-hours needed to produce one unit of Good X, and the amount of man-hours needed to produce one unit of Good Y, it can trade off man-hours if it wishes to produce more of Good X and less of Good Y (and also vice versa). Therefore, the cost of producing Good X is thought of in terms of the amount of Good Y it forgoes in order to produce one unit of Good X. This is called the opportunity cost, and is the basis for trade between the two countries. If Country A has a lower opportunity cost for Good X (in terms of Good Y), relative to Country B, then Country A will export Good X to Country B.

Ricardo's theorem of Comparative Advantage was revolutionary at its time, since most economists were advocates of Mercantilism, which based International trade on the basis of building a trade surplus with other countries. Through specialization and trade, Ricardo's model proves that there is a mutual benefit for countries when they export the goods for which they have a comparative advantage, and import the goods that they cannot produce at a lower opportunity cost relative to other countries.

In the early 1900s, Eli Heckscher and Bertil Ohlin built upon Ricardo's idea of Comparative Advantage, by presenting their neo-classical trade theorem that is based upon each country's difference in relative factor endowments. The Heckscher-Ohlin model predicts that a country will produce and export goods that makes use of locally abundant factors of production, and will import goods that make use of locally scarce factors. Therefore, if Resource T is more abundant in Country A relative to Country B, and Resource T is the primary factor of production used in Good X, then it will produce and export Good X to Country B, since it can produce Good X at a lower opportunity cost in terms of Resource T than Country B.

2.1 The Stolper-Samuelson Theorem

Taking the Heckscher-Ohlin analysis one step further, Wolfgang Stolper and Paul Samuelson enhanced the Heckscher-Ohlin model, by including the of payments given to each factor of production in the model – specifically the wages paid to labor and the rent earned on capital. In their 1941 paper titled *Protection and Real Wages,* Stolper and Samuelson base their analysis upon the Hecksher-Ohlin model's idea that a country will export the good that it produces with relatively abundant factors, and import the good that relies on relatively scarce factors. As a result, this will shift production towards the good that uses the abundant factor, and away from the good that uses the scarce factor. Once trade occurs, this should move both countries towards an equalization of the factor prices paid to the of production of goods in both countries (i.e. wages and rent). However, this movement in factor prices will be partial and will not result in full equalization, otherwise there would be no basis for future trade. Nonetheless, after trade if the world price of a good is higher than the domestic price of the good, than that country has the comparative advantage in the production of the good since they can produce at a lower price relative to others.

The theoretical basis of the Stolper-Samuelson theorem is given by the following model. In the model, Country A is a low skill abundant country that is open to trade. It can produce two goods, Good X and Good Y. Both goods are produced using two factors of production, high skilled (H) and low skilled labor (L). Assume that there is perfect competition in both the goods market and the factor markets, and that labor is perfectly mobile across sectors within the country. Let Good X be the skill intensive good, while Good Y is the low skill intensive good. Therefore, the price of each good is equal to its unit cost, giving the following normal profit condition:

$$P_x = W_H A_{Hx} + W_L A_{Lx}$$

$$P_y = W_H A_{Hy} + W_L A_{Ly}$$

Where P_x and P_y are the relative prices of Goods X and Y. W_H and W_L are the wages of the skill intensive good and low skill intensive good. A_H and A_L are the relative levels of skill intensity for each good – which is given exogenously in this model.

Since the country is abundant in low skilled labor, it will export the low skill intensive good (Y) and import the skill intensive good (X). The price of each good is given by the following conditions:

$$P_x = (1 + t)P_x^*$$
$$P_y = P_y^*$$

Where P_x and P_x^* are the domestic and world price of the skill intensive good, and P_y and P_y^* are the domestic and world price of the low skill intensive good. The tariff level is represented by t. Both the world price and the tariff level are given exogenously in this model.

In order to graph this relationship in factor price space (Figure 1), we can rearrange the above equations to get the following isocost line equations:

$$W_H = \frac{P_x}{A_{Hx}} - \frac{A_{Lx}}{A_{Hx}} W_L$$
$$W_H = \frac{P_y}{A_{Hy}} - \frac{A_{Ly}}{A_{Hy}} W_L$$

The slope of each isocost line is the negative ratio of skill intensities required to produce each good. Therefore, the slope is the cost of one factor of production in terms of the other.

Figure 1 graphically shows the two isocost lines. The x-axis represents the low skilled wage and the y-axis is the high skilled wage. The isocost line for Good X is flatter, since it is skill intensive, and thus requires a lower ratio of $\frac{A_{Lx}}{A_{Hx}}$ to produce Good X (since it is a ratio of low skill intensity over high skill intensity). Therefore, the isocost line for Good Y is steeper since its production requires a larger share of low skill factors of production. Since there is positive production of both goods, the isocost lines intersect within the factor price space, which gives the first equilibrium point in Figure 1. When there is a reduction in the tariff level, the isocost line for Good X shifts downwards. This causes our equilibrium high skill wage to decrease, while our low skill wage increases. This shift and resulting new equilibrium point of high skilled wages and low skilled wages is the theoretical basis of this paper's hypothesis. From Figure 1, the Stolper-Samuelson Theorem predicts that the low skill abundant Country A, will see a decline in the wages of high skilled labor and an increase in the wages of low skilled labor when there is a reduction in tariffs.

2.3 The Stolper-Theorem in the Context of post-liberalized India

In the context of India, the Stolper-Samuelson theorem would lead us to predict an increase in the returns to low skilled labor and a decline in the returns to high skilled labor. Given the fact that India is a labor-intensive country, we would expect India to increase its trade of labor-intensive goods, leading to a rise in the wages of the low skilled labor. From the mechanism provided in Section 2.2, we conclude that that wage inequality within exporting firms would decrease as the demand for unskilled labor increases. This implies that at the firm level, the wages of executives would be stagnant or growing at a slower rate than that of non-executives, since the model predicts that the wages of non-executives will be increasing relative to their executive counterparts. Despite the model's predictions, there is a growing number of empirical literature that demonstrates contradictory wage movements. The empirical background for the Stolper-Samuelson Theorem is given in Section 3.

3. Empirical Literature Review

3.1 Empirical Issues of the Stolper-Samuelson Theorem

When Wolfgang Stolper and Paul Samuelson submitted their theorem to the *American Economic Review*, the paper was praised for its "brilliant theoretical performance", but was rejected due to the fact that it did not "have anything to say about any of the real situations with which they theory of International trade has to concern itself" (Davis and Mishra, 2007). There are many inherent problems with the Stolper-Samuelson Theorem, a few of which will be highlighted below.

The first problem involves the goods that are produced by rich countries and poor countries within the model. According to Davis and Mishra (2007), there is growing empirical evidence that the goods produced domestically in poor countries, "differ systematically in the factor input composition, and they differ systematically in quality" from the goods imported from rich countries. If such is the case, the Stolper-Samuelson Theorem wrongly treats these goods as perfect substitutes for one another. In actuality, these goods might be more accurately depicted as noncompeting goods.

Another shortcoming of the Stolper-Samuelson Theorem is that it is limited in explaining the relative wages and movements across skill groups, occupations, and sectors. There is growing empirical evidence of increasing wage inequality in both developing and developed countries as well as growing wage inequality among workers with similar characteristics and across firms within sectors (Helpman et al., 2015).

3.2 Empirical Literature Review

In Chiquiar (2008), the author tests the presence of the Stolper-Stamuleson theorem in post-liberalized Mexico. He finds that after Mexico joined NAFTA, wages of unskilled workers increased in regions that had stronger export ties to the U.S., compared to regions that were less export oriented, which is consistent with the predictions of the Stolper-Samuelson theorem. Within this context, Chiquiar (2008) demonstrates the existence of spatial differences in the effects of trade liberalization. Wage differentials rose within Mexico between states that were expert oriented and those that were not, which suggests that workers with similar characteristics fared differently in post-liberalization Mexico.

Amiti & Cameron (2012) take a different approach to empirically testing the Stolper-Samuelson Theorem. In their analysis, the authors examine the effects of trade liberalization on the wage skill premium within firms by examining the input and output tariff levels in Indonesia. They define the wage skill premium as high skilled wages divided by low skilled wages, which is a measure that is used in this paper. In the authors estimation of the tariff levels effect on the wage skill premium, they interact the input tariff level with the firm's share of intermediate inputs, as well as the output tariff level with the firm's share of exports. By doing so, they predict that a reduction in input tariffs will make the production of domestically produced inputs less profitable leading to a reallocation of resources away from domestically produced inputs. This should reduce the demand for skilled labor, since they show that intermediate inputs are more skill-intensive than manufacturing in Indonesia. Therefore, if wages are set at the firm or industry level, the authors expect the input tariff level and the interacted term of the input tariff level and intermediate import share to have a positive relationship with the wage skill premium. With regards to output tariffs effect on the wage skill premium, they interact the output tariff level and the export share to identify any impact on exporting firms. The authors find that reducing input tariffs reduces the wage skill premium within firms that import their intermediate inputs, but do not find significant effects from reducing tariffs on export goods on the wage skill premium within firms.

Goldberg & Pavcnik (2007) provide a discussion on the recent empirical research that links globalization to income inequality in developing countries. Their review includes a discussion of the benefits and downfalls related to a variety of topics used in this paper, as well as a review of the empirical literature surrounding various countries that underwent trade liberalization in the 1980s and 1990s. The authors defend potential endogeneity concerns related to trade policies and inequality, provide an assessment of the Stolper-Samuelson Theorem, as well as a robust discussions of measurements used to capture trade reform and inequality. The authors discussion of these topics have been crucial in forming this paper's empirical analysis.

In Topalova (2010) the author studies the impact of trade liberalization on poverty in India. Topalova uses variation in sectoral composition across districts and liberalization intensity across sectors in a difference-in-difference approach to measure the impact on poverty. The identification strategy used in the paper is as follows: since there were spatial differences in industrial composition in India prior to trade liberalization, the drastic reduction in tariff levels (which varied by industry, and occurred at different times) caused different spatial exposure to trade liberalization across Indian districts. Therefore, the paper establishes whether the changes in district-level poverty and consumption before and after trade liberalization is related to the reduction of tariffs at the district level. This empirical framework allows the author to measure the relative effect of liberalization on districts based off of their trade exposure. Topalova finds that average real per capita expenditure in districts where employment was primarily focused in industries exposed to larger tariff cuts grew relatively more slowly. This pattern was the most robust among the poorest households, while households with larger consumption patterns had a lesser and statistically indistinguishable effect from zero.

Gonzaga et al. (2006) investigates the effect of trade liberalization on skilled labor earning differentials in Brazil. The authors look at the relationship between relative tariff changes and relative price changes in order to observe the relationship between trade liberalization and wage differentials. Their model predicts that the relationship between tariffs and the price of goods in each sector will depend on the share of imported goods in each sector. Therefore, under the Stolper-Samuelson theorem, this model predicts that trade liberalization will increase the relative price of the factor of production that is found in abundance. The authors find that the earnings of workers with at least a high-school diploma decreases with respect to earnings of less educated workers. Additionally, they show that prices and tariffs are positively correlated, but the impact of tariff changes on prices are higher in sectors with larger amounts of imports.

In Davis (1996), the author provides further theoretical framework that builds upon the Stolper-Samuelson theorem. In his analysis, the author explains that it is incorrect to analyze factor abundance in the global context, but rather factor abundance should be analyzed relative to the nearby regions in which one country produces. Therefore, if a country is very labor abundant in the global context, but capital abundant relative to its neighbors, then the outcome of the Stolper-Samuelson theorem would be the opposite as to what is expected – it will find that trade liberalization reduces wages for unskilled labor.

Using the same database as this study presented in this paper, Ahsan and Mitra (2013) investigate the impact of Indian trade reforms on labor's share in revenue. According to the authors, market liberalization will affect labor's share of revenue by reducing firm-level price-cost markups as well as the bargaining power of workers. They suggest that these two mechanisms will have an ambiguous effect on labor's share of revenue at the firm level depending on the labor intensity of production. In their analysis, they find that in small, labor-intensive firms, trade liberalization led to an increase in labor's share in revenue but a reduction in this share for larger, less labor-intensive firms.

In Verhoogen (2007), the author investigates wage inequality and trade liberalization in Mexico, however he takes an approach rooted in firm heterogeneity. He proposes the quality-upgrading mechanism, which is a model with heterogeneous plants and quality-differentiated goods. In this model, only the most productive firms are able to enter the export market, and are able to produce higher quality goods that appeal to consumers in export markets. This allows the firm to pay higher wages and attract high skilled workers. This mechanism predicts that inter-industry wage inequality would grow after market liberalization. Empirically, the authors findings support this prediction, giving evidence that larger, more productive plants were more likely to increase exports, white-collar wages, blue-collar wages, and production certifications, than initially smaller, less productive plants.

In Helpman et al. (2015) the authors argue that trade-base wage inequality is not a product of neoclassical trade theories, but rather firm heterogeneity. The wage inequality theory derived from the heterogeneous firm's specification in Helpman et al. is constructed using mechanisms that are derived from firm's export decisions and human resource hiring practices. In their model, there are many sectors and firms that produce differentiated products – or products produced within the firm. The purpose of the model is to predict the wages and employment decisions across firms within each sector, focusing on the variation across firms and workers within each sector (Helpman et al., 2015).

The complete model predicts the following two relationships between exporting and firm characteristics. The first, the selection effect, states that more productive firms will hire more workers, are more likely to export, and pay higher wages. Firms that have higher screening efficiency hire workers of greater ability and are more profitable, which allows them to pay higher wages and increases their likelihood to export. The second, the market access effect, states that exporting leads to higher firm employment and wages. If a firm can access foreign trade markets, it will require a larger scale of production, and thus raise the firm's selectivity of labor. Screening costs raise firm's profitability and increase the firm's number of matches, but also increases their selectivity in the labor market, which reduces employment levels.

4. Indian Market Reform & Labor

4.1 Post-Independence Period

After declaring Independence in 1947, India's major economic policy was dominated by protectionist policies that favored import substitution, complex industrial licensing requirements, financial repression, and public ownership of large industries (Cerra & Saxena, 2002). The Indian Rupee was not convertible to other currencies and tariff levels were high, preventing an inflow of foreign goods. Its macroeconomic policy fostered stability through low monetary growth and public sector deficits. As a result, inflation remained low and the current account was in surplus for many years until 1980.

Figure 2 shows the current account balance in India as a percentage of GDP starting in 1980. In the first half of the 1980s, India's current account deficit remained relatively low, fluctuating just above -2% of its GDP. Although there was a current account deficit, a rise in domestic petroleum production allowed savings on energy imports and external inflows of financing kept India's debt servicing manageable (Cerra & Sexena, 2002).

In the latter half of the 1980s, India's current account deficit rose sharply due to growing expenditures, reaching a high of -2.96% of GDP in 1990. India's current account deficit exceeded the amount of available domestic credit with which it had access to, and was increasingly financed through foreign borrowing. Its debt "nearly doubled from some $35 billion at the end of 1984/85 to $69 billion by the end of 1990/91" (Cerra & Sexana, 2002). With its fiscal and foreign exchange sectors in crisis, India underwent major economic reforms to liberalize its trade, financial and investment markets (Goldberg & Pavcnik, 2007). Specifically, the government eased industrial and import licensing requirements and implemented tariff levels to replace import restrictions which led substantial increases in exports (Cerra & Sexana, 2002). The comparison of average tariff levels before and after trade liberalization shows a 73 percentage point reduction (Goldberg & Pavcnik, 2007).

In regard to wage inequality in India over this time period, during the 1980s India experienced an overall increase in the 90-10 log wage differential. After trade liberalization, the 90-10 log wage differential increased more rapidly than it had during the 1980s, thereby increasing overall income inequality (Goldberg & Pavcnik, 2007). Additionally, consumption inequality remained relatively stable during the 1980s, experiencing a slight increase over this time period. However, after liberalization consumption inequality increased dramatically (Goldberg & Pavcnik, 2007).

4.2 Indian Labor Markets

Data from Barro & Lee's educational attainment dataset is used in this paper to determine the relative factor abundance of India's skill groups. Figure 3 shows the average years of primary, secondary, tertiary and total schooling for a sub-sample of countries from 1950 until 2010. These countries include Canada, India, Singapore, USA, China, Mexico, South Africa, and the United Kingdom. These countries are included to provide a context of Indian educational attainment levels relative to a sample of high and medium income countries.

The first panel in Figure 3 shows the average years of primary schooling for the sample of countries. Although the average years of primary schooling have improved in India from about 1 year in 1950 to above 3 years in 2010, it still severely lags behind the other countries in our sample. The second panel shows the average years in secondary school. In 2010, India's average years of secondary school had risen to 2.67 years, which is just above the average years of secondary schooling in China. Despite this, compared to the other countries in our sample this is still a low level. The next panel shows the average years of tertiary school. Again, in 2010 India is not the lowest country in our sample, but relative to the entire group its average years of tertiary schooling is still low. The lowest average years of tertiary schooling in our sample is South Africa, which averages 0.1 years. Next is China which averages 0.14 years, then India at 0.27 years. The next lowest country is Mexico, which averages 0.53 years, nearly double that of India. The final panel in Figure 2 shows the average years of total schooling for the sample of countries. In 1950 India has the lowest average years of total schooling, and despite making large increases over the years, it still has the lowest level of total schooling relative to countries in our sample.

Figure 3 is used to illustrate the relative abundances of high and low-skilled labor in high and middle income countries. Countries with high average years of schooling are classified as having an abundance of high skilled labor. Where countries with low average years of schooling are classified as having an abundance of low skilled labor. Therefore, Figure 2 indicates that India is classified as having an abundance of low skilled labor relative to other high and middle income countries. In the context of the Stolper-Samuelson Theorem, India is relatively abundant in low skilled labor and has a relative scarcity in high skilled labor when compared to other high and middle income countries.

Since the basis of this paper is rooted in the relative factor endowments of India, the Stolper-Samuelson Theorem predicts that labor will move away from sectors that experience price declines, and move towards sectors that experience relative price increases. However, after liberalization took place in India, Topalova (2010) demonstrates that there was little evidence of reallocation India. The author contributes this to rigid labor markets, and rather that the adjustments to trade liberalization occurred through relative wage adjustments.

5. Data and Methodology

5.1 Firm Level Data

The data used in this paper is taken at the firm level from the Prowess database. It includes all publicly traded firms in India and is collected by the Center for Monitoring the Indian Economy (CMIE). The firms within the database account for 60 to 70% of total output in the organized industrial sector, and 75% of all corporate taxes in India. The data in this paper spans from 1997 to 2014 for over 26,000 publicly traded firms. The Prowess database provides compensation data that includes salaries, wages, bonuses, and pension contributions for both executive and non-executive workers. Using firm level data to evaluate skill levels is advantageous since it is readily available throughout our sample period, and since the data provides more robust industry classifications than household surveys (Goldberg & Pavcnik, 2007).

Wage inequality is used as opposed to consumption inequality for a variety of reasons. The first of which being that household data, let alone consumption data is not included in the Prowess database. The second is due to the fact that many developing countries do not consistently report expenditures in their household surveys (Goldberg & Pavcnik, 2007). Additionally, household surveys are often redesigned, so that the wage, income or consumption data provided are not easily comparable across years (Goldbeg & Pavcnik, 2007).

5.2 Tariff Data

The data on output tariffs spans the entire sample period (1997-2004) and is taken from the International Monetary Fund (IMF). Since the IMF's tariff data is given using the Harmonized Tariff Schedule code (HS), which is not included in the Prowess database, each industry's corresponding two-digit HS code was matched by hand to the corresponding industry in the Prowess database. Each two-digit tariff level is the average tariff level for a specific industry in a given year. A graphical analysis of the tariff level is given in Section 6.1.

One challenge that faces the empirical methodology used in this study are endogeneity concerns related to the political process involved in reducing tariff levels. Some might argue the existence of preferential treatment given to specific industries, brought about by special interest groups within an industry hoping to keep protection levels high. Although these concerns are genuine, they do not apply to the context of India. The tariff reforms brought about by the Indian government were negotiated with the World Trade Organization (Goldberg & Pavcnik, 2007). As a result, industries with initially higher level of protection experienced greater declines in tariff levels. Therefore, trade liberalization did not only lower tariff levels, but also restructured the level of protection across industries (Topalova, 2010). This pattern suggests that industry lobbies had little influence on the magnitude of tariff changes after liberalization.

5.3 Methodology

The estimation strategy of this paper is to use industry variation in tariffs over time to identify how reductions in the two-digit industry level tariff level affect three different measures of wage shares paid by firms. The baseline results include industry-firm fixed effects in order to control for time-invariant firm and industry characteristics, as well as year fixed effects which capture economy-wide effects. In addition, the baseline results include location fixed effects to control for potential shifts in the relative supply of labor, as well as other shocks across different locations in India. Using OLS, the estimation of the Stolper-Samuelson Theorem is given by the following equation:

$$\ln(X_{ijt}) = \alpha_0 + \beta_1 \ln(Sales_{ijt-1}) + \beta_2\left(Export\ Dummy_{ijt}\right) + \beta_3 \ln\left(Tariff\ Level_{jt}\right) + \beta_4[Export_{ijt} \times \ln(Tariff_{jt})]$$

where X_{ijt} is a vector of the following dependent variables for company *i,* industry *j,* and time *t* :

$$X_{ijt} = \begin{cases} \dfrac{W_H}{W_L} \rightarrow Wage\ Skill\ Premium \\ \dfrac{W_H}{W_H + W_L} \rightarrow Executive\ Share\ of\ Total\ Wages \\ \dfrac{W_L}{W_H + W_L} \rightarrow Non - excutive\ Share\ of\ Total\ Wages \end{cases}$$

The three different dependent variables are as follows. First is the wage skill premium given by Amiti & Cameron (2012). It is calculated as the natural log of total executive compensation divided by the total compensation given to non-executive employees. The second measure is the executive share of total wages. It is calculated as the natural log of executive wages divided by the sum of executive wages and non-executive wages. The third measure is non-executive share of total wages. Similarly, it is the natural log of non-executive wages divided by the sum of executive and non-executive wages.

On the right hand side of our baseline equation, the first coefficient (β_1) is the natural log of total sales for company i, industry j, at time $t-1$. It is deflated using 2010 Indian Rupees. I predict that executives will be the primary beneficiaries of increased total sales, and thus expect a positive relationship between total sales and executive compensation. Therefore, I expect $\beta_1 > 0$ for the wage skill premium and executive share of total wages, and $\beta_1 < 0$ for non-executive share of total wages.

The next coefficient (β_2) represents a dummy variable that takes the value of 1 if the firm is an exporter and 0 otherwise. It is taken for company i, industry j, and time t. Rather than lagging this variable by one-time period, it is taken in the current period in order to capture the exporting effects as they occur. In line with the predictions of the Stolper-Samuelson Theorem, I expect $\beta_2 < 0$ for the wage skill premium and executive share of total wages, and $\beta_2 > 0$ for non-executive share of total wages. That is that exporters will pay higher wages to low skilled labor, relative to high skilled labor, since that is the factor that is abundant in India relative to the rest of the world.

Next is β_3 which measures the natural log of the average tariff level for industry j, and time t. This variable is also taken in the current time period since tariff levels are realized by the firm when they make their export decisions. Therefore, this coefficient will capture the current period effects of trade barrier reduction on compensation structures within firms. I expect that $\beta_3 > 0$ for the wage skill premium and executive share of total wages, and $\beta_3 < 0$ for non-executive share of total wages. Or rather as tariff levels are reduced, executive compensation will decrease relative to non-executive share of wages.

The final independent variable (β_4) is an interaction term of the export dummy and tariff level. This variable will capture the effect of tariff reductions for exporting firms on executive and non-executive share of wages. I expect $\beta_4 > 0$ for the wage skill premium and executive share of total wages, and $\beta_4 < 0$ for non-executive share of total wages. Again, in line with the Stolper-Samuelson Theorem, executive compensation for exporters should be decreasing as the tariff level is reduced, while the wages paid to non-executives should be increasing as the tariff level is reduced, since that is the factor that India is abundant in.

6. Results: Does Stolper-Samuelson Hold Up?

6.1 Average Tariff Level by Year

Figure 4 shows the average tariff level for every industry in our sample over the entire sample period. Each point on the graph represents the average tariff level in India for a given year. It shows a clear downwards tend, indicating that the average tariff level has gone down since 1997. This demonstrates that over the sample period, Indian trade barriers have drastically reduced, which is essential for our analysis of the Stolper-Samuelson Theorem.

6.2 Average Wage Skill Premium by Year

Figure 5 shows the average wage skill premium in each year for every firm in our sample. Each point represents the average wage skill premium for all firms in our sample in a given year. From 1999 to 2006, there is substantial growth in the average wage skill premium. It decreases in 2007 and increases again until 2009, where it begins to decline until the end of our sample. Although there are periods where the wage skill premium declines, the overall trend remains increasing. Additionally, at the end of our sample the wage skill premium is at a larger share then when our sample began. This is an indication that executive compensation grew in relation to non-executive compensation over our sample period.

The Stolper-Samuelson Theorem predicts that in India, as trade barriers continue to decline, the wages of non-executives will increase relative to the wages of executives, and hence the wage skill premium will decrease over our sample. Since the wage skill premium is increasing over our sample period, this is an indication that the Stolper-Samuelson Theorem fails to predict wage movements across skill groups. In Section 6.3, we begin our empirical analysis of the Stolper-Samuelson theorem, which confirms these results.

Figure's 6 and 7 show the wage skill premium for the ten most volatile industries and the ten least volatile industries. In Figure 6, we see that the industries where the wage skill premium is most volatile experience very large shifts from year to year. It is worthwhile to note that for 7 of the 10 most volatile industries, there is an increasing trend of the wage skill premium over time. In Figure 7 (note the scale of the y-axis is drastically reduced) we see less industries that display increases in the wage skill premium over time (4 out of 10).

Figures 8 shows the industries with the largest wage skill premiums in 1997. Here, we see that the distribution is about even between industries that show a decreasing and increasing wage skill premium. It is also worth noting that although the largest wage skill premium in 1997 was around .6 in the General Machinery industry, many industries saw larger wage skill premiums in their industry as time went on. Figure 9 shows the industries with the largest wage skill premium in 2014. Here, every industry shows an increasing trend over time, with most industries having the wage skill premium in 2014 being the largest wage skill premium over the sample period.

6.3 Empirical Results

Table 1 presents the baseline results. In column 1 the wage skill premium is the dependent variable. The export dummy coefficient is positive and significant at the 10% level. This indicates that on average, exporters experience a 0.303% increase in the wage skill premium. Additionally, the coefficient for the interaction term is negative and significant at the 5% level. This indicates that for exporting firms, a fall in tariffs is associated with a decline in the within-firm wage skill premium.

Again in column 2, there is a positive and significant coefficient for the export dummy and a negative effect on the interaction term. Both of these results contradict the predictions of the Stolper-Samuelson Theorem, since the wages of executive's relative to non-executives is increasing for exporters as tariff levels decreased. In order to show evidence of the Stolper-Samuelson Theorem, these coefficients effect would need to be positive. Since the coefficient for the tariff level is positive (although not significant), it becomes clear that globalization has a larger and negative effect on the wage skill premium in exporting firms. Column 3 confirms these results by showing a negative export dummy coefficient, and positive interaction term when non-executives share of wages is the dependent variable.

Table 2 shows the same specification as Table 1, however in this specification the sample is divided into small and large firms. Within the Prowess database firm population size is broken into 10 deciles (the specific number of employees is not given in the dataset). Therefore, small firms fall into deciles 1-5, and large firms fall into decile's 6-10. Additionally, total sales are also used to determine the size of firms. Firms that fall below the 25th percentile of our sample's total sales are also considered small firms, where firms above the 75th percentile of total sales are classified as large firms. Therefore, a firm must exhibit both characteristics in order to fall into the small or large specifications.

For large firms, the coefficient for sales is positive and significant at the 1% level in columns 1 and 2, indicating that executives are rewarded for increased level of sales relative to non-executives. Again in columns 1 and 2, the export dummy coefficient is positive and significant at the 1% level, indicating that executives in large, exporting firms demonstrate larger wages relative to non-executives. The tariff level coefficient is also positive and significant at the 10% level for both columns 1 and 2, indicating that reduction in tariff levels are associated with increases in executive compensation relative to non-executives for large firms. Finally, the coefficient for the interaction term in both columns are negative and significant at the 5% level. This confirms the results presented in Table 2, showing that large, exporting firms see an increase in executive share of wages relative to non-executives as the tariff level decreases.

For small firms, none of the explanatory variables provide significant results for the dependent wage share variables. This indicates that firm size plays a large role in determining the effects of trade liberalization on wage inequality. A reduction in tariff level causes large firms to experience wage movements that contradict the Stolper-Samuelson Theorem.

6.4 Robustness Check: R&D and Training and Welfare

According to Goldberg & Pavcnik (2007), the current economic literature has been split between economists who "favored the trade-openness-based explanations for the increase in the skill premium, and those who considered skilled-biased technological change as the primary force behind the documented changes in the wage distribution worldwide". Therefore, the following robustness check to our specification uses the interaction of trade openness with skill-biased technological change to measure its effect on inequality.

Wood (1995) who coined the term "defensive innovation" to describe firms' response to trade openness postulated that intensified competition from abroad would induce firms to engage in R&D. Therefore, when trade openness is interacted with skill-biased technological change, or rather R&D expenditures, the demand for skilled labor should increase. Hence, I expect to see an increase in the wage skill premium and the executive share of total wages.

Additionally, training and welfare expenditures are also interacted with trade openness in order to explore the quality upgrading of firms' labor supply. This quality upgrading mechanism in response to trade openness may arise as firms in import competing sectors try to avoid competition by differentiating themselves from their overseas competitors (Goldberg & Pavcnik, 2007). Therefore, when interacting trade openness and training and welfare expenditures, I expect to see a positive effect on the wage skill premium. Or rather, as tariff levels are reduced, the quality upgrading mechanism will result in an increase to the wage skill premium.

Table 3 explores the interaction of tariff levels with R&D expenditure and training and welfare expenditure. For training and welfare expenditure in column 1, there is a negative and significant effect at the 1% level on the wage skill premium. In addition, the interaction term of training and welfare expenditure and tariff level is negative and significant at the 10% level. Interacting this term at the mean training and welfare expenditure level, we see that a 1% decrease in the tariff level leads to a 0.117% increase in the wage skill premium. This effect is stronger for firms with a larger training and welfare expenditures. For firms with a training and welfare expenditure in the 90^{th} percentile, a 1% decrease in the tariff level leads to a 0.207% increase in the wage skill premium. These results confirm the predictions of the quality upgrading mechanism.

In columns 4, 5 and 6 of Table 3, we do not see any significant effect of the interaction term on our dependent variables. Therefore, we do not see any evidence of firms engaging in R&D as trade barriers are reduced. It is worth noting that the coefficient for the tariff level in columns 4 and 5 are negative and significant at the 10% level. Although this provides evidence that confirm the results of the Stolper-Samuleson Theorem, since the sample size has been drastically reduced to only 618 firms, they do not hold much weight in our overall specification.

6.5 Robustness Check: Financial Crisis

Another potential concern is that during the global financial crisis, Indian firms experienced tighter credit constraints which could affect the results. Although the location-year fixed effects would control for the average of these effects, it could be argued that domestic firms and exporters could be affected differently. Table 5 shows the effect of trade liberalization when the sample is split up into time periods before and after the global financial crisis. Before the financial crisis, the interaction term is negative and significant at the 1% level for the wage skill premium and executive share of wages. Additionally, it is positive and significant for the interaction term in column 3. This confirms our results given in previous specifications of a rising wage skill premium for exporting firms.

After the financial crisis, the tariff level has a positive and significant effect on the wage skill premium and executive share of wages. This indicates that despite tighter credit constraints, wage skill premium continued to have an inverse relationship with falling tariff levels.

7. Conclusions

This paper adds to the growing empirical literature demonstrating that the Stolper-Samuelson Theorem fails to explain trade liberalizations effect on wage inequality. This study contributes to the previous literature by exploring trade liberalizations effect on the wage skill premium in India, in addition to its differentiation between executive share of total wages and non-executive share of total wages as additional dependent variables. Using firm level and industry level tariff data, this paper provides evidence that for exporting firms, reductions to the tariff level lead to a rise in the wage skill premium. In addition, this study also shows the differentiated effects that tariff reduction has on firm size, and its effect on firms that engage in R&D and training and welfare activities. Additionally, the paper shows that these results are robust when controlling for the impacts of the global financial crisis. Our results suggest that reducing tariff levels produces a large significant within-firm effect on the wage skill premium for exporting firms.

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Figure 1: The Stolper-Samuelson Theorem

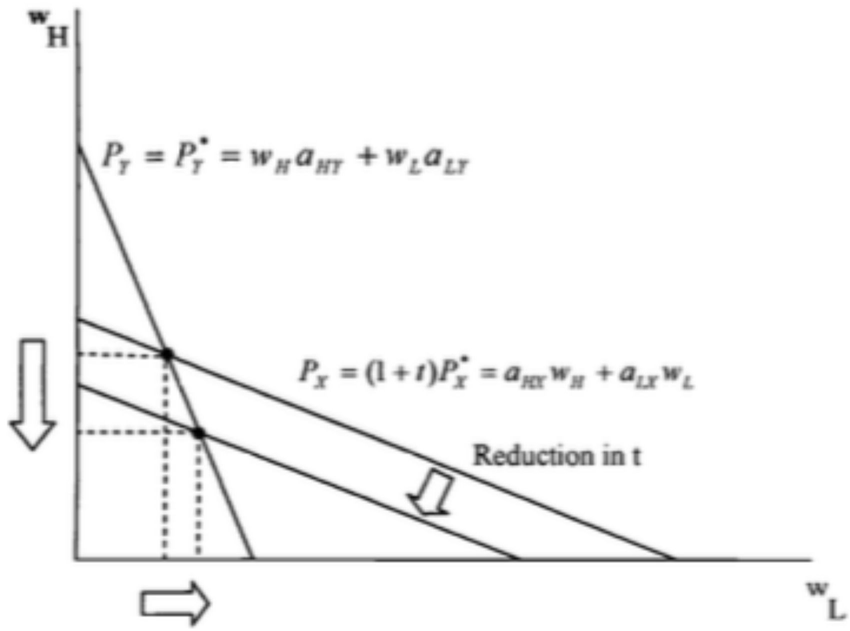

Fig. 2.1 Trade liberalization and factor prices: Stolper-Samuelson theorem

Figure 2

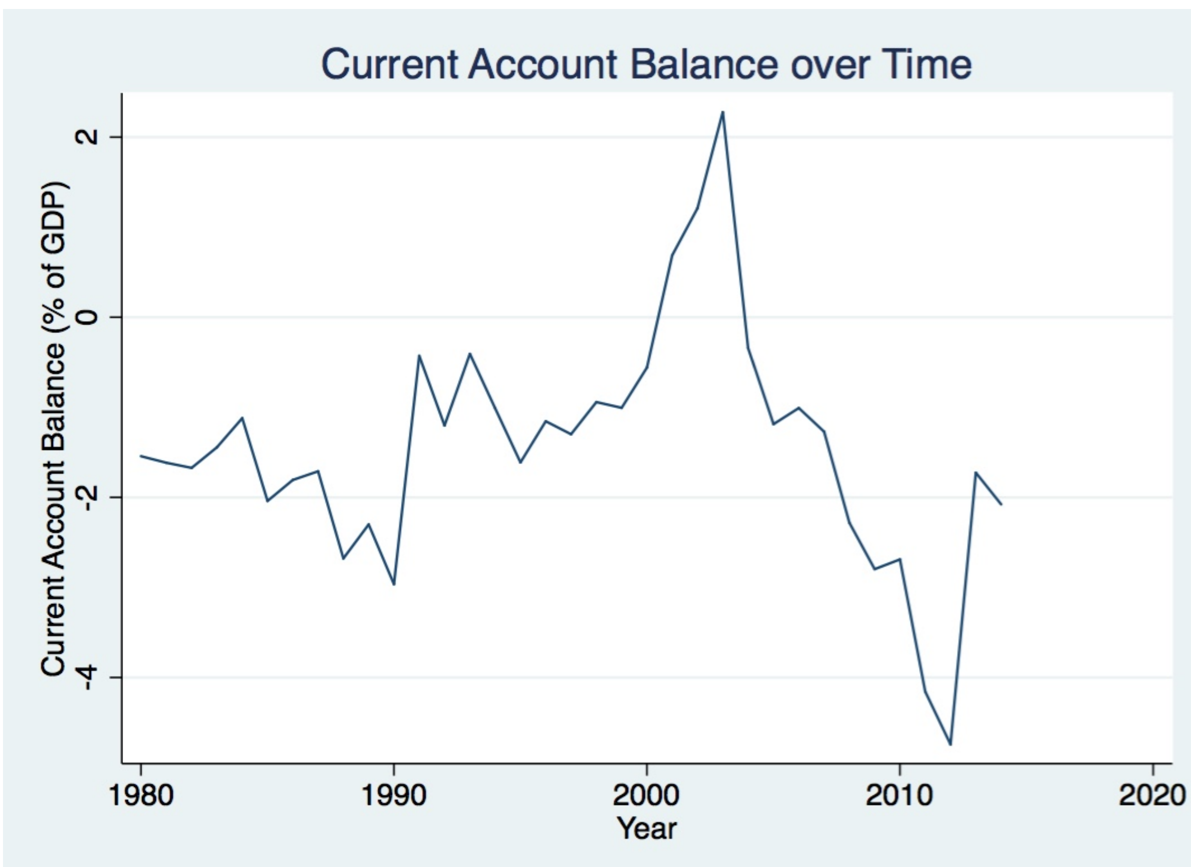

Figure 3: Average Years of Schooling in India

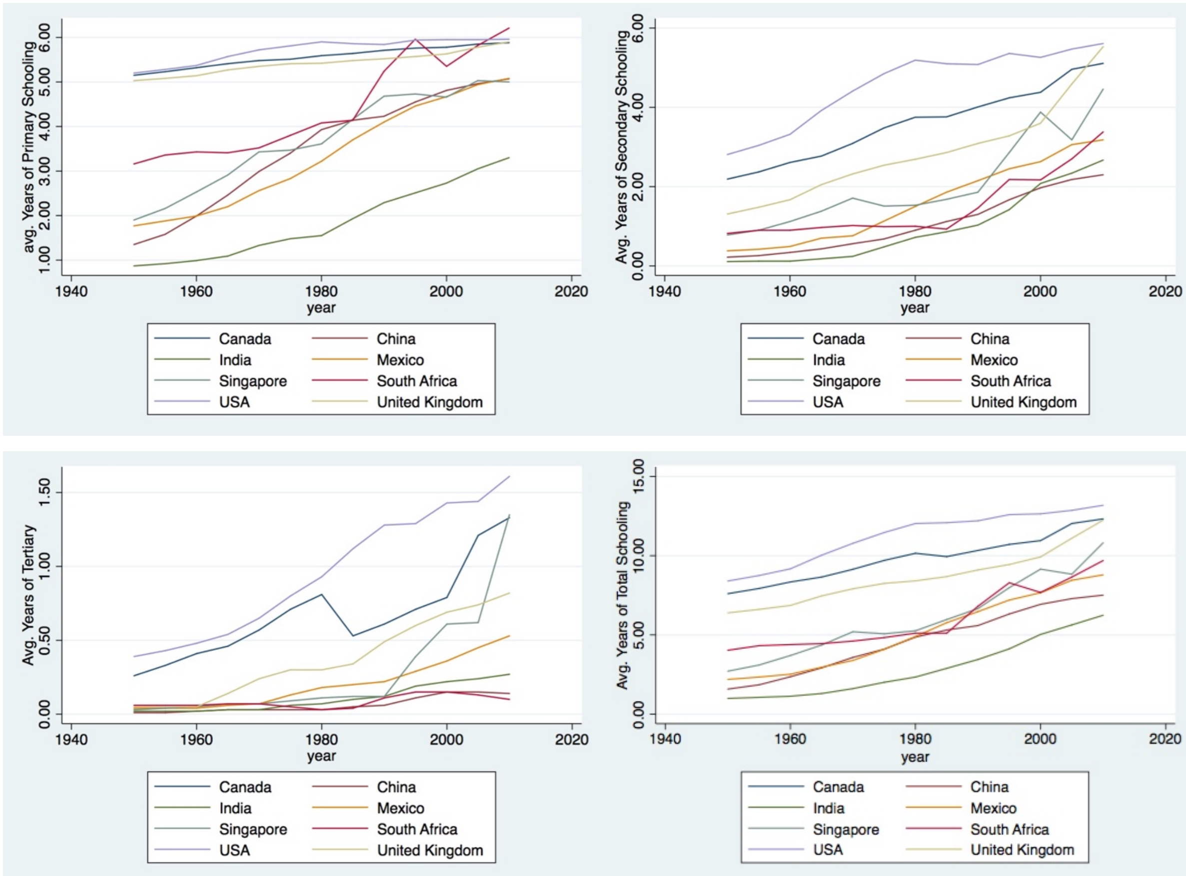
avg. Years of Primary Schooling
1.00
2.00
3.00
4.00
5.00
6.00
1940
1960
1980
2000
2020
year
Avg. Years of Secondary Schooling
0.00
2.00
4.00
6.00
Avg. Years of Tertiary
0.00
0.50
1.00
1.50
Avg. Years of Total Schooling
0.00
5.00
10.00
15.00
Canada
China
India
Mexico
Singapore
South Africa
USA
United Kingdom

Figure 4

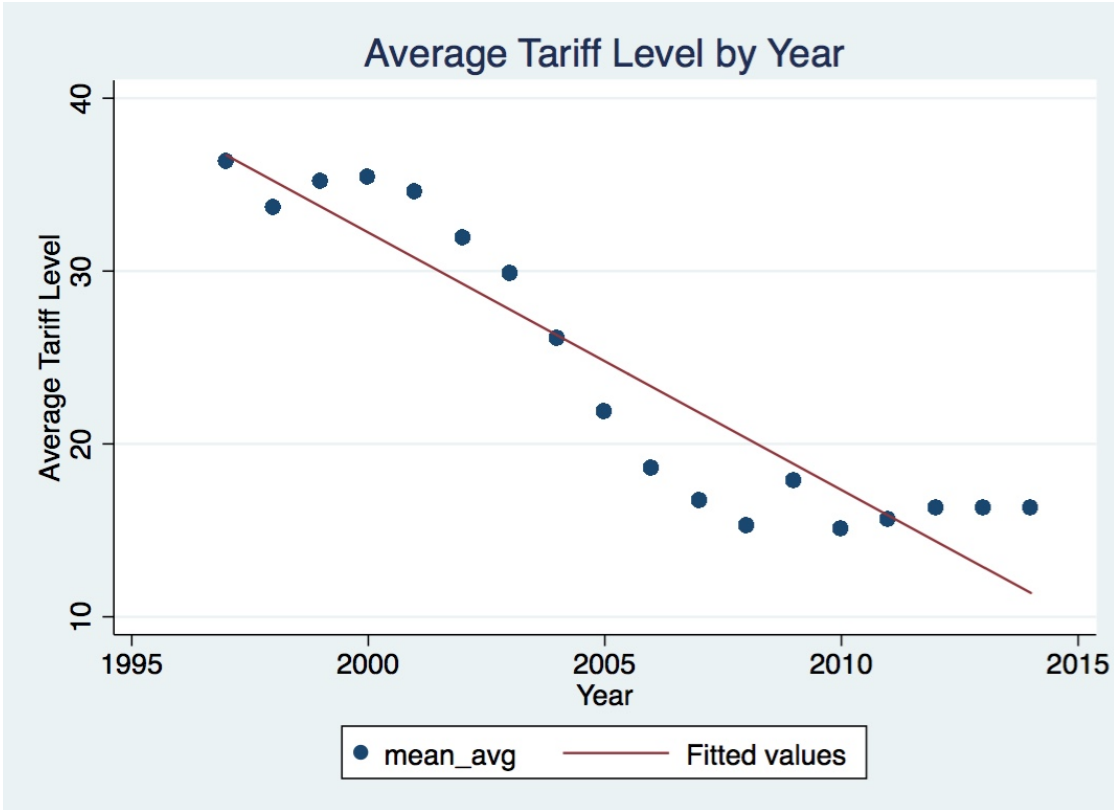

Figure 5

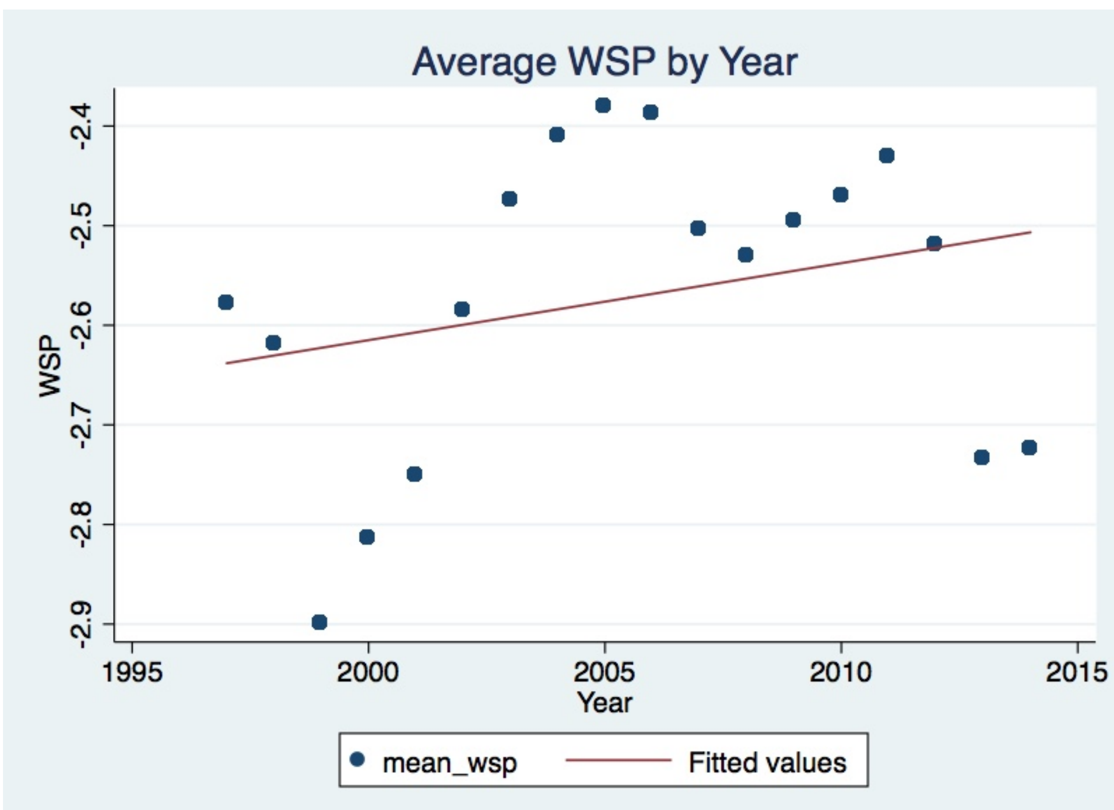

Figure 6: Most Volatile WSP by Industry

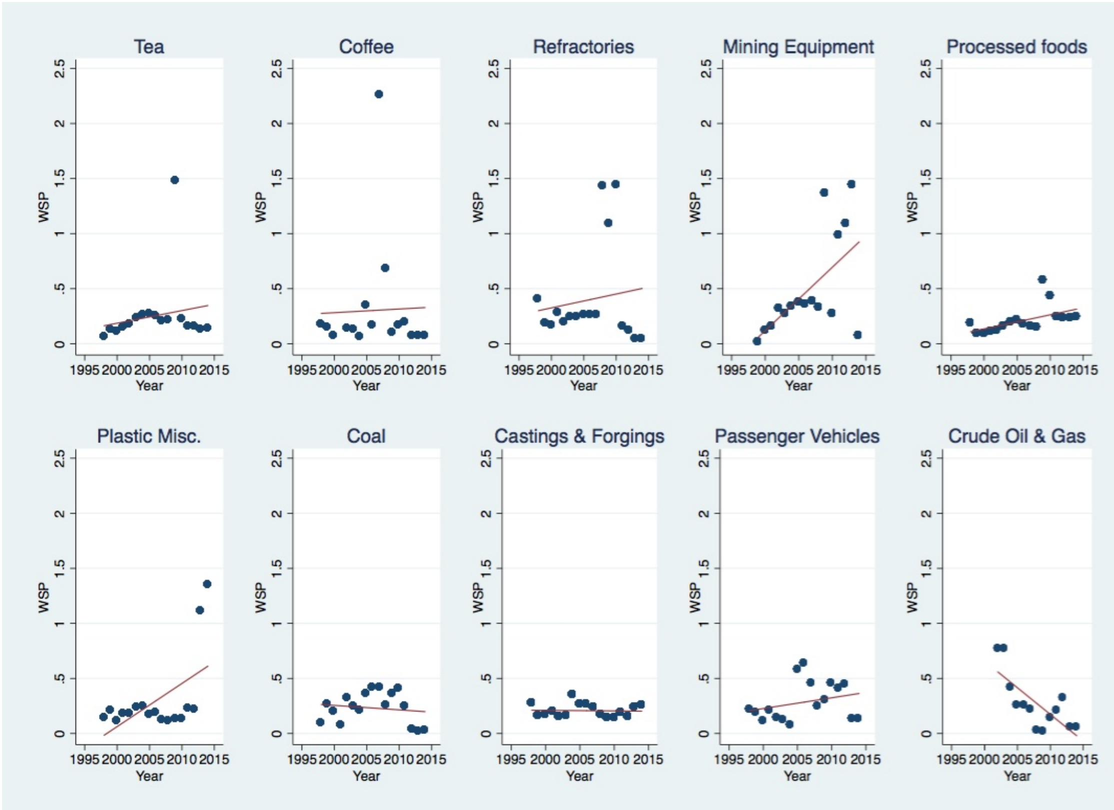

Figure 7: Least Volatile WSP by Industry

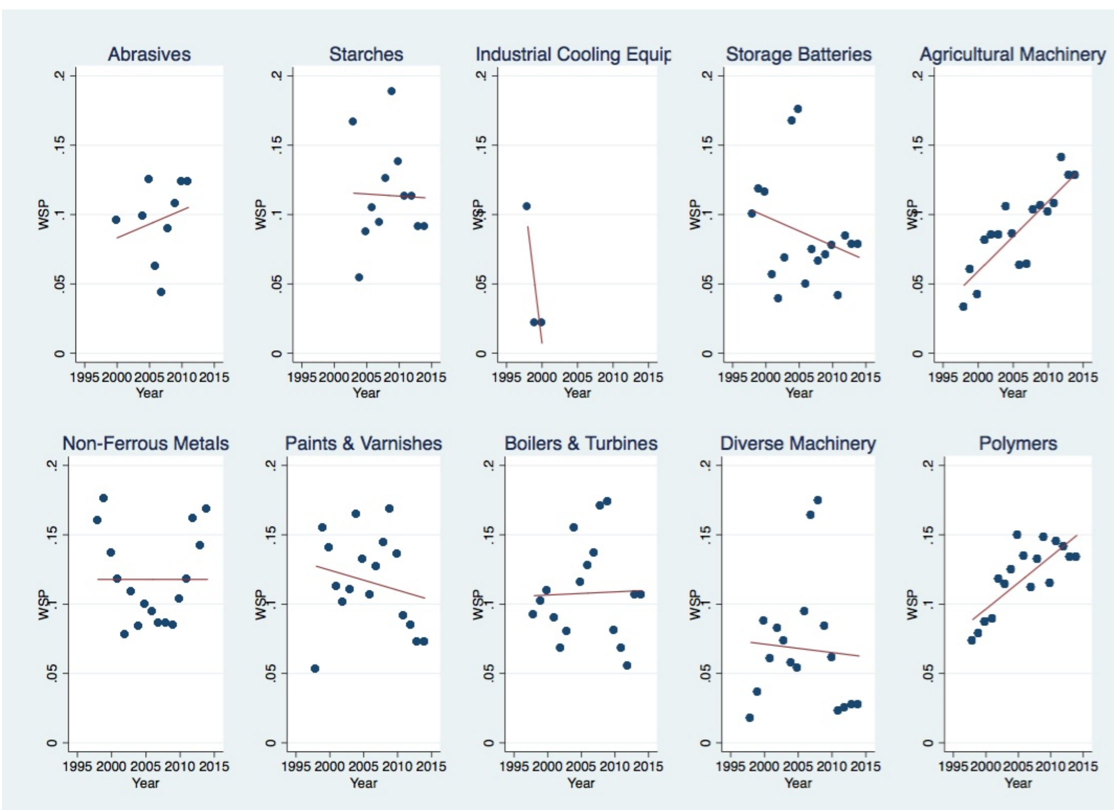

Figure 8: Largest WSP in 1997 by Industry

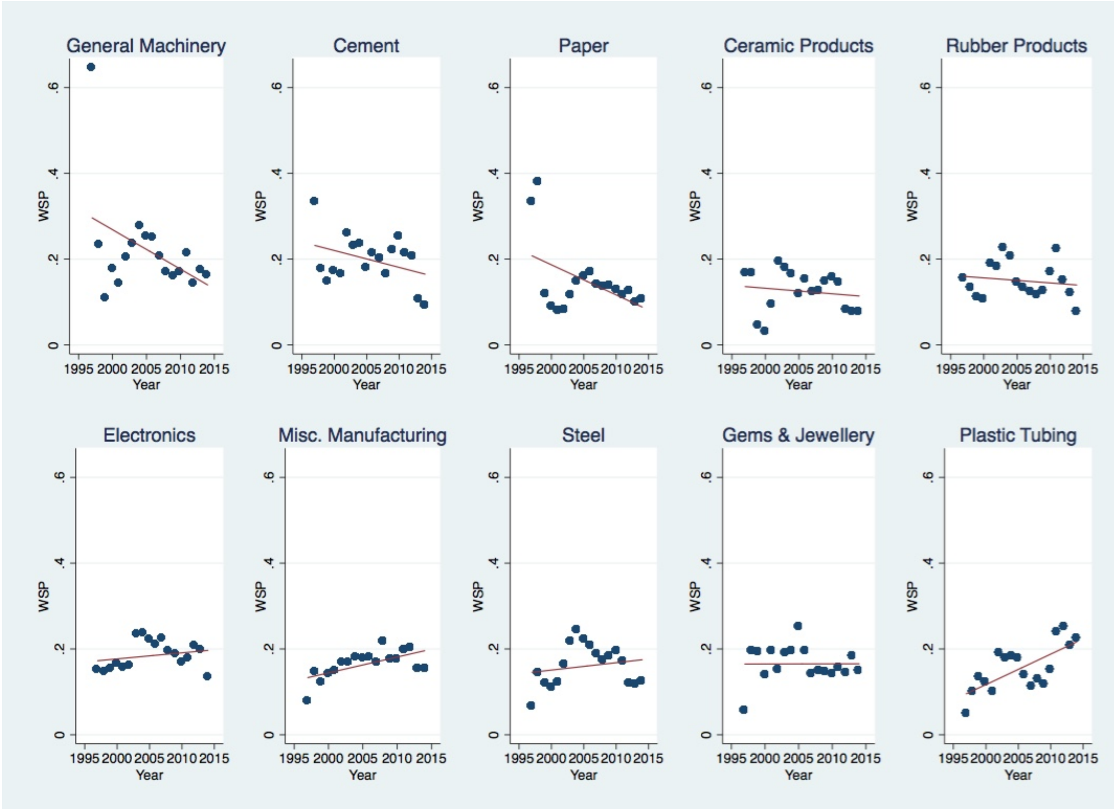

Figure 9: Largest WSP in 2014 by Industry

Table 1: Baseline Results

VARIABLES	(1) WSP	(2) Executive's Share of Wages	(3) Non-Executive's Share of Wages
Sales	0.00819	0.00617	-0.00153
	(0.00817)	(0.00758)	(0.00101)
Export Dummy	0.303**	0.260*	-0.0342*
	(0.149)	(0.136)	(0.0187)
Tariff Level	0.0213	0.0204	-0.000837
	(0.0460)	(0.0415)	(0.00517)
Export X Tariff	-0.118**	-0.102**	0.0124*
	(0.0547)	(0.0499)	(0.00658)
Constant	0.260	-0.183	-0.447***
	(0.179)	(0.162)	(0.0211)
Observations	11,901	11,903	12,114
R-squared	0.014	0.014	0.008
Number of Groups	2,604	2,604	2,622
Year FE	Yes	Yes	Yes
Industry-Firm FE	Yes	Yes	Yes
Location FE	Yes	Yes	Yes
R-Squared	0.0138	0.0140	0.00764

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	Large Firms			Small Firms		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	WSP	Executive's Share of Wages	Non-Executive's Share of Wages	WSP	Executive's Share of Wages	Non-Executive's Share of Wages
Sales	0.0881***	0.0793***	-0.00811**	-0.0193	-0.0170	0.00215
	(0.0320)	(0.0294)	(0.00317)	(0.0150)	(0.0136)	(0.00180)
Export Dummy	0.917***	0.865***	-0.0502	-0.300	-0.303	0.0180
	(0.333)	(0.303)	(0.0435)	(0.337)	(0.306)	(0.0416)
Tariff Level	0.202*	0.195*	-0.00841	-0.0119	-0.0189	-0.00276
	(0.116)	(0.107)	(0.0122)	(0.0786)	(0.0718)	(0.00942)
Export X Tariff	-0.346**	-0.322**	0.0236	0.0813	0.0821	-0.00606
	(0.142)	(0.130)	(0.0163)	(0.119)	(0.108)	(0.0144)
Constant	-4.172***	-4.222***	-0.0492	0.195	-0.208	-0.425***
	(0.434)	(0.405)	(0.0428)	(0.301)	(0.276)	(0.0358)
Observations	2,881	2,881	2,928	2,865	2,867	2,909
R-squared	0.043	0.045	0.013	0.025	0.025	0.016
Number of Groups	826	826	836	837	837	844
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Location FE	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.0433	0.0454	0.0135	0.0250	0.0251	0.0163

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	Training & Welfare			Research & Development		
VARIABLES	(1) WSP	(2) Executive's Share of Wages	(3) Non-Executive's Share of Wages	(4) WSP	(5) Executive's Share of Wages	(6) Non-Executive's Share of Wages
Sales	-0.00343	-0.00397	-0.000325	0.0602**	0.0546**	-0.00606*
	(0.00878)	(0.00811)	(0.000848)	(0.0248)	(0.0222)	(0.00329)
Tariff Level	0.0578	0.0585	-0.00168	-0.333**	-0.320**	0.0120
	(0.0589)	(0.0545)	(0.00547)	(0.139)	(0.124)	(0.0183)
Training & Welfare	-0.152***	-0.128***	0.0170***			
	(0.0500)	(0.0469)	(0.00490)			
Training & Welfare X Tariff	-0.0326*	-0.0336**	0.00100			
	(0.0170)	(0.0159)	(0.00202)			
R&D				0.121	0.103	-0.0184
				(0.115)	(0.104)	(0.0157)
R&D X Tariff				-0.0640	-0.0546	0.00965
				(0.0459)	(0.0406)	(0.00660)
Constant	-3.116***	-3.219***	-0.0959***	-1.840***	-1.987***	-0.140**
	(0.201)	(0.186)	(0.0181)	(0.457)	(0.400)	(0.0655)
Observations	8,759	8,760	8,902	618	618	624
R-squared	0.084	0.081	0.059	0.103	0.104	0.071
Number of Groups	2,059	2,059	2,073	184	184	184
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Location FE	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.0843	0.0809	0.0591	0.103	0.104	0.0712

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

	Pre-Financial Crisis			Post-Financial Crisis		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	WSP	Executive's Share of Wages	Non-Executive's Share of Wages	WSP	Executive's Share of Wages	Non-Executive's Share of Wages
Sales	0.000795	0.000269	-0.000525	-0.00492	-0.00729	-0.00146
	(0.0135)	(0.0119)	(0.00188)	(0.0154)	(0.0142)	(0.00152)
Export Dummy	0.719***	0.650***	-0.0694**	0.228	0.188	-0.0268
	(0.236)	(0.214)	(0.0275)	(0.200)	(0.183)	(0.0285)
Tariff Level	-0.0206	-0.0176	0.00298	0.0947***	0.0902***	-0.0133**
	(0.0589)	(0.0530)	(0.00694)	(0.0338)	(0.0315)	(0.00573)
Export X Tariff	-0.258***	-0.235***	0.0231**	-0.0715	-0.0552	0.00848
	(0.0811)	(0.0740)	(0.00908)	(0.0819)	(0.0753)	(0.0119)
Constant	-2.335***	-2.553***	-0.218***	-2.771***	-2.892***	-0.106***
	(0.205)	(0.184)	(0.0247)	(0.118)	(0.110)	(0.0177)
Observations	4,990	4,990	4,990	5,641	5,643	5,854
R-squared	0.022	0.022	0.010	0.006	0.006	0.007
Number of industry_company	1,676	1,676	1,676	1,849	1,849	1,868
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Location FE	Yes	Yes	Yes	Yes	Yes	Yes
R-Squared	0.0219	0.0224	0.0104	0.00621	0.00619	0.00743

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1