

Global Production Sharing and Wage Premiums: Evidence from the Thai Manufacturing Sector

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The paper aims to promote a better understanding of the determinants of wage skill premiums in developing countries, with emphasis on the role of firm heterogeneity as well as global production sharing. An interplant, cross-sectional analysis of the Thai manufacturing sector is undertaken. Our key finding is in line with the theoretical postulation of the established firm heterogeneity literature—i.e., tariff cuts have different effects on firms depending on the mode by which firms are globally integrated. We also find that outsourced economic activities to developing countries are skills intensive. Our finding has implications for the management of economic globalization. First, reluctance to continue trade policy reform could inflate demand for unskilled workers and eventually jeopardize the competitiveness of exporting firms. Second, participation in global production sharing provides not only lucrative business opportunities, but also the chance to move up to a higher rung on the technology ladder. In addition, increasing economic globalization by participating in global production sharing could bring adverse effects to unskilled workers. Social safety net programs must be put in place to mitigate such adverse effects.

Keywords: wage premiums, global production sharing, trade liberalization, Thai manufacturing

JEL codes: F14, F16, O14, O53

I. Introduction

In theory, opening up to international trade could create a favorable impact on income distribution as a result of proper resource allocation in line with a country's comparative advantage. As a result, the wage gap between unskilled and skilled workers (henceforth referred to as the wage skill premium) is narrowed. Nonetheless, the empirical results do not always support this theoretical postulation. Only a few developing countries see the wage skill premium reduced empirically (Goldberg

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and Pavcnik 2007). To a certain extent, this is related to the ongoing debate on economic globalization and its side effects, especially the effects on inequality (e.g., ADB 2012, Milberg and Winkler 2013). More importantly, empirical research on wage skill premium persistence has so far paid less attention on East Asia relative to developed countries or Latin American developing countries. A recent exception is the study conducted by Amiti and Cameron (2012) based on the Indonesian manufacturing experience.

While persistence of wage skill premiums has been observed since the 1970s, explanations have so far been unsatisfactory. Recent attempts to explain wage skill premium persistence can be collapsed into two hypotheses—the presence of firm heterogeneity and the increasing importance of global production sharing. As argued in the literature on firm heterogeneity, firms vary against each other in terms of productivity, and only those outperforming other firms become globally integrated. Under certain circumstances, (i.e., fair-wage constraints), productivity differences cause firms to pay wages differently according to worker productivity, leading to observed wage skill premiums (Amiti and Cameron 2012). Such premiums continue and/or become enlarged when trade liberalization takes place. For firms that have been globally integrated, trade expands with liberalization because of the bigger market. In contrast, locally-oriented firms are not only placed under more intense competitive pressure from imports, but they also experience output contraction.

The second hypothesis notes the increasing importance of global production sharing, where the whole production process is divided into separate stages and economically allocated to locations according to relative competitiveness. Given differences in resource endowment, activities located in developing countries, as a result of global production sharing, would be unskilled and labor intensive. Nonetheless, despite being regarded as unskilled labor-intensive activities in the context of developed countries, such outsourced activities might be considered as relatively skilled and labor intensive in the context of the developing world. Therefore, global production sharing could induce an increased demand for skilled workers (as opposed to unskilled workers) in both developing and developed countries. This widens the wage skill premium in developing countries.

Although the presence of firm heterogeneity and the increasing importance of global production sharing are interrelated to a great extent as echoed in case studies explaining the export success of East Asian firms, they have been treated as mutually exclusive so far.¹ In previous studies, only the former is incorporated to examine the wage skill premium in Indonesia by Amiti and Cameron (2012). The latter is yet to be discussed in the developing countries' context, although global

¹See Chapter 2 in Kohpaiboon (2006) for a comprehensive literature review of the role of multinational enterprises on export success in East Asia. Also see the recent work explaining the export success of the Malaysian electronics sector in Athukorala (2014).

production sharing is far more important in East Asian economies than in other parts of the world. It is worth studying both factors together to gain a better understanding of wage skill premiums in developing countries.

Against this backdrop, this study aims to examine the determinants of wage skill premiums by using plant-level data from the Thai manufacturing sector as the focus of the case study. The key departure in this study from Amiti and Cameron (2012) is the introduction of the role of global production sharing over and above the presence of firm heterogeneity. Three alternative measures of global production sharing are used to ensure the robustness of our results while carefully controlling for firm-specific and industry-specific factors.

Thailand represents an excellent case study for the issue at hand for at least two reasons. First, Thailand has long been engaged in global production sharing via multinational enterprises. This has an impact on the relative demand for unskilled and skilled workers, as well as on wage skill premiums within the country. Second, despite the substantial progress in trade liberalization observed in the past two decades, much remains to be done. The tariff peak remains unchanged, suggesting that protection varies across sectors. Such protection patterns across sectors are partly influenced by the tariff escalation structure, the key policy implication of an import-substitution industrialization ideology. Tariffs on finished products are still higher than those on intermediate products. Thus, further liberalization of both inputs and outputs still has implications on the allocation of skilled and unskilled labor.

The rest of the paper is organized as follows. Section II presents an analytical framework of the determinants of wage skill premiums. A brief discussion of wage skill premiums in Thailand is presented in Section III. Section IV discusses the empirical model, while data and variable measurements are presented in Section V. Section VI discusses the empirical results, while the last section focuses on conclusions and policy inferences.

II. Analytical Framework

This section lays down the analytical framework underpinning the international trade-wage nexus. The standard neoclassical trade model postulates that opening up to international trade leads to specialization across countries according to their comparative advantage. For developing countries, where comparative advantage is determined by the abundance of unskilled workers, opening up to international trade may raise the price of unskilled labor-intensive goods due to increased exports. In the meantime, the price of the skilled labor-intensive products may decline as a result of increased imports. Such relative price changes potentially affect the relative demand for skilled and unskilled workers. Therefore, it is expected that the wage difference between skilled and unskilled workers would contract with

the corollary outcome of international trade generating a favorable effect on income equality.

Such theoretical postulation is not always supported by empirical studies. It is found only in some countries, such as India (Mishra and Kumar 2005), Kenya (Bigsten and Durevall 2006), and Indonesia (Amiti and Cameron 2012). In contrast, wage premiums are found to be persistent in the cases of Morocco (Currie and Harrison 1997), Mexico (Hanson and Harrison 1999), Argentina (Galiani and Sanguinetti 2003), and Colombia (Attanasio et al. 2004).

At least three explanations are offered in these papers—i.e., friction in labor markets, pre-liberalization and post-liberalization protection structures, and the skill-enhancing trade hypothesis—to explain the persistence of wage skill premiums. However, they remain unsatisfactory. While friction in labor markets, for example, may cause workers to be unable to move across sectors, this could only represent a short-term phenomenon and become less important over time.

With regard to pre-liberalization and post-liberalization protection structures, it is noted that the unskilled labor-intensive sectors had been the most protected prior to trade liberalization. In such case, when trade liberalization takes place, demand for unskilled workers, which tends to become inflated during a high protection era, decreases. Hence, the relative demand for skilled workers increases and widens the wage gap between unskilled and skilled workers.

The skill-enhancing trade hypothesis points to a complementary relationship between imported goods and skilled workers. In particular, opening up to international trade may raise the demand for unskilled workers in developing countries as postulated by the standard neo-classical trade model. It also stimulates imported capital goods as well as intermediates, which are generally designed in the developed country. The technology embodied in these imports, such as new management practices and new forms of work organization, is skill-biased so that the demand for skilled workers increases correspondingly. Hence, the net effect of the relative demand for skilled workers is ambiguous. If large enough, this shift can outweigh the reduction in demand for skilled labor postulated by traditional trade theory.²

At best, these three explanations are satisfactory in explaining wage skill premium persistence during the transition period only (Pissarides 1997, Goldin and Katz 1998). In addition, it is unlikely to be different across firms (Pavcnik et al. 2004, Verhoogen 2008).

Recent research efforts explaining wage skill premium persistence are founded on two hypotheses. The first concerns the presence of firm heterogeneity. Amiti and Davis (2011) extended the firm heterogeneity model pioneered by Melitz (2003) to explain wage premium persistence. In Amiti and Davis (2011) a fair-wage constraint equation is introduced to represent a link between wages paid and firm productivity. Workers expect higher wages when firms earn extra profits that

²See a comprehensive discussion in Arbache et al. (2004).

are positively related to their productivity. Meanwhile, profitable firms pay higher wages to workers to elicit greater effort. In other words, wages paid to workers are an increasing function of firms' productivity. Such productivity is related to the modes by which firms are globally integrated—i.e., exporting final goods, importing intermediates, or both. The key theoretical proposition in Amiti and Davis (2011) is that wages paid by firms exporting final goods, importing intermediates, or doing both, are higher than those in companies without a direct link to global networks. The presence of firm heterogeneity implies a wage skill premium.

Wage skill premiums persist or become enlarged as a consequence of trade liberalization. This is due to the fact that trade liberalization has different effects across firms in a given industry. For firms that have been globally integrated, trade liberalization may positively affect firms' profits, as it lowers cost cutoffs because of a bigger market for exporting firms and reduces costs for importing firms. In contrast, trade liberalization for organizations that are locally oriented implies smaller markets, so that cost cutoffs may be even higher. This forces some firms to exit the process. All in all, different firms are affected differently by trade liberalization. This may eventually widen wage skill premiums.

The second hypothesis concerns the increasing importance of global production sharing. As mentioned above, global production sharing refers to circumstances where whole production processes are divided into separate stages and economically allocated across many locations according to competitiveness (Athukorala 2014). This can affect the relative demand for skilled and unskilled workers in countries participating in global production sharing, though the exact effect of relative worker demand in developing countries is ambiguous. Relatively unskilled labor-intensive activities may be moved to developing countries in line with their comparative advantage. As a result, with continued specialization in global production, the wage gap between unskilled and skilled workers would tend to contract.

Nonetheless, the discussion above is carried out under the implicit assumption that there is a single production cone where there is no factor intensity reversal and firms in developed and developing countries face the same factor endowment vector. In reality, a number of studies point to such an assumption being rather restrictive (Leamer and Levinsohn 1995, Feenstra 2004, Leamer and Schott 2005, Kiyota 2012).³ Therefore, unskilled labor-intensive activities outsourced by firms in developed countries might require relatively skillful workers in developing countries for these activities to be performed.⁴ Therefore, it is possible that demand for skilled to

³For example, consider the footwear industry. While much of the footwear in the world is produced in developing countries, the US retains a small number of plants, e.g., New Balance has a plant in Norridgewock, Maine. Operations there are fully computerized. This is a far cry from the plants in Asia and the People's Republic of China (PRC), in particular, which use traditional production technology and rely heavily on workers.

⁴See similar evidence in Isaacson (2011, Chapter 41), in the context of the conversation between US President Barack Obama and Apple Inc. CEO Steve Jobs. Particularly, Apple had 700,000 factory workers employed in the PRC, Jobs said, and that was because it needed 30,000 engineers onsite to support those workers. . . . "You can't find that many in America to hire." These factory engineers did not have to be PhDs or geniuses; they simply needed to

unskilled workers increases in both developing and developed countries simultaneously, so that a wage gap persists as a result of global production sharing.

All in all, the discussion above highlights a sensible explanation for wage skill premium persistence in developing countries. It is unlikely that wage skill premium in developing countries would be simply a symmetrical opposite to that in developed ones. This represents an empirical challenge.

III. Wage Skill Premium in the Thai Manufacturing Sector

Wages in Thailand are largely determined by the market, as the Thai labor force is largely non-unionized. Domestic and foreign investors have been able to carry on their business activities without any fear of labor problems. This is a result of the abolition of the Labor Act of 1956. Establishing labor unions, as well as any form of labor movement, was prohibited until 1978, when the Labor Act was amended to allow firms to set up labor unions under the auspices of the Labor Relations Law. Nevertheless, there has not been any threat of labor union action within Thai manufacturing. In addition, despite the presence of minimum wage regulations since 1973, their impact on actual wage behavior has been low in Thailand (Kohpaiboon 2006).

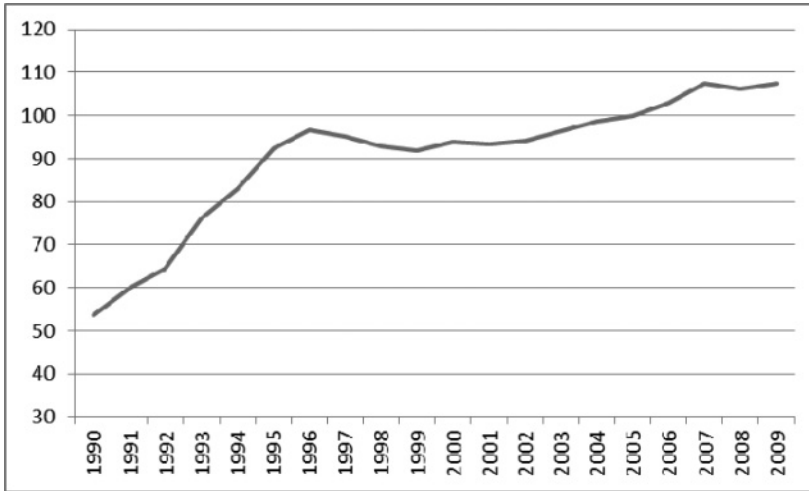
Figure 1 illustrates the (real) wage patterns in Thailand between 1990 and 2009. Real wages in Thailand grew at a relatively rapid rate between 1990 and 1996, the pre-crisis era. The annual growth rate was 10.4% during this period. As a result, the Thai baht experienced real appreciation plus deteriorating international competitiveness and eventually caused the economy to succumb to the crisis in 1997/1998. When the economy experienced the 1997/1998 turmoil, real wages dropped. It was not until 2000 that real wages grew noticeably. From 2002 to 2009, the real wage grew at a rate of 1.7% and showed a significant upward trend.

The upward trend in real wages in Thailand was associated with a low and declining unemployment rate. In 2011, the unemployment rate in Thailand was 0.7%. This rate was much lower than their neighbors in Southeast Asia, e.g., Malaysia (3%), Indonesia (6.6%), and Viet Nam (2%), which suggests tightening labor market conditions in Thailand.⁵ Interestingly, patterns of employment share by sector (i.e., agriculture, manufacturing, and services) suggest that labor tightening in the manufacturing sector was more severe than in other sectors. The employment share in the manufacturing sector remained virtually unchanged, fluctuating within a narrow

have basic engineering skills for manufacturing.” Such factory engineers are unlikely to be unskilled workers in the PRC as well.

⁵The data for unemployment reported here are the latest available figures from the Key Indicators of Asia and the Pacific 2012, Asian Development Bank (ADB). Note that there is suspicion about the official report of unemployment figures being unrealistically low. Nonetheless, information available in local newspapers in recent years supports the existence of a tightening labor market.

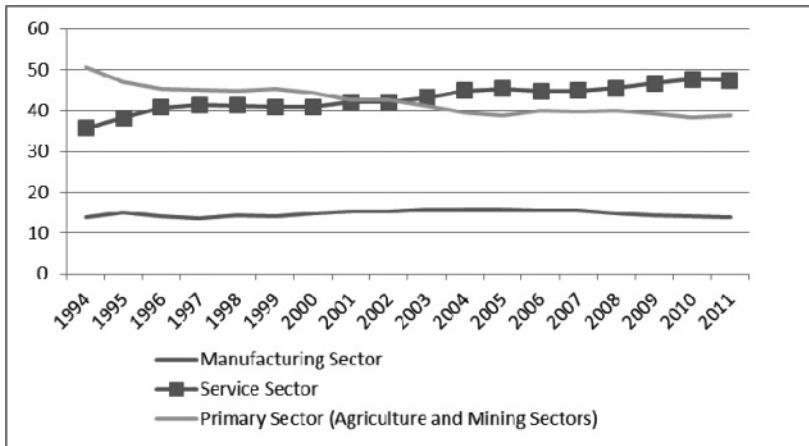
Figure 1. Wage Patterns in Thailand between 1990 and 2009



Note: Wage per worker is the ratio between wage compensation and employed workers. The consumer price index (2005 = 100) is used to convert wages into real terms.
 Sources: National Economic and Social Development Board; Asian Development Bank, 2012; Key Indicators of Asia and the Pacific; International Monetary Fund; International Financial Statistics.

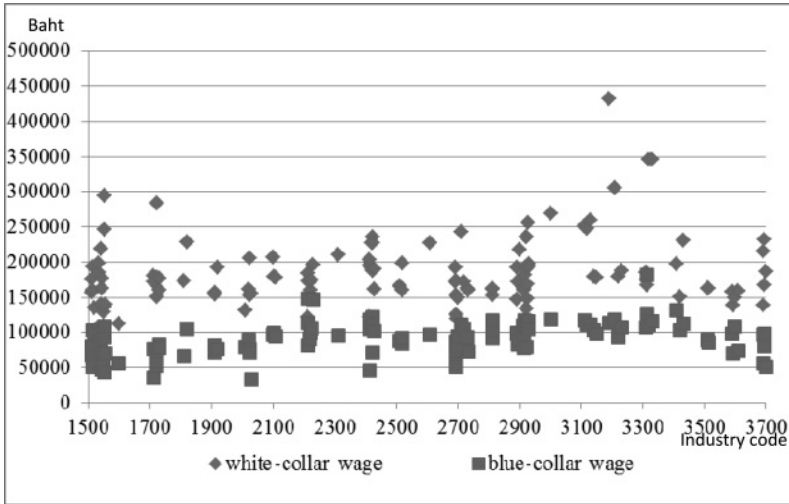
range between 13.6% and 15.8% during the period 1994–2011. The service sector mainly absorbed workers moving out from the primary sector, the agricultural sector in particular. In 2011, the employment share of the service sector approached 50%, increasing from 35.6% in 1994. In contrast, the share of the primary sector dropped from 50.5% in 1994 to 38.8% in 2011 (Figure 2).

Figure 2. Employment Share in the Thai Economy, 1994–2011



Source: ADB. 2012. Key Indicators of Asia and the Pacific.

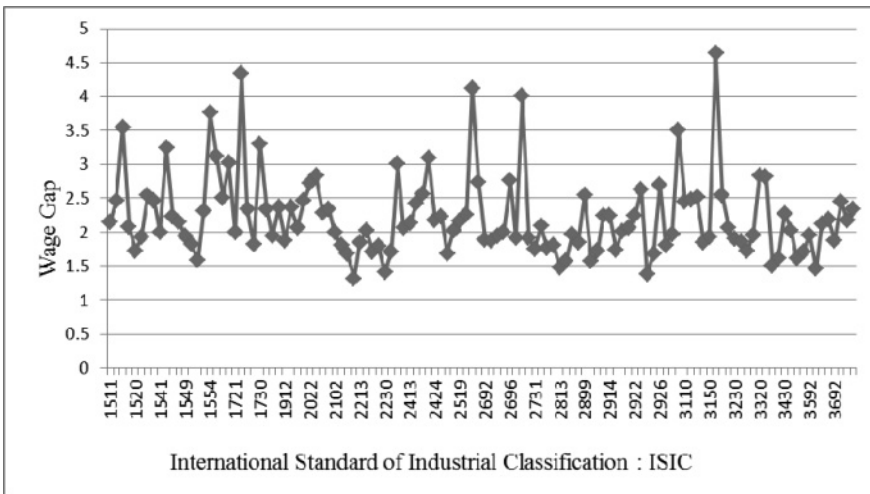
Figure 3. White-collar and Blue-collar Wages in Thai Manufacturing, by Industry Code



Source: Authors' calculations based on the Industrial Census 2006.

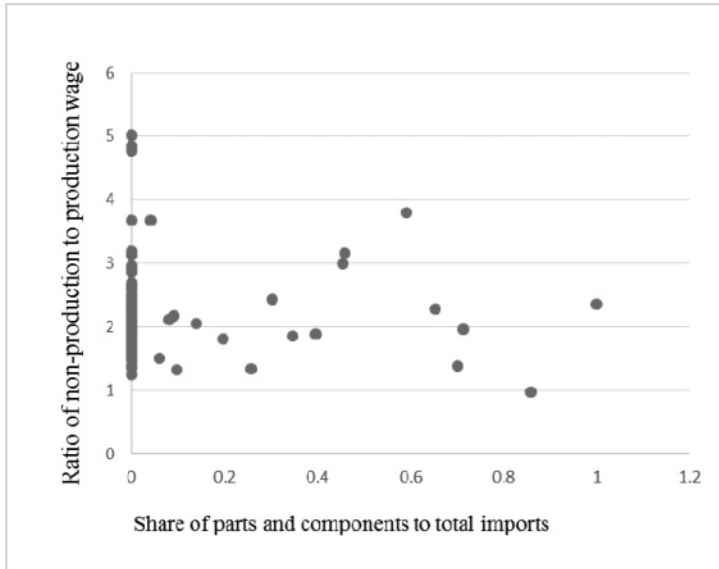
Wage differentials across industries in Thailand are observed. As shown in Figures 3 and 4, although wages paid for white-collar staff are higher than those of blue-collar workers, the wage gap tends to be different across industries. It seems that labor-intensive industries tend to have a higher level of wage gap than capital-intensive industries. Labor-intensive industries include fruit and vegetable

Figure 4. Wage Gap in Thai Manufacturing, by Industry (ISIC 4-digit classification)



Note: The wage gap is defined as the ratio of white-collar wages to blue-collar wages.
 Source: Authors' calculations based on the Industrial Census 2006.

Figure 5. Relationship between Wage Gap and Share of Parts and Components Imports in 2006



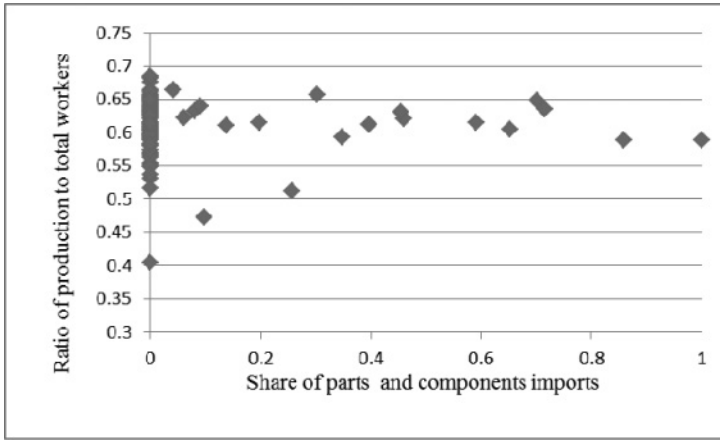
Source: Authors' calculations based on the Industrial Census 2006.

processing (ISIC 1513) and the manufacture of soft drinks (ISIC 1554), carpets and rugs (ISIC 1722), and knitted and crocheted fabrics (ISIC 1730). They also include resource-based industries such as the manufacture of basic iron and steel (ISIC 2710); sugar (ISIC 1542); basic chemicals (ISIC 2411); and pharmaceuticals, medicinal chemicals, and botanical products (ISIC 2423). Capital-intensive industries comprise manufacturing sectors such as motor vehicles (ISIC 3410), bodies for motor vehicles (ISIC 3420), other transport equipment (ISIC 3599), and jewelry and related articles (ISIC 3691). This could be because such industries need a more skillful workforce to partner with capital. Consequently, most workers in such industries are categorized as skilled workers.

Figure 5 presents a scatter plot illustrating the differences in wages paid and the types of employed workers across industries according to the extent to which they are engaged in global production sharing. The share of parts and component imports to total imports is used as a proxy for the extent to which industries are engaged in global production sharing.⁶ In Figure 5, the relationship between the wage gap and the share of parts and component imports across industries tends to be positive to a certain extent, suggesting the wage gap tends to be higher as industries

⁶See discussion on the use of parts and component import shares as a proxy for the extent to which industries are engaged in global production sharing.

Figure 6. Relationship between Production Workers and Share of Parts and Components Imports in 2006



Source: Authors' calculations based on the Industrial Census 2006.

increasingly engage in global production sharing. The same positive relationship is found between the share of production to total workers and the share of parts and components imports, despite the relationship being relatively less clear cut in Figure 6.

IV. Empirical Model

The empirical model employed in Amiti and Cameron (2012), (Equation 1, p. 280) is used in this paper,

$$\ln \left(\frac{W_s}{W_u} \right)_{ij} = \alpha_j + \alpha_i + \beta_1 * Inputtariff_i + \beta_2 * Inputtariff_i * IM_i + \beta_3 * Outputtariff_i + \beta_4 * Outputtariff_i * EX_i + Z_{ij}\Gamma + \varepsilon_{ij} \quad (1)$$

where $\ln \left(\frac{W_s}{W_u} \right)_{ij}$ is the wage skill premium. The equation states that this premium is a function of the input tariff ($Inputtariff_j$), the output tariff ($Outputtariff_i$), and their interaction with import share (IM_i) and export share (EX_i) at the firm level.

To construct the input tariff, we weight the output tariffs by their input cost shares, as follows,

$$Inputtariff_j = \sum_{i=1}^n a_{ij}t_i \quad (2)$$

where t_i = tariff of product i , and a_{ij} = shares of product i used in producing product j (input-output coefficient).

In theory, it should not matter if policy-induced incentives from cross-border protection measures are generated by input tariffs or by output tariffs. Instead, it would be theoretically superior to employ an effective rate of protection (ERP) instead of separating input and output tariffs. However, in reality, the effect of input and output tariffs could differ in at least two circumstances. First, this occurs when domestically-manufactured and imported intermediates are not close substitutes. A change in the input tariff would have a significant effect only on firms that actually import them. For firms that use domestically-manufactured intermediates, such change would not have any significant effect on worker demand. Second, as echoed in the firm heterogeneity literature, switching market orientation between the domestic and the export market is costly. Hence, changes in the output tariff might not have any significant impact on those who still export; they just continue to do business because of the presence of sunk and fixed costs within the export business.

Both circumstances above are often observed in a country long engaged with the world and pursuing a dual-objective trade policy, where the reluctance to lower tariffs is associated with the introduction of input tariff exemption schemes to promote export-oriented activities. Under such a policy environment, firms decide to be either purely export-oriented, or purely domestic-market oriented. Export-oriented firms focus on the global market simply because of the inherently larger scale of operations and tend to rely on high quality imported intermediates to strengthen their position in the world market. Sourcing local intermediates could be costly due to input tariff protection as well as the difficulty in finding qualified inputs. In the case of domestic market-oriented firms, tariff protection allows them to operate in an enclave, isolated from global competition, in order to maximize profits. However, this makes them slow to respond to technological advancements elsewhere. To address these circumstances, two interaction terms, $Inputtariff_i * IM_i$ and $Outputtariff_i * EX_i$, are introduced in addition to $Inputtariff_i$ and $Outputtariff_i$.

The row vector Z_{ij} in Equation 1 is a set of controlling firm-specific variables including ownership (OWN_{ij}), size ($SIZE_{ij}$), export (EX_i) status, import (IM_i) status, and the share of non-production workers ($Blueshare_{ij}$).⁷ In this study, three additional firm-specific variables are included—i.e., the level of fixed asset stock ($\ln K_{ij}$), the ratio of females to the total number of workers ($female_{ij}$), and the composition of blue-collar workers ($skillshare_{ij}$). The variable $\ln K_{ij}$ is introduced to capture the degree of capital deepening at the firm level. The higher the degree of capital deepening, the larger the share of wage skill premiums. Hence, its effect is expected to be positive. Meanwhile, the variable $female_{ij}$, the ratio of female

⁷In Amiti and Cameron (2012), another firm-specific variable is the state-owned enterprise variable. This is excluded from our model as it is not relevant to Thailand.

workers to total workers, is included to address any possible gender bias that might occur. The sign of the corresponding coefficient could be either positive or negative.

Finally, $skillshare_{ij}$, defined as the ratio of skilled to total operational/blue-collar workers, is included simply because of the nature of the Thai dataset which further disaggregates blue-collar workers into skilled and unskilled. The former refers to supervisors with long experience who are skilled in monitoring production lines to an extent that they should be regarded as white collars. Unfortunately, in the dataset, wage compensation paid to operational workers is not separated, and this makes it impossible to redefine more precise wage compensation of true white-collar staff. The higher value of $skillshare_{i,j}$ implies that the denominator in the wage skill premium includes some element belonging to actual skilled workers. Hence, a negative sign is expected.

As mentioned in Section II, engaging in global production sharing can have an implication on wage skill premiums. Ideally, to capture the effect of global production sharing (GPS_j) on wage skill premiums, details at the firm level (e.g., whether firms are actually engaged in multinational enterprises' production sharing, whether they import tailor-made raw materials for specific customers, etc.) are needed. Unfortunately, such details at the firm level are not available within the Thai dataset. To overcome the unavailability of perfect measures of global production sharing, therefore, three alternative proxies are used in this study.

The first two proxies are shares of parts and components in total imports ($GPS1_j$) and total trade ($GPS2_j$), respectively, as reflected in the following equations:

$$GPS1_j = \frac{\text{P\&C Imports}_j}{\text{Total Imports}_j} \quad (3)$$

$$GPS2_j = \frac{\text{P\&C trade (import + export)}_j}{\text{Total Trade}_j} \quad (4)$$

The higher the share, the more important the global production sharing is to the industry. The parts list is the result of a careful disaggregation of trade data based on Revision 3 of the Standard International Trade Classification (SITC, Rev 3) extracted from the United Nations trade data reporting system (UN Comtrade database).⁸ It is important to note that the Comtrade database does not provide for the construction of data series covering the entire range of fragmentation-based trade. The parts list used here is from Athukorala and Kohpaiboon (2009).⁹

⁸The list of parts and components is available upon request.

⁹Lists of parts in the Board Economics Classification (BEC) 42 and 53 is a point of departure. Note that the parts in BEC 211 are not included as they are primary products which are usually classified as traditional, rather than fragmented-intermediates. The additional lists of parts are included based on firm interviews reported in Kohpaiboon (2010). Data on trade in parts are separately listed under the commodity classes of machinery and transport equipment (SITC7) and miscellaneous manufacturing (SITC8). Based on firm interviews elaborated in Kohpaiboon (2010).

Another proxy is the binary dummy variable ($GPS3_j$), which is equal to 1 for industries in the electronics, electrical appliances, and automotive¹⁰ sectors; and 0 otherwise. It is in these three industries where global production sharing takes place intensively as suggested by previous empirical studies (Athukorala 2014, Kohpaiboon and Jongwanich 2013). These three proxies are used alternatively as robustness checks in the estimations.

In addition to the role of global production sharing, two industry-specific factors are included in the empirical model. This is different from the previous studies where industry-specific factors are largely captured by the dummy variable.¹¹ The first one is producer concentration (CR_j). Industries with high barriers to entry are likely to be concentrated and are often capital and/or skill intensive. Hence, in a highly concentrated industry, the demand for skilled workers would be higher. The wage skill premium would also be higher, therefore a positive sign is expected. Producer concentration is measured by the sum of the sales share of the top four firms in total.

Another industry-specific variable is output growth ($GROWTH_j$) which is intended to capture the dynamics of labor movement. In general, in industries experiencing rapid output expansion, there would be a greater demand for inputs, including labor. To motivate resource movement, input prices would increase. In such case, wages for skilled workers are likely to grow at a faster rate than that for unskilled staff, so that the wage skill premium would be higher in a faster growing industry.

Log-linear least squares regression is used in calculating annual growth rates over the past 5 years:

$$\ln Y_{jt} = \alpha + \beta t \tag{5}$$

where Y_{jt} is the real gross output value of industry j at time t where t is from 2000 to 2005. The OLS estimate of β represents annual growth.

All in all, the empirical model employed in this study is:

$$\begin{aligned} \ln \left(\frac{W_s}{W_u} \right)_{ij} = & \alpha_j + \alpha_i + \beta_1 * Inputtariff_i + \beta_2 * Inputtariff_i * IM_i \\ & + \beta_3 * Outputtariff_i + \beta_4 * Outputtariff_i * EX_{ij} + \beta_5 IM_{ij} + \beta_6 EX_{ij} \\ & + \beta_7 OWN_{ij} + \beta_8 SIZE_{ij} + \beta_9 blueshare_{ij} + \beta_{10} \ln K_{ij} + \beta_{11} \sqrt{female_{ij}} \\ & + \beta_{12} skillsh_{ij} + \beta_{13} GPS_j + \beta_{14} CR_j + \beta_{15} GROWTH_{ij} + \varepsilon_{ij} \end{aligned}$$

¹⁰This includes ISIC 2911, 2913, 2915, 2919, 2921, 2922, 2923, 2924, 2925, 2926, 3000, 3110, 3120, 3220, 3230, 3311, 3312, 3313, 3320, 3330, and 3410.

¹¹When these two industry-specific variables are introduced into the model, zero-one industry dummies turn out to be statistically insignificant.

where

$\ln\left(\frac{W_s}{W_u}\right)_{ij}$ = wage skill premium of firm i in industry j ;

Inputtariff = tariff on raw materials in industry j ;

Outputtariff = tariff on finished products in industry j ;

SIZE _{i,j} = size of firm i in industry j ;

EX _{i,j} = share of exports of firm i in industry j ;

IM _{i,j} = share of raw material imports of firm i in industry j ;

OWN _{ij} = foreign ownership of firm i in industry j (= 1 if foreign firm, 0 otherwise);

$\ln K_{ij}$ = level of fixed asset stock of firm i in industry j ;

Blueshare _{ij} = share of production to total workers of firm i in industry j ;

female _{ij} = ratio of females to total workers of firm i in industry j ;

skillshare _{ij} = ratio of skilled to total operational/blue-collar workers of firm i in industry j ;

GPS _{j} = degree that industry j is engaged in global production sharing, proxied by three alternatives;

GPS1 _{j} = shares of parts and component imports to total imports;

GPS2 _{j} = shares of parts and component (import + export) trade to total trade;

GPS3 _{j} = binary dummy variable (= 1 for electronics, electrical appliances, and automotive industries; 0 otherwise);

CR _{j} = producer concentration of industry j ;

GROWTH _{j} = annual output growth rate over the past 5 years of industry j based on the log-linear regression method; and

$\varepsilon_{i,j}$ = disturbance terms of firm i in industry j .

V. Data and Econometric Method

Ideally, the empirical questions in this paper must be properly addressed by panel data analysis at the firm level with comprehensive information on wage compensation and workers at the disaggregate level, i.e., workers are properly classified as unskilled, skilled, scientists, and office workers. Given the available data, this preferred dataset is not possible. So far there are two industrial census sets—i.e., 1996 and 2006—both of which are establishment level data. Even though both provide establishment identification numbers, the numbers are not assigned systematically. For a given ID number, an establishment in 1996 is not necessarily the same as that in 2006. Hence, the industrial census of 2006 is used.

The census covers 73,931 plants, classified according to 4-digit industries as per the International Standard of Industrial Classification (ISIC). The census was cleaned up by first checking for duplicated samples. As occurred in the 1996 industrial census, there are some duplicated records in survey returns, presumably

because plants belonging to the same firm completed questionnaires using the same records. The procedure followed in dealing with this problem was to treat records that report the same value of the eight key variables of interest in this study being counted as one record only. The eight variables are registered capital, number of male workers, number of female workers, sales value, values of capital stocks (initial and ending periods), value of intermediates, and initial stock of raw materials. There are 7,992 such cases hence, the final sample drops to 65,940 plants.¹² This is to minimize any potential problems emerging from mixing plant and firm data.

In addition, we deleted establishments which had not responded to one (or more) of the key questions concerning such factors as sales value and output, and which provided seemingly unrealistic information on such details as negative output value or recorded an initial capital stock of less than B5,000 (less than \$200).¹³ The 2006 census contains a large number of microenterprises defined as plants with fewer than 10 workers. There are 39,152 samples which employ fewer than 10 workers, of which 52% are microenterprises which do not hire paid workers (zero paid workers).

The problem of self-employed samples is less severe when considering samples with more than 10 workers (1,623 samples out of 26,788). Hence, our analysis focuses on samples with more than 10 workers net of self-employed firms. Seven industries that exist either to serve niches in the domestic market (e.g., the processing of nuclear fuel, and manufacture of weapons and ammunition), in the service sector (e.g., the building and repair of ships, manufacture of aircraft and spacecraft, and recycling), or explicitly preserved for local enterprises (e.g., the manufacture of ovens, furnaces and furnace burners, and manufacture of coke oven products) are excluded. Overall, these remaining establishment plants accounted for 75% of Thai manufacturing gross output and 62% of manufacturing value added in 2006.

In compiling the census, Thai firms are often reluctant to share wage compensation information. This is especially true for non-operational workers (white-collar). There are only 13,809 samples providing both wage compensation for operational and non-operational workers. Among these, there are 2,940 firms that report compensation per operational worker greater than or equal to that of non-operational workers. It seems unrealistic to observe such a pattern given the definition of non-operational workers used in the census and the labor market situation in Thailand where most office workers attain an undergraduate degree and receive a higher wage than staff on the production line. Hence, those samples are excluded and the final sample size drops to 10,706 firms.

¹²As a robustness check, we alter the criteria from eight to seven variables (excluding initial raw materials). The number of duplicated samples slightly increases to 8,067 samples. Hence, we remain with our initial criteria to maintain as many samples as possible in our analysis.

¹³If we alter to B10,000, the number to be dropped increases to 1,289 samples (another 500 samples to be dropped).

Table 1. Statistical Summary

	No. of obs.	Average	St. Dev.	Min.	Max.
$\ln\left(\frac{W_s}{W_a}\right)_{ij}$	10,258	0.63	0.46	0.00	2.84
$EX_{i,j}$	10,258	14.58	30.10	0.00	100.00
$IM_{i,j}$	10,258	12.49	25.64	0.00	100.00
OWN_{ij}	10,258	8.24	23.94	0.00	100.00
$SIZE_{i,j}$	10,258	17.50	2.62	0.00	25.16
$skillshare_{ij}$	10,258	0.71	0.36	0.00	1.00
$Blueshare_{ij}$	10,258	0.59	0.08	0.04	0.69
$female_{ij}$	10,190	-0.96	0.64	-4.44	0.00
$GROWTH_j$	10,258	0.06	0.08	-0.19	0.40
$Inputtariff_i$	10,258	0.04	0.02	0.00	0.11
$Outputtariff_i$	10,258	0.07	0.06	0.00	0.30
CR_j	10,258	0.55	0.16	0.02	1.00
$GPS1_j$	10,258	0.03	0.11	0.00	1.00
$GPS2_j$	10,258	0.02	0.09	0.00	1.00
$GPS3_j$	10,258	0.08	0.26	0.00	1.00

Source: Authors' calculations.

Gross output and its corresponding price deflators are derived from the National Economics and Social Development Board (NESDB). The annual growth rate is based on gross output at constant prices (1988). Trade data is compiled from UN Comtrade data and the standard concordance between ISIC and HS is applied. The nominal rate of protection is calculated in this study based on official data provided by the custom duty offices of the Ministry of Finance.

Producer concentration data is obtained from Kophaiboon and Ramstetter (2008) where concentration is measured at the more aggregate level (e.g., many figures are measured at the 4-digit level, whereas some are calculated at the 3-digit ISIC classification standard). This is to guard against possible problems arising from the fact that two reasonably substitutable goods are treated as two different industries according to the conventional industrial classification at a high level of disaggregation. Our tariff data are at the 6-digit HS code level. To calculate tariffs on raw materials, concordance between 6-digit HS code level and the input-output table is developed. The weight of inputs in each product is calculated by using information from the input-output table. Tables 1 and 2 provide a statistical summary, including a correlation matrix of all relevant variables in this analysis.

The empirical model in Equation 2 above is first estimated using the ordinary least squares (OLS) method, while paying attention to the possible effect of statistical outliers on estimation results. Cook's Distance is applied here to identify suspected outliers. In addition, it is likely that the model would be subject to simultaneity problems from two possible sources. First, as argued largely in the political economy literature, certain industries have more political power to lobby government for protection (see Grossman and Helpman 1994). Thus, input and output tariffs are

Table 2. Correlation Matrix of Variables

	$\ln\left(\frac{w_s}{w_n}\right)_{ij}$	$EX_{i,j}$	$IM_{i,j}$	OWN_{ij}	$SIZE_{i,j}$	$skillshare_{ij}$	$Blueshare_{ij}$	$female_{ij}$	$GROWTH_j$	$Inputtariff_i$	$Outputtariff_i$	CR_j	$GPS1_j$	$GPS2_j$	$GPS3_j$	
$EX_{i,j}$	0.13	1.00														
$IM_{i,j}$	0.10	0.33	1.00													
OWN_{ij}	0.06	0.33	0.34	1.00												
$SIZE_{i,j}$	0.15	0.27	0.24	0.23	1.00											
$skillshare_{ij}$	-0.07	0.02	-0.01	0.02	-0.06	1.00										
$Blueshare_{ij}$	0.14	0.08	-0.06	-0.02	-0.03	-0.06	1.00									
$female_{ij}$	0.08	0.22	0.08	0.06	-0.01	-0.01	0.05	1.00								
$GROWTH_j$	-0.01	-0.05	0.00	0.07	0.05	-0.02	-0.01	-0.06	1.00							
$Inputtariff_i$	0.01	0.06	0.06	0.10	0.13	-0.01	-0.04	-0.11	0.19	1.00						
$Outputtariff_i$	0.01	0.01	0.06	0.06	0.04	0.03	-0.04	-0.15	0.27	0.39	1.00					
CR_j	-0.03	0.02	0.10	0.04	-0.02	0.06	-0.05	0.03	-0.09	0.03	0.13	1.00				
$GPS1_j$	0.03	0.08	0.08	0.11	0.09	-0.01	0.01	0.01	0.13	0.22	0.09	0.07	1.00			
$GPS2_j$	0.02	0.06	0.10	0.11	0.08	0.00	0.01	0.01	0.20	0.22	0.13	0.08	0.06	1.00		
$GPS3_j$	-0.02	0.06	0.13	0.15	0.06	0.04	-0.02	-0.07	-0.03	0.36	0.14	0.23	0.04	0.06	1.00	

Source: Authors' calculations.

endogenous, resulting in biased estimators. In addition, industry-specific factors could influence both wages and tariffs.

To mitigate possible simultaneity bias, instrument variable estimation is used. We follow the practice employed in previous studies such as Treffer (2004), Amity and Davis (2011), and Amity and Cameron (2012), where lagged values are used as instruments. That is, 1999 tariffs are used for 2006, while producer concentration in 1996 substitutes for that in 2006. Consequently, the following discussion is based on the IV estimates.

VI. Empirical Results

Table 3 provides the IV estimation results. All equations in the table perform well in terms of joint significance of parameter estimates based on the Wald test. Three alternative proxies of global production sharing yield basically comparable results. All firm-specific variables are statistically significant. The positive and statistical significance of the coefficient associated with $SIZE_{ij}$ suggests that the wage skill premium is higher for larger firms.

Table 3. Instrument Variable Estimation (IV) Results for the Three Global Production Sharing Proxies

	GPS1		GPS2		GPS3	
	coeff.	t-stat	coeff.	t-stat	coeff.	t-stat
<i>Intercept</i>	-0.45	-1.85	-0.435	-1.79	-0.44	-2.13
IM_{ij}	0.01	1.49	0.013	1.44	0.01	1.66
$Inputtariff_i$	0.44	0.23	0.230	0.12	0.72	0.41
$Inputtariff_i * IM_{i,j}$	-0.25	-1.29	-0.249	-1.24	-0.27	-1.46
EX_{ij}	-0.01	-2.18	-0.013	-2.15	-0.01	-2.42
$Outputtariff$	-11.22	-2.19	-11.645	-2.14	-9.63	-2.29
$Outputtariff_i * EX_{ij}$	0.20	2.34	0.207	2.3	0.18	2.61
OWN_{ij}	0.00	0.09	0.000	0.03	0.00	0.13
$lnoutput$	0.02	6.45	0.025	6.29	0.02	7.14
$skillshare_{ij}$	-0.05	-1.79	-0.047	-1.74	-0.05	-2.32
$Blueshare_{ij}$	0.84	7.71	0.837	7.51	0.84	8.49
$female_{ij}$	-0.14	-1.63	-0.153	-1.62	-0.12	-1.57
GPS_j	0.29	2.18	0.393	2.21	0.12	1.36
CR_j	1.15	1.77	1.173	1.74	1.00	1.84
$Outputtariff_i$	2.11	2.00	2.159	1.96	1.83	2.09
No. of obs.	8,732		8,732		8,732	
F (14, 8,717)	13.56		12.94		16.20	

Source: Authors' estimates.

We cannot find any difference between foreign and local firms in our analysis. This might be due to the fact that Thailand has long opened for foreign investors since the early 1960s. Also, foreign and local firms interact with each other concerning

workers. Therefore, the hypothesized difference in wage premium disappears. The coefficient corresponding to $Blueshare_{ij}$ carries a negative sign as expected. The negative and statistical significance of $Skillshare_{i,j}$ is also in line with our hypothesis. Due to the way data were collected, wage compensation for operation workers partly covers that of skilled workers so that the denominator in the wage premium is inflated. Wage skill premiums in firms hiring more female workers are smaller than for those hiring more male workers.

The effect of producer concentration on the wage premium is found to be both positive and statistically significant. Firms within highly concentrated industries are often capital and/or skill intensive. There is more demand for skilled workers than firms in less concentrated sectors. Firms in industries experiencing rapid output expansion (high output growth) tend to have a greater demand for skilled workers. Industries with brighter growth prospects would be in a better position to attract skilled workers. Hence, wage skill premiums in such industries would be higher in a faster growth industry.

A. Effects of Trade Liberalization

Our findings are in line with the literature on firm heterogeneity. In particular, tariff cuts have different effects on firms depending on choices of globalization mode. The average effect of changes in input tariffs on wage skill premiums is found only in firms which actually import. The coefficient of the interaction term is negative, though not highly significant. The coefficient on input tariffs becomes statistically insignificant, indicating that a cut in input tariffs does not have any effect on firms that do not import.

One possible explanation for this is that domestic and foreign intermediates are not closely substitutable. This seems to be sensible for developing countries, including Thailand, with dual objectives in conducting trade policy—i.e., maintaining tariff protection while promoting exports through tariff exemption schemes, under a cascading tariff structure. There is less incentive for local entrepreneurs to produce intermediate and capital goods that directly compete with imports. Instead, the cascading tariff structure encourages local entrepreneurs to produce finished products for highly protected markets while relying on imported intermediates.

For those actually involved in the production of intermediates, their products are unlikely to be close substitutes of imported goods. Hence, a cut in input tariffs would not have any significant effect on their business decisions, including their demand for skilled workers. However, for those who import intermediates (and who cannot find similar products in the local market), an input tariff cut has negative effect on the wage skill premium. While the relationship is only weakly significant, it indicates a complementary nature between imported intermediates and skilled

workers. This result seems consistent with the theoretical justification originally proposed by Rosen (1968), Griliches (1969), Goldin and Katz (1998), and Krusell et al. (2000).

Where output tariffs are concerned, both the coefficient on output tariff and its interaction with export share are statistically significant. The former is negative, while the latter is positive. The negative coefficient associated with output tariffs suggests that a cut in output tariffs widens the wage skill premium. In theory, this could come from either an increase in demand for skilled workers or a decrease in demand for unskilled workers. The statistically significant and positive sign of the interaction term with export share suggests the latter.

As mentioned earlier, Thailand has dual objectives, conducting trade policy under a cascading tariff structure. In this setting, local firms have two choices: to operate under the cascading tariff structure by producing goods for the highly protected domestic market, or to export by making use of the abundant unskilled labor. Both measures increase demand for unskilled workers. With an output tariff cut, the resulting increase in imports of finished goods could force firms previously operating under the heavy protection to exit. Pressures on unskilled worker wages would be weaker.

On the other hand, for purely exporting firms, the effect of output tariffs on wage skill premiums turns out to be positive, as they benefit from less pressure on the wages of unskilled workers.¹⁴ In addition, there are extra activities for firms engaged in exports, including negotiating with customers, bargaining, overcoming day-to-day problems on the production line, arranging delivery schedules, and offering after-sale services as suggested in firm-specific case studies.¹⁵ All other things unchanged, this raises wages for skilled workers and widens the wage gap. In our estimates, a positive effect on wage skill premiums is found when firms' export-output ratio virtually exceeds 50%. Note that the coefficient associated with the export share variable itself is negative and statistically significant, but very small, so that the net effect remains largely positive.

Our findings above highlight the side effects of the country's dual objectives for trade policy. Such effects are even worse when they operate under a cascading tariff structure. To a certain extent, this explains the high import content of export-oriented products in many developing East Asian economies. More importantly, under a cascading tariff structure, tariffs on consumer products, which are likely to be unskilled-worker-intensive, are high. This may inflate demand for unskilled workers and jeopardize the competitiveness of exporting firms.

¹⁴When the export-output ratio is 100% or $EX = 1$, the net effect of output tariff cuts turns out to be positive in all cases.

¹⁵Evidence from firm interviews in Kohpaiboon (2006), Kohpaiboon et al. (2012), and Kohpaiboon and Jongwanich (2013) concerning processed food, garments, hard disk drives, and automotive industries. The interview period was between 2004 and 2012. The sample covered all firm sizes.

B. Role of Global Production Sharing

Another main contribution is the role of global production sharing. The wage skill premium is also influenced by the extent to which industries participate in global production sharing. Our findings support the hypothesis that firms in developing and developed countries face different production cones. Outsourced economic activities from developed countries which are generally regarded as unskilled-worker-intensive could be seen as being skill-intensive in the context of developing nations. All three proxies of global production sharing reach a positive sign at the conventional level of statistical significance, except *GPS3*.¹⁶

This finding is in line with the different cones of production hypothesis. Relatively unskilled labor-intensive activities outsourced by firms in developed countries tend to be skilled worker-intensive in developing countries. Demand for skilled to unskilled workers increases in developing countries as a result of participation in global production sharing. It is also consistent with case studies such as Kohpaiboon (2010) and Kohpaiboon and Jongwanich (2013) for four Thai industries (television sets, hard disk drives, automotive, and garments) and Athukorala (2014) for electronics in Penang, Malaysia, all of which demonstrate that tasks in global production sharing are far more complicated than simple assembly.

There is a heated public debate in developing countries on the issue that participation in global production sharing could trap domestic enterprises on the lower rung of the sharing ladder, which mainly involves simple assembly operations, and could make them heavily reliant on low wages to stay competitive globally. Our results suggest the opposite. As described in the global value chain literature, the governance of the supply chain within production sharing plays a key role in determining costs, flexibility, and risk within the productive capacity of suppliers, and the degree of reliability of supplier contracting. Thus, for firms in developing countries, the natural endowment of unskilled labor is inadequate to participate and fully engage in the production sharing. Skilled workers are also demanded. This finding also raises concerns regarding the side effects of increasing economic globalization by participating in global production sharing on unskilled workers. In particular, unskilled workers unable to obtain adequate skills may be left behind.

VII. Conclusion

The paper aims to gain a better understanding of the determinants of wage skill premiums, defined as the wage difference between skilled and unskilled workers. The Thai manufacturing sector is selected as a case study for the issue at hand. Both the

¹⁶The coefficient associated with *GPS3* is positive, but its p-value (two-tailed) is 0.174.

presence of firm heterogeneity and the increasing importance of global production sharing are brought together in our empirical model to avoid any estimation bias.

Our key finding is that tariff cuts have different effects on firms depending on their globalization mode. For importing firms, a cut in input tariffs tends to reduce wage skill premiums. Conversely, a cut in output tariffs forces such firms—particularly those operating under heavy protection—to exit, lowering the pressure on unskilled worker wages. For exporting firms, an output tariff cut induces greater demand for skilled workers and raises wages for skilled workers. This eventually widens the wage skill premium.

Another key finding is that outsourced economic activities from developed countries, which are generally regarded as unskilled worker-intensive, are still skill intensive in the perspective of developing countries. For firms in such countries, the natural endowment of unskilled labor is inadequate for participating and fully engaging in production sharing. Skilled workers are also needed.

Our finding has three policy implications regarding managing ongoing economic globalization. First, a dual-objective trade policy that maintains cross-border protection for some local firms while encouraging others to export through tariff exemption schemes has a side effect, which is made even worse when objectives are pursued under a cascading tariff structure. While linkage within a country lessens with continued globalization, the dual-objective trade policy further destroys any potential linkage between upstream and downstream industries. When such a policy is conducted under a cascading tariff structure, the result may be inflated demand for unskilled workers and lower competitiveness of exporting firms.

Second, our findings suggest that participating in global production sharing provides not only lucrative business, but also offers the chance to move up to a higher rung on the technology sharing ladder. For such opportunities to materialize, workers need to obtain more skills. To a large extent, this is an area where the government can play a leading role through education reform as well as public–private coordination in training programs.

Finally, increasing economic globalization by participating in global production sharing could have a negative impact on unskilled workers. In particular, unskilled workers who are unable to receive adequate skills may fall by the wayside. Social safety net programs must be put in place to mitigate the adverse effects.

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