Chapter 6

Global Production Sharing and Wage Premium: Evidence from Thai Manufacturing

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CHAPTER 6

Global Production Sharing and Wage Premium: Evidence from Thai Manufacturing*

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The paper examines wage premium across firms with emphasis on the effect of global production sharing, using firm level data of Thai Manufacturing as the case study. Our results show the effect of engaging into the global production network on the wage skill premium varies across firms, depending on the extent to which firms actively engage. The more active the firm, the larger the benefit expected from the network. For active firms there are a wide range of activities, far beyond simple assemble and unskilled-intensive activities, to be participated. This reduces the risk to be trapped in the production network. The key policy inference is there is benefit from globalization through global production sharing but is not automatic. The role of government should emphasize adequate and qualified skilled workers in order to facilitate the participation of indigenous firms in the network.

Keywords: Skill Premium, Wage differential, Global Production Sharing, Thai Manufacturing
JEL: JEL: F14, F16, O14, O53

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1. Issues

International trade-wage nexus remains the ongoing debate in the context of economic globalization. Even though the theoretical postulation from the standard neo-classical trade theory highlights potential favorable impact on income distribution as a result of proper resource allocation in line with the country's comparative advantage and hence narrowing a wage gap between unskilled and skilled workers (henceforth referred to the wage premium), empirical results remain mixed at best. Such a favorable impact is found only in some cases such as Mishra and Kumar (2005) of India, Bigsten & Durevall (2006) for Kenya, Amiti & Cameron (2012) for Indonesia. There are a number of empirical evidence (e.g. Currie & Harrison, 1997; Hanson & Harrison, 1999; Galiani & Sanguinetti, 2003; Attansaio, *et al*. 2004; Goldberg & Pavcnik, 2007) where wage premium is persistent. This raises concerns about the impact of globalization on income inequality.

While the earlier explanation of the persistence of wage premium was on imperfection of resource reallocation[3] and the protection structure[4], it is far from satisfactory (Goldberg & Pavcnik, 2007). The recent explanation is shifted toward the role of firm heterogeneity. In particular, the recent study by Amiti & Davis (2011) lays down theoretical ground connecting wages paid, firm performance and trade policy. That is, firms with different performance would pay different wage and their performance is related to whether and how firms are globally integrated, i.e. export final goods and import intermediates. This is to a certain extent related to policy stance toward trade liberalization.

On par, global production sharing is highlighted as a main cause of the persistence of wage premium in developed countries (Feenstra & Hanson, 1996, 1997, 1999, and 2003).

[3]See details in Revenga (1997), Hanson & Harrison (1999), Feliciano (2001), Attanasio, *et al*. (2004), Currie & Harrison (1997), Topalova (2004) and Wacziarg & Seddon (2004). Noticeably the results are largely based on Latin American experience.

[4] It was the unskilled labor-intensive sectors like that were protected the most prior to trade reform. When trade liberalization takes place, inflated demand for unskilled workers as a result of protection is diminished. Hence, the wage premium would increase. See Hanson &Harrison (1999) and Robertson (2000; 2004) for Mexico; Currie & Harrison (1997) for Morocco; Attanasio, *et al*. (2004) for Colombia.

The global production sharing is referred to a circumstance where the whole production processes are divided into separated stages and economically allocated in many locations according to competitiveness. Given the fact that developed countries are relatively endowed by skilled labor as opposed to developing ones, this would positively affect the relative demand for workers in the former. Empirical studies in this area is lopsided, most of which examine the impact on developed countries. The effect on developing countries is both theoretically and empirically unknown. In theory this could either narrow or widen the wage premium in developing countries. As postulated in the standard HO theory, activities located in developing countries as a result of global production sharing would be unskilled-labor intensive so that participating to the global production sharing would raise demand for unskilled workers and narrow the wage premium. On the other hand, despite being regarded as unskilled-labor intensive in the context of developed countries, activities could be skilled-labor intensive in the developing countries. In other words, developing and developed countries could face different cones of production. Therefore, global production sharing could induce more demand for skilled workers as opposed to that for unskilled ones in both developing and developed countries simultaneously. The impact on developing countries' labor market is immense policy relevant as there is growing concern in developing countries' policymakers that participating in the global production sharing could make their enterprises to be trapped in low-skilled or low quality workers and retard technological advancement.

To the best of our knowledge so far, the role of firm heterogeneity and global production sharing are yet brought under the common framework. Besides, research on wage premium persistence has so far paid less attention on East Asia relative to developed countries or Latin-American developing countries. Against this backdrop, this study aims to examine the determinants of the wage premium by using plant level data of Thai manufacturing as the case study. This study is distinct from previous studies by incorporating the effect of global production network along with trade liberalization in determining the wage premium. Three alternative measures of global production network are used to ensure the robustness of our results while carefully controlling for firm and industry specific factors.

Thailand is the excellent case study for the issue in hand for at least two reasons. First, Thailand has been long engaged into the global production network by

multinational enterprises. This would have impact on the relative demand for unskilled and skilled workers as well as the wage skill premium in the country. Secondly, despite substantial progress in trade liberalization observed in the past two decades, many remain to be done. The tariff peak remains unchanged, suggesting protection varies across sectors. Such protection pattern across sectors is partly influenced by tariff escalation structure, the key policy implication of import substitution industrialization ideology. Tariff on finished products are still higher than that on intermediate products. Thus, further liberalization on both input and output would still have some implication on allocation of skilled and unskilled labor.

The rest of the paper is organized as follows. Section 2 presents analytical framework of determinants of the wage skill premium. The brief discussion of the wage skill premium in Thailand is presented in Section 3. Section 4 discusses the empirical model while data and variable measurements are in Section 5. Section 6 discusses our empirical results. Last section presents conclusions and policy inferences.

2. Analytical Framework

This section lays down analytical framework illustrating the effect of global production sharing and the wage premium. The standard neo-classical trade model postulates that opening up to the international trade would lead to specialization across countries according to their comparative advantage. For developing countries whose comparative advantage is determined by abundance of unskilled workers, opening up to international trade would raise price of unskilled worker-intensive goods due to export opportunity. In contrast, these countries would experience a decline in price of the skilled-labor intensive products as a result of import surge. Changes in the relative price would affect the relative demand for skilled and unskilled worker. Therefore, it is expected that wage premium between skilled and unskilled workers would decline. This would generate a favorable effect on income equality.

Such theoretical postulation is not always supported empirically. In some cases, the gap was even widened (Goldberg & Pavcnik, 2007; Davis & Mishra, 2007). Earlier

explanations of the persistence of wage premium emphasize fiction in labor market that constrains resource reallocation and the structure of protection. Nonetheless, they could not be satisfactory in explaining the persistence of wage premium observed. For example, imperfect labor mobility could be at best the short-run phenomenon and be less important over time. It is unlikely to be different across firms. Interestingly, the premium is also observed not only at the economy-wide level, but also within industries and within firms (Pavcnik, *et al.* 2004; Verhoogen, 2008).

The research direction is shifted toward firm heterogeneity. Pioneered by Melitz (2003), the firm heterogeneity literature raises possibility that firms in a given industry can have different productivity and so behave noticeably different, including wage paid to their workers. The link between firm heterogeneity is explicitly pronounced in the general equilibrium framework developed by Amiti & Davis (2011).[5] While the model workhorse is based on Melitz (2003) where firms' productivity is not unique, Amiti & Davis (2011) add two additional features into the general equilibrium model. The first feature is the fair-wage constraint to create link between wages paid and firm performance. In the fair-wage constraint, workers employed in the high productivity firms tend to receive higher wages. The second feature in Amiti & Davis (2011: 5) is firms' productivity and modes where firms are globally integrated, i.e. export final goods, import intermediates, or both. The key theoretical proposition in Amiti & Davis (2011) is wage paid by firms exporting final goods, importing intermediates and doing both is higher than those without the direct link to the global.

Another branch of literature focuses the effect of participating in global production sharing. As mentioned above, global production sharing refers to a circumstance where the whole production processes are divided into separated stages and economically allocated in many locations according to competitiveness. There are three phases in the global spread of production sharing (Athukorala, forthcoming). It begins with two-way exchange between home and host country where parts and component assembly/testing in the host country to be incorporated in final assembly in the home country. The next phase is component assembly networks encompassing many host countries whereas R&D, final assembly and head-quarter functions are still in the home country. The final

[5] This study also conducts empirical analysis, using Indonesian manufacturing

phase is the full-fledged production networks involving component production/assembly/tenting and final assembly encompassing host countries. In the last phase, R&D and head-quarter functions only perform predominantly in the home country. This would affect the relative demand for skilled and unskilled workers in countries participating in the global production sharing.

The effect of relative worker demand in the developing countries is ambiguous. On the one hand, relatively unskilled-labor intensive activities would be located in developing countries according to their comparative advantage. When specialization in global production network continues, the wage gap between unskilled and skilled workers would be narrow down. Nonetheless, the discussion above is under the implicit assumption that there is a single production cone where there would not be any factor intensity reversal and firms in developed and developing countries are facing the same factor endowment vector. In reality, a number of studies point such an assumption is rather restrictive (Leamer & Levinsohn, 1995; Feenstra, 2004; Leamer, *et al*., 2005; Kiyota, 2012). For 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 Norridegewock, Maine. Operation there is full with computerized equipment. This is a far cry from the plants in Asia and China in particular which using traditional production technology and rely heavily on workers. Therefore, for any given activity, it can be regarded as unskilled in the North but skilled labor intensive in the South. Unskilled labor intensive activities outsourced by firms in developed countries might require relative skillful workers in developing countries to perform.[6] Therefore, it is possible that demand for skilled to unskilled workers increases in both developing and developed countries simultaneously so that the wage gap is persistently observed.

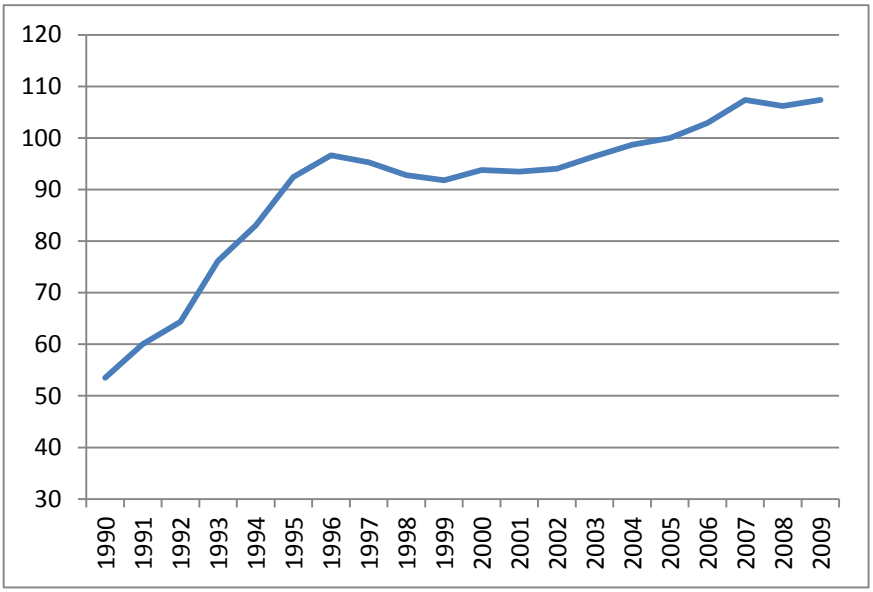
[6] See the similar evidence in Isaacsan (2011: Chapter 41), the conversation between US President Barak Obama and Apple Inc. CEO Steve Job. Particularly, Apple had 700,000 factory workers employed in China, he said, and that was because it needed 30,000 engineers on-site to support those workers. "You can't find that many in America to hire", These factory engineers did not have to be PhDs or geniuses; they simply needed to have basic engineering skills for manufacturing". Such factory engineers are unlikely to be unskilled workers in China as well.

3. Wage Premium in Thai Manufacturing

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

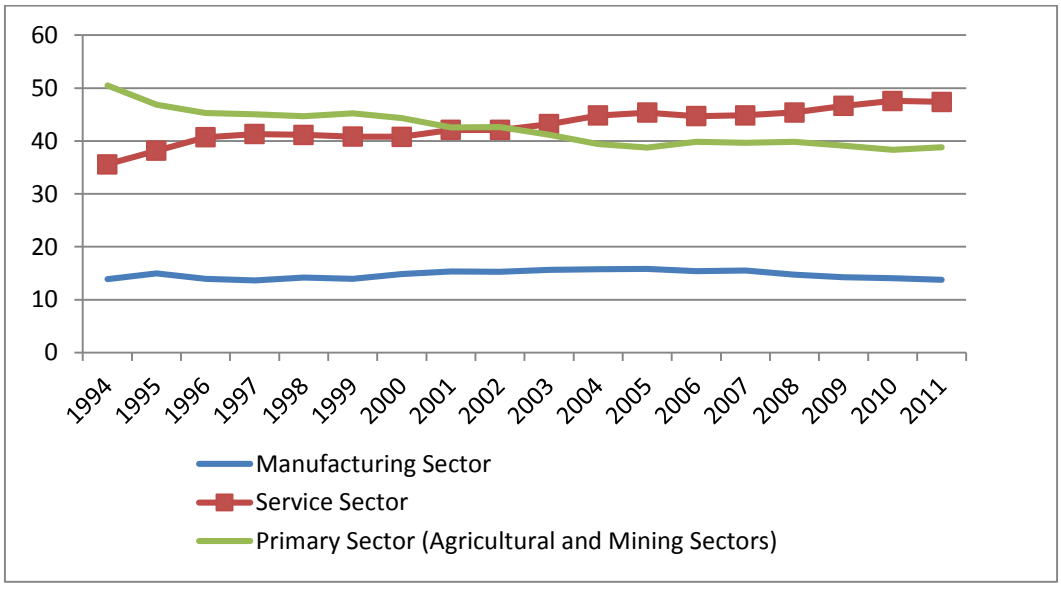
Figure 1 illustrates (real) wage pattern in Thailand between 1990 and 2009. Real wage in Thailand grew at the relatively rapid rate between 1990 and 1996, the pre-crisis era. The annual growth rate was 10.4 per cent during this period. As a result, Thai baht experienced real appreciation, deteriorating international competitiveness and eventually causing the economy to be succumbed to the crisis in 1997/98. When the economy experienced the 1997/98 crisis, real wage dropped. Not until 2000, real wage has grown noticeably. From 2002 and 2009, the real wage grew at 1.7 per cent and showed a noticeably upward trend.

Figure 1: Wage Pattern in Thailand between 1990 and 2009



The upward trend of real wage in Thailand was associated with the low and declining unemployment rate by developing country standard. In 2011, unemployment rate in Thailand was 0.7 per cent. Such a rate was much lower than the neighbors in Southeast Asia, e.g. Malaysia (3 per cent), Indonesia (6.6 per cent), Vietnam (2.0 per cent). This rather suggests the tightening labor market condition in Thailand.[7] Interestingly, patterns of employment share by sectors (i.e. agriculture, manufacturing and service) suggest labor tightening in manufacturing sector is getting more serious. Employment share in the manufacturing sector slighted changed in a small range between 13.6 and 15.8 per cent during the period 1994-2011. It was the service sector absorbing workers from the primary sector (agricultural and mining). In 2011, the employment share of service sector was approaching 50 per cent, increasing from 35.6 per cent in 1994. By contrast, the share of primary sector dropped from 50.5 per cent in 1994 to 38.8 per cent in 2011 (Figure 2).

Figure 2: Employment Share in Thai Economy 1994-2011



Source: Key Indicator of Asia and the Pacific 2012, Asian Development Bank (ADB).

[7] Data for unemployment reported here are the latest available from Key Indicator of Asia and the Pacific 2012, Asian Development Bank (ADB).

Wage differentials across industries in Thailand are observed but limited. Its estimate of diary wage was concentrated in 300-600 baht in 2006. By contrast, wage tends to vary significantly across firms as postulated in the firm heterogeneity literature. Table 1 shows a simple regression in order to illustrate statistical relationship between wage and several firm characteristics such as size, whether firms import intermediates, whether firms export.[8] The observed pattern is larger plants and those engaged with international activities (either export or import) pay higher wage for production workers (henceforth referred to blue collar workers) than domestically-oriented ones within industries even after controlling for the skill share among production workers (Columns A and B in Table 1).

Table 1: Wage Across Firms in Thai Manufacturing in 2006

	Production Workers		Non-production workers	
	A	B	C	D
	Without Industry Dummies	With Industry Dummies	Without Industry Dummies	With Industry Dummies
Intercept	8,89	9,87	8,07	8,7
	-349,5	-24,1	-47,51	-13,6
Export share	0,001	0,002	0,002	0,002
	-6,27	-9,45	-8,07	-7,5
Import share	0,004	0,002	0,004	0,003
	-16,6	-10,2	-11,3	-9,73
Size (output)	0,11	0,09	0,051	0,054
	-75,6	-61,8	-17,6	-17,9
Skillshare	0,28	0,12		
	-22,1	-10,1		
Wage of production workers			0,24	0,19
			-15,8	-12
Ad-R^2	0,2574	0,41	0,09	0,1102

Source: Authors' Calculation.

[8] The regression does neither aim to estimate wage determination-Mincer-styleequation and nor infer the causality relationship of wage and other key firm-specific characteristics. It is mainly used for statistic discussion only.

When non-production workers (henceforth referred to white collar workers) are concerned, the similar regression exercise is applied. That is, wage of white collar workers is regressed with size, mode of engaging international activities, and wage of blue collars. The latter is introduced to see whether wage of non-production workers is generally higher than that of production workers. The results in Columns C and D in Table 1 are to a large extent similar to Columns A and B where large plants and those engaged with international activities (either export or import) pay higher wage than domestically-oriented ones within industries. In addition, non-production workers tend to receive higher wage than production workers. In other words, wage premium exists in Thai manufacturing.

Figure 3 presents the scatter plot illustrating difference in wage paid and types of employed workers across industries according to the extent to which they are engaged to 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 to global production sharing.[9] In Figure 3a, there is to a certain extent positive relationship between the wage gap and the share of parts and component imports across industries. This suggests that the wage gap tends to be higher as industries are increasingly engaged into 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 less clear (Figure 3b).

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

Figure 3a: Ratio of Non-production to Production Wage

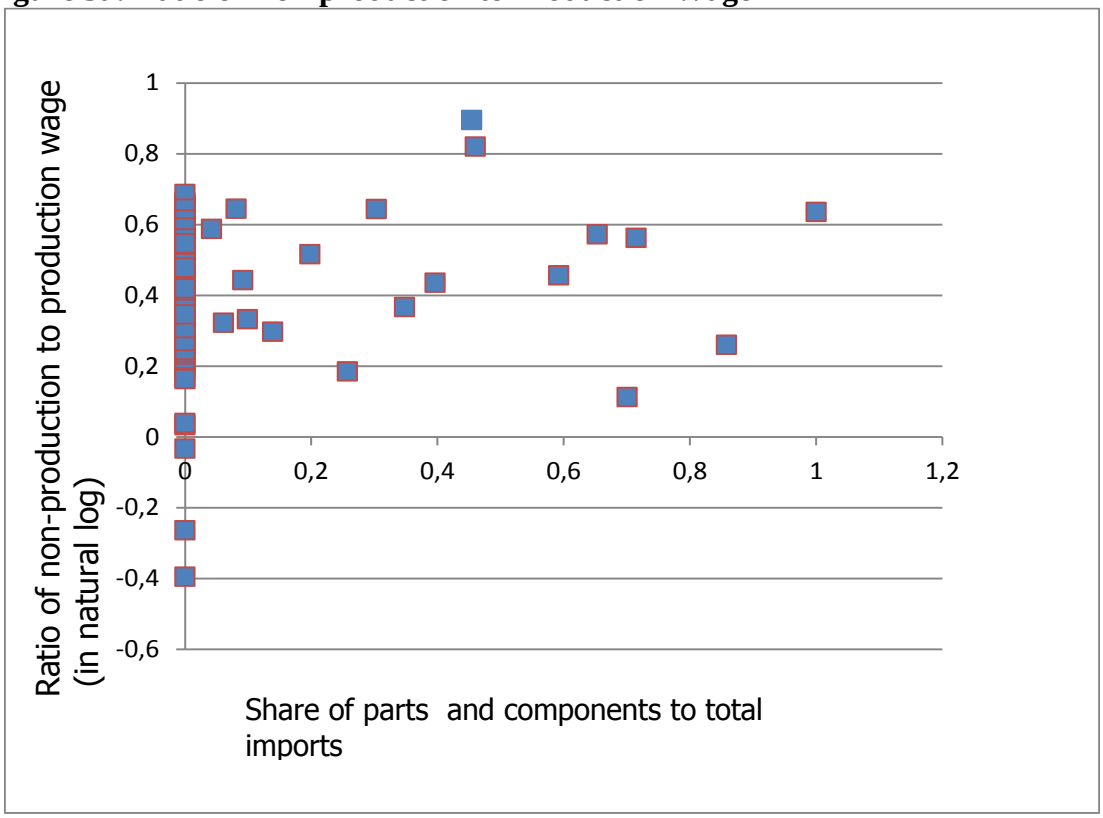
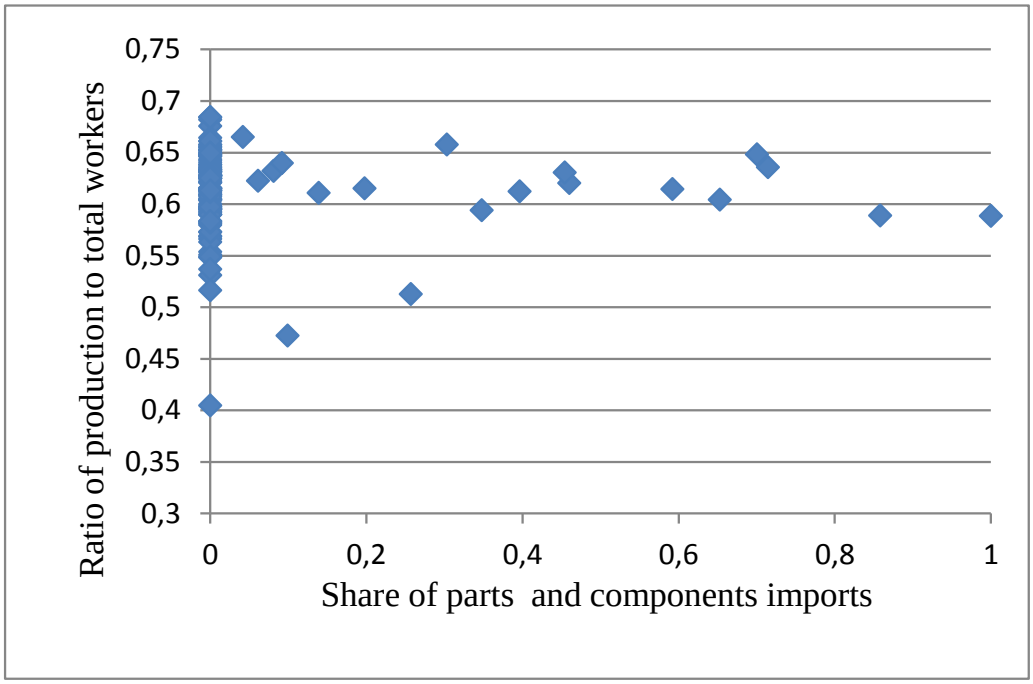


Figure 3b: Ratio of Production to Total Workers Across Industries



4. The Empirical Model

The empirical model employed in Amiti & Cameron (2012) is used as a point for departure. That is, the wage premium (*Ws/Wu*), the ratio of wage compensation of skilled worker to unskilled workers is a function of a set of firm specifics including size ($output_{i,j}$), export ($EX_{i,j}$) and import ($IM_{i,j}$) status, firms' ownership ($FOR_{i,j}$).[10] In addition, three additional firm-specific variables are introduced. They include the level of fixed asset stock capturing the degree of capital deepening at the plant level, the ratio of female to total worker to examine any possible gender bias, and the region which equals to 1 for Bangkok and Vicinity and 0 otherwise.

Since the definition of blue and white collar workers in micro dataset can vary from one to others, dataset-specific aspect in this regard must be taken into consideration. For Thailand's industrial census 2006, a number of blue collar workers employed at the plant are further disaggregated into skilled and unskilled blue workers. The former refer to supervisors who have long experience and are skillful to look over production lines so they should be regarded as white collars. Unfortunately, in the dataset, wage compensations paid to the operation workers are not separated and makes impossible to re-define more precise wage compensation of true white collar. Hence, to mitigate this problem, $skillshare_{i,j}$, the ratio of skilled to total operation worker, is introduced as one controlling firm-specific variable for the wage premium equation. The higher value of $skillshare_{i,j}$ implies that the denominator in the wage premium includes some belonging to actual skilled workers.

Similar to Amiti & Cameron (2012), input and output tariffs are separated in determining possible different effect of input and output trade liberalization on the wage premium in this paper. As argued in Amiti & Cameron (2012) when domestically-produced inputs are perfectly substitutes by imported ones and input production is more skilled worker intensive, cutting input tariffs encourages firms to import instead of buying locally-produced ones. This would reduce demand for skilled workers and, *certaris*

[10] Note that in Amiti & Cameron (2012) the model also includes government ownership perhaps due to the fact that state-owned firms seem to be relevant for Indonesia. By contrast, state-owned firms in the manufacturing sector in Thailand were rare so it is excluded in our model.

paribus, the wage premium would be narrower. The effect of output tariff would have the same effect, i.e. reduction in output tariff resulting in a decline in the wage skill premium. However, it is possible that reduction in output tariff would not have any significant impact because of the switching effect taking place when firms are to shift production between multiple products with different factor intensity. Otherwise, firms must continue in business due to presence of sunk and fixed cost in export business. Interaction terms these trade liberalization variables with the extent to which firms are engaged to the international business (export and import) are introduced. The positive sign is expected for these interaction terms on the wage skill premium.

As mentioned in Section 2, engaging into the global production sharing can have an implication on the wage skill premium. Ideally, to capture the effect of global production network $\left(GPN_j\right)$ on wage premium, details at firm level (e.g. whether firms are actually engaged to MNEs' production network, whether they import tailor-made raw materials for specific customers, etc.) are needed. Unfortunately, such details at the firm level are not available for Thai dataset.

In this study, therefore, three alternative proxies are used; First, the share of parts and component imports to total imports $\left(GPN1_j\right)$ is used to indicate the extent to which an industry is engaged into the production network. The higher the imported share, the more important the global production network on the industry. Parts list is a result of a careful disaggregation of trade data based on the Revision 3 of the Standard International Trade Classification (SITC, Rev 3) extracted from the United Nations trade data reporting system (UN Comtrade database).[11] 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. Parts list used here is from that developed in Athukorala & Kohpaiboon (2009).[12] To convert SITC to ISIC, the standard concordance is applied.

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[11] For details on the decomposition procedure, see Athukorala (2005). The list of parts and components is available on request.

[12] Using lists of parts in Board Economics Classification (BEC) 42 and 53 as a point to departure. Note that parts in BEC 211 are not included as they are primary products which are usually classified as traditional rather than fragmented-intermediates.[12] Additional lists of parts are included based on firm interview in Kohpaiboon (2009). 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 interview in Kohpaiboon (2009).

Second, the ratio of parts trade (the sum of imports and exports) to total goods trade is used $\left(GPN2_j\right)$. This is due to the fact that firms might be engaged into the global production network as parts suppliers, focusing on parts import might mislead to a certain extent. Using trade instead of import would mitigate such a problem as well as acts as the robustness check for GPN proxy.

Third, zero-one dummy variable $\left(GPN3_j\right)$is used. The dummy variable equals to one for industries in electronics, electrical appliances, and automotive [13] and zero otherwise., It is these three industries, in which global production network takes place intensively as suggested by previous empirical studies (Athukorala, forthcoming; Kohpaiboon & Jongwanich, 2013).

As argued in Kohpaiboon (2009) and Kohpaiboon & Jongwanich (2013) based on the firm-case study analysis in Thailand, benefits firms could gain from the network are not automatic, largely depending on how active firms participate. Some firms gain substantial benefits from the network and smoothly move up from relatively simple to more complicated activities. Simultaneously there are the others that are trapped to a relatively simple unskilled-worker intensive activity. This would have significant impact of relative demand for skilled and unskilled workers. To examine this argument, the interaction term between $GPNi_j$ and $skillshare_{i,j}$ is introduced. $skillshare_{i,j}$ is used as a proxy to measure how active the firm participates in the network. That is, the higher the number of employed skill blue collar workers, the more active the firm. The positive sign of the interaction term is expected. All in all, the overall impacts of engaging into the global production network also depend on the proportion of skilled and unskilled workers varying across firms.

The final departure from Amiti & Davis (2012) is to introduce two additional industry-specific factors instead of heavily relying on industry-specific dummy.[14] The first one is industrial concentration (CR_j). In general, industries with high barriers to entry are likely to be concentrated as it would be relatively more difficult for new entrants to

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

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

involve. Such industries are often capital and/or skilled intensive. Hence, in the highly concentrated industry, demand for skilled workers would be higher and the wage premium is observed. On the other hand, the effect of industrial concentration could be negative. As argued in the firm heterogeneity literature, productivity could vary across firms in a given industry. Over the period, low productivity firms would be faded out so that the observed industrial concentration would be the outcome that only high productive firms are operating. This could occur in the unskilled-worker intensive industry where developing countries like Thailand gain international competitiveness. In this study, industrial concentration is measured by the sum of sale share of top-4 firms to total.

Theanother industry-specific variable is output growth ($GROWTH_j$) and its interaction with $skillshare_{i,j}$ to capture dynamics in labor movement. In general, in industries which experience rapid output expansion, there would be greater demand for inputs including labor. Arguably it would be relatively easier for firms in a rapid-expansion industry to hire unskilled workers relative to skilled ones so that the negative sign would be expected. To test this hypothesis, both output growth ($GROWTH_j$) and its interaction with $skillshare_{i,j}$. The hypothesis would hold if the coefficients associated with output growth ($GROWTH_j$) and its interaction with $skillshare_{i,j}$ are negative and positive, respectively. That is, while output growth tends to narrow the wage premium, the impact on wage premium is less for the relatively skilled worker intensity.

All in all, the empirical model employed in this study is as followed;

$$\begin{aligned}(W_s/W_u)_{i,j} = {} & \alpha_0 + \alpha_1 inputtariff_j + \alpha_2 input\_IM_{i,j} + \alpha_3 outputtariff_j + \alpha_4 output\_EX_{i,j} \\ & + \alpha_5 GPN_j + \alpha_6 GPN\_Skillshare_{i,j} + \alpha_7 SIZE_{i,j} + \alpha_8 EX_{i,j} + \alpha_9 IM_{i,j} \\ & + \alpha_{10} Capital_{i,j} + \alpha_{11} FOR_{i,j} + \alpha_{12} femaleratio_{i,j} + \alpha_{13} Skillshare_{i,j} + \alpha_{14} region_{i,j} \\ & + \alpha_{15} CR_j + \alpha_{16} Growth_j + \alpha_{17} Growth_j\_Skillshare_{i,j} + \varepsilon_{i,j}\end{aligned}$$

where

$(W_s/W_u)_{i,j}$ = the wage premium of firm *i* in industry *j*, measured by the ratio between

wage compensation per workers of non-operation to operation workers (in
natural logarithm)

$inputtariff_j$ (+) = Tariff on raw materials in industry j

$input\_IM_{i,j}$ (+) = Interaction term between input tariff and the share of raw material imports of firm i in industry j

$outputtariff_j$ (+) = Tariff on finished products in industry j

$output\_EX_{i,j}$ (+) = Interaction term between output tariff and export share of firm i in industry j

GPN_j (?) = Degree that industry *j* is engaged into the global production network[15]

$GPN\_skillshare_{i,j}$ (+) = Interaction term between degree that industry engaged into the global production network and labor skill share

$SIZE_{i,j}$ (+) = size of firm *i* in industry *j* measured by output (in natural logarithm)

$EX_{i,j}$ (+) = the share of exports of firm *i* in industry *j*;

$IM_{i,j}$ (+) = the share of raw material imports of firm *i* in industry *j*;

$FOR_{i,j}$ (+) = foreign ownership of firm *i* in industry *j*; (1 = foreign firms; 0otherwise)

$Capital_{i,j}$ (+) = Capital of firm i in industry j (in natural logarithm)

$female\_male_{i,j}$ (+) = The ratio of female to male workers

$Skillshare_{i,j}$ (-) = Ratio of skill operational workers to total operation workers of firm *i* in industry *j*

$region_{i,j}$ (-) = Location of firm i in industry j (1 = Bangkok and Vicinity; 0 otherwise)

CR_j (?) = Industrial concentration of industry *j*, measured by the share of top-4 output
plants to total plants in industry *j*.

$GROWTH_j$ (-) = (Real) Output growth of industry *j*

$\varepsilon_{i,j}$ = Disturbance terms of firm *i* in industry *j*

[15] See full discussion of the variable measurement in Section 3.

5. Data

Data for the study are compiled from unpublished returns to the Industrial Census 2006, the latest industrial census available, conducted by the National Statistics Office (NSO). A well-known limitation of the cross-sectional data set with each industry representing a single data point is that they make it difficult to control for unobserved industry specific differences. Long-term averages tend to ignore changes that may have occurred over time in the same country. These limitations can be avoided by using the panel data set compiled by pooling cross-industry and time-series data. Particularly, when our key interest is the wage premium, panel data at firm level with a comprehensive information on wage compensation and workers at the disaggregate level, i.e. workers are properly classified by unskilled, skilled, scientists and office workers.

Unfortunately, given the nature of data availability in this case, this preferred data choice is not possible. So far there are two industrial census sets, i.e. 1996 and 2006, both are establishment-level data. Even though both of them provide establishment identification number, the number is not assigned systematically. For a given ID No., an establishment in 1996 is not necessarily the same as that in 2006.

The census covers 73,931 plants, classified according to four-digit industries of International Standard of Industrial Classification (ISIC). The census was cleaned up by firstly checking duplicated samples. As occurred in the 1996 industrial census, there are some duplicated records in survey return, presumably because plants belonging to the same firm filled the questionnaire using the same records. The procedure followed in dealing with this problem was to treat the records that report the same value of the eight key variables of interest in this study, are counted as one record. The eight variables are registered capital, number of male workers, number of female workers, sale value, values of (initial and ending periods) capital stocks, value of intermediates and initial stock of raw materials. There are 7,992 such cases so that the final sample drops to 65,940 plants.[16] In addition, we delete establishments which had not responded to one or more the key questions such as sale value, output and which had provided seemingly unrealistic

[16] For robustness check, we alter the criteria from 8 to 7 variables (excluding initial raw materials), the number of duplicated samples slightly increase to 8,067 samples. Hence, we strict with our initial criteria to maintain as much samples as possible in our analysis.

information such as negative output value or the initial capital stock of less than 5,000 baht (less than $200).[17]

The 2006 census contains a large number of micro-enterprises defined as the plants with less than 10 workers. There are 39,152 samples which employ less than 10 workers, out of which 52 per cent of which are micro enterprises which do not hire paid workers (zero paid workers). The problem of self-employed samples is less severe when considering the 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 (7) industries that are either to serve niches in the domestic market (e.g. processing of nuclear fuel, manufacture of weapons and ammunition), in the service sector (e.g. building and repairing of ships, manufacture of aircraft and spacecraft, and recycling) or explicitly preserved for local enterprises (e.g. manufacture of ovens, furnaces and furnace burners, manufacture of coke oven products) are excluded. All in all, these remained establishment plants accounted for 75% of the Thailand's manufacturing gross output and 62% of manufacturing value added in 2006.

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

Gross output and its corresponding price deflators are from National Economics and Social Development Board (NESDB). The annual growth rate is based on gross output at constant price (1988). Trade data are compiled from UN Comtrade and the standard concordance between ISIC and HS is used. Nominal rate of protection is fresh calculated in this study based on official data provided by Custom Duty, Ministry of Finance. *CR4*

[17] If we alter to 10,000 baht the number to be dropped increased to 1,289 samples (another 500 samples dropped).

is obtained from Kophaiboon & Ramstetter (2008) in which the concentration is measured at the more aggegrate level (e.g. many measured at the 4-digit whereas some at the 3-digit ISIC classification) 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 high level of disaggregation.

Our tariff data is at the 6-digit HS code level. To calculate tariff on raw material, concordance between 6-digit HS code level and input-output table is developed. The weight of inputs in each product is calculated by using information from IO table. The formula to calculate input tariff is as follows:

$$inputtariff_i = \sum_{i=1}^{n} a_{ij} t_i$$

where t_i = nominal tariff on product i^{th}

$\sum_{i=1}^{n} a_{ij}$ = the sum of the shares of intermediate inputs (1, …, n) in the output value of product j^{th}

Since the data from the industrial census is based on the TSIC classification, concordance between input-output and TSIC classifications is developed to obtain the input and output tariff in each industry. Tables 2 and 3 provide a statistical summary as well as a correlation matrix of all relevant variables in this analysis.

Table 2: Statistic Summary of the Variables used in the Econometric Analysis

	# Obs	Mean	Standard Deviation	Min	Max
$(Ws/Wu)_{ij}$	10757	0,7	0,59	0	5,47
EX_{ij}	24865	9,34	25,15	0	100
IM_{ij}	24865	8,06	21,44	0	100
FOR_{ij}	21813	1,08	0,28	1	2
$SIZE_{ij}$	21813	15,83	3,65	0	25,16
$Skill\_share_{ij}$	21813	0,69	0,4	0	1
$GPN1_j$	21813	0,02	0,09	0	1
GPN2j	21813	0,02	0,08	0	1
GPN3j	21813	0,06	0,23	0	1
$Female\_share_{ij}$	23851	0,54	0,29	0	1
$Capital_{ij}$	24865	15,41	2,52	8,52	24,51
$region_{ij}$	24865	0,63	0,48	0	1
$inputtariff_j$	24865	0,04	0,02	0,002	0,11
$outputtariff_j$	24865	0,06	0,06	0	0,3
CRj	21730	0,53	0,16	0,02	1
GROWTHj	21730	0,06	0,07	-0,18	0,31

Source: Authors' Calculation

Table 3: Correlation Matrix of The Variables used in the Econometric Analysis

	$(Ws/Wu)_{ij}$	EX_{ij}	IM_{ij}	FOR_{ij}	$SIZE_{ij}$	$Skill\_share_{ij}$	$Female\_share_{ij}$	$Capital_{ij}$	$inputtariff_j$	$outputtariff_j$	$GPN1_j$	$GPN2j$	$GPN3j$	CRj	$GROWTHj$	$region_{ij}$
$(Ws/Wu)_{ij}$	1,00															
EX_{ij}	0,09	1,00														
IM_{ij}	0,08	0,33	1,00													
FOR_{ij}	0,05	0,32	0,32	1,00												
$SIZE_{ij}$	0,08	0,27	0,23	0,23	1,00											
$Skill\_share_{ij}$	-0,05	0,00	-0,01	0,01	-0,07	1,00										
$Female\_share_{ij}$	0,09	0,23	0,08	0,06	-0,02	-0,03	1,00									
$Capital_{ij}$	0,08	0,29	0,25	0,29	0,55	-0,08	-0,01	1,00								
$inputtariff_j$	0,00	0,06	0,06	0,10	0,12	-0,01	-0,11	0,09	1,00							
$outputtariff_j$	-0,02	0,01	0,05	0,05	0,04	0,03	-0,15	0,00	0,39	1,00						
$GPN1_j$	0,01	0,08	0,09	0,10	0,09	-0,01	0,02	0,05	0,22	0,08	1,00					
$GPN2j$	0,01	0,06	0,11	0,11	0,08	0,01	0,01	0,06	0,22	0,13	0,91	1,00				
$GPN3j$	-0,01	0,06	0,14	0,14	0,07	0,03	-0,08	0,07	0,38	0,15	0,04	0,06	1,00			
CRj	0,00	0,01	0,11	0,05	-0,02	0,06	0,04	-0,03	0,05	0,14	0,07	0,08	0,24	1,00		
$GROWTHj$	-0,05	-0,09	0,00	0,06	0,00	0,02	-0,23	0,03	0,15	0,22	0,08	0,16	0,17	-0,01	1,00	
$region_{ij}$	0,05	-0,02	0,10	0,06	0,10	0,02	0,04	0,04	-0,01	0,01	-0,01	0,04	0,08	0,14	0,07	

Source: Authors' Calculation.

6. Results

The equations are estimated using the ordinary least squares (OLS) method while paying attention to the possible presence of outliers as well as the performance in functional form. Cook's Distance is applied here to identify suspected outliers. Table 4 provides all the estimation results. In general, all equations in Table 4 perform well in the overall fitness (Wald/F-test). The results with and without the Cook's Distance detected outliers are not much different except minor changes in statistical significance. Three alternative proxies of global production network yielded basically comparable results. The following discussion focuses on the results based on the trade share of parts and components to total $(GPN1)$. This choice was made on the basis of the better performance on overall fit.

The intercept is positive and statistically significant in all cases, suggesting that the wage skill premium is persistent. Wage compensation paid for white collar workers is on average 38-43 per cent higher than that for blue collar ones, given the other controlling factors.

The coefficient on output tariff is positive and statistically significant. The wage premium is relatively high in firms operating under the high output tariff. This would reflect unfinished business in tariff restructuring in Thailand. Despite targeting 3 tariff rates (0-1, 5 and 10 per cent), there are more than one forth of tariff lines yet in the 3 rates structure. When we examine top 20 in terms of output, they are rather capital intensive where there would be more demand for skilled workers. This finding is in line with neo-classical trade model, opening up to the international trade would lead to specialization across countries according to their comparative advantage. A coefficient on the interaction term with export share is statistically insignificant. This would not be surprised. In an industry where firms already export, output tariff is quite low. They are not capital intensive as opposed to those subject to heavy tariff protection.

Table 4: Estimations of Three Alternatives of Global Production Sharing Measures

	GPN1				GPN2				GPN3			
	with outliers		without outliers		with outliers		without outliers		with outliers		without outliers	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Intercept	0.43***	7,02	0.33***	7,11	0.42***	7	0.32***	7,05	0.42***	6,84	0.32***	7,02
$inputtariff_{j}$	-0,18	-0,61	-0.36*	-1,54	-0,181	-0,61	-0.35*	-1,48	-0,140	-0,45	-0.38*	-1,57
$inputtariff_{j*}IMij$	0,02	1,37	0.02**	2,08	0.015*	1,34	0.015**	1,97	0.015*	1,39	0.02***	2,75
$outputtariff_{j}$	0.17**	1,62	0.17**	2,08	0.17*	1,6	0.16**	2	0.18*	1,62	0.16**	1,99
$outputtariff_{j*}EXij$	0,00	0,19	0,00	-0,46	0,001	0,18	-0,001	-0,48	0,001	0,19	-0,001	-0,22
GPNij	-0,09	-0,93	-0.10*	-1,52	-0,038	-0,32	-0.13*	-1,37	-0,047	-0,88	-0.10***	-3,31
*GPNij*Skill_shareij*	0.21**	1,59	0.23***	2,56	0,162	1,03	0.28***	2,32	0,066	1,04	0.10***	2,64
SIZEij	0.01***	3,8	0.01***	8,89	0.009***	3,8	0.015***	8,99	0.01***	3,86	0.015***	9,16
EXij	0.001***	3,22	0.001***	3,41	0.001***	3,23	0.001***	3,26	0.001***	3,22	0.001***	3,1
IMij	0,001	0,98	-0,00004	-0,1	0,001	0,98	0,000	-0,12	0,001	0,97	0,000	-0,44
FORij	0.025**	1,34	0,01	0,5	0.03*	1,34	0,010	0,68	0.026*	1,37	0,013	0,93
$Capital_{i,j}$	0.02***	5,9	0.02***	6,1	0.02***	5,9	0.015***	5,89	0.021***	5,87	0.015***	5,77
$Female\_share_{,j}$	0.06***	6,41	0.06***	9,35	0.06***	6,37	0.063***	9,09	0.062***	6,44	0.064***	9,3
Skill_share i,j	-0.12***	-5,32	-0.12***	-6,58	-0.1***	-5,22	-0.11***	-6,46	-0.12***	-5,26	-0.11***	-6,44
$region_{i,j}$	-0.12***	-6,18	-0.05***	-3,55	-0.1***	-6,2	-0.051***	-3,66	-0.12***	-6,18	-0.052***	-3,76
CRj	-0.07***	-2,07	-0.06***	-2,28	-0.07**	-2,09	-0.06**	-2,07	-0.07**	-1,96	-0.054*	-1,91
GROWTHj	-0.55***	-3,04	-0.65***	-5,04	-0.55***	-3,02	-0.64***	-4,83	-0.53***	-2,9	-0.61***	-4,69
*GROWTHj*Skill_share i,j*	0.41**	1,83	0.56**	3,45	0.4**	1,77	0.53***	3,21	0.39*	1,73	0.50***	3,09
# of Obs	10636		10085		10636		10113		10636		10098	
R2	0,0469		0,0504		0,0468		0,049		0,0467		0,0517	
F-stat	28.37(p=0)		37.55(p=0)		28.42(p=0)		36.33(p=0)		28.64(p=0)		38.5(p=0)	
RESET	1.68(p=0.1699)		2.17(p=0.0897)		1.63(p=0.1799)		2.22(p=0.0832)		2.16(p=0.0901)		3.04(p=0.028)	

Notes: t-stat is based on robusted standard error; *, **, and *** indicate the statistical significant level at 10,5 and 1 per cent, respectively.
Source: Authors' Calculation

Note that the interaction term between output tariff and export share ($output\_Ex_{i,j}$) is positive but statistically insignificant. This could be a result of a larger reduction of tariff in sectors with a high proportion of unskilled workers so that in those sectors, domestic prices are long approaching to world prices. Incentives for resource allocation between export and firms who sell their products only in domestic markets are not significantly different. The wage skill premium between these firms is statistical indifferent.

When input tariff is concerned, the positive sign is found only when the input tariff is interacted with import share. It indicates that input tariff would have effect only on firms who actually import intermediates from abroad. The positive sign suggests that as intermediates are capital/skilled labor intensive so that firms which import them demand skilled workers are less. Lower tariff encourages firms to import intermediates.

The coefficient associated with GPN1 is negative and statistical significance while the interaction term between GPN1 and the share of skilled workers ($GPN1\_skillshare_{i,j}$) is positive and significance. The negative sign on the network variable with the positive sign on the interaction term would suggests that it is not necessary for plants in the network would have greater demand for skilled workers. They can be at the unskilled-labor intensive segment. This could cause worrisome for policymakers for being trapped in the low-end segment. However, plants which put greater effort tend to move up and demand for more skilled workers. On average, when we use the mean value of skill share in Thailand, we find the small positive value of the wage skill premium as a result of engaging into the network. This raises attention to policymakers in supplying adequate skilled workers available to ensure the sustainable development while participating into the global network.

In line with the firm heterogeneity literature, firm-specifics have significant on the wage premium. All these variables but importer and foreign ownership are statistically significant at the 1% per cent or better and in line with the previous studies. The wage skill premium in firms engaged to the global economy is generally higher than that in those entirely domestically oriented. Interestingly, exporting firms have higher wage premium than importing ones. Such asymmetry would be due to the fact revealed in a

number of case studies[18] that there are extra activities for firms engaging international market. A number of extra activities tend to higher for exporting firms, including negotiating with customers, bargaining, and overcoming day-to-day problems in the production line, arranging delivery schedules, and after-sale services. Generally, firms must hire some professionals with sufficient foreign language ability and invest certain infrastructures (personal computer, internet, satellites, etc.). All of these incur fixed and sunk cost to firms. Such extra activities would be far less for imports as opposed to exports as some activities are shared by their suppliers aboard.

The statistical significance of the firm size variable ($Output_{i,j}$) suggests that the larger the firm, the greater the wage premium observed. The positive sign of capital ($Capital_{i,j}$) reflects firms with having the higher degree of capital deepening would need more skilled worker in order to harness benefits of their capital deepening. This would widen the wage skill premium. As expected, the wage skill premium tends to be higher for rural area. For skilled/higher educated workers, extra wage compensation is needed to work in rural areas. Unskilled workers working in Bangkok and vicinity face higher cost of living so that wage compensation must at least cover it.

We cannot find the difference between foreign and local firms in our analysis. This might be the fact that foreign investment policy in Thailand is long open since the early 1960s. Foreign and local firms interact with each other long for workers. The difference that supposed to have on wage premium disappears. This is especially true after controlling for capital and size in the equation.

The negative and statistically significance of $Skillshare_{i,j}$ is in line with our hypothesis. Due to the way data collected, wage compensation for operation workers partly cover that of skill workers so that the denominator in the wage premium is inflated.

The effect of industrial concentration on the wage premium is found negative and statistically significant at 1 per cent in all cases. The negative estimate suggests that the observed high industrial concentration is the outcome of firm dynamics where top firms are all highly productive. The highly concentrated industry tends to be relatively

[18] See more detail in Kohpaiboon (2006), Kohpaiboon, et al. (2012) and Kohpaiboon and Jongwanich (2012). Such evidence was revealed, based on experience of firms in processed food, garment, hard disk drive, automotive industries. The interview period is between 2004-2012 and the sample covers all firm sizes.

unskilled-worker intensive. Firms in the industry experiencing rapid output expansion (high output growth) tend to have greater demand for workers. To rapidly materialize a growing business opportunity, worker demands are geared toward unskilled ones, thereby narrowing the wage premium. Nonetheless, the positive coefficient associated between output growth and $Skillshare_{i,j}$ suggests that it would be more difficult for already high-skill intensity plants to rely on hiring unskilled workers in response to the output expansion.

7. Conclusion and Policy Inferences

This paper examines the determinants of the wage skill premium, with an emphasis on the effect of global production sharing, one facet of the ongoing globalization, by using firm level data of Thai Manufacturing as the case study. Our results show that the impacts of engaging into the global production network on the wage skill premium varies among firms and tends to be an increasing function of a number of skill operation workers. When we use the mean value of skill share in Thailand, it shows that participation into the network requires more skilled workers than unskilled ones and slightly widens the wage skill premium within firms.

In addition, output tariffs matter in determining the industry wage skill premium across firms in Thailand. The positive result of this variable is in line with neo-classical trade model, where opening up to the international trade would lead to specialization across countries according to their comparative advantage and reduction in the wage skill premium. Reduction in input tariff could help to reduce the wage skill premium but only for firms who import their intermediate input. Our findings also support the important role of firm- and industry-specific factors on the persistence of the wage skill premium.

Our study inference raises policy awareness on managing globalization. While being a part of the global production sharing can bring in various benefits including technology and chance to moving up to more skill intensive activities, it is irrefutable for presence of risk of being trapped in low-end activities. To avoid the trap, the policy focus should be on adequate and qualified skilled workers supply to allow firms to harness benefit from

the global production sharing. The more the skilled workers available, the less likely the firms to be trapped. In addition, it is needed for public information dissemination about pros and cons of being a part of global production sharing as well as systematic case studies of both indigenous winners and losers. This is to avoid misunderstanding and misallocation of resources. Our result is also in favor for continued trade liberalization due to presence of developmental impacts on income inequality.

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