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Trade liberalization and the Wage Premium:

Evidence from Thai Manufacturing

Juthathip Jongwanich

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Faculty of Economics, Thammasat University

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Juthathip Jongwanich*
Faculty of Economics,
Thammasat University, Thailand
E-mail: juthathip@econ.tu.ac.th

Abstract: This paper examines the impacts of trade liberalization on the wage premium using firm level data of Thai Manufacturing as the case study. The tariff protection is applied here to represent trade liberalization, in terms of both nominal and effective tariffs. Output and input tariffs are separately examined for nominal protection while for effective rates of protection (ERP), both a traditional ERP measure and a measure incorporating a possible water in tariffs and the effect of FTAs are applied. In addition to tariff protection, impacts of GVCs, considered through trade in parts and components (P&Cs), on the wage premium is investigated in the study. Our results show that firm-specific factors are more crucial in affecting the wage premium than trade liberalization and participation in global production networks. For trade liberalization, only input tariffs matter in determining the wage premium, but only in a situation where firms actually import while insignificant relationship is observed when either output tariffs or ERPs are employed to reflect trade liberalization. The participation in GVCs also shows insignificant impact on the wage premium. However, wage-employment skills decupling is evident when trade liberalization and participation in global production networks are concerned. That is the wage premium is not influenced by these factors, though they could significantly affect skilled and unskilled workers.

Keyword: Trade liberalization, labour market outcomes, Thailand

JEL Code: F13, F16, O53

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1. Introduction

Trade-wage premium nexus remains the ongoing debate in the context of economic globalization. On the one hand, 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 prices of unskilled worker-intensive goods due to export opportunity while experience a decline in prices of skilled-labor intensive products as a result of import surge. Therefore, it is expected that wage gap between skilled and unskilled workers (henceforth referred to as the wage premium) would decline and generate a favorable effect on income equality (e.g., Bigsten and Durevall, 2006; Kumar and Mishra, 2008; Amiti and Cameron, 2012). On the other hand, a number of empirical evidence (e.g., Galiani and Sanguinetti, 2003; Attansaio et al. 2004; Goldberg and Pavcnik, 2007; Koymen-Ozer, 2020) shows that liberalization increases the wage premium within industries, within firms and at the economy-wide level, especially in developing countries.

In addition to the ongoing debate of trade liberalization on the wage premium, phenomenon of global production networks or global value chains (GVCs) has added issue on developing countries' labor market outcomes. Given the fact that developed countries are relatively endowed by skilled labor, activities outsourced to developing countries within GVCs tend to be unskilled-labor intensive. From this fact, on the one hand, such phenomenon could reduce the wage premium in developing countries. The shift in favor of demand for skilled workers in developed country would imply an increase in demand for unskilled labor in developing countries. On the other hand, skilled workers and the wage premium could increase from the phenomenon of global production networks. As argued by Feenstra (2004), Leamer and Schott (2005) and Kiyota (2012) regarding factor intensity reversals, firms operating in developing and developed countries are facing different cones of production. For a given activity, it can be regarded as unskilled in the North but skilled labor intensive in the South. In other words, unskilled labor-intensive activities outsourced by firms in developed countries might require relative skillful workers in developing countries to perform. Therefore, it is possible that demand for skilled to unskilled workers increases simultaneously in both

developing and developed countries so that rise in the wage premium could be observed in developing countries.

Despite immense policy relevance, these issues, particularly the role of production networks, are rare in Southeast Asian countries. There are numerous studies examining such issues, especially persistence in the wage premium, but research attention is on either developed countries or Latin-American developing countries.[1] With the gap in empirical literature, this paper aims to examine the impacts of trade liberalization on the wage premium using firm level data of Thai manufacturing as the case study. The tariff protection is applied here to represent trade liberalization, in terms of both nominal and effective tariffs. With nominal tariffs, their effects on finished (output) and raw material (input) products are separately examined. Different impacts of such tariff reductions were revealed in previous empirical studies (Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Jongwanich and Kohpaiboon, 2017). In terms of effective rates of protection (ERP), both a traditional ERP measure, and a measure incorporating a possible water in tariffs[2] are applied. The effect of FTAs is also considered in examining impacts of ERP on the wage premium. In addition to tariff protection, impacts of GVCs, measured through trade in parts and components (P&Cs) on the wage premium is investigated in the study.

The paper is organised as follows. Section 2 presents an analytical framework illustrating the effect of globalization on the wage premium, followed by a discussion of tariff liberalization, engagement in GVCs and the wage gap in Thai Manufacturing in section 3. Section 4 discusses the research methodology used in this paper, including the empirical model, variable measurements, and data sources while the estimation results are discussed in section 5. The conclusions and policy inferences are in the final section.

[1] See for example, Revenga (1997), Hanson and Harrison (1999), Feliciano (2001), Attanasio et al. (2004), Currie and Harrison (1997), Topalova (2004), Robertson (2000; 2004) and Wacziarg and Wallack (2004).

[2] The term 'water in tariffs' refers to a situation where applied tariff rates are lower than the actual rates due to the involvement of exports in an industry. The imposed tariffs become ineffective in protecting producers who export those products so that the applied tariff rates for such products tend to be inflated.

2. Analytical Framework

This section lays down analytical framework illustrating the effect of globalization on 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 countries whose comparative advantage is determined by abundance of unskilled workers, opening up to international trade would raise prices of unskilled worker-intensive goods. By contrast, these countries would experience a decline in prices of the skilled-labor intensive products because of import surge. The wage premium between skilled and unskilled workers is expected to decline and generate a favorable effect on income equality.

However, such theoretical postulation is not always supported empirically. In some studies, the gap was widened (Goldberg and Pavcnik, 2007; Davis and Mishra, 2007). Earlier explanations of the persistence of wage premium emphasized friction 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 actual wage premium has still been observed not only at the economy-wide level, but also at the industry and at the firm levels (Pavcnik et al 2004; Verhoogen, 2008).

The research direction is shifted toward firm heterogeneity. Pioneered by Melitz (2003), many researchers pay attention to firms in a given industry, which can have different productivity and behave differently, including wage paid to their workers. In particular, Amiti and Davis (2011) developed a general equilibrium model that features firm heterogeneity as well as empirical evidence of Indonesian economy explaining persistence of the wage premium. While the model workhorse was based on Melitz (2003) where firms' productivity is not unique, Amiti and Davis (2011) added two important features to the existing literature. First, the fair-wage constraint was incorporated into the model in order to forge link between wages paid and firm performance. That is, workers employed in the high productivity firms receive higher wages. Second, firm heterogeneity dimension in Amiti and Davis (2011: 5) could come from firms themselves and modes where firms were globally integrated, i.e., export final

goods, import intermediates, or both. The key theoretical proposition in Amiti and Davis (2011) was wage paid by firms exporting final goods, importing intermediates and doing both is higher than those without the direct link to the global. The proposition was extended to examine the wage premium-trade liberalization nexus in Amiti and Cameron (2012).

In Amiti and Cameron (2012)[3], the effect of input and output tariffs was highlighted along with firm-specific factors and modes where firms were globally integrated. The effect revealed in the study was to a large extent in line with the Stopler-Samuelson theorem. That is, 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 products. This would reduce demand for skilled workers and, *certaris paribus*, the wage premium would be narrower. The effect of output tariff would have the same effect. The only difference is the switching effect takes 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 costs in export business so that the insignificant effect of output tariff is hypothesized. In addition, Amiti and Cameron (2012) introduced interaction terms to allow the extent to which firms were engaged to the international business (export and import) to have the effect on wage premium over and above giving input and output tariffs. Kumar and Mishra (2008), employing Indian micro-level data from the National Sample Survey Organization (NSSO) with data on international trade protection for the years 1980–2000 and using the Haisken-DeNew and Schmidt (1997) two-step restricted least squares procedure, also show that the wage inequality between skilled and unskilled workers in India tend to be lower in response to trade liberalization. The authors argue that perhaps the declining gap would be due to the relatively larger reductions of tariffs in sectors with a higher proportion of unskilled workers.

Lechthaler and Mileva (2019) developed a dynamic general equilibrium trade model, basing on Bernard et.al. (2007), consisting of two countries and two factors with the idea of heterogenous firm and comparative advantage, and Ghironi and Melitz (2005), introducing

[3] They argue that input and output tariff could have different effect on the wage premium with the postulation that the former is expected to play a significant role. The latter would occur in special circumstance. They employ a census of all manufacturing establishments in Indonesia during 1991 to 2000 and tariffs for 290 manufacturing with 5-digit industry code while fixed-effect estimation is used for revealing the findings.

dynamic adjustment into Melitz' s model with one sector. The model is calibrated to examine inter-sectoral wage inequality induced by trade liberalization between the US and China. In the short run, inter-sectoral wage inequality is noticeable but tends to wane when more workers move to the expanding export sector. They argue that training subsidies are more effective than sector-migration subsidies in lowering the wage inequality induced by trade liberalization. In addition, Koymen-Ozer (2020) employs a heterogeneous firm trade model with job search and unemployment to investigate the long-run effects of trade liberalization and trade-induced skill-biased technological change on wage inequality and unemployment. The model predicts that trade liberalization leads more firms to enter into foreign markets and causes the least productive firms to exit from the market while technological upgrading induced by trade liberalization is evident. All these cause redistributions of market share toward more productive firms so that demand for workers, both skilled and unskilled, improve thereby reducing unemployment. However, asymmetric effect of trade liberalization on wage is observed as the liberalization leads to the higher wage premium. Di Comite., Nocco and Orefice (2018) develop a monopolistic competition model with varying elasticity of substitution among products and labour differentiated by skill level, and empirically test whether trade liberalization, specifically tariff reductions, affects the wage skill premium in presence of vertical linkages in the fixed cost of production. The EU KLEMS dataset, reporting information on wage and employment level by skill group, for 17 OECD countries from 1996 to 2005 and the TRAINS dataset for applied tariff rates are applied to empirically test the theoretical model. The authors employ a wage-premium estimation strategy based on Revenga (1997) using both OLS and 2SLS estimations to solve the endogeneity problem of export tariffs. The authors show that 10 percent tariff reductions result in a 3.8 percent increase in the wage gap while total employment is unaffected as a decline in unskilled employment in domestic production is offset by those expanding in the export segment of production.

Firm heterogeneity is also applied in Hahn and Choi (2022) and Bhattacharya and Nguyen (2018). For the former, the authors investigate impacts of output and input tariff reductions on within-plant wage skill premium in Korean manufacturing, using Mining and Manufacturing Census during 1992-2003 and tariff data at 10-digit level from Korean Custom Service. Basing on fixed effect model, the authors demonstrate that output tariff reduction increases the wage skill premium, especially in R&D-oriented plants, but lowers the wage gap

in the facility-oriented plants while there is weak evidence concerning input tariff reduction enlarging the wage skill premium. Bhattacharya and Nguyen (2018), using the firm-level dataset complied from Enterprise Surveys in 2009, show the similar results as in Hahn and Choi (2022), i.e., output tariff reduction tends to increase the wage skill premium in the presence of R&D and foreign ownership. In particular, the authors reveal that the wage gap in foreign-invested enterprises is 40 percent higher than that of domestic ones.

Apart from applying firm heterogeneity, a number of empirical studies determined wage and skills' workers basing on the job competition model proposed by Thurow, 1975 and 1979 (see for example, Groot and Maassen van den Brink, 2000; Borghans and Grip, 2000; Büchel and Pollmann-Schult, 2001). The model involved a matching process in which two queues were considered, i.e., the person queues and the job queue. The latter was arranged by the skills required by firms while the former was sorted by qualification they had acquired. Key implication from this framework was enlarging pools of formal-educated skilled workers or offering public training programs to encourage skill formation without considering job queue offering by firms could result in overeducation. Firms' characteristics were crucial in influencing job queue and they varied their assessment of a given (skilled) worker by his/her anticipated benefits. Under this framework, wages for specific occupations could possibly not react adequately to changes in demand and supply in labour market.

In addition, similar to installing machinery and equipment, hiring skilled workers incurs fixed and sunk costs to firms as recruiting processes are rather complicated and costly (Blatter et al. 2012). Once a candidate is hired, it still takes time and possibly some extra training for him or her to become fully productive (Blatter et al. 2012; Ejarque and Nilsen, 2008; Manning, 2006; Merz and Yashiv, 2007). Possibly, skilled workers and physical capital are complementary to each other (Griliches, 1969; Krusell, et al. 2000). This could be connected to efforts to commit industrial upgrading by firms as upgrading firms or firms involving more to innovation are likely to hire more skilled workers. This is known as the skill-enhancing trade hypothesis. Decision for firms to hire skilled workers is related to business environment within they operate. There was evidence that firms in competitive environment tended to be active in productivity improvement so that they were likely to hire skilled workers or commit to in-house skill formation (Hall and Soskice, 2001; Bustos, 2011; Aghion et.al., 2015). Note that the competitive environment could come from domestic market, aboard or both. All in all, it

suggests firm- and industry-specific factors have impact on demand for skilled workers and the wage premium.

Another branch of literature focuses on the effect of participating in global production networks. As mentioned above, global production networks refer 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 networks (Athukorala and Nasir, 2012). It begins with two-way exchange between home and host country where part and component assembly/testing in the host country is incorporated in the 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 phase is the full-fledged production networks involving component production/assembly/testing 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 networks.

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 networks 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 and Levinsohn, 1995; Feenstra, 2004; Leamer et al., 2005; Kiyota, 2012). 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. Therefore, it is possible that demand for skilled to unskilled workers simultaneously increases in both developing and developed countries so that the wage gap is persistently observed. Note that there are empirical studies examining demand for skilled workers in the developed countries such as Flug and Hercowitz (2000), Silva (2008), Katz and Margo (2013), McGowan and Andrews (2017), Modestino et al. (2020)

and, Sloane and Mavromaras (2020). Among those relevant to the research focus here, their research attention is either on skill/quality mismatching and its effect or impact of outsourcing on their local labour markets. Impacts of trade liberalization and participating in global production sharing have not been addressed simultaneously in empirical research. With an ambiguous effect of these two factors, possibly depending on activities/industries involved by firms, it is worth to closely investigate such impacts on the wage premium in Asian developing countries like Thailand where an empirical study has been limited.

3. Trade Liberalization and the Wage Premium in Thai Manufacturing: First look

In the area of trade policy, Thailand has implemented both tariffs and quantitative restrictions (QRs) as trade policy instruments, but historically it had a greater reliance on tariffs rather than quantitative restrictions (QRs). While the use of high tariff protection measures had been long recognized by policymakers in the early 1980s, the most comprehensive tariff reform plan was implemented in the late 1990s to lower and rationalise tariff rates.[4] As a result, the average tariff dropped substantially to 9.3 percent in 2019 from 15.6 percent in 1995 and 35 percent in 1991 (Table 1). Tariff bands were cut from 39 to six (0, 1, 5, 10, 20, and 30 percent). However, continuous work is still needed since there exist substantial exemptions with tariffs greater than 20 percent, comprising around 16 percent of total tariff lines (Table 2). In addition, Thailand has adopted a cascading tariff structure where protection granted to industries producing raw materials as well as intermediate goods (e.g., chemicals, metal products and construction materials) has been lower than that to finished products (e.g., food, pharmaceuticals, garments, and vehicles). Hence, using actual tariffs (nominal tariffs) to represent protection tends to understate the true level of protection from which an industry receives benefits.

[4] While tariff restructuring received renewed emphasis in the new millennium (i.e., from June 2003 to 2008), the magnitude of such tariff reduction was moderate and focused on intermediate inputs.

Table 1: Nominal Rates of Protection in Thailand, 1991–2019 (percent)

	1991	1995	2002-05	2006-10	2011-15	2016-19
Processed foods	44.8	28.5	21.1	20.6	20.6	18.2
Textile products	42.2	21.2	16.8	12.8	12.8	8.8
Leather and footwear products	64.0	28.5	22.1	21.9	21.9	20.6
Wood products	21.8	n.a.	14.3	8.6	8.6	7.5
Paper and pulp	n.a.	n.a.	13.4	5.4	5.4	5.1
Chemical and petroleum products	31.6	12.2	8.2	6.5	6.4	5.2
Rubber products	49.5	26.8	24.7	18.6	18.6	13.5
Other non-metal products	n.a.	n.a.	15.2	11.5	11.3	8.9
Metal products	16.1	11.4	10.0	6.8	6.8	5.7
Machinery	35.0	9.5	8.8	6.7	6.7	5.1
Transportations	58.1	38.9	22.1	20.2	20.2	18.6
Total manufacturing	**34.7**	**15.6**	**13.4**	**11.1**	**11.1**	**9.3**

Note: n.a.= unavailable data. Data in 1991 and 1995 are from World Integrated Trade Solution (WITS).
From 2002, data are from Ministry of Finance, Thailand. The weighted average, using import share, is applied to calculate nominal tariff rates in each category.
Source: Author' s calculation.

Table 2: Share of 4-Digit HS Categories of Applied Tariff Rates in Thailand, 1991–2019 (percent)

Tariff band	1991	1995	2002-05	2006-10	2011-15	2016-2019
0	2.5	2.6	5.7	20.3	20.5	31.6
0.1–5	14.4	17.3	37.0	31.1	31.1	26.8
5.1–10	14.2	17.6	13.6	11.1	11.0	14.2
10.1–15	12.7	3.2	5.8	10.6	10.6	4.8
15.1–20	15.4	16.4	17.5	8.3	8.3	6.9
20.1–30	15.8	16	13.7	12.9	12.9	11.3
30.1–100	25	26.8	6.8	5.6	5.6	4.5

Note: Note: n.a.= unavailable data. Data in 1991 and 1995 is from World Integrated Trade Solution (WITS).
From 2002, data is from the Ministry of Finance, Thailand
Source: Author' s calculation

Since the onset of the new millennium, political attention and negotiating resources in Thailand have shifted towards preferential trade and bilateral free trade agreements, largely due to the slowdown in WTO liberalisation negotiations and political factors. As a result, from

the 1990s until December 2020, Thailand has involved with 24 FTAs, of which 14 have come into force. Regarding the coverage of tariff cuts, there are only nine FTAs in which tariff cuts have been substantial, covering more than 80% of tariff lines and having been offered since 2010. They comprise the ASEAN Free Trade Area (AFTA), the Thailand–Australia FTA (TAFTA), the Thailand–New Zealand FTA (TNFTA), the Japan–Thailand Economic Partnership Agreement (JTEPA), ASEAN–China FTA (ACFTA), the ASEAN-Australia-New Zealand FTA (AANZFTA), the ASEAN–Japan FTA (AJFTA), the ASEAN–Korea FTA (AKFTA), and the ASEAN–India FTA (AIFTA). For another three FTAs (the Thailand-Peru FTA, the Thailand-Chile FTA, and ASEAN-India FTA), substantial tariff cuts have taken place only in recent years, specifically in 2015 and 2016.[5] Interestingly, the signed FTAs have been used primarily for market access into FTA counterpart markets. The tariff cuts offered by Thailand in FTA deals were in a narrow range of 6-10 percent compared with the MFN rate and associated with rather long-time schedules.

Concerning development of trade in Thailand, since the Asian financial crisis, exports performed relatively well during 2000-08 as the average growth rate of exports during this period was around 13 percent, while the degree of trade openness, measured either in terms of total trade or exports, also continued to rise. Interestingly, after 2008, export performance, especially of goods, became relatively poorer due to both internal and external factors interplaying.[6] These included political unrest starting in 2005, the deteriorating global situation (that is, the global financial crisis beginning in 2008 and the European crisis), and the 2011 Great Floods in Thailand. The average growth rate of manufacturing exports was around five percent during 2011-17. The share of exports of good over GDP declined, but thanks to the export of services, especially the tourism sector, total exports over GDP during 2011-17 remained relatively stable. The total trade of goods and services over GDP dropped noticeably

[5] The Regional Comprehensive Economic Partnership (RCEP) is the latest free trade agreement, which was signed in November 2020 and became effective in 2021. Countries included in the agreement compose of ten Southeast Asian countries, and additional five countries, i.e., South Korea, China, Japan, Australia and New Zealand. It is still early to judge the benefits of RCEP, compared to other existing FTAs in Thailand. However, Park (2022) revealed that ASEAN+ FTAs, except ASEAN-India, offer better tariff concession rates than RCEP, i.e., while the tariff concession rates of the former is about 94 percent on average, the latter is around 91 percent. For Thailand specifically, the gap is wider, i.e., 96 percent for ASEAN+ FTAs and 90 percent for RCEP. Kohpaiboon and Jongwanich (2022) showed that Rules of Origin (RoOs) in RCEP are comparable to other ASEAN+ FTAs, i.e., adopting the diagonal cumulation scheme, and the flexible criteria to identify product origin – there are more than one RoO rules for firms to choose in identifying product origin.

[6] Note that export growth slumped to -14.3 percent in 2009, before rebounding to 26.8 percent, partly due to a low export base in the previous year.

from 140 percent in 2011 to around 109 percent in 2017. The same picture is revealed when the total trade of goods is considered. The noticeable drop of trade openness during this period resulted mainly from a decline in the imports of goods in response to sluggish domestic demand, especially concerning investment.[7] External environmental factors, like the US-China trade war and COVID-19, resulted in a significant decline in exports in 2018-2020, except electrical machinery and equipment (HS85) and some food products, particularly fruits and vegetables, gaining momentum in response to the growing demand caused by COVID-19. Note that machinery and equipment (HS84), and electronics and computer (HS85) accounted for the highest proportion of total exports (about 30 percent in 2020), followed by motor vehicles (HS87) (10 percent); rubber (6.7 percent) and plastics (5.1 percent).

The structure of production and trade in the region, particularly in East and Southeast Asia, has changed over the past two decades. The cross-border dispersion of component production/assembly within vertically integrated production processes, or the so-called international product fragmentation, has dominated production and trade patterns in the region, especially in machinery and equipment (HS84), and electronics and computer (HS85) and motor vehicles (HS87).[8] By the new millennium, Thailand and other ASEAN countries continued to participate in GVCs, as shown by the relative importance of parts and components (P&Cs) in total manufacturing trade, despite a slightly declining trend being observed in recent years (Table 3).[9] The import share of P&C in Thailand has always been greater than the export. For example, P&C exports accounted for 24 per cent of total

[7] The share of imports of goods over GDP dropped from 56 percent in 2011 to 44 percent in 2017, while the share of private investment and consumption declined from 21 and 53 to 16 and 49 percent during the same period, respectively.

[8] Jongwanich (2017) using detailed trade data showed that parts and components (P&C) exports to total manufacturing exports in Thailand jumped from 28.7 percent in 1992 to 31.4 in 2000. Such evidence was also revealed in other Asian countries like Malaysia, Singapore, and the Philippines. The share of parts and components in their manufacturing exports increased during this period from 40.0, 37.5 and 38.4, respectively in 1992 to 45.6, 42.8 and 68.9 percent in 2000. The increasing trend of parts and components in imports was evident in these countries.

[9] Note that Indonesia has remained a small player in regional production networks. P&C imports slightly increased from 24 percent in 2002-5 to 26 percent in 2017-8. The P&C export share to total manufacturing exports was lower, ranging between 14 per cent and 18 per cent during the period with a declining trend. Infrastructure development, as well as an unfavorable business environment, in particular labor market rigidities hinder restructuring operations to be in line with global changes in the semiconductor industry.

manufacturing exports in 2017-8, whereas its corresponding share on the import side was 29 percent. The lopsided importance of P&C trade reflects the position of Thailand in GVCs in producing finished products, while sourcing P&Cs from elsewhere. Interestingly, the gap between Thai P&C exports and imports has narrowed. This picture is similar to China where parts and components still account for a larger share of imports compared to exports, reflecting its status as a final product assembler using parts and components procured from countries in the region, including Thailand. This is different from Malaysia and Singapore, which have intensively participated in GVCs as P&C suppliers. They imported and exported a considerable amount of P&Cs so that their import and export shares were virtually the same, exceeding 40 percent during the period under consideration. GVC trade played an important role in the Philippine's manufacturing. For example, P&C imports and exports accounted for 32 percent and 38 percent in 2017-8, respectively. The relative importance in P&C exports reflects the fact that the Philippines plays a role as a P&C supplier in GVC networks.

Table 3: Share of P&Cs in Manufacturing Trade (percent), 2003-2020

	Exports								Imports							
	2002-5	2006-10	2011-15	2016	2017	2018	2019	2020	2002-5	2006-10	2011-15	2016	2017	2018	2019	2020
Brunei Darussalam	15.7	28.5	22.3	27.9	18.1	19.6	19.0	n.a.	17.8	17.8	17.1	19.4	25.3	26.9	18.1	n.a.
Cambodia	0.2	0.2	1.7	4.4	4.1	4.0	3.8	n.a.	8.4	8.5	10.2	13.4	13.3	12.2	13.4	16.3
Indonesia	17.8	16.5	15.6	18.0	14.6	14.4	14.4	14.0	24.3	25.0	25.7	26.6	25.8	25.6	24.8	n.a.
Lao People's Dem. Rep.	n.a.	8.3	7.3	12.0	7.1	7.8	7.8	n.a.	n.a.	21.4	23.4	27.2	27.9	31.5	26.9	20.5
Malaysia	48.8	44.5	44.3	43.1	27.4	23.7	24.1	24.5	57.1	50.2	44.4	43.8	30.2	28.2	29.5	25.5
Myanmar	n.a.	0.5	1.8	17.8	4.1	3.7	2.2	10.4	n.a.	13.9	10.8	13.2	13.6	12.7	12.5	23.4
Philippines	65.4	59.3	55.5	45.1	37.6	39.4	28.3	n.a.	68.4	61.5	44.8	41.9	32.2	33.2	25.6	21.3
Singapore	48.9	55.5	54.4	45.8	25.0	26.7	28.2	27.0	50.8	53.5	53.9	49.2	29.3	31.8	33.9	n.a.
Thailand	32.1	28.0	26.0	33.1	24.1	23.6	22.7	24.0	38.4	35.2	32.3	36.6	29.0	28.6	27.8	29.4
Viet Nam	11.7	13.3	31.3	48.1	37.0	38.3	37.1	38.7	15.9	19.3	30.9	37.3	27.1	26.9	26.7	n.a.
ASEAN6	47.3	43.9	41.9	37.6	25.2	25.0	24.5	24.3	53.7	46.3	41.7	41.0	29.2	29.5	29.7	31.5
ASEAN10	45.6	41.8	40.3	39.1	27.1	27.2	26.8	27.8	50.7	43.6	39.7	39.5	28.4	28.6	28.6	29.6
China	21.6	22.6	24.5	26.4	25.3	25.7	24.8	24.0	38.8	41.6	41.5	45.1	22.3	21.3	20.8	28.4
Japan	32.5	31.4	31.1	31.7	27.8	27.2	26.5	26.4	27.1	27.5	27.0	28.7	25.5	25.0	24.2	29.4
Korea	35.6	34.2	34.5	37.8	22.7	22.5	24.3	23.7	34.9	30.5	30.8	32.3	20.6	20.5	22.6	29.2
Northeast Asia	28.6	27.0	27.4	34.5	25.4	25.5	25.0	25.9	34.3	36.1	36.6	36.5	22.7	22.0	21.8	15.9
EU27	23.8	22.6	22.0	22.2	21.6	21.5	21.3	20.5	24.0	23.3	23.4	23.6	25.2	24.5	24.2	23.7
NAFTA	33.2	29.6	27.4	27.8	25.8	26.7	28.2	n.a.	25.5	25.0	26.3	26.3	23.6	23.6	23.5	22.8

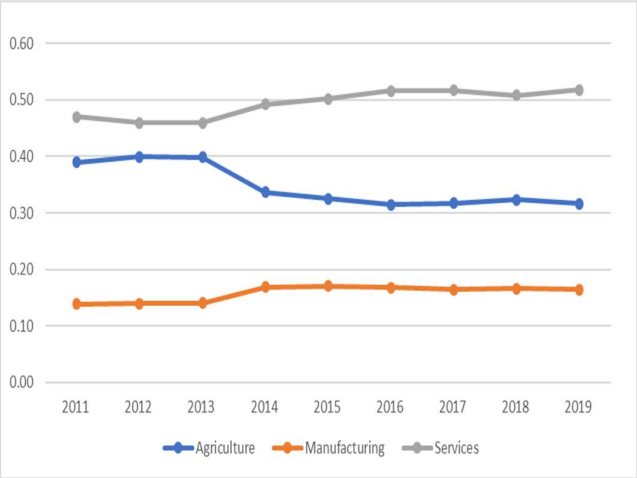
Note: List of P&Cs is from a careful disaggregation of trade data based on the Revision 3 of the Standard International Trade Classification (SITC, Rev 3) extracted from the United Nations trade data reporting system (UN Comtrade database). Concordance between SITC and Harmonized system (HS code) is applied to obtain parts and components exports and imports.

Source: UN Comtrade database

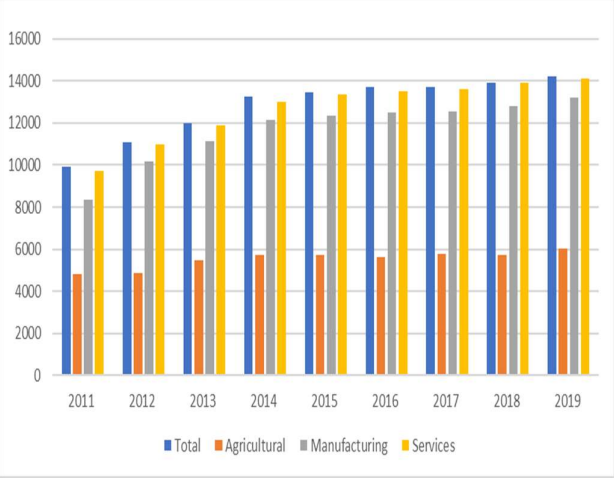
In consideration of employment and wages in Thailand, Figure 1 shows that the share of employment to total employment in the manufacturing sector remained relatively stable at around 17 percent during 2014-19, while the share of employment in service sectors had increased to around 52 percent from 2014 onwards, up from around 47 percent in 2011. With the agriculture sector, the share of employment declined significantly from 40 percent in 2013 to around 32 percent in 2019. Average wages, measured by baht per month, in the manufacturing and service sectors, increased sharply in 2011-2014, before appreciating gradually during 2015-19. In contrast, wages in agriculture remained relatively low and stable post-2011. In the service and manufacturing sectors the wage rate was around twice that of agriculture. Agriculture is the only sector in which the wage rate in some years, e.g., 2015 and 2018, was adjusted at a lower rate than headline inflation.

Figure 1: Employment and wages in Thailand, by industry

A. Share of employment by sector



B. Wages (baht per month) by sector



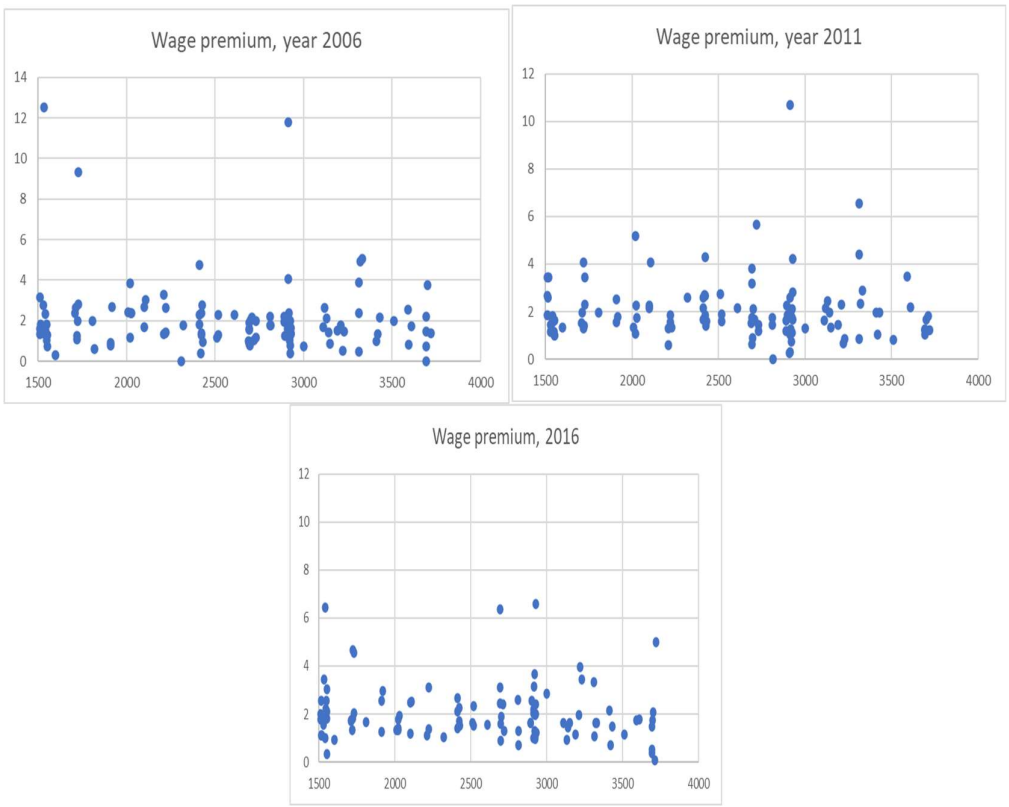
Source: National Statistical Office, Thailand

Basing on Thailand's industrial censuses, wage differentials across industries in Thailand were observed during 2006-2016 (Figure 2). The non-negative value of wage differentials confirms that wage paid for white-collar was higher than that paid for blue collar for all industries. The low density of wage premium shown in 2011 and 2016 implies that wage premium tended to increase in many industries. Excluding industries where the ratio of wage

associated with skilled workers to that associated with unskilled workers exceeded 10[10], the wage premium in 2006 on average was around 1.7 while that in 2011 and 2016 was around 1.9 and 2.0, respectively. The variance of wage gap across industries also soared during this period, i.e., 1.35 and 1.13 in 2016 increasing from 0.90 in 2006. Although the wage gap increased, the pattern of the wage gap, to some certain extent, tended to be similar. It seems that labor-intensive industries, e.g., processing of fruit and vegetables (code 1513); manufacture of soft drinks (1554); manufacturer of carpets and rugs (1722); manufacture of knitted and crocheted fabrics (1730) and resource-based industries, e.g. manufacture of basic iron and steel (2710); manufacturer of sugar (1542); manufacture of basic chemicals (2411) and manufacture of pharmaceuticals, medicinal chemicals and botanical products (2423) tend to have a higher level of wage gap than capital-intensive industries, e.g. manufacture of motor vehicles (3410); manufacture of bodies for motor vehicles (3420); manufacture of other transport equipment (3599); manufacturer of jewelry and related articles (3691). This could be because in the latter, those industries need more skillful workforces to work with capital than unskilled ones so that most of workers in those industries are categorized as skilled workers. Differences in white-collar wage and blue-collar wage are, therefore; limited in those industries. This finding indicates that industry-specific factors are crucial to control in the empirical model. In addition to industry level, Figure 3 shows wage gap by firms during 2006-2016. The same picture has been derived from utilizing firm level data, i.e., the wage premium varied across firms in each industry and the premium tended to increase during this period. This, to a certain extent, implies that the role of firm heterogeneity such as firm size and mode of engaging international activities, tends to be crucial in determining wage gap.

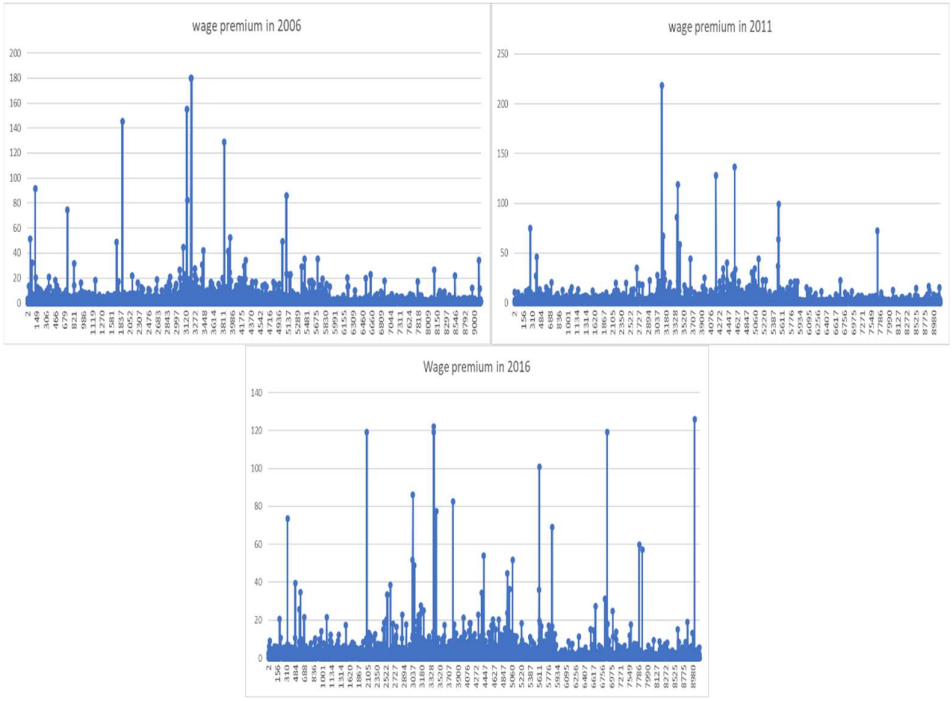
[10] These include manufacture of prepared animal feeds (ISIC1533); Manufacture of pumps, compressors, taps and valves (ISIC2912); manufacture of knitted and crocheted fabrics and articles (ISIC1730).

Figure 2: Wage Premium in Thai Manufacturing, by industry during 2006-2016



Source: Author's calculation from Thailand's industrial censuses in 2006, 2011 and 2016

Figure 3: Wage Premium in Thai Manufacturing, by firms during 2006-2016



Source: Author's calculation from Thailand's industrial censuses in 2006, 2011 and 2016

4. The Empirical Model

The empirical model employed in Amiti & Cameron (2012), considering firm specific factors, is used as a point of departure. The wage premium $(Ws/Wu)_{ijt}$, the ratio of wage compensation of skilled worker to unskilled workers is a function of a set of firm specific factors including export (exp_{ijt}) and import (rim_{ijt}) status, firms' ownership (own_{ijt}), and firms' size ($size_{ijt}$).[11] The extent to which firms participate in the global economy would influence decision to hire skilled workers and wage premium. There are two aspects of global participation in this study. First, firms involve in international trade (i.e., either export, import or both). They are likely to hire more skilled workers. All other things being equal, exporting firms are facing more intense competition. As echoed in the firm heterogeneity literature, exporting firms must surpass productivity thresholds to survive the competition. Hence, these firms might hire more skilled

[11] Note that in Amiti and Casson (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.

workers to enhance their productivity as opposed to domestic-oriented firms (Greenaway et al, 1999; Milner and Wright, 1998; Hine and Wright, 1997; Roberts and Skoufias, 2007). Importing often involves with complicated procedure ranging from selecting suppliers, negotiating price and quality, and understanding technology embedded into imported products, and dealing with documentation with custom officials from countries. Hence, importing firms are also likely to hire more skilled workers. To measure firms' market orientation, export-output ratio (exp_{ijt}) and the proportion of imported to total inputs (raw materials and intermediates) (rim_{ijt}) are used. As skilled workers are expected to increase along with participation of firms in global market, expected signs of these two variables in influeicng wage premium are both positive.

Another aspect of global participation is firms' ownership (own_{ijt}). Clearly, foreign firms are more likely to hire skilled workers. This is because firms investing aboard are often associated with some proprietary asset (Caves, 2007). This is done to ensure the established affiliates can compete with indigenous counterparts which are more familiar with business environment in host investment-receiving countries. To harness the associated advance technology, skilled workers are needed and possibly widen the wage premium. As argued in the innovation literature (e.g., Pavitt, 1987; Vaona and Pianta, 2008) innovation decision is positively related to firms' size ($size_{ijt}$). This is based on Schumpeterian Creative Deconstruction where larger establishments are in a better position to cover fixed costs incurred from innovative activities (Schumpeter, 1942) As the rational to hire skilled workers is similar to innovation activities to some extent so that it is expected to the larger the firm's size, the more likely to hire skilled workers and widen the wage premium (Blatter et al. 2012; Ejarque and Nilsen, 2008; Manning, 2006; Merz and Yashiv, 2007).

In addition, four extra firm-specific variables are introduced in this study. They include the capital-labour ratio ($klratio_{ijt}$) capturing the degree of capital deepening at the plant level, the ratio of female to male workers ($female\_male_{ijt}$) to examine any possible gender bias, firms investing in research and development (RD_{ijt}), and obtaining BOI investment incentives (BOI_{ijt}).

Firms' capital deepening ($klratio_{ijt}$) would affect demand for skilled workers thereby the wage premium, but its influence is inconclusive. It can be either positive or negative, depending on how physical capital and skilled workers interact to each other. When skilled

workers are likely to be complement with physical capital, the positive relationship of this factor with the wage premium is expected. Otherwise, it could be negative. The firm's capital deepening is measured by the proportion of fixed asset at the beginning of period to total workers. R&D activities by nature are skilled workers intensive so that firms committing to R&D activities (RDD_{ijt}) are likely to hire more skilled workers and widen the wage gap between skilled and unskilled workers.[12] BOI-promoted establishments (BOI_{ijt}) are included in this study and expected to have a positive relationship with the wage premium. Obtaining BOI investment incentives is *de facto* compulsory for foreign plants in order to overcome many constraints involved in operating a business in Thailand and indigenous firms who apply for BOI promotion privileges are likely to be exporters. As mentioned earlier, these firms are likely to engage more with skilled labour thereby widening the wage premium.

Note that since the definition of blue- and white-collar workers in deriving their corresponding wages in micro dataset can vary from one to others, dataset-specific aspect in this regard must be taken into consideration. For Thailand's industrial censuses, a number of blue-collar workers employed for operational jobs are further disaggregated into skilled and unskilled workers. The former refers to supervisors who have long experience and are skillful to look over production lines so that they should be classified as white collars. Unfortunately, in the dataset, wage compensations paid to the operational workers are not separated and makes impossible to re-define more precise wage compensation of true white collar. Hence, to mitigate this problem, $skill\_total_{ijt}$, the ratio of skilled to total production workers, is introduced as one controlling firm-specific variable for the wage premium equation. The higher value of $skill\_total_{ijt}$ implies that the denominator in the wage premium includes some belonging to actual skilled workers.

Similar to Amiti and Cameron (2012), input and output tariffs are separately included as industry-specific factors in determining possible different effect of input and output tariff reductions on the wage premium. As mentioned earlier, 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 paribus*, the wage premium

[12] Note that interaction terms between R&D and proxies of trade liberalization are introduced in the study. However, they turn out to be insignificant so that we exclude these variables from the model.

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 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 costs in export business. Interaction terms between trade liberalization variables and 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.

However, as mentioned earlier, under the cascading tariff structure, using nominal tariffs to represent protection tends to understate the true level of protection from which an industry receives benefits. Effective rate of protection (ERP) is introduced to capture the level of protection. Four alternatives of ERP are introduced in the model, that is ERP import-competing products (ERP_1_{jt}); ERP considering water in tariffs (ERP_2_{jt}); ERP capturing the effect of partial trade liberalisation (ERP_3_{jt}); and ERP combining the effects of partial trade liberalisation and water in tariffs (ERP_4_{jt}). The formula of the first ERP_1_{kt} is derived from equation 1:

$$ERP\_IM_{kt} = \frac{t_{kt} - \sum_{i=1}^{n} a_{ikt}^{*} t_{it}}{1 - \sum_{i=1}^{n} a_{ikt}^{*}} \qquad (1)$$

where t_{kt} = applied tariff on product (finished products) k at time *t;* t_{it} = applied tariff on product (raw materials) i at time *t;* a_{ikt}^{*} = share of product *i* used in producing product k at time *t.* Note that the input-output table is applied to determine the share of raw materials used in producing product k. Concordance between IO and ISIC (International Standard Industrial Classification) is employed to convert ERP at the product level (ERP_IM_{kt}) to ERP at the 4-digit industry level (ERP_1_{jt}).

The second formula is intended to capture possible water in tariffs[13] wherein the output tariffs imposed become ineffective. One of the key possible circumstances of such an ineffective tariff is when firms improve productivity and export products. Since only a proportion of firms in an industry can export, the ERP capturing water in tariffs (ERP_2_{jt}) is calculated as the weighted average between ERP for import-competing products (ERP_1_{jt}) and the ERP for exporting (ERP_export_{jt}), as in equation (2):

$$ERP\_2_{jt} = (1-\alpha_{jt}) \cdot ERP\_1_{jt} + \alpha_{jt} \cdot ERP\_export_{jt} \quad (2)$$

where α_{jt} is the share of exports in the output of industry j at time t. In terms of ERP exporting (ERP_export_{jt}), tariffs on finished products, (t_{kt}) is treated as zero since the tariffs imposed become ineffective in protecting producers who export those products. Tariffs on raw materials are also treated as zero as exporters can apply for duty drawbacks. However, exporters must pay tariffs in advance before applying for duty drawbacks. This creates opportunity costs for exporters, which in this study are captured by interest rates. In other words, t_{it} in the case of ERP for exports is equal to market interest rates adjusted by tariff rates of raw materials.

Third, in order to examine the effects of the partial trade liberalization induced by in-effect FTAs, a weighted tariff between MFN and FTA preferential rates (t_{kt}^{*}) is used as expressed in equation 3.

$$t_{kt}^{*} = \left(1 - \sum_{l=1}^{n} \theta_{klt}\right) t_{kt}^{MFN} + \sum_{l=1}^{n} \theta_{klt} t_{klt}^{FTA} \quad (3)$$

[13] In this paper, the term 'water in tariffs' refers to a situation where applied tariff rates are lower than the actual rates due to the involvement of exports in an industry. The imposed tariffs become ineffective in protecting producers who export those products so that the applied tariff rates for such products tend to be inflated. ERP for import-competing products (ERP_IM_{jt}), employing the applied tariff rates, tends to overstate protection induced by the tariffs. Thus, $ERP\_FTA\_water_{jt}$ is introduced to capture a possible water in tariffs in each product/industry.

where t_{kt}^{MFN} = MFN tariff on product *k* at time *t;* t_{klt}^{FTA} = FTA tariff on product *k* at time *t* in which Thailand offered to FTA partner *l;* θ_{klt} = the import share of FTA partner *l* for product *k* at time *t* to total import. Thus, ERP_3_{jt} is calculated using the new tariffs on finished products (t_{kt}^{*}) as in equation 3 to capture the effect of partial trade liberalization.

Lastly, to capture both the effect of partial trade liberalization and water in tariffs, $ERP\_4_{jt,}$ the weighted average between ERP considering the effect of partial trade liberalization (ERP_3_{jt}) and the ERP for exporting (ERP_export_{jt}) is introduced as in equation (4).

$$ERP\_4_{jt} = (1-\alpha_{jt}) \cdot ERP\_3_{jt} + \alpha_{jt} \cdot ERP\_export_{jt} \qquad (4)$$

where ERP_export_{jt} is ERP exporting products and α_{jt} represents the share of exports in the output of industry j at time t. Note that the differences of the estimated coefficients between the original ERP and ERP considering the effects of the partial trade liberalization would to a certain extent suggest distinct impacts of FTA-led trade liberalization from that of multilateral trade liberalization.

Engaging into GVCs ($Network_{jt}$) can have an implication on the wage premium. Ideally, to capture the effect of global production networks, details at firm level (e.g., whether firms are actually engaged to MNEs' production networks, 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. Trade data are employed to capture the aspect of international production networks, i.e., it is measured by the ratio of parts and components (P&C) trade (the sum of imports and exports) to total goods trade. List of P&Cs is from 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) (Jongwanich, 2011). Trade data, compiled from UN Comtrade are matched with International Standard of Industrial Classification (ISIC, Rev 3).

The final departure from Amiti and Davis (2012) is to introduce additional industry-specific factors, i.e., industrial concentration (HHI_{jt}). In general, industries with high barriers to

entry are likely to be concentrated as it would be relatively more difficult for new entrants to 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 should be 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 addition, it is possible that firms are in low industrial concentration face higher competitive environment than those in high industrial concentration. As argued by Hall and Soskice (2001); Bustos (2011) and Aghion et.al. (2015) firms in competitive environment tend to be active in productivity improvement so that they are likely to hire skilled workers or commit to in-house skill formation thereby increasing the wage premium. In this study, industrial concentration is measured by the Hirschman Herfindahl index.

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

$$\begin{aligned}(W_s/W_u)_{ijt} = {} & \alpha_0 + \alpha_1 \exp_{ijt} + \alpha_2 rim_{ijt} + \alpha_3 own_{ijt} + \alpha_4 size_{ijt} + \alpha_5 klratio_{ijt} + \alpha_6 female\_male_{ijt} + \alpha_7 RD_{ijt} \\ & + \alpha_8 BOI_{ijt} + \alpha_9 skill\_total_{ijt} + \alpha_{10} outputtariff_{jt} + \alpha_{11} output\_\exp_{ijt} + \alpha_{12} inputtariff_{jt} \\ & + \alpha_{13} input\_rim_{ijt} + \alpha_{14} HHI_{jt} + \varepsilon_{ijt}\end{aligned} \quad (5)$$

$$\begin{aligned}(W_s/W_u)_{ijt} = {} & \alpha_0 + \alpha_1 \exp_{ijt} + \alpha_2 rim_{ijt} + \alpha_3 own_{ijt} + \alpha_4 size_{ijt} + \alpha_5 klratio_{ijt} + \alpha_6 female\_male_{ijt} + \alpha_7 RD_{ijt} \\ & + \alpha_8 BOI_{ijt} + \alpha_9 skill\_total_{ijt} + \alpha_{10} ERP_{jt} + \alpha_{11} HHI_{jt} + \varepsilon_{ijt}\end{aligned} \quad (6)$$

where

$(Ws/Wu)_{ijt}$ = the wage premium of firm i^{th} in industry j^{th}, measured by the ratio between wage compensation per workers of white collar (non-production and skilled production workers) to blue collar (operation workers) at time t

exp_{ijt} = the share of exports of firm i^{th} in industry j^{th} at time t

rim_{ijt} = the share of raw material imports of firm i^{th} in industry j^{th} at time t

own_{ijt} = foreign share of establishment i^{th} of industry j^{th} at time t

$size_{ijt}$ = size of firm i^{th} in industry j^{th} at time t measured by output

$klratio_{ijt}$ = the capital-labour ratio of firm i^{th} in industry j^{th} at time t

$female\_male_{ijt}$ = the ratio of female to male workers of firm i^{th} in industry j^{th} at time t

RD_{ijt} = R&D effort by establishment i^{th} of industry j^{th} at time t measured by two alternatives:

(1) RDD_{ijt} = the binary dummy variable, equal to 1 when there is R&D effort and zero otherwise,

(2) RDS_{ijt} = the R&D expense to sale of establishment i^{th} of industry j^{th} at time t

BOI_{ijt} = a zero-one binary dummy, equal to 1 when an establishment i^{th} of industry j^{th} is BOI-promoted and zero otherwise

$skill\_total_{ijt}$ = the ratio of skilled production workers to total production workers of firm i^{th} in industry j^{th} at time t

$outputtariff_{jt}$ = output tariffs of industry j^{th} at time t

$inputtariff_{jt}$ = input tariffs of industry j^{th} at time t

$output\_exp_{ijt}$ = Interaction term between output tariff and export share of firm i^{th} in industry j^{th} at time t

$input\_rim_{ijt}$ = interaction term between input tariff and the share of raw material imports of firm i^{th} in industry j^{th} at time t

ERP_{ij} = effective rate of protection of industry j^{th} at time t measured by four alternatives;

(1) ERP_1_{jt} = ERP import-competing products

(2) ERP_2_{jt} = ERP considering water in tariffs

(3) ERP_3_{jt} = ERP capturing the effect of partial trade liberalisation

(4) ERP_4_{jt} = ERP combining the effect of partial trade liberalisation and water in tariffs

HHI_{jt} = Hirschman Herfindahl producer concentration of industry j^{th} at time t

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

The data set used in this research is derived from the Thai industrial census, conducted by the National Statistical Office. So far, four censuses are available (i.e., 1996, 2006, 2011, and 2016). As plant level data in Thailand is still at the early development stage, a fraction of observations can be matched and a panel-data analysis conducted amongst the three latest censuses (2006, 2011, and 2016), involving 14, 617 observations. In this paper, panel data from the three latest censuses is used.[14] The data used in the empirical model is summarized in Appendices 1 and 2. To calculate trade protection, measured by both nominal and effective rates of protection, the inter-industry linkage relationship is derived from Thailand's input–output table compiled by the National Economic and Social Development Board (NESDB). Since the input–output table for Thailand is updated every five years, three tables are available for 2005, 2010 and 2015, which are employed to match the industrial censuses of 2006, 2011 and 2016, respectively. The output and input tariffs for 2006, 2011 and 2016 are from HS2002 6-digits. Concordance between HS-code, ISIC, and IO table is applied in calculating four alternative ERPs at the industry level as mentioned earlier. The interest rates applied to reflect the opportunity costs of exporters are sourced from the weighted average of minimum lending rates (MLR) offered by various commercial banks in Thailand. As our dependent variable is censored to zero, i.e., it cannot be negative value and there are a number of zero observations, the standard log-linear panel-estimation model (fixed and random effect) is not applicable and would possibly lead to bias and inconsistent estimators. To deal with this problem, our econometric analysis uses Poisson Pseudo-Maximum-likelihood

[14] Data cleaning in our study starts with examining the possibility of duplicated observations, that is, samples with different plant identification numbers reporting the same values of key variables. Presumably, this is largely driven by multi-plant cases where all affiliates fill in a particular questionnaire using identical company-level information wherein all affiliates are included. Seven key variables are used to identify duplication: (i) years in operation, (ii) total employment, (iii) wage compensation, (iv) raw materials, (v) initial raw material stocks, (vi) initial finished product stocks, and (vii) initial fixed assets. When duplicated samples are found, only one is kept in the sample and the others are removed. We drop observations which report annual sales of less than ฿12,000 (less than $400), annual value added of less than ฿10,000, and/or less than ฿10,000 of initial fixed assets. To mitigate the discretionary criteria employed, we run a sensitivity analysis. In addition, small/micro enterprises, defined as plants employing less than ten workers, are excluded as they would behave differently from, and might not participate directly with larger plants. The final feature that must be addressed is industrial classification. Generally, the International Standard of Industrial Classification (ISIC) revision 3 is employed to analyse the three censuses with observations matched as a panel dataset by plant identification. There are 3,395 cases where the ISIC assigned to a given plant identification changes among these three censuses because of changes in product coverage. They are dropped from the analysis. Note that all the nominal variables (e.g., sales, raw materials expenses, and inventory) are converted into 2001 prices, using the price deflator at the 4-digit ISIC disaggregation.

with panel fixed effect model. Non-linear relationship between the wage premium and independent variables is considered in the study. In order to redress the potential endogeneity of the tariff, the control function approach (see Lin and Wooldridge, 2019) for panel data with PPML is applied in this study.[15]

5. Results

Tables 4 present the empirical results of the wage premium's determinants. Columns A presents the result in which input, and output tariffs are separately included in the model while Column B includes interaction term between input (and output) tariffs and the extent to which firms are engaged in the international business, i.e., export (exp_{ijt}) and import (rim_{ijt}). Columns C-H, present results when ERP_1 to ERP_4 are employed, respectively. Columns E and F are ones where the R&D expense to sale (RDS) is used as independent variable, instead of dummy variable (RDD). Without any overdispersion, the control function approach for panel data with PPML is also applied to redress possible endogeneity arising from trade liberalization for determining the wage premium (Column F).

The results show that firm-specific factors are more crucial in affecting the wage premium than trade liberalization and participation in global production networks. Regarding 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 the wage premium is found only in firms which actually import. The coefficient of the interaction term is positive, 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 in general. This seems to be sensible for developing countries, including Thailand, with dual

[15] Export-output ratio of industry is employed as an instrument variable due to its significant impact on a possible endogenous variable as mentioned while they do not show any significant impact on labour-market outcomes. For export-output ratio of industry, industries involving more with exports are likely to receive less benefits from protection so that demand for protection become less.

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 with 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, an input tariff cut has effect on the wage premium. While the relationship is only weakly significant, it indicates a substitution nature between imported intermediates and skilled workers so that narrowing the wage premium is evident in responding to tariff cuts. All in all, the impact of input tariffs on the wage premium is conditioned by the actual imports of raw materials/intermediate products.

For output tariffs, the coefficients associated with the tariffs and its interaction with exports are statistically insignificant. The insignificance suggests that reduction in output tariffs would not have any significant impacts on the wage premium. This result tends to be in line with Amiti and Cameron (2012), arguing that reduction in output tariff might not have any significant impact on the wage premium because of the switching effect taking place when firms are to shift production between multiple products with different factor intensity. In other words, reducing output tariffs may shift firms to produce other products with different factor intensities so that such liberalization would not affect relative demand for skilled/unskilled workers. For Thailand, the insignificance could also be induced by two opposite consequences arising from output tariff reductions. On the one hand, although tariff rates in Thailand have declined substantially over the past three decades, but the escalating tariff structure remained in place, reflecting by a higher tariff rate of finished products than capital and intermediate goods. The high tariff rates, though noticeable decline, tend to be imposed on relatively capital-intensive sectors, including motor vehicles, where demand for skilled workers is involved so that liberalization is likely to cause a decline in demand for skilled workers. On the other hand, output tariff reduction promoting more exports could raise wage for skilled workers and widen the wage premium since there are extra activities for firms engaging in exports such as negotiating with customers, bargaining, overcoming day-to-

day problems on the production line, arranging delivery schedules, and offering after sale services, requiring skillful workers.

As mentioned earlier, under the cascading tariff structure, using nominal tariffs to represent protection tends to understate the true level of protection from which an industry receives benefits. Meanwhile, exporting firms are unlikely to receive any benefits from cutting output tariffs as their prices tend to follow world prices, thereby possibly reducing explanatory power of output tariffs in influencing the wage premium. Effective rate of protection (ERP) is introduced to capture the level of protection, instead of separately including input and out tariffs. The results show unexpected outcome, i.e., such liberalization could not significantly influence wage skill premium for all types of ERP (see Table 4: Columns C-H), but are in line with some previous studies, including Pavcnik et.al. (2004) for Brazil and Feliciano (2001) for Mexico, which show no relationship between trade policy and the wage premium. Two possible explanations emerge from this finding. First, the insignificance of trade liberalization on the wage premium may result from a limited number of observations included in the 3-year censuses in formulating panel data in Thailand. Second, it may occur due to structure of labour market in Thailand where there is a friction in labour market as well as shortage of skilled workers, especially ones involved with operational activities while foreign workers, including those from Myanmar, Cambodia, Loas increase supply of unskilled workers. The former tends to cause wages of skilled workers remain at the relatively high level, though tariff reductions lower demand for skilled workers, while the latter reduces probability of unskilled workers' wages to go up.

Another point, argued by Jongwanich, Kohpaibbon and Obashi (2022)[16], is that wage-employment skills dissociation may emerge so that impacts of trade liberalization on the wage premium could not be revealed, though it could change demand for unskilled/skilled workers. This would probably be due to a friction in labour market and largely weakly unionized in Thai labour market. The relatively low level of human capital in Thailand could somewhat explain the lack of strong labour unions and to a certain extent, lower ability of workers,

[16] Note that Jongwanich, Kohpaibbon and Obashi (2022) using labour force survey during 2012-2017 show that income adjustments in some cases, induced by introduction of advanced technologies, are not in line with employment status. For example, introduction of ICT was likely to generate favourable outcome in generating skill upgrading, but no income adjustment was indicated from the study.

especially unskilled ones, to negotiate their wages with employers. All in all, these possibly suggest labour market conditions tend to decouple employment-wage outcomes induced by trade liberalization. To clearly understand a possible wage-employment skills dissociation, this study further examines relationship between trade liberalization and skilled and unskilled employments, using the same set of variables and estimation method, i.e., Poisson regression with panel fixed effect model, as in the wage premium equations.[17] Table 5 shows that trade liberalization in terms of tariff reductions in all scenarios, was not harmful to unskilled workers. When tariffs are disaggregated into input and output, in line with the results of wage premium above, only input tariff is positive and statistically significant when skilled workers are employed as the dependent variable, indicating that reduction in input tariff leads to a decline in skilled workers. When effective rates of protection regardless of whether water in tariffs and FTAs are considered, the coefficients associated with these variables show the positive and significant relationship with skilled workers (Table 5: Columns B - E). The positive coefficients associated with these variables indicate that trade liberalization, through reductions either in output or both output and input tariffs, reduces demand for skilled workers. Although final goods are produced with a lower skilled intensive technology than intermediate inputs, as mentioned earlier, in Thailand high tariff rates have still been imposed on relatively capital-intensive sectors where demand for skilled workers are involved. Thus, trade liberalization or lower effective rate of protection, lowers demand for skilled workers in response to cheaper imports of finished products. The significant coefficients associated with

[17] Unskilled workers refer to blue-collar workers employed for operational jobs, except those who are classified as supervisors who have long experience and are skillful at monitoring production lines. These workers are classified as a group of the white-collar workers. Note that (1) skilled and unskilled workers are separately estimated since variation between skilled and unskilled workers tends to be minimal in our study periods so that it seems that relationship between dependent, defined as the ratio of skilled to total workers, and all independent workers cannot be revealed and (2) in addition to the same set of variables as in the wage premium equation, value-added per worker ($vapw_{ijt}$) are included as another independent variable to control for productivity improvement at firm level in employment analysis. Note that industrial growth is employed as an instrument variable for value-added per worker. For this variable, arguably, it can influence value added per worker since in industries, which experience rapid output expansion, firms are likely to expand production. With slower adjustment in inputs, this could have an implication to labour productivity.

skilled employment, but the insignificance associated with the wage premium tend to confirm wage-employment skills dissociation in Thailand.

Wage-employment skills decupling is also evident when participation in global production networks ($Network_{jt}$) is concerned. From table 5, participation in GVCs tends to encourage more skilled workers. The results are robust regardless of how trade liberalization is measured (See Table 5: Columns A-E). This support arguments that firms operating in developing and developed countries are facing different cones of production (Feenstra, 2004; Leamer and Schott, 2005; and Kiyota, 2012). For a given activity involved in the network, mostly in electronics, electrical appliances, and machinery, it can be regarded as unskilled in the North but skilled labor intensive in the South. In other words, unskilled labor-intensive activities outsourced by firms in developed countries tend to require relative skillful workers in developing countries to perform. However, the participation has no significant impact on the wage premium. As mentioned earlier, data limitations in formulating panel data or labour market conditions in Thailand could probably constrain impacts of global production networks on the wage premium in the country.

Firm-specific factors are crucial in affecting the wage premium as mentioned earlier (Table 4). Firms' market-orientation, especially exports, positively influence the wage premium, and the relationship tend to be non-linear. The wage skill premium tends to increase at the beginning when the share of exports to output of firms (exp_{ijt}) increases, but after a certain threshold, the wage skill premium declines. This confirms what we discussed earlier, i.e., exporting firms must surpass productivity thresholds to survive the global competition so that they are likely to hire more skilled workers to enhance their productivity and do other extra activities as mentioned earlier as opposed to domestic-oriented firms. However, in all scenarios, the negative and significant coefficient associated with ($exp_{ijt}\wedge 2$) is revealed. This implies that when the share of exports to total output exceeds a certain threshold, which from our estimation the threshold is around 1.3, firms' demand for skilled worker starts declining and they are likely to hire more non-skilled workers instead thereby narrowing the wage premium.[18] As show in Table 5, the coefficient associated with ($exp_{ijt}\wedge 2$) is positive and significant when nonskilled workers are employed as the dependent variable.

[18] Note that on average, the share of exports to total output in our samples during 2006-2016 was around 1.12 (see Appendix 1)

To a certain extent, it seems that in Thai manufacturing skilled and non-skilled workers are still substitutable to serve a large scale of exports and several Thai firms are still original equipment manufacturer (OEMs), in which volume of exports matters for those firms to expand in the global markets. With the relatively thin market, unskilled workers are likely to be employed in producing those products. Original design manufacturers (ODM) or origianl brand manufacturers (OBM) tend to demand more skilled workers, but those firms have still been limited in Thai manufcaturing. Imports tend to increase the wage premium, but the effect is not vigorous as its positive impact is shown only when input and output tariffs are separately included in the analysis (Table 4).

Capital-labour ratio ($klratio_{ijt}$) is another important firm specific factor in influencing the wage premium. The results show that an increase in capital-labour ratio tends to promote more skilled workers and widen the wage premium as shown by the positive and significant coefficient associated with this variable (See Table 4). This suggests skilled workers are likely to be complement with physical capital. However, probably due to a law of diminishing, surpassing a certain threshold, which is relatively low (at least ten time lower than the average value of capital-labour ratio in our samples)[19], capital deepening starts to reduce demand for skilled workers and narrowing the wage gap. The negative coefficient associated with $klratio_{ijt}$^2 and low value of the threshold may raise some concerns whether introducing more and more capital would replace (skilled) workers, and push workers out of the job market. With limited information in the industrial censuses, we cannot address this issue properly. Interestingly, however, Jongwanich, Kopaiboon and Obashi (2022), using labour force survey during 2012-17, examine whether introducing advanced technologies, including robots and ICT, would generate adversely impacts on labour market outcomes in Thailand. They show that instead of pushing workers out of the job market, the advanced technologies, particularly robots, tend to reallocate workers from skilled to unskilled jobs and lower wage. This result may probably suggest that capital deepening, especially one involved with advanced technology, would still have limited power in pushing labour out of the job market in Thai manufacturing, but without any adjustments, such deepening could push noticeable proportion of workers to be employed in the unskilled positions.

[19] Note that on average, capital-labour ratio in our samples during 2006-2016 was around 1.1 million baht (see Appendix 1)

Concerning an impact of R&D, the wage premium is either inresponsive or shrinking in response to R&D investment (Table 4). The negative response of wage premium to R&D, measured by binary dummy variables, tends to suggest that so far innovation/technology invloved with R&D investment could not significantly boost skilled labour, thereby narrowing the wage gap. Table 5 shows that R&D tends to promote both skilled and unskilled workers when R&D is measured by binary dummy variables, but the coeffcients associated with the latter are larger than the former, confiming results of the possible shrinking wage premium induced by R&D investment. When R&D expense is employed to reflect participation of firms in R&D activities, the wage premium is inrespoinsive to such expense. This may reflect a relative small amount of R&D expenditure, which in our sample, was only around 2 percent of sale on average during 2006-2016.

In line with the results of R&D, BOI privileges are likely to reduce the wage gap between skilled and unskilled workers. This implies that firms receiving BOI privileges tends to hire more unskilled workers than skilled ones.[20] This contrasts to our hypothesis, which expects that foreign and indigenous firms, mostly exporters, would likely to hire more skilled workers and push up the wage premium. However, the negative relationship occurs probably because a number of Thai exporting firms, who obtain BOI privileges, are still original equipment manufacturer (OEMs), including those in electronic and eletrical appliances, garments and food products. Volume of export orders matter so that unskilled workers are needed to perform a task while only few firms can upgrade to be original design manufacturers (ODM) or origianl brand manufacturers (OBM) as mentioned earlier.

We cannot find any difference between foreign and local firms (own_{ijt}) in determining the wage premium. This might be due to the fact that Thailand has long opened for foreign investors since the early 1960s and foreign and local firms interact with each other concerning workers. Therefore, the hypothesized difference in the wage premium disappears. The possible gender bias was not revealed during the study period as the wage premium in firms hiring more female workers are higher than those hiring more male workers (Table 4). The negative and statistical significance of $Skillshare_{ijt}$ is also in line with our hypothesis. Due to the way data were collected as mentioned earlier, wage compensation for operational workers partly

[20] See results in Table 5 where coefficients corresponding to BOI of unskilled workers are higher (or decline at the lower magnitude) than those of skilled ones.

covers that of skilled workers so that the denominator in the wage premium is inflated causing the negative influence of $Skillshare_{ijt}$ on the premium.

6. Conclusions

This paper examines the impacts of trade liberalization on the wage premium using firm level data of Thai Manufacturing as the case study. The tariff protection is applied here to represent trade liberalization, in terms of both nominal and effective tariffs. With nominal tariffs, their effects on finished (output) and raw material (input) products are separately examined. In terms of effective rates of protection (ERP), both a traditional ERP measure, and a measure incorporating a possible water in tariffs are applied. The effect of FTAs is also considered in examining impacts of ERP on the wage premium. In addition to tariff protection, impacts of GVCs, measured through trade in parts and components (P&Cs) on the wage premium is investigated in the study. Our results show that firm-specific factors are more crucial in affecting the wage premium than trade liberalization and participation in global production networks. Firms' market-orientation, especially exports, the level of capital-labour ratio, R&D investment and BOI privileges are crucial in affecting the wage premium. In line with the results of R&D, BOI privileges are likely to reduce the wage gap between skilled and unskilled workers while the role of exports and capital deepening tend to be inconclusive as non-linear relationship with the wage premium is established in these variables.

For trade policy, only input tariffs matter in determining the wage premium, but only in a situation where firms actually import while insignificant relationship is observed when either output tariffs or ERPs are employed to reflect trade liberalization. The participation in GVCs also shows insignificant impact on the wage premium. Wage-employment skills decupling is evident when trade liberalization and participation in global production networks are concerned. That is the wage premium is not influenced by these factors, though they could affect skilled and unskilled workers. The results reveal that trade liberalization tends to lower demand for skilled workers in response to cheaper imported products while participation in global production networks encourages more skilled workers. In addition to a rather short and small panel-data set, labour market condition, especially friction in labour market, a shortage of skilled workers, especially ones involved with operational activities,

somewhat excess supply of unskilled workers induced by migrant workers, and the largely weakly unionized labour market in Thailand could cause wage-employment skills dissociation.

All in all, this study highlights four policy inferences. First, trade liberalziation could continue with less concern on its effects in widening the wage premium. Although tariff rates in Thailand have declined substantially over the past three decades, the escalating tariff structure remains in place. This would reflect unfinished business in tariff restructuring in Thailand. In addition, 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. Second, our findings suggest that participating in global production sharing involves with skilled workers. Participation in the networks could provide not only lucrative business, but also offers the chance to move up to a higher rung on the technology sharing ladder. However, for such opportunities to materialize, workers still 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.

Third, to redress wage-employment skills dissociation, wages should be properly readjusted commensurate to skills improvements/changes. From our study, in some cases wages/income fail to be adjusted to reflect their skills development. Proper payment schemes, beyond relying merely on providing the minimum wage, should be developed to treat workers fairly, along with encouraging them to improve their skills and be flexible. Fourth, to a certain extent, volume of exports matters for firms to expand their products in the global markets, especially ones involving with original equipment manufacturing (OEMs) products. However, these products tend to demand less skilled workers than those under original design manufacturers (ODM) or origianl brand manufacturers (OBM). To promote more skilled workers, along with creating smooth transition, new products, inclduing ODM and OBM should be simultaneously boosted along with improving production of traditional ones (OEM products). R&D investment needs to be properly encouraged, since such investment has still played a limited role in promoting skilled workers in Thailand.

Table 4: Empirical Results: the Wage Premium

	Column A		Column B		Column C		Column D		Column E		Column F (IV with CFA)#		Column G		Column H	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
own ijt	0.123	0.255	0.112	0.250	0.063	0.26	0.065	0.259	0.086	0.254	0.069	0.254	0.096	0.257	0.092	0.256
exp ijt	2.487	0.813***	2.609	0.821***	2.532	0.814***	2.529	0.813***	2.568	0.839***	2.638	0.858***	2.355	0.806***	2.356	0.808***
*exp*ijt^2	-3.416	1.206***	-3.450	1.203***	-3.514	1.212***	-3.529	1.21***	-3.594	1.248***	-3.941	1.454***	-3.205	1.195***	-3.210	1.197***
rim ijt	0.322	0.232	0.694	0.349**	0.363	0.231	0.367	0.232	0.344	0.241	0.501	0.367	0.342	0.232	0.343	0.232
klratio ijt	0.305	0.168**	0.299	0.166*	0.307	0.170*	0.294	0.172*	0.308	0.172*	0.318	0.173*	0.286	0.169*	0.284	0.1705*
*klratio*ijt^2	-0.015	0.007**	-0.015	0.007**	-0.015	0.007**	-0.014	0.007**	-0.015	0.007**	-0.016	0.007**	-0.014	0.007**	-0.014	0.007**
sizeijt	0.491	0.34	0.490	0.338	0.487	0.339	0.499	0.336	0.473	0.348	0.501	0.338	0.514	0.333	0.533	0.331
*size*ijt^2	-0.010	0.009	-0.010	0.009	-0.010	0.009	-0.010	0.009	-0.010	0.009	-0.010	0.009	-0.011	0.009	-0.011	0.009
female_maleijt	0.045	0.018**	0.045	0.018**	0.042	0.017**	0.042	0.017**	0.041	0.018**	0.029	0.026	0.046	0.018**	0.046	0.018**
RDD ijt	-0.367	0.211*	-0.359	0.213*	-0.347	0.196*	-0.335	0.180*					-0.316	0.162**	-0.299	0.147**
RDS ijt									0.055	0.284	0.103	0.292				
skill_total ijt	-0.130	0.078*	-0.116	0.075	-0.125	0.078	-0.124	0.078	-0.131	0.081*	-0.133	0.081*	-0.136	0.078*	-0.137	0.078*
BOI ijt	-0.175	0.11	-0.177	0.109*	-0.187	0.110*	-0.189	0.110*	-0.223	0.119*	-0.278	0.164*	-0.197	0.112*	-0.198	0.111*
HHI jt	-0.054	0.074	-0.051	0.073	-0.074	0.075	-0.075	0.076	-0.077	0.078	-0.102	0.102	-0.061	0.074	-0.060	0.074
Network jt	-0.715	0.704	-0.658	0.701	-0.826	0.716	-0.812	0.722	-0.700	0.754	-1.123	0.861	-1.152	0.732	-1.201	0.739
inputtariff jt	0.796	0.993	1.696	1.086												
outputtariff jt	2.477	2.171	2.280	2.182												
input_rim ijt			7.939	4.468*												
output_exp ijt			-0.626	1.430												
*ERP_1*jt					0.349	0.221										
*ERP_2*jt							0.568	0.392	0.655	0.476	3.976	5.447				
*ERP_3*jt													0.599	0.4748		
*ERP_4*jt															0.883	0.643
time dummy	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
No. of observations	9,304		9,304		9,304		9,304		9,304		9,304		9,304		9,304	
No.of groups	3,283		3,283		3,283		3,283		3,283		3,283		3,283		3,283	
Wlad chi2 (prob>chi2)	232.53 (0.000)		234.32 (0.000)		241.05 (0.000)		232.88 (0.000)		229.08 (0.000)		231.6 (0.000)		235.03 (0.000)		235.1 (0.000)	
Log-likelihood	-13074.192		-13053.484		-13055.232		-13040.342		-13118.15		-13090.473		-13029.303		-13006.9	

Note: # The control function approach for panel data with PPML is applied to redress endogeneity problems of tariffs. All variables, except $female\_male_{ijt}$; RDD_{ijt}; BOI_{ijt}, $Network_{ijt}$, $inputtariff_{jt}$, $outputtariff_{jt}$, and ERP_{jt} are in logarithm formula. *** = 1 percent significance, ** = 5 percent significance and * = 10 percent significance.

Source: Author's estimations.

Table 5: Empirical Results: Unskilled and Skilled Workers

	Column A		Column A1		Column B		Column B1		Column C		Column C1		Column C2		Column C3	
	unskilled		skilled		unskilled		skilled		unskilled		unskilled		skilled		skilled	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
own ijt	-0.424	0.121***	0.086	0.068	-0.425	0.121***	0.084	0.068	-0.425	0.121***	-0.442	0.121***	0.090	0.068	0.085	0.068
exp ijt	-0.435	0.357	0.700	0.198***	-0.432	0.357	0.685	0.198***	-0.430	0.357	-0.355	0.357	0.685	0.198***	0.689	0.198***
$exp_{ijt\hat{}2}$	0.925	0.544*	-1.374	0.304***	0.919	0.544*	-1.378	0.303***	0.913	0.545*	0.803	0.545	-1.371	0.304***	-1.375	0.304***
rim ijt	0.029	0.107	0.151	0.059**	0.022	0.107	0.171	0.059***	0.024	0.108	0.044	0.108	0.163	0.060***	0.165	0.060***
klratio ijt	-0.123	0.089	0.241	0.051***	-0.040	0.089	0.241	0.051***	-0.039	0.089	-0.038	0.089	0.234	0.051***	0.231	0.051***
$klratio_{ijt\hat{}2}$	0.002	0.003	-0.015	0.002***	-0.001	0.003	-0.015	0.002***	-0.001	0.003	-0.001	0.003	-0.014	0.002***	-0.014	0.002***
$size_{ijt}$	0.089	0.132	-0.355	0.078***	0.060	0.132	-0.348	0.078***	0.060	0.132	0.066	0.132	-0.339	0.078***	-0.341	0.078***
$size_{ijt\hat{}2}$	-0.004	0.003	0.008	0.002***	-0.003	0.003	0.008	0.002***	-0.003	0.003	-0.003	0.003	0.008	0.002***	0.008	0.002***
female_male ijt	-0.038	0.008***	0.002	0.003	-0.037	0.008***	-0.0003	0.003	-0.037	0.008***	-0.037	0.008***	0.0003	0.003	0.00004	0.003
RDD ijt	0.216	0.046***	0.077	0.025***	0.218	0.046***	0.069	0.025***	0.218	0.046***			0.070	0.025***		
RDS ijt											-0.075	0.149			0.064	0.075
BOI ijt	-0.001	0.052	-0.017	0.028	-0.004	0.052	-0.004	0.028	-0.005	0.052	0.007	0.052	-0.004	0.028	-0.002	0.028
VAPW ijt	0.208	0.031***	0.313	0.024	0.208	0.032***	0.312	0.023***	0.208	0.031***	0.204	0.031***	0.315	0.023***	0.316	0.023***
HHI jt	-0.046	0.022**	-0.005	0.015	-0.042	0.0212*	-0.026	0.015*	-0.041	0.021*	-0.039	0.021*	-0.022	0.015	-0.022	0.015
Network jt	-0.066	0.112	0.320	0.087***	-0.059	0.112	0.304	0.087***	-0.061	0.112	-0.067	0.112	0.324	0.087***	0.319	0.087***
inputtariff jt	0.571	0.747	2.748	0.561***												
outputtariff jt	0.041	0.282	0.344	0.228												
*ERP_1*jt					-0.017	0.175	0.602	0.142***								
*ERP_2*jt									0.028	0.299	-0.015	0.299	0.569	0.235***	0.573	0.235**
*ERP_3*jt																
*ERP_4*jt																
time dummy	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
No. of observations	8,764		10,268		8,764		10,268		8,764		8,764		10,268		10,268	
No.of groups	3,115		3,675		3,115		3,675		3,115		3,115		3,675		3,675	
Wlad chi2 (prob>chi2)	198.73 (0.000)		1267.13 (0.000)		194.24 (0.000)		1257.16 (0.000)		194.23 (0.000)		173.61 (0.000)		1244.44 (0.000)		1243.5 (0.000)	
Log-likelihood	-17550.427		-29676.629		-17552.92		-29679.627		-17552.921		-17563.213		-29685.976		-29686.654	

Table 5: Empirical Results: Unskilled and Skilled Workers (Cont.)

	Column D		Column D1		Column E		Column E1		Column E2		Column E3	
	unskilled		skilled		unskilled		unskilled		skilled		skilled	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
own ijt	-0.406	0.121***	0.088	0.068	-0.407	0.121***	-0.425	0.121***	0.088	0.068	0.082	0.068
exp ijt	-0.492	0.358	0.681	0.199***	-0.482	0.358	-0.401	0.357	0.684	0.199***	0.689	0.199***
*exp*ijt^2	1.017	0.546**	-1.319	0.305***	0.999	0.545**	0.878	0.545*	-1.323	0.304***	-1.329	0.305***
rim ijt	0.045	0.107	0.132	0.059**	0.047	0.107	0.068	0.107	0.130	0.059**	0.132	0.059**
klratio ijt	-0.029	0.089	0.234	0.050***	-0.031	0.089	-0.029	0.089	0.234	0.050***	0.231	0.050***
*klratio*ijt^2	-0.002	0.003	-0.014	0.002***	-0.002	0.003	-0.002	0.003	-0.014	0.002***	-0.014	0.002***
size$_{ijt}$	0.072	0.132	-0.339	0.078***	0.074	0.132	0.081	0.132	-0.340	0.078***	-0.342	0.078***
*size*ijt^2	-0.004	0.003	0.008	0.002***	-0.004	0.003	-0.004	0.003	0.008	0.002***	0.008	0.002***
female_male ijt	-0.037	0.008***	0.002	0.003	-0.037	0.008***	-0.037	0.008***	0.002	0.003	0.002	0.003
RDD ijt	0.223	0.046***	0.072	0.025***	0.222	0.046***			0.072	0.025***		
RDS ijt							-0.080	0.149			0.055	0.075
BOI ijt	-0.019	0.052	0.005	0.028	-0.019	0.052	-0.008	0.052	0.006	0.028	0.009	0.028
VAPW ijt	0.212	0.031***	0.317	0.023***	0.212	0.031***	0.207	0.031***	0.317	0.023***	0.318	0.023***
HHI jt	-0.055	0.022**	-0.019	0.015	-0.055	0.022**	-0.052	0.022**	-0.018	0.015	-0.019	0.015
Network jt	-0.068	0.112	0.357	0.086***	-0.063	0.111***	-0.072	0.112	0.359	0.086***	0.354	0.086***
inputtariff jt												
outputtariff jt												
ERP_1$_{jt}$												
ERP_2$_{jt}$												
ERP_3$_{jt}$	0.662	0.247***	-0.099	0.168								
ERP_4$_{jt}$					0.872	0.323***	0.873	0.324***	-0.18675	0.217	-0.191	0.217
time dummy	Yes		Yes		Yes		Yes		Yes		Yes	
No. of observations	8,764		10,268		8,764		8,764		10,268		10,268	
No.of groups	3,115		3,675		3,115		3,115		3,675		3,675	
Wlad chi2 (prob>chi2)	200.84 (0.000)		1237.98 (0.000)		200.85 (0.000)		180.31 (0.000)		1238.5 (0.000)		1237.34 (0.000)	
Log-likelihood	-17549.391		-29689.265		-17549.348		-17559.657		-29689.081		-29689.801	

Note: With overdispersion, the control function approach for panel data is applied for determining unskilled and skilled workers and possible endogeneity problems of value-added per workers and tariffs (both nominal and effective rates). All variables, except *female_male*$_{ijt}$; *RDD*$_{ijt}$; *BOI*$_{ijt}$, *Network*$_{ijt}$, *inputtariff*$_{jt}$, *outputtariff*$_{jt}$, and *ERP*$_{jt}$ are in logarithm formula. *** = 1 percent significance, ** = 5 percent significance and * = 10 percent significance.

Source: Author's estimations.

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Appendix 1

Data Used in the Empirical Model

Variable	Obs	Mean	Std. Dev.	Min	Max
$(W\,s/W\,u)_{ijt}$	14,566	2.01	6.30	0.00	218.53
own_{ijt}	14,616	0.05	0.16	0.00	0.69
exp_{ijt}	14,616	0.09	0.20	0.00	0.69
rim_{ijt}	14,616	0.08	0.17	0.00	0.69
$klratio_{ijt}$	14,616	12.42	1.57	4.40	21.54
$size_{ijt}$	14,616	17.51	2.12	10.07	25.61
$female\_male_{ijt}$	14,313	1.44	2.68	0.00	76.50
RDD_{ijt}	14,616	0.12	0.32	0.00	1.00
RDS_{ijt}	14,616	0.01	0.10	0.00	3.35
BOI_{ijt}	14,616	0.16	0.37	0.00	1.00
$vapw_{ijt}$	14,356	12.46	1.32	4.57	18.55
$skill\_total_{ijt}$	14,568	0.67	0.38	0.00	1.00
HHI_{jt}	14,600	-3.38	0.98	-5.52	-0.01
$network_{jt}$	13,965	0.08	0.17	0.00	0.69
$inputtariff_{jt}$	14,153	0.06	0.04	0.00	0.21
$outputtariff_{jt}$	14,153	0.11	0.09	0.00	0.60
ERP_1_{jt}	14,596	-0.01	0.27	-0.82	0.99
ERP_2_{jt}	14,596	0.00	0.20	-0.67	0.81
ERP_3_{jt}	14,596	0.01	0.14	-0.28	1.14
ERP_4_{jt}	14,596	0.01	0.11	-0.16	0.86
$(L\,s)_{ijt}$	14,616	123.66	340.70	0.00	14023.00
$(L\,u)_{ijt}$	14,616	59.48	208.70	0.00	4579.00

All variables, except $female\_male_{ijt}$; RDD_{ijt}; BOI_{ijt}, $Network_{ijt}$, $inputtariff_{jt}$, $outputtariff_{jt}$, and ERP_{jt} are in logarithm formula.

Source: Author' s calculations

Appendix 2

Correlation Coefficient Matrix of All Relevant Variables

$(Ls)_{ijt}$	1																					
$(Lu)_{ijt}$	0.20	1																				
$(Ws/Wu)_{ijt}$	0.04	0.05	1																			
own_{ijt}	0.22	0.12	0.06	1																		
exp_{ijt}	0.23	0.19	0.07	0.40	1																	
rim_{ijt}	0.17	0.10	0.07	0.37	0.41	1																
$klratio_{ijt}$	0.03	0.01	0.01	0.13	0.05	0.09	1															
$size_{ijt}$	0.42	0.36	0.10	0.32	0.35	0.29	0.37	1														
$female\_male_{ijt}$	0.06	0.03	0.03	0.08	0.16	0.09	-0.15	-0.03	1													
RDD_{ijt}	0.11	0.08	0.02	0.07	0.12	0.11	0.09	0.23	-0.01	1												
RDS_{ijt}	0.03	0.02	0.01	0.02	0.06	0.05	0.02	0.05	0.00	0.39	1											
BOI_{ijt}	0.25	0.19	0.06	0.42	0.55	0.34	0.12	0.39	0.08	0.14	0.12	1										
$vapw_{ijt}$	0.07	0.07	0.04	0.19	0.13	0.17	0.51	0.69	-0.14	0.14	0.04	0.20	1									
$skill\_total_{ijt}$	0.15	-0.33	-0.01	0.02	0.00	0.00	-0.01	-0.07	0.06	-0.04	0.01	0.00	-0.04	1								
HHI_{jt}	0.05	0.04	0.02	0.07	0.04	0.10	0.02	0.04	-0.05	0.04	0.02	0.06	0.03	0.01	1							
$network_{jt}$	0.08	0.06	0.03	0.19	0.08	0.14	0.02	0.14	-0.03	0.01	0.00	0.14	0.08	0.01	0.13	1						
$inputtariff_{jt}$	0.05	0.06	0.01	-0.02	0.01	-0.03	-0.01	-0.02	0.09	0.03	0.00	-0.03	-0.03	-0.03	0.16	0.05	1					
$outputtariff_{jt}$	0.06	0.03	0.00	-0.01	0.10	-0.04	-0.08	-0.02	0.22	0.01	0.00	0.03	-0.09	0.01	0.07	0.06	0.49	1				
ERP_1_{jt}	0.02	-0.05	0.02	0.01	0.06	0.03	-0.07	-0.02	0.05	0.01	0.13	0.15	-0.03	0.07	0.01	0.02	-0.36	0.12	1			
ERP_2_{jt}	0.03	-0.03	0.02	0.01	0.08	0.03	-0.06	-0.01	0.07	0.01	0.13	0.17	-0.02	0.06	-0.01	0.02	-0.33	0.12	0.97	1		
ERP_3_{jt}	0.02	-0.01	0.02	-0.01	0.01	0.00	-0.01	-0.02	-0.01	0.00	0.06	0.07	-0.02	0.01	0.14	0.01	-0.11	0.18	0.42	0.43	1	
ERP_4_{jt}	0.02	-0.01	0.02	-0.01	0.02	0.00	-0.02	-0.02	-0.01	0.01	0.07	0.07	-0.03	0.01	0.14	0.00	-0.09	0.19	0.42	0.46	0.984	1

Note: All variables, except $female\_male_{ijt}$; RDD_{ijt}; BOI_{ijt}, $Network_{ijt}$, $inputtariff_{jt}$, $outputtariff_{jt}$, and ERP_{jt} are in logarithm formula.

Source: Author' s calculations