Trade linkages and skills demand: Empirical evidence for the Malaysian electrical and electronics industries

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Abstract

International trade enhances competition providing access to technology and markets of partner countries as well as spillover effects from interactions with more developed countries. Existing studies on the effect of trade linkages on relative demand (particularly skill upgrading) for skilled workers mainly focus on the manufacturing sector at a high level of aggregation. These studies also typically focus on developed countries and use outsourcing intensity as the measurement for trade linkages. Previous studies pool data across industries controlling for industry effects without considering trade linkages on relative skill demand for specific industries. We depart from previous literature by considering only the E&E industry which has the highest trade volume in Malaysia's manufacturing sector. Particularly, this paper empirically investigates the skill upgrading effect of broad measures of trade linkages for establishments in the Malaysian E&E sector over the period 2000 to 2005 drawing data from the Department of Statistics Malaysia (DOSM) Annual Survey of Manufacturing Industries (ASMI). The database allows this paper to analyse the direct impact of each aspect of trade linkage including export intensity, outsourcing intensity as well as vertical trade intensity on relative demand for skills. The vertical trade measure used in this paper is taken from Khalifah and Azhar (2013) which would best capture the trend in vertical trade in the Malaysian E&E sector. This paper estimates a dynamic skill share equation linking the employment share of skilled workers in a given establishment to trade intensity amongst other control variables accounting for heterogeneity of establishments. Estimation is based on the Generalised Method of Moment estimator addressing both the issue of endogeneity and sub-industries as well as firms fixed effect. Contrary to the results of previous studies, our econometric analysis suggest that changes in export intensity and outsourcing intensity measures, commonly used in the literature does not significantly contribute to skill upgrading in Malaysian E&E establishments within the period under study. Furthermore, vertical trade intensity and foreign share have negative impact on relative demand for skilled workers. These findings provide evidence that vertical trade as well as the presence of MNCs is associated with skill downgrading in Malaysia's E&E sector. Empirical evidence does not uphold the conventional wisdom of the beneficial effects of trade especially ultra-vertical or export processing trade on skill upgrading.

Keywords: fragmentation, empirical studies of trade, trade and labour market interaction, labor demand
JEL Classification: F12, F14, F16, J23

1. Introduction

In general, this study aims to conclude the relevance of trade linkages in shaping the landscape of Malaysian manufacturing, by focusing its influence on employment. In particular, we empirically test the significance of every aspect of trade, international outsourcing (importing inputs), export of goods, and vertical trade, as underlying forces for the changes in skills demand for the Malaysian E&E sector within the period 2000 – 2005. This study is crucial with reference to several facts pertaining to current trends regarding

Malaysian trade as well as the composition of labour demand in the manufacturing sector, particularly for policy implications.

The high share of both imported inputs as well as exports for E&E industries show the large volume of overlapping exports and imported inputs which then indicates the high intensity of vertical trade or international production sharing in these industries. However, based on the Economic Transformation Programme Annual Report 2011, Malaysian E&E industries is still heavily focused on the assembly of low value added tasks or stages of productions using unskilled workers intensively. Therefore, despite being a major exporter of this group of high-technology industries (Hatzichronoglou, 1997) most of the Malaysian export oriented industries, including E&E industries, have been involved in stages of production consisting of unskilled assembly and labour intensive stages of production (Menon, 1998; Devadason 2011). It is anticipated that international trade enhances competition providing access to technology and markets of partner countries as well as spillover effects from interactions with more developed countries which in turn increases the relative demand for skilled workers – skill upgrading. If the E&E industries continue focusing on low–value stages of production and relatively unskilled-intensive assembly activities, these would induce opposite effects on skilled workers demand. Therefore, how do trade linkages affect the skills demand for Malaysian E&E firm's labour market? This issue has not yet been properly analysed. In particular, the empirical analysis in this paper aims to answer two questions, (i) which aspect of trade matters or is relevance in explaining the changes in relative demand for skilled workers within establishments in this industry? Therefore, we seek to identify which channel does trade linkages affect Malaysian E&E labour market. (ii) And, how does this trade channel influence the skill-intensity? Does trade lead to upgrading or downgrading of the skill-intensity for E&E establishments in Malaysia.

The workhorse of neoclassical theory, the Heckscher-Ohlin model (HOM) and Stolper-Samuelson theorem (SST)[1], provides for the central framework and elementary intuition on the association of international trade and labour market. Nevertheless, recent evidence on changes in labour market – relative demand and relative wages – as well as recent trends in trade structure – trade pattern, trade composition, and trade direction are inexplicable to classical trade theory. Empirical evidences reveal both rising wage inequality and skill intensity in manufacturing industries for developed (Berman, Bound & Griliches, 1994; Feenstra & Hanson, 1995, 1996, 1997a, 1999; Anderton & Brenton, 1999; Strauss-Khan, 2004; Agnese, 2012) as well as developing countries (Wood, 1997; Pavcnik, 2003; Goldberg & Pavcnik, 2004, 2007; Meshi & Vivarelli, 2009; Meschi, Taymaz, Vivarelli, 2011; Gourdon, 2011). Moreover, the changes in relative demand for skilled workers is characterised as *factor-biased*, opposing to the prediction of HOM that suggest sector-biased changes in relative demand, revealing that changes in the relative demand for skilled workers occur *within* the industry or firms[2] (Berman *et al.*, 1994; Bernard & Jensen, 1997; Berman, Bound and Machin, 1998; Berman & Machin, 2000; Feenstra & Hanson, 2001; Strauss-Kahn, 2004; Meschi *et al.*, 2011). One explanation for these recent trends is the strategized action by firms in the developed countries to disintegrate their production process via international production sharing, which results in massive changes in global linkages with substantial increase in foreign direct investment as well as trade in intermediate goods.

Formerly, studies on the effect of international production sharing on relative demand for skilled workers mainly focus on the manufacturing sector at a high level of aggregation (Feenstra and Hanson, 1995, 1996, 1997a, 2001; Berman *et al.*, 1994, Egger, Pfaffermayr & Wolfmayr-Schnitzer, 2001; Egger & Egger, 2005; Agnese, 2012). Only, recently, studies start using firm-level data (Bernard & Jensen, 1997; Head & Ries, 2002; Pavcnik, 2003; Gorg & Hanley, 2005; Meschi *et al.*, 2011). Moreover, most above mentioned studies focused on the developed countries. Recent evidence shows that the developing countries are also

affected by global trade linkages. This new form of trade is more intensive in East Asian and Asian countries, and has exceeded the growth rates of trade in final goods (Athukorala & Menon, 2010; Ahn, Fukao & Ito, 2008; Athukorala & Yamashita, 2006). Nevertheless, studies on the effects of international linkages for developing countries are initially focused on Latin American countries (Feenstra & Hanson, 1997b; Harrison & Hanson, 1999b, and Robertson, 2004; for Mexico; Pavnick, 2003; Gallego, 2012; for Chile). Only recently, studies began to examine the trade linkages effects on changes in relative labour demand in Asian countries. For instance, studies by Berman & Machin (2000) for developing countries including Asian developing countries, Devadason (2005a, 2011), McNabb & Said (2013) for Malaysia; Tangavelu & Chongvilaivan (2011) for Thailand, Fajnzylber & Fernandes, (2009) for China and Brazil.

We depart from previous literature by considering only the E&E industry, using highly disaggregated data, which has the highest trade volume in Malaysia's manufacturing sector. Particularly, this paper empirically investigates the skilled workers demand effect of every aspect of trade linkages for establishments in the Malaysian E&E sector over the period 2000 to 2005.

This paper contributes to the empirical literature in a number of ways. Firstly, we use the establishments-level data which overcome aggregate bias and measurement bias (Horgos, 2009). We fully utilise the richness of the provided database by analysing different type of trade linkages including outsourcing intensity, export intensity as well as vertical trade intensity while controlling for foreign ownership (FDI). The establishments-level database enables us to directly analyse the effect of different type of trade linkages on skill intensity of production. Most studies only focus on specific aspects of trade, mainly on outsourcing, except for Meschi *et al.* (2011) and Fajnzylber & Fernandes (2009) analysing both imports and exports, as well as the foreign share (FDI) of establishments. This study, extend previous literature by also analysing the vertical trade effects on skilled workers demand in addition to other standard trade variables. In particular, we use the establishment-level index by Khalifah & Azhar (2013) which has overcome the limited database for studies that rely on industry-level data and Input-Output Tables to estimate the share of imported inputs (refer to Horgos (2009) for extensive clarifications on the measurement issues).

Secondly, the analysis in this paper addresses the heterogeneity of firms within the industries, the time-variant heterogeneity of firms – capital intensity, foreign share as well as firm's scale effects. In particular, we analyse the effects of trade linkages on skilled workers demand *within-firm* for E&E industries. Using the one sector framework, E&E, enables us to predict the sector-biased versus factor-biased effects of international outsourcing on skilled workers demand. In particular, if sector-bias effect matters, international outsourcing should increase relative demand for skilled workers since E&E industries are skill-intensive industries (Egger *et al.*, 2001; Geishecker & Gorg, 2005; Horgos, 2011). On the contrary, if factor-bias matters, the effects of international outsourcing depend on the factor-intensity of the tasks or stage of production. For Malaysian based E&E firms, which mainly provide outsourcing services (import skill-intensive inputs) and focus on unskilled-intensive activities (assembly activities), international outsourcing is expected to increases the relative demand for unskilled workers. In addition, focussing on E&E industries, we depart from previous studies that pool data across industries controlling for industry fixed effects without considering trade linkages on relative skill demand for specific industries. To the best our knowledge, there is no study that empirically examine the effect of trade on skilled workers demand by focusing on E&E industries, particularly using establishment level data for industry as well as trade variables for Malaysia. Studies by McNabb & Said (2013) and Devadason (2005a, 2011) have matched the SITC (Standard International Trade

Classification) trade data at 3-digit industry-level with the Household Income Survey and ASMI (provided by DOSM), respectively.

Thirdly, we estimate the skill share equation using the two-step *System* GMM which addresses several econometric issues: (i) dynamic demand for labour (panel data), (ii) the issue of endogeneity arising from the interrelationship among the variables in the models, as well as controlling the unobserved time invariant establishment characteristics.

Finally, we contribute to the literature where result shows trade linkage does not necessarily upgrade skill-intensity within firms. In summary, results show that both changes in export intensity and outsourcing intensity does not contribute to changes in skill-intensity within establishments for Malaysian E&E industries. However, using the narrower measure vertical trade intensity (Khalifah & Azhar, 2013), our empirical analyses infers that changes in vertical trade intensity has led to skill downgrading in the establishments. From the results, we also predict that changes in the skilled workers demand is characterised by factor-biased effects, i.e. the intensity of the tasks or stages of production involved in the international outsourcing, and not the intensity of industries (sector-biased effects). Therefore, the changes in the skilled workers demand occur within the firms similar to the SBTC[3] effect, which in our paper represents unskilled biased technological change (USBTC).

The remainder of this paper is organised as follows: the next section review the theoretical and empirical literature on the association of trade linkages, particularly international outsourcing, and relative labour demand. In Section 3 we discuss the empirical strategy, describe the data and present the descriptive statistics. In Section 4 we present and discuss the empirical results. Finally, the last section discusses the conclusion of this study.

2. Literature Review

International production sharing is a strategic action where firms disintegrate their production by segmenting or slicing up the production process into several stages and relocating one or several fragments to another location or country (cross-border sourcing). The motivations are cost efficiency strategies, i.e. by relocating tasks where factor prices relatively are cheaper (Heckscher-Ohlin theory), or where the skill-intensity is more suitable or appropriate for the certain tasks due to in skill differences across countries (Ricardian model).

Two main theoretical views on the effects of international outsourcing on relative demands of skilled workers are by, first Feenstra & Hanson (1996), and second, by Arndt (1997, 1998, 1999), Arndt & Kierzkowski (2001) and Deardorff (2001).

In summary, Feenstra and Hanson (1995) proposes that foreign investment and outsourcing activities by the developed MNCs has contributed to the rise in relative wages for skilled workers in both developed and developing countries. Analysis in the paper is based on a model of a single manufactured good (one sector) produced from a continuum of intermediate goods, that are in turn produced using skilled workers, unskilled workers and capital. Hence, this model assumes all the activities occur within a single industry. The developed countries relocate or outsource the unskilled-intensive fragments to developing countries. The activities transferred to developing countries will be relatively more skilled worker intensive than those formerly produced in those developing countries, but less skilled-worker intensive than those currently produced in the developed countries. Consequently, relative demand for skilled-workers in both countries increases. The implication from the model; developing countries should receive positive effects from this win-win trade where changes in relative demands are towards skilled workers. Furthermore, the model also suggests that the changes in relative demand occurs within-industry, similar to SBTC, towards factor-biased effects.

Arndt (1997, 1998, 1999), Arndt & Kierzkowski (2001), Deardorff (2001) present a different view on potential effects of international fragmentation production on skilled workers demand. Using the traditional trade framework at a disaggregate level, Arndt (1997, 1998) claims that the effect of international outsourcing on relative wages depend on the factor intensity of the outsourced fragment. The sector-biased effects matter, particularly in models with a multi-sector set-up. If outsourcing occurs in an unskilled intensive industry, it will increase the relative wages for unskilled workers. On the contrary, if outsourcing activities involve the high-skilled intensive industry, the relative wages for high-skilled workers increases. Therefore, who gains and who loses from international outsourcing remains an empirical issue, particularly in the short run. Rigidity in wages, immobility in inter-industry movements of workers as well as inadequate changes in outputs, act as restraints in the labour market to fully adjust to any structural change (Egger *et al.*, 2001).

Empirical evidence on skills demand effect of outsourcing, measured by share of imported input in total inputs, provides a consensus of a positive association between the two variables. In general, studies provide evidence that outsourcing the low skills fragments of the production chain to the low-wage countries or less-developed countries reduce relative demand or wages for unskilled workers in the developed countries. Feenstra & Hanson (1995, 1996 and 1999), focuses on U.S. manufacturing labour markets in 1980s. Using different measures of international outsourcing (respectively, import penetration ratio, share of imported intermediate inputs in the total purchase of non-energy materials, and the narrower index of outsourcing), results for all three studies found that international outsourcing increases the cost share of non-production (skilled) labour for U.S. industries. Also, Yamashita (2010) who replicate Feenstra & Hanson (1999), construct a new measure of outsourcing based on trade in parts and components (P&C) in SITC trade data (United Nations Broad Economic Category) relative to total intermediate inputs. The study used data for 48 U.S. manufacturing industries (machinery and transport) for the period 1979-1990. Results from the study also suggest that only import of intermediate inputs from developing countries is significant in increasing wage inequality in the U.S. Similarly, Anderton & Brenton (1999) also finds similar results for U.K.'s industries within the period 1970-1986. Using data for 4-digit textiles (unskilled intensive) and non-electrical machinery (skilled intensive) industry, estimation suggest that only the imported input from low-wages countries pushes down relative demand for less-skilled labour. The study also implies that unskilled-intensive sector was more affected by outsourcing than higher-skill sectors. Anderton, Brenton & Oscarsson (2002) also explore this issue on U.K. (1970-1986), USA (1970-1993), Sweden (1970-1993) and Italy (1973-1995). The measurement of outsourcing is proxied by import penetration (the share of imports of intermediate relative to final goods). Results of the panel data analysis also conform that imports from low-wage countries has significantly increased wage inequality and relative employment of high skill workers in those countries.

Recently, studies have diverted to developed countries in Europe. Strauss-Kahn (2004) studies the impacts of vertical specialization on changes in relative demand for unskilled workers in France within the period 1977 to 1993. The study firstly showed that reduction in relatively demand for unskilled workers mainly occurs within industry. Estimation result revealed that vertical specialization is significant in explaining the decline in the within-industry share of unskilled workers in French manufacturing employment. Helg & Tajoli (2005) suggest that outward processing trade, a narrow measure of production sharing, consistently increase the relative demand for skilled workers for Italy, but have no influence on Germany's labour demand in 1990s. Geishecker & Gorg (2008), also focus on Germany within the period 1991-2000, combining the household survey database (GSOEP) and industry-level outsourcing activities to analyse the effects of outsourcing on wages. Skills categories in the study are based on both education attainment (using the International

Standard Classification Education/ISCED) as well as the required on-the-job skills. Estimation results also suggest that outsourcing has negative effects on unskilled workers.

Studies by Head & Ries (2002), Yamashita (2008) and Agnese (2012) focus on an Asian developed country, Japan, to analyse the effects of international production sharing on within home firm's skilled workers demand. Head & Ries employ 25-year (1965-1990) panel data set for over 1000 manufacturing firms and specifically examines the electronics industry as a special case of extensive foreign production. Yamashita (2008), constructs a measure of fragmentation intensity using the trade data on P&C (focus on SITC 7 and SITC 8) over the period 1980-2000. The estimation using panel data techniques found that the expansion of fragmentation trade with East Asia (developing countries) significantly upgrades the skills of Japanese manufacturing employment, while fragmentation trade with OECD (developed countries) had a skill downgrading effect. Similar to Yamashita, Agnese (2012) also focus on industry-level data, however the study analyses both materials as well as services offshoring activities across occupation and across three major sectors of the economy (manufacturing, services and primary plus energy) for 1980-2005. The study concludes, highly skilled occupation gains from the services offshoring, while production workers (unskilled) benefit from materials offshoring.

For the developing countries, studies on the relationship of standard trade measures and skilled workers demand are quiet numerous[4], particularly for Latin American countries. Fewer studies focus on the impacts of the new forms of trade – international production sharing for Asian developing countries. Robertson (2004) and Feenstra & Hanson (1997b) focus on Mexico, Pavcnik (2003) on Chile, and Arcabche, Dickerson & Green (2004) on Brazil. For Peru, Mazumdar & Quispe-Anoli focus on input materials, domestic as well imported as determinants for rising wage inequality for the period within 1994-2000. In particular, the study focuses on the within-industry rise in wage inequality. The paper shows that capital accumulation and not technology that is responsible for increments in demand for skilled labour in Peru. Pavcnik (2003) focus on relative skilled demand within manufacturing plant in Chile for 1979-1986 when studying the effects of technology adoption (measures by imported input, patented technology and FTA). Meschi *et al.* (2011) also study developing countries but utilising the plant-level data for Turkey. Both studies find, as most studies on developed countries, positive association between trade measures and relative skilled workers demand. Similar results also were obtained for Thailand manufacturing plants, as shown in the study by Thangavelu & Chongvailavan (2009). In particular, Thangavelu & Chongvailavan explores the effects of both materials as well as services outsourcing. The study suggests that materials outsourcing in Thailand manufacturing industries are skilled-biased. The result shows that materials outsourcing reduces both skilled and unskilled workers demand, and the effects is larger for the unskilled workers.

However, Fajnzylber & Fernandes (2009) show that trade effects on skilled workers demand varies across countries, as found by Berman & Machin (2000). Fajnzylber & Fernandes (2009) hypothesized the effects of trade on skilled workers demand depends on the underlying forces of trade, comparative advantage or technological change. The study test the hypothesis on Brazil and China and it shows that imported inputs and FDI increases skilled workers demand for Brazil, and the opposite effect for China. Thus, for China, FDI and imported inputs are made to utilise the comparative advantages, the bulk of which is unskilled labour assembly activities which hence increases relative demand for unskilled workers. For Brazil, FDI as well as imported inputs are skilled-biased or enhancing demand for skill.

For Malaysia particularly, several studies have been conducted to analyse underlying factors that contribute to changes in labour demand or wages. The earliest, Robbins (1996), found the wage gap between educated and less educated workers has narrowed over the

period 1973-1989 for exporting sectors. Berman & Machin (2000) focus on the effect of cross-border technological transfer (measured by U.S. R&D intensity and computer used) and find that cross-border technological transfer has reduced the relative demand for skilled workers in Malaysia within 1980-1990 – the technological transfers are unskilled biased. The study also suggests that changes in relative demand in Malaysia within those periods occurs within-industry. Devadason (2005) has focus on the effects of fragmentation trade on relative labour demand for Malaysian manufacturing industries. However, the study utilises SITC trade data which commonly measure the effect of imported of intermediate inputs which unable to capture the true nature of international outsourcing. Also, her study in Devadason (2011) for a balanced panel of 19 major industry groups (3-digit SITC) within 1983-2004 which has shown that growth of imports reduced growth of skills share in these industries. McNabb & Said (2013) also analyses the sources for the changes in skilled workers demand by focusing on trade and technical change. The study matched trade data (3-digit SITC) with the Household Income Survey (for the year 1984, 1989, 1992, 1995, and 1997). The measures of wage inequality in the study (standard deviation of wage distribution, and the ratio of the 90 to 10 per cent deciles) have shown the decreasing trends over the period 1984-1997. Results suggest that trade liberalization and TFP growth in Malaysian manufacturing industries are biased towards the less educated or unskilled workers. Though the results are fairly conclusive, these studies suffer from several empirical issues including the measurement problems as well aggregation bias due to the nature of the database that have been used.

Furthermore, several empirical studies have raised the issue of sector-biased and factor-biased effects of international outsourcing. Egger *et al.* (2001) focus on Austrian manufacturing industries (NACE 2-digit industries) for the period 1990 to 1998, explores the potential of sector-biased effects of fragmentation trade on relative factor prices as well as productivity by dividing industries into low-skilled and high-skilled intensive. Hijzen (2007) also analyses relative importance of factor and sector bias of SBTC and outsourcing on productivity and relative wages in the UK for the period 1993-1998. Both studies apply the same two-stage mandated wage approach (Feenstra & Hanson, 1996, 1999). Results of the 3SLS in Hijzen shows that outsourcing significantly contribute to the rise in UK's wage inequality in the 1990s, and suggest that factor-biased outsourcing is more important than sector-biased outsourcing in explaining the increase in wage inequality. Egger *et al.* (2001) find that outsourcing increases relative wages of skilled workers in the skilled-intensive industries – providing support for the sector biased effects. Horgos (2011) also study the issue by focusing on Germany using more disaggregated industry-level data for 1991-2000. The study contribute to the literature by showing that unskilled workers are not necessarily harmed by the international outsourcing in developed countries and the importance of sector-biased effects of wages. The study divided industries into low-skilled and high-skilled intensive industries using cluster analysis (following Geishecker & Gorg, 2005). Results consistently show that international outsourcing significantly affect wages differential when data are disaggregated and the wage gap between skilled and unskilled workers decreased when international outsourcing taking places in low skill intensive industries – reflecting the sector biased effect. Geishecker & Gorg (2005) also suggest the sector-biased effects of fragmentation trade for German industries data within the period 1991 to 2000. The study confirms that fragmentation trade only significantly reduced wages for unskilled labour attached to unskilled intensive industries. Similar to Hijzen (2007), several studies has indirectly shown the factor-biased effects of international outsourcing by decomposing the changes in skilled workers demands into within and between industries or firms changes in demand. Berman & Machin (2000) when studying 37 developing countries including Malaysia, , Strauss-Kahn (2004) for France, and Bernard & Jensen (1997) for U.S. claim that

changes in relative demand are dominated by the changes within the industries or firms which conclude the factor-biasness of outsourcing.

Most of the studies on this issue assume that imported inputs affect all industries equally by pooling the data across all industries. Only some studies focus on particular industry, for instance, the study by Anderton & Brenton (1999) focus on textiles and non-electrical machinery, Pavcnik (2003) study all manufacturing industries as well as focus on electronic, as done by Head & Ries (2002) for Japanese plants and Gorg & Hanley (2005). Using plant-level data for the Irish electronic industry for the period 1990 to 1995, Gorg & Hanley (2005) investigate the implication of international outsourcing on labour demand especially the short-run employment effects in outsourcing plants. Specifically, the study differentiated two types of outsourcing, i.e. materials and services outsourcing. Results show that international outsourcing, both level and changes reduce plant-level labour demand for Irish electronic industry in the short run, and the outsourcing of materials have a stronger negative effect than the outsourcing of services.

Horgos (2009) raise the issue of measurement and aggregation bias when studying the impact of international outsourcing on labour market, particularly wage differential between high-skilled and low-skilled labour. The study utilise four indices commonly used in previous studies, namely share of imported inputs from total input (IITI), from total imports (IITM), from total output (IIGO) and standard vertical trade index on data for German for 1991-2000. To test for the potential of aggregation bias, the study uses both aggregated and disaggregated level industry. Empirical results in the study have shown that measurement differences as well as aggregation of data are crucial in determining the significant role of international outsourcing on German's labour markets.

3. Empirical Methodology and Descriptive Statistics

In this empirical analysis, we aim to examine (i) which type of trade is significant in explaining changes in skill intensity, (ii) in what manner that particular trade types influence changes in the skill-intensity, induce skill upgrading or skill downgrading, and (iii), both results in (i) and (ii) enables us to *basically* identify whether the changes in skill intensity are characterised as sector-biased or factor-biased effects (Geishecker & Gorg, 2005).

a. Empirical Strategy

In line with previous studies, we use the skill share equation derived from a translog cost function[5] in our estimation procedure. In particular, the quasi-fixed translog cost function (Brown & Christensen, 1981) with two variable factors[6], skilled (*S*) and unskilled (*U*) workers) and capital (*K*) as quasi-fixed factor. The cost function is as follows:

$$\ln C = \alpha_0 + \sum_{j=S,U} \alpha_j \ln W_j + \frac{1}{2}\sum_{j=S,U}\sum_{k=S,U} \alpha_{jk} \ln W_j \ln W_k + \beta_K \ln K + \frac{1}{2}\beta_{KK}(\ln K)^2 + \gamma_Q \ln Q + \frac{1}{2}\gamma_{QQ}(\ln Q)^2 + \delta_T T + \frac{1}{2}\delta_{TT}(T)^2 + \sum_{j=S,U} \theta_{jK} \ln W_j \ln K + \sum_{j=S,U} \theta_{jQ} \ln W_j \ln Q + \sum_{j=S,U} \theta_{jT} \ln W_j T + \vartheta_{KQ} \ln K \ln Q + \vartheta_{KT} \ln K T + \vartheta_{QT} \ln Q T \quad (1)$$

where C is variable cost in firm *i* (for simplification, we dropped the subscript *i* that represent the firm *i*). W_j are prices for variable factor *j* (W_S and W_U are wages for skilled and unskilled workers, respectively), Q is output, K is capital stock. T denotes the structural variables or technological shifter; comprising the observable measure of trade linkages as well as technological change. The cost-minimizing quantity of *S* and *U* are derived by differentiating

the cost function with respect to (w.r.t.) price of each type of worker. Thus, differencing the cost function (1) w.r.t. W_S[7], we obtain[8]:

$$s_s = \alpha_s + \alpha_w \ln\left(\frac{w_S}{w_U}\right) + \theta_{sK} \ln K + \theta_{sQ} \ln Q + \theta_{sT} \ln T \quad (2)$$

We rewrite Equation (2) in econometric form by taking the differences form, to remove firms as well as industries unobserved time-invariant specific, and include the lag dependent variable (LDV) as one of our regressors. Introducing LDV as one of the regressors, to allow for labour adjustment costs and therefore we analyse a dynamic version of the employment share equation. Consequently, our estimation equation for empirical analysis is as follows:

$$\Delta \ln e_{it} = \beta_0 + \Delta\beta_1 \ln e_{it-s} + \beta_2 \Delta \ln \left(\frac{w_s}{w_u}\right)_{it-s} + \beta_3 \Delta \ln K_{it-s} + \beta_4 \Delta \ln Q_{it-s} + \beta_5 \Delta \ln F_{it-s} + \beta_6 \Delta \ln O_{it-s} + \beta_7 \Delta \ln X_{it-s} + \beta_8 \Delta V_{it-s} + \Delta\delta_t + \varepsilon_{it} \quad (3)$$

where subscript *i* and *t* denote respectively firms and years; e_{it} is the skilled workers employment share; $\left(\frac{w_s}{w_u}\right)$ is the relative wages of skilled workers, *K* is capital, *Q* is output, *F* is foreign share (FDI), *T* is a vector of trade linkages measure; comprising the outsourcing intensity (*O*), the export intensity (*X*) and the vertical trade intensity index (*V*); δ_t[9] is time trend; ε_{it} is observation specific error, and β parameters are estimated coefficient for explanatory variables.

For estimation purposes, we take lagged *1* and *2* for LDV, while for our explanatory variables we take both the current (contemporaneous value) and lagged *1*. The significance of parameter β_1 confirms the dynamic nature of our panel model. The coefficient for relative wages (β_2) is ambiguous, depending on the elasticity of substitution between skilled and unskilled labor[10]. If the coefficient for the capital intensity variable is positively significant ($\beta_3 > 0$) we conclude capital-skills complementary (or capital substitutes for skilled workers if parameter $\beta_3 < 0$). Total output reflects firm's scale effect. If $\beta_4 > 0$ and statistically significant, as production increase, firm tend to increase demand for skilled labor. If parameter β_4 is not significant, then output growth is not related to skill-share growth. Parameter β_5 is the estimated coefficient for foreign share or FDI variable. Devadason (2011) uses FDI to measure the potential existence of foreign technology upgrading (indirectly). The positively significant sign of the coefficient of FDI ($\beta_5 > 0$) reflects skilled biased technological cross-border transfer when capital-skill complementarity exists as well. In Head and Ries (2002), the signage for statistically significant coefficient for FDI variables act as a predictor for type of FDI, i.e. whether horizontal or vertical FDI. If $\beta_5 < 0$, FDI is mostly vertical where the extent of technological transfer is lower, i.e.the activities (or stage of production) shifted to developing countries are unskilled intensive, and hence lead to increase demand for unskilled labour. If the FDI is mostly horizontal (replicate downstream activities – when trade cost are high and economics of scale low), $\beta_5 > 0$. Parameters β_6, β_7 and β_8 measure the effects of our trade linkages on changes in skill demand; outsourcing intensity, export intensity and vertical trade intensity, respectively. The outsourcing intensity and export intensity are treated as broad measures for international fragmentation production, as explained in the next section. The changes in outsourcing intensity and export intensity will lead to increments in skill intensity (skill upgrading) if the coefficient for both measures is positively significant[11]. This is true when firms import unskilled-intensive inputs (outsource unskilled-intensive activities) and concentrate on skilled-intensive tasks, imported inputs are complementary to skilled workers. And, the opposite sign is true if firms outsource the skilled intensive inputs or tasks and domestic task is concentrate on low-end value chain.

Finally, the coefficient β_8 represents a measure for international outsourcing or vertical trade (import inputs to produce goods or goods in process that will be exported). If a higher trade overlap (higher imported inputs and export) lead to a reduction in skilled workers demand, the coefficient for this variable (β_8) will be negative. This reveals that trade linkages involve unskilled intensive tasks. And, $\beta_8 > 0$, if the activities involved are complements to skilled workers. Δt in this study, measure the indirect effect of technological progress. Technological change is skill-biased if the coefficient for the time trend is positive and significant.

b. GMM Estimators

We estimate a dynamic model of establishment-level labour demand using a generalised method of moments estimator (GMM), specifically the two-step System GMM. Following Arellano-Bond (1991), it is expected that the adjustment in labor demand share due to the changes in the determinants (wages, capital, output, and trade measures) are not an immediate process[12]. The adjustment towards its steady state always is delayed which depend on the passage of time as well as the deviation of previous year's actual level (employment) from its steady state level. Therefore, this study includes the LDV and lagged independent variables as well among the regressors. Estimation using the dynamic GMM controls for the firms or industries specific fixed effects as well as solve the endogeneity problems in the model, due to the interrelation among the variables in the model.

Clearly, the endogeneity problem arises as the LDV is correlated with fixed effects[13] and due to interrelationships among the regressors[14]. Arellano and Bond (1991) propose the GMM estimation to solve the problems, the first differenced equation is estimated using lagged levels of the DV as instrument, and the lagged level of regressors as instruments for the first-differenced regressors – *Difference* GMM estimator. However, the *Difference* GMM estimator of the autoregressive coefficient is often found to be downward biased in finite samples in particular, when the DV has near unit root properties. In that case, instruments in the first differenced equation are weak (Blundell & Bond, 1998). Additionally, *Difference* GMM estimator is also to weak if cross section variability dominates times variability and strong persistence in the investigated time series (Bond, Hoeffer & Temple, 2001). Efficiency improves when applying an extended GMM estimation method, the *System* GMM estimators.

The system combines the equation in first difference with the equation in levels. The *System* GMM estimator uses lagged differences of the DV as instruments for the levels DV in addition to the levels that again serve as instruments for the first-differenced equation. Regressors in level in second equation are also instrumented with their own first differences. *System* GMM with fixed effect need additional assumption, the first-differenced instrument used for variables in level are not correlated with the fixed effect. One solution is to difference the equation.

In this analysis, we treat the relative wages, real capital and real outputs as predetermined variable which might also be correlated with unobserved firm specific effect, e.g. computer innovation. Also, the interconnection between the trade linkages within a firm might not be random for our data that reveal a high correlation between imported inputs and exports which raises collinearity issues. Furthermore, outsourcing and export may also be correlated with time-invariant firm effect (e.g. productivity or managerial ability or financial constraint that affects the relative demand for skilled workers independent of technology use). Therefore, in this analysis, we treat all the three measures of our trade linkages as predetermined while the foreign share is exogenous (decision is made by the parents company).[15]

We conduct the diagnostic test to assess the model and the validity of our *System* GMM estimator. First, since the first difference equation produces unbiased and consistent estimates under the assumption that there is no second order serial correlation of the error

term, the Arellano-Bond (second order) autocorrelation, AR(2) is use to test for no second-order serial correlation. The test for AR(2) in first difference is more important than AR(1), because it will detect autocorrelation in level.

Second, the Sargan test and Hansen test are used to test for the validity of the over-identifying restriction of the GMM with the null hypothesis of strict exogeneity of our instrumental variables, i.e. the overall validity of the instruments, not correlated with errors in the first differenced equation, or strictly exogenous. The test statistic has a χ^2 distribution with q equal to the number of instruments minus number of parameters in the model. If Sargan test or Hansen test reject the null hypothesis of no correlation, the instrumental variables estimator is biased and inconsistent. Third, the Difference-in-Hansen test which test for the exogeneity of each instrument is conducted.

c. Data and Descriptive Statistics

This study uses the establishment-level data retrieved from the Annual Survey of Manufacturing Industries (ASMI) provided by Department of Statistics Malaysia (DOSM). Analysis focuses on the Malaysian electrical and electronics (E&E)[16] industry for the period 2000 to 2005 (2000 and 2005 are census years). The data is a balanced panel of 258 establishments and a total of 1548 establishment-year observations[17]. The E&E industries include industries 30-32 at the 2-digit level in the Malaysia Standard Industry Classification (MSIC) 2000.

The datasets contain basic establishment-level information on manufacturing, including number of establishments, number of workers employed, salaries & wages per annum, fixed assets, cost of inputs, gross output, value added, foreign equity share, value of imported raw materials, and value of exported products[18].

Defining and Measuring Trade Linkages

Production process of goods become disintegrated where each country specialize in particular stages or process of a good's production sequence. The growing internationalization of production process and trade means that no single measure can capture the importance of trade linkages in a given industry (Campa & Goldberg, 1997).

The uniqueness of our database provided by DOSM gives broad information on trade activity; imported inputs, goods that are exported as well as foreign share or FDI enabling this paper to examine the whole spectrum of international linkages, including international outsourcing, export as well as vertical trade as well as controlling the foreign ownership structure of the firms[19]. Therefore, the analysis in this paper involves an empirical investigation on the effect of 'a wide measure of international linkages' effects on skills demand. Fajnzylber & Fernandes (2009) suggest that estimating all the activities or measures concurrently lead to multicollinearity problems. Nevertheless, focusing separately on each activity may raise an omitted variables bias, i.e. may over- or under-estimate the effects of particular measure (Kraay, Isidro & Taybout, 2006). Fajnzylber & Fernandes (2009) analyses the imported inputs, export and FDI effects on skilled labour demand, while our study examine the wider or 'true' aspects of trade linkages which include the vertical trade intensity and also controlling for foreign share (most studies refers to this as FDI intensity).

Empirical studies proxies the trade in tasks or international fragmentation of trade by computing the intensity of imported inputs[20] (Feenstra & Hanson (1996, 1997, 1999), Campa & Goldberg (1997), Strauss-Kahn (2004), Horgos (2009). However, these measures seem relatively broad when considering the trade composition for Malaysian E&E industries that have a high share of imported inputs as well as high share of exported goods. Hummels, Ishii & Yi (2001) define vertical specialization trade when imported inputs are used by plants to make goods or goods-in-process that are in turn exported to other countries. Hummels *et al.*

(2001) compute an index[21] to measure the vertical trade, which we refer to as the narrow or *true* measure of international outsourcing (Chen, Kondratowicz & Yi, 2005). Khalifah & Azhar (2013) also create a new index of vertical trade in output (*VTQ*) using establishment-level data.

For estimation purposes, this study will employ the vertical trade intensity (*VTQ*) measure of Khalifah & Azhar (2013) at the establishment-level. The index is based on the production box of establishment methodology (refer to Khalifah & Azhar, 2013 for further explanation). Vertical trade (VT_i) is defined as the volume of overlapping exports (X) and imported inputs ($Minp$) as follows:

$$VT_i = 2\min(X_i, Minp_i) \tag{4}$$

where i refer to establishments indexes and X_i is exports for establishment i and $Minp_i$ is imported inputs for establishment i. Hence, the intensity of vertical trade is measured by the share of vertical trade in the gross output (Q) of the establishment, as follows[22]:

$$VTQ_i = \frac{2\min(X_i, Minp_i)}{Q_i} \tag{5}$$

where X_i and $Minp_i$ are defined as above while Q_i refer to gross output of the establishment i.

The index is expected to be able to directly and accurately measure the intensity of vertical trade as opposed to commonly used indexes in the previous literature which heavily rely on industry-level data and Input-Output tables (to estimate trade or foreign components of inputs)[23].

In addition to the vertical trade intensity, we also use outsourcing intensity as a broad measure of a international fragmentation trade as used in previous literature. For outsourcing intensity for each firm i at time t, we compute the share of imported inputs in total inputs Several studies (Pavcnik, 2003; Meschi and Vivarelli, 2008; Fajnzylber & Fernandes, 2009; and Meschi *et al.*, 2011) use imported materials as a proxy for technology adoption.[24] Additionally, we measure export intensity of firm i at time t by the ratio of exports to total output[25]. Imports are deflated using an import deflator at the 5-digit MSIC while cost of inputs are deflated using an intermediate input deflator at the 5-digit MSIC. The value of exported goods is deflated using the Producer Price Index (PPI).

Measuring Skill Intensity

In previous literature, two measurements commonly used, i.e. share of wages of skilled workers in wage bill (Head & Ries, 2002; Pavcnik, 2003; Fajnzylber & Fernandez, 2009; Thangavelu & Chongvilaivan, 2011) and share of skilled workers in employment (Devadason, 2005, 2011; Strauss-Kahn, 2004; Fajnzylber & Fernandez, 2009). Skill intensity in this paper is measured by the second classification, the employment share of skill workers, i.e. ratio of skilled workers in total employment. Total employment only considers the full-time paid employees. The database provides detail information on occupational category (distinguishes between non-production and production workers) which we use to group the workers into skilled and unskilled workers.[26] We follow most previous studies which refer to skilled workers as *non-production workers* in managerial, professional, technical and supervisory positions (among others: Berman *et al.*, 1994; Feenstra & Hanson, 19960; Head & Ries, 2002; Devadason, 2005a, 2005b). While, unskilled workers refer to the sum of production workers, including production or operative workers directly employed as well as employed through contractors. In concordance with our main objectives, to analyse the effect of trade linkages on skill upgrading for Malaysian E&E industry, it is more appropriate to

focus on the share of skilled workers in total employment. Therefore, the dependent variable in this study is change in the share of nonproduction workers in total employment within each firm.

Other Explanatory variables:

Wages: Our database only has information on total amount paid by each establishment without classifying into occupation category. Therefore, we cannot construct the share of skilled to total wages as well as share of unskilled to total wages. Hence, analysis in this study uses the real average wages. Head & Ries (2002) use the average wages as one of the measurements for skill intensity in addition to the share of SGA (selling, general and administrative) pay in total wage bill and high-skilled worker share of the wage bill.

Outputs: We use interchangeably three different proxies for firm's scale (or firm's demand shocks), i.e. value of gross outputs (value of sales of goods less the change in inventories), value added[27] (value of gross outputs minus inputs costs) and the ratio of firm's outputs to 5-digit sub-industry's average outputs (deviation of firm's output from the sub-industry's average outputs)[28] – we refer this as normalised outputs. The gross output is deflated using the Producer Price Index (PPI).

Capital: capital stock is the stock of fixed assets which comprises net book value of land and land improvement, building, transport equipment, computer, machinery and equipment at the end of each reference year. Capital intensity is measured using the ratio of capital stocks to total outputs.[29]

Foreign ownership share (FDI): Most studies use dummy variable to control for foreign ownership[30] or skill-biased effect of FDI. The dataset provide by DOSM has the information on foreign share which enable the study to directly analyse the impacts of foreign equity share on skills demand within the firms.

Technological Progress: Most studies use the share of ICT (information and communication technology) capital stock or expenditure on R&D to measure the technological change, or particularly SBTC. Due to the unavailability of data, we follow Baltagi & Rich (2005) and use the time trends to account for technological change.

The descriptive statistics for our database within year 2000 until 2005 appears in Table A1 in Appendix. The table show the mean value, as well as the standard deviation, minimum and maximum value of our variables for domestic and foreign firms based on the database provided by DOSM within year 2000 until 2005.

Table A2 shows the correlation matrix for our variables. Focussing on trade measures, negative association are revealed between export intensity, outsourcing intensity and vertical trade with skill intensity. The negative relationship is also shown between skill-intensity and foreign share.

4. Empirical Results

We begin by analysing the relevance of each type of trade in affecting within firm's skilled workers demand for the E&E industry in the short run. Initially, we estimate the basic model which exclude all trade linkages measures and only control for foreign ownership in addition to other standard heterogenous firm characteristics. The result is shown in Column (1) in Table 1. Next, we include our trade linkages measure interchangeably, to determine through which channel does trade relates with skill intensity. The results are shown in Columns (2) until (5). Subsequent, we also estimate multiple measurements of trade linkages effect on skill intensity to solve the potentially omitted variables problems (Kraay *et al.*, 2006; Fajnzylber & Fernandes, 2009).

Results in Table 1 and Table 2 confirm the validity of the dynamic nature of our models with the highly significant coefficient of LDV for each model in Table 1 and Table 2 (positive association between skill-intensity in previous year and its current value). The results for our diagnostic test confirm the power of the models. For the Arellano-Bond (second-order) test, in all models (1 to 5) we fail to reject the null hypothesis which conclude no second order serial correlation (no original error term is serially uncorrelated). *Stata 12.0* provides both Sargan and Hansen test to test the overall validity of our instruments. Based on the Sargan test, we cannot reject the null only for model (2) and (5). However, result for Hansen test pass the overall validity of the instruments hypothesis in all models (1 to 5). Since the Hansen test is more powerful than the Sargan test, we conclude that our instruments are strictly exogenous as a whole. Additionally, our all models also pass the Diff-in-Hansen test which confirms the exogeneity of each instrument.

In particular, the result in Column (1) in Table 1 is our basic model, without trade linkages measure, except controlling the foreign firm status (share). For Column (2) until (5) we test the significance of single trade linkages – changes in outsourcing intensity, export intensity, total trade intensity (openness) and vertical trade intensity, separately, in affecting changes in skill intensity in our data.

Including the trade measure into our basic model, consistently, increase the value of Wald χ^2 test and is highly statistically significant. Therefore, inserting the trade measures increases the power of models – all the explanatory variables as a whole – to explain variations in skill-intensity growth. The highest value of Wald χ^2 is in model (5) when we estimate the vertical trade intensity.

In Column (2) and (3) of Table 1, we identify the effect of changes in outsourcing intensity and export intensity on changes in skill intensity within firms, respectively. The result in Column (2) indicate that changes in the broad measure the outsourcing intensity does not significantly contribute to skill changes for E&E firms. This result is similar with Pavcnik (2003) which found the share of imported inputs – as a measure of technology adoption – is not significant in explaining skill intensity for Chilean plants when controlling the plant fixed effects, contrasting the general result in other studies with a statistically positive relationship (Feensta & Hanson, 1995, 1996, 1999; for U.S.; Fajnzylber & Fernandez (2009) for Brazil) or negative association (Thangavelu & Chongvilaivan, 2011 for Thailand; Fajnzylber & Fernandez, 2009 for China) between material outsourcing and skill intensity. Our result is robust; the coefficient of the outsourcing intensity is not significant when we use the ratio of imported inputs to total outputs as well as to the ratio of value added.

Similarly, Column (3) shows that export intensity is not statistically significant in influencing changes in skill intensity. Fajnzylber & Fernandez (2009) find a negative association of export intensity and employment share as well as wage bill share of skilled workers in Brazil and China.

There is no evidence to support that the use of imported inputs and exports of goods will increase the skill intensity within firms for E&E industry in Malaysia within the period under study. In conclusion, our data does not support the notion of skilled-biased outsourcing or the skill-enhancing trade (SET) hypothesis (Thangavelu & Chongvilaivan, 2011; Egger & Egger, 2006; Feenstra & Hanson; 1999, 1996; Robbins, 1996).

Furthermore, following Meschi & Vivarelli (2009), Meschi *et al.* (2011) and McNabb & Said (2013) we also test whether the total trade intensity (trade openness), the ratio of total trade (export plus import) to total outputs, would significantly affect changes in skill-intensity. The result is shown in Column (4) for Table 1. As expected, the coefficient for trade openness variable does not significantly contribute to changes in skilled workers demand.

Table 1
Impact of Trade Linkages on Skill Intensity – Single Measurement

	(1)	(2)	(3)	(4)	(5)
Skill Intensity (-1)	0.468***	0.488***	0.436***	0.515***	0.478***
	(0.123)	(0.120)	(0.122)	(0.114)	(0.119)
Skill Intensity (-2)	0.083	0.082	0.064	0.083	0.082
	(0.086)	(0.086)	(0.086)	(0.087)	(0.075)
Average Wages	0.246**	0.248***	0.223***	0.245***	0.241***
	(0.095)	(0.091)	(0.084)	(0.089)	(0.081)
Average Wages (-1)	-0.088	-0.085	-0.090	-0.086	-0.072
	(0.070)	(0.071)	(0.070)	(0.068)	(0.068)
Capital Intensity	0.064	0.063	0.063	0.061	0.069*
	(0.045)	(0.044)	(0.043)	(0.043)	(0.041)
Capital Intensity (-1)	0.088***	0.085***	0.082***	0.086***	0.086***
	(0.033)	(0.033)	(0.031)	(0.032)	(0.031)
Outputs	-0.016	-0.0160	-0.017	-0.018	-0.013
	(0.015)	(0.015)	(0.015)	(0.014)	(0.012)
Outputs (-1)	0.019	0.021	0.021	0.023	0.019
	(0.021)	(0.021)	(0.020)	(0.020)	(0.017)
Foreign Share	- 0.008**	-0.007*	-0.007**	-0.006*	-0.006**
	(0.004)	(0.004)	(0.003)	(0.004)	(0.003)
Foreign Share (-1)	0.011**	0.009**	0.009**	0.008*	0.009**
	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
Outsourcing Intensity		0.032			
		(0.056)			
Outsourcing Intensity (-1)		0.006			
		(0.030)			
Export Intensity			0.040		
			(0.041)		
Export Intensity (-1)			-0.028		
			(0.023)		
Trade Openness				0.050	
				(0.034)	
Trade Openness (-1)				-0.034	
				(0.027)	
Vertical Trade Intensity					0.030
					(0.054)
Vertical Trade Intensity (-1)					-0.103**
					(0.046)
Time Trend	-0.005	-0.003	-0.001	-0.003	-0.007
	(0.013)	(0.012)	(0.012)	(0.013)	(0.0117)
Constant	-1.116***	-1.068***	-1.141***	-1.011***	-1.090***
	(0.390)	(0.373)	(0.376)	(0.354)	(0.380)
Wald χ^2	55.64***	63.88***	72.86***	86.86***	92.51***
Arellano-Bond (order 2)[a]	0.240	0.294	0.240	0.384	0.366
Sargan test[b]	0.082	0.110	0.083	0.063	0.109
Hansen test[b]	0.709	0.775	0.754	0.680	0.772
Diff-in-Hansen	Pass	Pass	Pass	Pass	Pass
Observation	1032	1032	1032	1032	1032
Number of plants	258	258	258	258	258

The dependent variable is share of skilled workers in employment.
Dynamic panel equation (Two-step *System*-GMM) with Windmeijer (2005) robust standard errors in parentheses.
*, **, *** signify statistical significance at 10, 5 and 1 percent, respectively.
[a] H_0: no autocorrelation ($P>z$).
[b] Overidentifying restrictions where H_0: overidentified ($P>\chi^2$).
Trade linkage measures and wages treated as *pre-determined*.
Output (firm's scale effects) measured by normalised output ($Q_{n_i} = \frac{Q_i}{Q_{average_n}}$ where Q_i = output for firm i and $Q_{average_n}$ = average of outputs for 5-digit industry); capital intensity measured by capital-output ratio; outsourcing measured by imported input-total inputs ratio; export intensity measured by exports-output ratio; trade openness measured by the ratio of total exports and import to outputs ($TO_i = \frac{M_i+X_i}{Q_i}$ where M_i is imported inputs for firm i, X_i is exported goods for firm i, and Q_i = output for firm's i); and vertical trade intensity based on index by Khalifah & Azhar (2013).

Our estimated coefficient for contemporaneous vertical trade index (Khalifah & Azhar, 2013) in model (5) is insignificant. Nevertheless, holding other variables unchanged, previous year changes in vertical trade has a negatively significant effect on current changesin skill intensity. The result reveals that increases in vertical trade intensity has leads to a decline in skill intensity (skill downgrading) within firms in the E&E industry. Vertical trade is unskilled biased type of trade which lead to increasing demand for unskilled workers within the period 2000 to 2005.

This study improve the previous literature (Pavcnik, 2003), by the uniqueness of database enabling analysis on the relationship between FDI and skill upgrading. Estimated coefficient for the foreign share (FDI) variables is robustness significant at contemporaneous and previous year in all models. The elasticity is negative for contemporaneous FDI, and positive for previous FDI. Contemporaneous FDI results in higher relative demand for unskilled workers within E&E firms in the short run. The result is similar with Devadason (2011) that found negative association between FDI and skills demand (though not significant). The point estimate for both time are fairly small. Studies by Feenstra & Hanson (1997b) and Hanson & Harrison (1999b) find positives effect of FDI on skilled workers demand in Mexico, Fajnzylber & Fernandez (2009) find positive significant association for Brazil and negative for China (though insignificant). And, our study suggests that changes in the FDI take one year lagged to positively affect the changes in skilled workers demand.

Coefficient for average wage variable is significant at contemporaneous and the sign is positive. The results suggest that increases in the average wages do indeed promote the relative demand for skilled workers. The elasticity is around 0.250 for all models (except for model 3 where the value is 0.223). Gorg & Hanley (2005) also find significant effect of the changes in average wages on labour demand in Irish electronics industry, though the sign for the estimated coefficient is negative.

Furthermore, for scale effects, the result for all models in Table 1 (Columns 1 to 5) suggests that a change in firm's outputs or scale does not have a significant effect on changes in share of skilled workers in their employment. The results is robust; the coefficient of the variable outputs is not significant when we use different measures of outputs; the value added as well as normalised outputs. This result is similar with Thangavelu & Chongvilaivan (2011) where the coefficient for this variable is insignificantly different from zero for high-technology industries in Thailand (E&E industries is categorised in high-technology based on ISIC Rev.3 classification). Head & Ries (2002) find negative scales effects on skill intensity when controlling the firm fixed effects within the E&E firms in Japan. Most studies find positive association between scale and skilled workers demand (Pavcnik, 2003; Gorg & Hanley, 2005).

For capital intensity, changes in the capital intensity significantly have a positive impact on skills demand for both contemporaneous and previous year, but only significant for previous year (except for our model (8) the coefficient is positive and significant for both time period). Hence, positive a sign for this estimated coefficient indicates that an increase in the capital intensity favour skilled workers in Malaysian E&E firms, holding other plant characteristics constant. This verifies the complementarities between capital and skills – capital-skills complementarity hypothesis. The result is similar with previous studies which (Pavcnik, 2003) in Chilean plants; Thangavelu & Chongvilaivan (2011) however find capital-skilled complementarity only for low-technology industries and capital-skilled substitutability for high-technology industries in Thailand's plants. Head & Ries (2002) also find capital-skilled substitutability for Japan's E&E firms.

Multiple Measurements

For Model (6) in Table 2, we only include outsourcing intensity and export intensity and in Model (7) all three types of trade linkages are included in the model, i.e. outsourcing intensity, export intensity and vertical trade intensity. While for Model (8) we include the trade openness measure along with vertical trade intensity.

Similar to Fajnzylber & Fernandez (2009), our estimation using the single measures is unbiased where the results are consistent when we use the multiple measures (Table 2). Coefficients for outsourcing intensity, export intensity as well as total trade intensity have never significant for all models in Table 2. As in Table 1, only the coefficient for lagged vertical trade index is significant (negatively) in both Model (7) and (8). Furthermore, the coefficient value for vertical trade index is generally around 0.1 for Model (5) in Table 1 and Model (7) and (8) in Table 2. Our analysis concludes that, previous year vertical trade has led to skill downgrading for Malaysian E&E within the period under study.

The results are also robust for all our control variables, the significance and sign for all variables, average wages, outputs, capital intensity and foreign share, are fairly consistent in all models. As in Table 1 (for all models), results in Table 2 also show that both changes in the average wage (contemporaneous) and capital intensity (previous year) are positively significantly related to skill intensity – leading to skill upgrading. And, a change in the current foreign share (FDI) has a negative effect on skill intensity whereas the previous year FDI significantly increases the relative demand for skilled workers. In addition, each time we include the vertical trade index in our models, the coefficient for capital intensity is significant (positively) for both current and lagged values.

5. Conclusion

This paper examines the relative importance of types of trade linkages in explaining the changes in skilled workers demand within firms in Malaysian E&E industries during the period 2000 to 2005. Within this period there is pronounced international production sharing, for Malaysian manufacturing industries, particularly in the E&E industries. This phenomenon is exhibited by the high share of imported inputs and exports of goods within the firms in these industries. Furthermore, the high ratio of imported inputs in total exports also shows significant vertical trade. Enhanced on competition and interaction with developed countries are expected to induced skilled workers demand.

However, results show no significant association between growth in both outsourcing intensity and export intensity with changes in skilled share employment. Furthermore, our empirical results suggest that vertical trade is unskilled biased or complements unskilled workers. This reveals that Malaysian E&E firms have outsourced or import the skilled-intensive inputs, focusing on low-value added activities such as assembly tasks which are unskilled-intensive processes. In conjunction with negative effects of changes in the foreign share on skilled workers demand, it is revealed that the presence of FDI or MNCs in E&E industries does not contribute to skill upgrading within these industries in the contemporaneous but skill upgrading occurs in one-year lagged.

Trade openness as well as export intensity of establishments are unrelated to skill upgrading questioning the conventional wisdom of export-oriented industrialisation and technology or skill enhancement in the presence of pronounced international production sharing.

Table 2
Impact of Trade Linkages on Skill Intensity – Multiple Measurements

	(6)	(7)	(8)
Skill Intensity (-1)	0.451***	0.446***	0.522***
	(0.118)	(0.115)	(0.109)
Skill Intensity (-2)	0.073	0.079	0.084
	(0.086)	(0.075)	(0.076)
Average Wages	0.235***	0.239***	0.246***
	(0.085)	(0.076)	(0.078)
Average Wages (-1)	-0.084	-0.070	-0.077
	(0.069)	(0.068)	(0.067)
Capital Intensity	0.063	0.072*	0.065*
	(0.043)	(0.041)	(0.039)
Capital Intensity (-1)	0.083***	0.087***	0.086***
	(0.032)	(0.030)	(0.030)
Outputs	-0.017	-0.015	-0.013
	(0.015)	(0.012)	(0.012)
Outputs (-1)	0.022	0.021	0.021
	(0.020)	(0.016)	(0.017)
Foreign Share	-0.006*	-0.006**	-0.006*
	(0.003)	(0.003)	(0.003)
Foreign Share (-1)	0.009**	0.008**	0.008**
	(0.004)	(0.003)	(0.004)
Outsourcing Intensity	0.046	0.041	
	(0.049)	(0.047)	
Outsourcing Intensity (-1)	0.014	0.024	
	(0.027)	(0.026)	
Export Intensity	0.040	0.051	
	(0.040)	(0.040)	
Export Intensity (-1)	-0.027	-0.024	
	(0.024)	(0.022)	
Trade Openness			0.054
			(0.034)
Trade Openness (-1)			-0.013
			(0.024)
Vertical Trade Intensity		0.031	-0.032
		(0.055)	(0.060)
Vertical Trade Intensity (-1)		-0.112**	-0.088*
		(0.047)	(0.051)
Time Trend	-0.001	-0.005	-0.0056
	(0.011)	(0.011)	(0.0115)
Constant	-1.111***	-1.097***	-0.975***
	(0.363)	(0.365)	(0.356)
Wald χ^2	78.97***	114.02***	118.07***
Arellano-Bond (order 2)[a]	0.287	0.399	0.428
Sargan test[b]	0.151	0.215	0.097
Hansen test[b]	0.863	0.915	0.772
Diff-in-Hansen	Pass	Pass	Pass
Observation	1032	1032	1032
Number of plants	258	258	258

The dependent variable is share of skilled workers in employment.
Dynamic panel equation (Two-step System GMM) with Windmeijer (2005) robust standard errors in parentheses.
*, **, *** signify statistical significance at 10, 5 and 1 percent, respectively.
[a] H_0: no autocorrelation ($P>z$).
[b] Overidentifying restrictions where H_0: overidentified ($P>\chi^2$).
Trade linkage measures and wages treated as *pre-determined*.
Output (firm's scale effects) measured by normalised output ($Q_{n_i} = \frac{Q_i}{Q_{average_n}}$ where Q_i = output for firm i and $Q_{average_n}$ = average of outputs for 5-digit industry); capital intensity measured by capital-output ratio; outsourcing measured by imported input-total inputs ratio; export intensity measured by exports-output ratio; trade openness measured by the ratio of total exports and import to outputs ($TO_i = \frac{M_i+X_i}{Q_i}$ where M_i is imported inputs for firm i, X_i is exported goods for firm i, and Q_i = output for firm's i); and vertical trade intensity based on index by Khalifah & Azhar (2013).

Since the E&E sector is characterised as highly skill-intensive (high technology industry group), our analysis also *generally* suggests that factor-biased effects dominate the sector-biased effects. However, for Malaysian E&E sector, the ratio of unskilled workers is higher which characterised as unskilled-intensive sector. Therefore, analysing using a multi-sectors framework would provide more precise conclusions regarding this issue.

Appendix

Table A1

Descriptive statistics of the variables included in the model: panel 2000-2005

Variable	Obs	Mean	Std. Dev.	Min	Max
Skill Intensity	1548	0.21	0.13	0	0.98
Average Wage	1548	18.31	8.51	0.86	74.66
Capital Intensity	1548	0.39	0.44	0	5.91
Outputs	1548	262953	528453	123	4386040
Foreign Share	1548	59.30	46.39	0	100
Outsourcing Intensity	1548	0.36	0.31	0	1.11
Export Intensity	1548	0.45	0.47	0	1.34
Trade Intensity	1548	0.72	0.62	0	2.05
Vertical Trade Intensity	1548	0.38	0.49	0	1.96

Table A2
Correlation matrix

	Skill Intensity	Average Wage	Capital Intensity	Outputs	Foreign Share	Outsourcing Intensity	Export Intensity	Trade Intensity	Vertical Trade Intensity
Skill Intensity	1								
Average Wage	0.521	1							
Capital Intensity	0.1895	0.0979	1						
Outputs	0.1884	0.3585	-0.1676	1					
Foreign Share	0.1024	0.1581	0.0094	0.434	1				
Outsourcing Intensity	-0.0489	-0.1027	-0.0801	-0.1444	-0.1516	1			
Export Intensity	-0.0697	-0.0753	-0.0919	0.0299	-0.0321	0.1062	1		
Trade Intensity	-0.0193	-0.0415	-0.1697	0.1341	0.0951	0.5135	0.2147	1	
Vertical Trade Intensity	0.0596	0.0548	-0.1632	0.4243	0.2804	0.1221	0.0797	0.5049	1

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Endnotes

[1] The basic HOM and SST predict that free trade should increase relative price of a country's relative abundant factor (unskilled workers for developing countries and skilled workers for the developed countries). Focusing on the developing countries, free trade therefore should have increase relative demand for unskilled workers, and hence reduce the wage inequality in the developing countries. Furthermore, the changes in this relative wages are induced by changes in the relative price of outputs, i.e. increases in relative wages of unskilled workers induced by the changes in relative price of unskilled intensive outputs. Therefore, the HO and SS theorems suggest that changes in relative demand, relative wages and relative price if outputs are sector-biased. Another implication, the unskilled-skilled workers ratio will decrease after trade.

[2] Several studies claim skill biased technological change (SBTC) and not trade as the main source for these trends in the labour market. For instance, studies by Berman *et al.* 1994; Berman *et al.* 1998.

[3] Refer to, among others, Leamer (1996), Berman *et al.* (1998), Haskel and Slaughter (2001), Krugman (2000), Gourdon (2011) for theoretical and empirical studies on the effects of technological change and trade on employment.

[4] Most studies on the impacts of trade on labour market concentrating on income inequality or wage inequality. However, increasing wage inequality also implies increasing in relative demand for skilled workers. Studies on trade and wage inequality relationship, among others, are Wood (1997), Goldberg and Pavcnik (2007), Meschi & Vivarelli (2009), and Gourdon (2011). Most of the studies focused on Latin America. Only several, specifically focused the analysis on Asian developing countries. For instance, McNabb and Said (2013) and Amiti & Davis (2012), and Devadason (2005).

[5] Anderton & Brenton (1999) for UK, Berman *et al.* (1994) and Freenstra & Hanson (1996, 1999, 2001) for the U.S., Strauss-Kahn (2004) for France, Gorg & Hanley (2005) for Irish, Helg & Tajoli (2005) for Italy and German, Devadason (2005a, 2005b, 2011) for Malaysia, Fajnzylber & Fernandes (2009) for Brazil and China, Meschi *et al.* Berman *et al.* (1994) and Pavcnik (2003) stressed that the translog cost function is very appealing because it provides a second-order approximation to any cost function and does not impose any restrictions on the substitutability of the various inputs.

[6] Several authors uses three variable factors, i.e. add raw materials as one of the variable factors together with skilled and unskilled workers. For instance, study by Thangavelu & Chongvilaivan (2011). Anderton and Brenton (1999) suggested to include the labor in sources (exported) countries as well as outsourced intermediate goods (price or quantity terms) in the cost function for complete derivation (though the study does not apply it)

[7] $\frac{\partial \ln C}{\partial \ln w_s} = \frac{\partial C/C}{\partial w_s/w_s} = \left(\frac{\partial C}{\partial w_s}\right)\left(\frac{w_s}{C}\right)$ where $\left(\frac{\partial C}{\partial w_s}\right) = L_s$, demand for skilled workers. Therefore $\left(\frac{\partial C}{\partial w_s}\right)\left(\frac{w_s}{C}\right) = \frac{w_s L_s}{C}$ is the payments to skilled workers relative to total costs (s_s), i.e. the cost share of skilled-labor. Since $\sum_{j=1}^{J} \alpha_j = 1$, only one cost share is linearly independent.

[8] We impose homogeneity of degree one in prices to ensure the cost function is linearly homogenous in wages (or Several restrictions are imposed:
First, $\sum_{j=S,U} \alpha_j = 1$ and $\sum_{j=S,U} \alpha_{jk} = \sum_{k=S,U} \alpha_{jk} = \sum_{j=S,U} \theta_{jK} = \sum_{j=S,U} \theta_{jQ} = 0$).

[9] δ_t represent time trend to control for skill-biased technological change (SBTC) following Baltagi and Rich (2005) to solve our data limitation. Dataset provided by DOSM has no information on R&D expenditure. Also, to control for common shocks across firms.

[10] Berman *et al.* (1994), Head and Ries (2002), Fajnzylber & Fernandes (2009), dropped the relative wages term for several reasons. First, its raises endogeneity problems due to the simultaneity determined with relative skills and unavailability of instrument variables to correct it. Second, cross-sectional variation in relative wages is small and is correlated with unobserved labour characteristics. The studies include the time (year) dummy or industry (firm) dummy to capture year-to-year changes in the wage levels face by all firms.

[11] Several previous studies have use the imported inputs or goods measure as well as export as measures for foreign technology adoption. If the coefficients for these variables turn to be positively significant, there are skill-biased technological transfer through the import and export channels.

[12] Bond (2002, p. 156) stated that adopting a dynamic specification is sometimes a useful 'for identifying the parameter of interest, even when the dynamics themselves are the principal focus of attention'.

[13] Consider a model without other explanatory variables: $y_{it} = \alpha y_{it-1} + \delta_t + \eta_i + \varepsilon_{it}$, clearly $y_{it-1}(= \alpha y_{it-2} + \delta_t + \eta_i + \varepsilon_{it})$ is correlated with η_i.

[14] For the general econometric form for dynamic model with a fixed effect: $y_{it} = \alpha y_{it-1} + \beta z'_{it} + \delta_t + \eta_i + \varepsilon_{it}$. First differencing the equation will eliminate the omitted variable bias in estimation, but differencing variables that are predetermined (e.g. w_{it}) but not strictly exogenous makes them endogenous. This is because w_{it} in $\Delta w_{it} = w_{it} - w_{it-1}$ is correlated with the ε_{it-1} in $\Delta\varepsilon_{it} = \varepsilon_{it} - \varepsilon_{it-1}$. Furthermore, lagged dependent variable (h_{it-1}) is also predetermined due to being correlated with ε_{it-1}. The valid instruments for ($h_{it-1} - h_{it-2}$), i.e. the first difference of lagged dependent variable, are the lagged levels $h_{it-2}, h_{it-3}, \ldots, h_{i1}$, as $E[h_{it-2}(\varepsilon_{it} - \varepsilon_{it-1})] = 0$.If explanatory variable, z_{it}, are endogenous, i.e. regressors (z_{it}) correlated with the ε_{it} ($E(z_{it}\varepsilon_{it}) \neq$

0), the valid instrument are z_{is} with s=1, …, t-2, as $E(z_{it-2}\varepsilon_{it}) = 0$. On other hand, if z_{it} are predetermined or weakly exogenous variables where current regressors (z_{it}) predetermined by the past error term (ε_{it-1}) or mathematically written as $E(z_{it}\varepsilon_{it-1}) \neq 0$ but $E(z_{it-1}\varepsilon_{it-1}) = 0$, i.e. or $E[(z_{it} - z_{it-1})(\varepsilon_{it} - \varepsilon_{it-1})] \neq 0$, the valid instruments are z_{is} with s=1, …, t-1. And z_{it} are strictly exogenous if z_{it} are uncorrelated with current and past errors or mathematically written as $E(\varepsilon_{it}z_{it}) = 0$.

[15] Gorg & Hanley (2005) stated that the error of predicting employment at time *t+1*, based on values of outsourcing (imported inputs) and wages at time *t*, are themselves predictive of employment and outsourcing at time *t+2*. Therefore, wages and outsourcing should be treated as predetermined variables. Hertveldt & Michel (2012) in their analysis treated relative wages as well as the indicator of offshoring as endogenous variables, due to the notion that the variables are determined simultaneously with the labor share, at the industry level data. More productive firms self-select into offshoring, spending more on R&D also export, or less productive firms hope to benefit from globalization (offshoring and export) or R&D in order to increases their technology shifter.

[16] Fajnzylber & Fernandes (2009) restrict their analysis to private firms since the publicly-own firms unlikely satisfy the cost-optimization assumption in their framework.

[17] Since 2008, DOSM are more restricted in providing the micro-data. Datasets are representative. For the cleaning process of datasets refer to Khalifah & Azhar (2013).

[18] The provided database does not capture the origin/destination of imported inputs and exported goods as well as the industrial classification of inputs.

[19] Berman *et al.* (1994), Feenstra & Hanson (1996, 1997a, 1999), Strauss-Kahn (2004), Gorg & Hanley (2005), Helg & Tajoli (2005), Devadason (2005a) focused on outsourcing or trade fragmentation; Head & Ries (2002) focused on offshoring which measures by investments; Bernard & Jansen (1997) focus on exports; Meschi & Vivarelli (2008) on trade openness and McNabb & Said (2013) focus on trade liberalization (degree of import and export penetration), Meschi *et al.* (2011) focus on export and import. Fajnzylber & Fernandes (2009) one of the study take into account the imported inputs, export and FDI – multiple international economic activity.

[20] Anderton & Brenton (1999) stated that outsourced certain part or stage of production abroad does not necessarily characterized by outflows investments; it can also be represented by the replacement of the processed involved with imports of intermediate or finished goods.

[21] Primary or simple instuition of vertical specialization based on Hummels *et al.* (2001) describe by formula: $VS_{ki} = (Minp_i/Q_i).X_i$; where *k* is denotes for country and *i* is a goods. $Minp$ is the imported inputs, Q is the gross outputs and X is export of goods.

[22] The VTQ_i is $(0 \leq VTQ_i \leq 2)$ with lower bound indicating no overlap between export and imported inputs value and values close to 2 showing massive overlap of exports and imported inputs relative to outputs.

[23] For instance, indexes by Feenstra & Hanson (1996); Hummels *et al.* (2001), and Strauss-Kahn (2004). The index by Khalifah & Azhar (2013) considered as broad measure of index (based on the definition of Feenstra & Hanson, 1996) as the datasets provide by DOSM does not capture the industrial classification of inputs.

[24] Horgos (2009) proved that differences measurement of outsourcing or offshoring has contributed to the puzzle or not consensus in empirical results in many previous studies. $OS_i^I = \frac{\text{imported intermediate inputs}_i}{\text{total inputs}_i}$ represent share of imported input to total inputs (Berman *et al.*, 1994; Feenstra and Hanson, 1996; Pavcnik, 2003; Thangavelu & Chongvilaivan, 2011), $OS_i^O = \frac{\text{imported intermediate inputs}_i}{\text{total outputs}_i}$ represent share of imported input to total ouputs (Campa & Goldberg, 1997 (2-digit SITC manufacturing industry); Egger & Egger, 2005; Geischker & Gorg, 2005), and $OS_i^V = \frac{\text{imported intermediate inputs}_i}{\text{value added}_i}$ represent share of imported input to value added (Hijzen, Gorg & Hine, 2005). Taking the value of imported inputs as a share of total inputs or total outputs or value added control for disparities in the use of the technology measures (outsourcing intensity measures– in this study) across plants of different size (Pavcnik, 2003).

[25] We also use the share of imported inputs to total outputs, and value added and the ratio of export to value added, interchangeably.

[26] Commonly, previous studies, for example, Berman *et al.* (1994), Feenstra & Hanson (1996), Bernard & Jensen (1997) and Leamer (1998) classified skilled and unskilled workers based on non-production and production workers. Meshi *et al.* (2011) divided total employment into administrative workers (management, skill administrative personnel and other office personnel) and production workers (technical personnel and everyone who work physically in the production process). Pavcnik (2003) used white-collar/blue-collar to differentiate the skilled/unskilled workers. Anderton & Brenton (1999) uses manual and non-manual workers. McNabb & Said (2013) define skills based on education attainment for Malaysia.

[27] Berman *et al.* (1994), Head & Ries (2002), Pavcnik (2003), Fajnzylber & Fernandez (2009) measure output by value added.

[28] Following Arellano & Bond (1991) and Gorg and Hanley (2005) used total output in sector to control for industry demand shocks.

[29] We also interchangeably estimates using the the capital-labor ratio (the ratio of total capital stocks to the total employment (*K/L*)) as well as the share total capital stocks to value added (*K/VA*).
[30] Meshi *et al*. (2011) use dummy variable (>10% foreign firms). Fajnzylber & Fernandes (2009) use both foreign share and dummy variables.