Technical Efficiency of Establishments in Malaysia's Electrical and Electronics Industries: Exporting or Vertical Trade?

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Abstract

This study compares export intensity and vertical trade intensity in determining technical efficiency of establishments in Malaysia's electrical and electronics industries (E&E) amongst other explanatory variables. We measure fragmentation or vertical trade intensity as two-way trade or the overlap of exports and imported inputs weighted by gross output of establishments. In the overall sample of establishments, vertical trade intensity is a significant determinant of technical efficiency (TE) whereas export intensity is not. A bigger scale of production, a higher degree of vertical integration and higher labour quality are positively related to TE whereas higher industrial concentration is negatively associated with TE. In the sub-sample of ordinary trading establishments, export intensity is a significant determinant of technical efficiency whereas in the sub-sample of vertical trading establishments, export intensity is not a significant determinant of TE. Higher export intensity does not necessarily mean higher efficiency of establishments and thus an unqualified policy of export expansion within the context of vertical trade and global value chains in production should be conducted with caution. Technical progress is not significant in all of the models estimated.

Keywords: empirical studies of trade; multinational firms and firm organization

JEL Codes: F14, F23, L22

1. Introduction

The pervasiveness of international product fragmentation,[1] i.e. the trading of component goods across borders as a result of vertically integrated production processes, has become a prominent feature in international trade. Factors such as low production costs in certain fragments of production in developing countries, decreasing tariffs due to trade liberalization by countries as well as falling transport and communication costs, all of which are further reinforced by technological advancements that allows the production value chain to be segmented, greatly contributed to the rapid growth of this type of trade.

Classical trade theories hinge on the assumption of the trading of final goods, while the role of vertical-specialization-based trade, which is the use of imported inputs to produce goods that are afterwards exported, has yet to be fully recognised in the theoretical literature.

It is only in very recent years that the empirical literature has started to focus on the role of vertical trade, but these studies tend to base their findings on industry-level trade data based on input-output tables rather than establishment-level data.

Malaysia is a prime example of a vertical-based trader (see Srholec, 2007). To accelerate the industrialization process, free trade zones were established and generous incentives were provided by the Malaysian Government since the 1970s to attract multinational enterprises (MNEs) and the attendant production networks. As fragmented production among MNEs began to take off earnestly and communication costs began to drop drastically, Malaysia fully utilized its comparative advantage in cheap labour and began to enjoy being a major recipient of foreign direct investment (FDI) and exporter of high-technology goods. FDI has been embraced by Malaysia and questions have arisen as to whether being a host to MNEs and their attendant vertical trade which includes high export intensity of establishments in high-tech goods is a still viable policy option under current circumstances.

This study seeks to contribute to both the theoretical and empirical literature in the following ways. It will first present an alternative way to measure vertical trade at the establishment level, named the Vertical Trade in Output (*VTQ*) index (see Khalifah and Azhar, 2013). The *VTQ* index sets itself apart from previous attempts of measuring vertical trade by adopting a more direct and interpretable approach in the technical sense. Secondly, this study examine relationships between trade variables (exporting, vertical trade intensity, a binary two way trade dummy, two-way trade dummies based on different threshold values of vertical trade intensity) and establishment-level efficiency amongst other determinants of technical efficiency for Malaysia's electrical and electronics (E&E) industries. At this juncture, the author is not aware of any other study that econometrically investigates the effect of high trade verticality or export processing trade on firm performance.

Our main finding is that higher intensity of involvement in vertical trade is a significant determinant of technical efficiency and not export-intensity *per se*. A dummy variable indicating vertical traders (*VTdummy*) based on different thresholds of vertical trade intensity was used to demarcate vertical traders from non-vertical or ordinary traders. For intermediate range threshold values, the vertical trade dummy is a significant determinant of TE whereas export-intensity is not. When low threshold values are used to demarcate vertical trading establishments from ordinary trading establishments, both export intensity and the vertical trade dummy variable are not significant determinants of technical efficiency. On the other hand, when high thresholds are used to demarcate vertical trading establishments from ordinary trading establishments, both the vertical trade dummy and export intensity variables are significant determinants of technical efficiency. When comparing sub-samples of vertical traders and ordinary traders; export-intensity is not a significant determinant of TE in the former sub-sample but is significant in the latter sub-sample.

The paper is organized as follows. The literature review in section 2 will begin with an overview of the extent of vertical trade around the East Asian region, followed by attempts to measure vertical trade. Section 3 describes the dataset and methodology to measure vertical trade and the model to assess the link between trade and efficiency in Malaysia's E&E industries. The results are presented in the penultimate section before the final section, Section 5, concludes the paper.

2. Literature Review

At the national level, technical efficiency and productivity growth raises living standards because more real income improve people's ability to purchase goods and services and enjoy leisure. At the firm level, productivity growth is important because it means that the firm can meet its obligations to its stakeholders and still remain competitive or even improve its competitiveness in the market place. Endogenous growth theory views innovation as the main source of productivity growth (Romer, 1990), although it may be associated with either internal or external factors. In particular, studies have shown that international linkages or technology transfer may be closely related to productivity growth (Keller, 2002). Trade and investment affect innovation in various ways such as through technology transfer, competition effects, scale economies and spillovers (defined as learning from exporting and/or learning by investing).

Foreign linkages through FDI and trade are often considered to be strong conduits for international technology transfer (Blomström and Kokko, 1998; Aitken and Harrison, 1999; Carr et al., 2001, Yasar and Paul, 2007). Learning by exporting seems to be given the greatest focus (Kraay, 1997; Clerides et al., 1998; Bigsten et al., 2002). The role of technology embodied in intermediate material and capital imports has been recognized in enhancing productivity of establishments (Grossman and Helpman, 1991; Xu and Wang, 1999; Eaton and Kortum, 2001). Foreign licensing has also been considered (Eaton and Kortum, 1996), although it may not have a significant productive effect if the best technologies are not available by license (UNCTAD, 2000). These channels may have both separate and synergistic productive effects, as well as linkages with internal factors such as input mix or scale of operations. Blomström and Kokko (1998) for example, show that FDI may enhance host country firms' productivity through knowledge flows from cumulative R&D efforts in the foreign country, and of skilled employees and management techniques across countries. Bernard et al. (2007) and López (2005) review theoretical and empirical findings and show that higher productivity as well as larger size is associated with firms engaged in international trade compared to firms that serve only domestic markets.

Export-Productivity Relationship

There are several hypotheses about how firm productivity is related to international linkages. The first suggests that only productive firms have the ability to penetrate export markets, because their characteristics make them better able to deal with the costs and complexities of international markets and therefore self-select into exporting (Yasar & Paul, 2007). It is widely acknowledged that there are fixed cost to exporting (the range of extra costs include transportation costs, distribution and marketing costs, personnel with skills to manage foreign networks, or production costs in modifying current domestic products for foreign consumption (Alvarez et al., 2007)). In order to make the investment to pay these fixed costs, exporting firms by definition need to be more productive. Melitz (2003) built a theoretical model showing that resources are reallocated from less efficient to more efficient plants as a result of a rationalization process with the opening up of trade. Bernard et al. (2003) contends that aggregate productivity increases as high productivity plants turn towards export markets and low productivity plants exit with import competition. The vast majority of studies support this explanation and find that “exporter premia” exist (see Bernard and Jensen, 1995; Clerides et al., 1998; Aw et al., 2000; Delgado et al., 2002).

The second explanation is that there may be a “learning by exporting” effect (see, for example, López, 2005; Wagner, 2007) by getting more access to technology, getting new ideas from customers and by being subject to stronger competition. The empirical evidence on “learning by exporting” is more ambiguous, with some studies finding such effects and others not. Examples of studies which have found evidence of “learning-by-exporting” include Sjöholm (1999), Baldwin (2003), Girma et al. (2003), Biesebroeck (2005) and Isgut and Fernandes (2007). On the other hand, a number of research works do not find such effects. For example, a research project using comparable micro-level data for 14 countries found evidence in favour of learning-by-exporting only for Italy (Alvarez et al., 2007). There is, however, a substantial amount of anecdotal evidence which point to the existence of “learning-by-exporting”, whereby foreign customers provide information about among others, product designs, materials, labelling, packaging and shipping, assistance to reduce costs and control quality, and help in the factory layout (López, 2005).

The third explanation why exporters may be more productive is that trade, especially exports, extend the size of the market over which margins can be earned, providing greater incentives for increased investment in innovation. A large part of research and development (R&D) costs are fixed; so a company selling to both domestic and export markets may be able to recoup R&D investments (which involves considerable uncertainty) over a larger sales quantity. These scale economies are especially important for countries with smaller domestic markets. Biesebroeck (2005) looked at sub-Saharan firms and finds that exporting companies are more productive and that they increase their productivity advantage after entry into the export market. Biesebroeck (2005) estimate the effect of exporting on productivity to be between 25 and 28 per cent, and found that scale economies are particularly important for small economies in sub-Saharan Africa. Thus, for smaller economies, export markets provide an avenue to achieve the economies of scale necessary for R&D and production on a globally competitive basis.

II.2 Prevalence of Vertical Trade

The literature on the export-productivity relationship has managed to eclipse discussions on exports embodying considerable sophisticated imported inputs for countries like Malaysia where two-way or processing trade is a distinct trait especially in the electrical and electronics industries. Empirical studies of production sharing have employed data sets either based on Standard International Trade Classification (SITC) or International Standard Industrial Classification (ISIC) data. In the former classification, trade in parts and components is referred to as fragmentation trade. In the latter classification, particular attention is given to offshoring of production as a measure of fragmentation trade. The most important advantage of using SITC data is its availability and comparability across countries and the most important limitation in measuring production fragmentation is the absence of information as to whether production sharing is conducted within MNE networks or through arm's length trade (Yamashita, 2011).

Early works by Alavi (1999) and Khalifah (2000) hinted the prevalence of vertical trade in Malaysia. Based on production data and computed import intensities, Alavi (1999) using ISIC data found that resource-based industries were more export-oriented than that of non-resource-based during the period 1975-1994. In addition, almost 70 per cent of the manufacturing industries were highly dependent on imported inputs and almost all of these industries were non-resource based. It was also found that there was a positive relationship between export share and imported input content for the non-resource-based industries. However, the relationship was negative for the resource-based industries.

Khalifah (2000) decomposed Malaysia's merchandise trade into intra-industry trade (IIT) and net trade (NT) for the period 1990-1997. Based on SITC trade statistics and computed Grubel-Lloyd (GL) index to indicate the share of IIT in total trade (TT), Khalifah (2000) showed that the total trade in the electronics industry increased from 28 per cent of TT (GL > 0.7) in 1990 to 45 per cent in 1997 (GL > 0.91). At the same time, the trade share of the primary industries was nearly halved from 30 per cent to 16 per cent of TT. Khalifah (2000) further attributed the high GL-index for selected manufacturing industries, especially for electronics parts and components, to the increased internationalization of production where Malaysia is part of the vertically-integrated international production chain and MNEs position different fragments of the production chain in different countries *ala*' Heckscher-Ohlin's factor proportions theory of international trade.

Srholec (2007) and Hanson (2012) conducted cross-country analysis of exports and imports using SITC data and concluded that production fragmentation is an important feature of manufacturing trade for countries like China, Malaysia and the Philippines. Athukorala (2005) discusses the prevalence of international product fragmentation by using trade flows on parts and components (SITC data) and examines the implications of this phenomenon for global and regional trade patterns, with special emphasis on countries in East Asia. Low production costs just were not enough of a reason for MNEs to locate their production in a developing country in the initial stage because the trade barriers and transaction costs were too high. The push factors were investment and trade liberalization and decreasing transport costs that made it more profitable to outsource specific product segments.

Hummels et al. (2001) define international fragmentation intensity (vertical specialization based trade share of exports) for a particular industry as the total value of imported inputs weighted by the industry's gross output. Seker (2012) analysed firms exporting and importing activities including for 43 developing countries using the World Bank Business Environment and Enterprise Performance Survey (BEEPS) and show that two-way traders (used as a binary dummy variable) are the fastest growing and most innovative group. Productivity premia of exporters are overestimated when import status is not controlled for in the regressions of trade variables on productivity (Seker, 2012). The intensity of two-way trade is not controlled for since only status as two-way traders are accounted for in Seker (2012) and Muûls and Pisu (2009).

Tucci (2005) attempt to measure production networks by adapting the framework of Hummels et al. (2001) to establishment level data. Tucci (2005) then introduces a firm level normalization of the Hummels et al. (2001) index by dividing by the total material inputs used in the production of the establishment. Tucci (2005) also suggested using the imported input content of exports, namely, imported inputs divided by exports to measure involvement in foreign networks. We contribute to the measurement of involvement in foreign networks at the establishment level by utilising the vertical trade to gross output (*VTQ*) index introduced by Khalifah and Azhar (2013). When using firm-level data, we suggest the use of the overlap of exports and imported inputs to gross output *(Q)* to measure fragmentation or vertical trade intensity *(VTQ)* with suitable thresholds to demarcate vertical trade from ordinary trade (see Khalifah and Azhar, 2013).

3. Data and Methodology

Data Set

The analyses in this paper are based on the data set from the Annual Survey of Manufacturing Industries, conducted by the Department of Statistics, Malaysia, for the period 2000-2005 (2000 and 2005 are census years). The annual surveys/censuses cover all establishments above a specific employment cut-off, which vary from industry to industry. Our data for the Malaysian manufacturing industries in the E&E sector provide a rich basis for examining vertical trade and cases of high or "ultra" trade verticality also known as export-processing trade. The E&E industries include industries in MSIC 30-32 at the 2-digit level, encompassing 15 categories at the 5-digit level.

The main variables for each establishment compiled are the number of workers employed, gross output, cost of inputs, value-added, fixed assets, value of imported raw materials as well as exports and also wages paid per annum. However, the country of origin of the imported inputs and destination of exports as well as the industrial classification of inputs are not captured. Also, the data does not distinguish between arms-length and intra-firm trade. Output is calculated as the value of sales less the change in inventories. Value added is taken to be the difference between the value of gross output and the cost of inputs. Capital stock is the stock of fixed assets reported by each establishment at the end of the reference year. Wages are the amount paid by each establishment during the reference year. The number of workers employed is adjusted for temporary workers, where two temporary workers are assumed to be equal to one permanent worker. All the data have been deflated using the appropriate deflators provided by the Department of Statistics Malaysia (DOSM). The nominal value of gross output as well as exports and cost of inputs are deflated using the Producer Price Index (PPI) and an intermediate input deflator at the 5-digit MSIC, respectively. Imports are also deflated using an import deflator at the 5-digit MSIC. The nominal value of fixed assets is deflated using the Gross Domestic Product (GDP) deflator, while wages are deflated using the domestic economy PPI deflator.

The initial coverage of the data set for the E&E sector ranges from 974 establishments in 2000 (census); 694 establishments in 2001; 738 establishments in 2002; 721 establishments in 2003; 638 establishments in 2004 and 967 establishments in 2005 (census); resulting in a total of 4,732 pooled observations. There were 242 observations with negative value added and thus, deleted from the sample. An additional 10 observations with real wages less than RM100 were also deleted. Outliers were omitted from the study based on the (arbitrary) criterion of one per cent of the observations with the highest and lowest value added.[2] A balanced panel of 258 establishments was extracted from the establishment level unpublished data over the years 2000-2005 with a total of 1,548 observations used in the analysis of Malaysia's E&E sector.[3]

Measuring Vertical Trade

A study by Hummels et al. (1998) is one of the pioneers in measuring vertical-specialization-based trade. Under this type of trade, countries are linked sequentially to produce goods, with each country specializing in particular stages of a good's production sequence. One feature of this sequential linkage is given focus: imported intermediates used by a country to make goods or goods-in-process that are in turn exported to another country. This feature highlights the multiple-border-crossing, back-and-forth aspect of trade. Hummels et al., 1998, measure the amount of imported inputs as a fraction of gross output embodied in a country's exports multiplied by 2 as vertical specialization based trade. Specifically, vertical specialization (VS) based trade for country *k* and good or sector *i* is defined as follows:

$$VS_{ki} \quad = \quad \left(\frac{Imported\ Intermediates}{Gross\ Output}\right)\ x\ \ Exports\ x\ 2 \tag{1}$$

This vertical specialization measure uses *gross output* as weights. Hummels *et al*. (2001) redefine vertical specialization share of exports akin to equation (1) above but removes the number "2". Thus, for country *k* and good or sector *i*, vertical specialization trade is defined as follows:

$$VS_{ki} = \frac{Imported\ Intermediates}{Gross\ Output}.Exports \tag{2}$$

Based on the production box of establishment methodology as in Khalifah and Azhar (2013), the volume of overlapping exports (*X*) and imported inputs (*Minp*) at the establishment level is defined as vertical trade *(VT)* as follows:

$$VT_i = 2\min(X_i\,, Minp_i) \tag{3}$$

where *i* indexes establishments and X_i and $Minp_i$ are respectively exports and imported inputs of establishment *i*. The share of vertical trade in gross output *(Q)* of the establishment is the *VTQ* measure and defined as follows:

$$VTQ_i = \frac{2\min(X_i, Minp_i)}{Q_i} = \frac{2\min(X_i, Minp_i)}{Q_i} \tag{4}$$

where *i* indexes establishments and X_i and $Minp_i$ are respectively exports and imported inputs of establishment *i* and Q_i refers to gross output of the establishment. The VTQ_i

measure takes on values in the interval [0, 2) with the lower bound indicating no overlap between exports and imported input values and values close to 2 showing massive overlap of exports and imported inputs relative to output. In the net-export *(*NX*)* plane, the *VTQ* measure is equal to $(2 * M_{inp})/Q$ and similarly in the net-import *(*NM*)* plane, *VTQ* is equal to$(2 * X)/Q$. Thus, in the NX plant, *VTQ* is "two" multiplied by offshoring intensity and in the net-import plant *VTQ* is "two" multiplied by export intensity. The Khalifah and Azhar (2013) methodology allows for the measurement of the degree or intensity of two-way trading (quantitation of two-way trading) as opposed to the dummy variable for two-way traders versus non-two-way traders used in Yasar and Paul (2007)[4], Seker (2012) and Muûls and Pisu (2009).

Stochastic Frontier Functions and Inefficiency Effects

The present study estimates a production frontier with inefficiency effects using a panel data version of the Aigner et al. (1977) approach, following the Battese and Coelli (1995) specification. In this specification, technical inefficiency is estimated from the stochastic frontier and simultaneously explained by a set of firm specific characteristics avoiding the problems encountered in the two-stage approach when analyzing the determinants of inefficiency. The stochastic production frontier can be written as:

$$y_{it} = f(x_{j,it}, t, \beta)\exp(v_{it} - u_{it}) \tag{5}$$

where $f(.)$ is a suitable functional form; y_{it} denotes the output of plant i at time t; $x_{j,it}$ is the corresponding level of input *j*; and β is a vector of unknown parameters to be estimated. The error term, is composed of a random error component, v_{it}, and an inefficiency component, u_{it} which are independent of each other. The efficiency error, u_{it}, represents production loss due to firm-specific technical inefficiency $(u_{it} \geq 0)$ and it is independent of the statistical error v_{it}. The random error component v_{it} is assumed to be a standard symmetric, independent and identically distributed (i.i.d.) error term, $v_{it} \sim N(0, \sigma_v^2)$, and uncorrelated with the regressors and u_{it}'s are the non-negative random variable of the normal distribution but truncated at zero with mean δz_{it} and variance σ_u^2.

Following the Battese and Coelli (1995) specification and assuming a linear functional relationship that allows a comparison of the dynamic performance of firms, mean inefficiencies are explained as follows:

$$u_{it} = \sum_k \delta_k z_{k,it} + W_{it} \qquad (6)$$

where u_{it} is the mean technical inefficiency of each establishment i at time t, $z_{k,it}$ is a (k x 1) vector of explanatory variables of plant inefficiency, δ_k is a (1 x k) vector of parameters to be estimated and W_{it} is an unobservable random variable defined by the truncation of the normal distribution with zero mean and variance σ^2.

The technical efficiency of production for the i^{th} plant at the time t is defined as the ratio of the actual output to the potential output (maximum feasible output from a given quantity of inputs) obtainable when there is no inefficiency and is written as follows:

$$TE_{it} = \frac{f(x_{it};\beta)\exp(v_{it} - u_{it})}{f(x_{it};\beta)\exp(v_{it})} = \exp(-u_{it}) \qquad (7)$$

Since u_{it} is a non-negative random variable, this technical efficiency measure lies between zero and one. A plant is technically efficient when the *TE* value is equal to one (i.e. the plant has an inefficiency effect equal to zero). The production function coefficients (β) and the inefficiency model parameters (δ) are estimated together with the variance parameters: $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\gamma = \sigma_u^2 / \sigma^2$, which lies between 0 and 1. γ is the ratio of the variance of the non-negative random variable *u*, as a proportion of total variance due to the random variables, u and v. If the null hypothesis that $\gamma = 0$ is true, then technical inefficiency is not present, indicating that the mean response function (Ordinary Least Squares - OLS) is an adequate representation of the data.

Based on the models of equation (5) and (6) we estimate a flexible functional form that is a translog production function, which can be re-written as follows:

$$y_{it} = \alpha_0 + \sum_j \alpha_j x_{jit} + \alpha_t t + \frac{1}{2}\sum_j \sum_l \beta_{jl} x_{lit} x_{jit} + \frac{1}{2}\beta_{tt} t^2 + \sum_j \beta_{tj} t x_{jit} + v_{it} - u_{it} \qquad (8)$$

$$j,l = L, K$$

where y_{it} is the log of observed output of the i^{th} establishment; t is the time variable; and the x variables are the log of inputs, subscripts j and l indicate inputs.

The production frontiers are fitted for a single output (value added) and two inputs, capital (K_{it}) and labour (L_{it}). The data were mean differenced for the panel-data analysis. The maximum-likelihood estimates of the parameters are obtained in the translog stochastic frontier production function model defined by equation (8) using the program FRONTIER 4.1 (Coelli, 1996). The program also predicts mean and time-varying firm specific technical efficiency given by equation (7). The likelihood ratio test is used to examine whether the technical efficiency effects are not simply random errors.

The vectors β, δ and σ^2 are estimated by maximum likelihood estimation (MLE) methods. The vector δ estimated relates the variables to u_{it}, which is an inefficiency component. Thus, negative δ values are positively related to efficiency. The variables incorporated within the technical inefficiency component of the stochastic frontier model are as follows:

$$u_{it} = \delta_0 + \delta_1 SCALE_{ijt} + \delta_2 FORsh_{it} + \delta_3 HHI_{jt} + \delta_4 Avgwage_{it} + \delta_5 VI_i + \delta_6 Trade_i \qquad (9)$$

where i indexes establishments, j indexes industries, u_{it} is technical inefficiency, $SCALE_{ijt}$ represent the value added of establishment i divided by the average value added in the respective 5-digit sub-sectors for the respective years. The larger the scale of production of an establishment, the more likely the establishment is technically efficient as larger establishments can be expected to benefit from R&D, have better access to foreign technology and have higher risk-bearing aptitude compared to establishments with smaller scale. Moreover, in order for establishments to become large, the establishments must be efficient in the past by having low-cost structures, which enable them to reduce prices and expand their scale. In contrast, other researchers argue that small firms are more flexible and adopt more appropriate technology, leading to higher technical efficiency.

FORsh is a variable representing foreign equity share of an establishment. Foreign equity ownership of an establishment provides control over key aspects of an establishment's operations, thus allowing for the exploitation of firm-specific assets of the foreign partner. It is expected of multinationals to possess large amounts of intangible assets compared to local firms and thus, higher foreign equity ownership in the FDI-recipient establishment will contribute to increases in efficiency and subsequently, productivity of an establishment. This direct effect not only refers to capital transfers but also transfers of new technologies, managerial skills, marketing expertise, brand names, patents and networking with others associated with the MNE. This expectation of higher efficiency and productivity of multinationals has led to attempts to attract FDI into host countries in the hope of transferring technology or generating spillover effects to local firms.

HHI_{jt} is the Herfindahl-Hirschman Index to measure the degree of market competition at the five-digit industry level in terms of value added. Higher values of HHI_{jt} indicate higher degree of industry concentration and thus, less competition and henceforth complacency, so that a negative relationship is expected between HHI_{jt} and technical efficiency. *Avgwage* is a proxy for human capital embodied in an establishment (Aswicahyono and Hill, 1995; Sinani and Meyer, 2004; Greenaway et al., 2005) defined by average wages per establishment. A higher skill level of the workforce measured by average wages paid by the establishment may lead to better quality products and higher levels of efficiency due to better absorptive capacity of workers in an establishment. Assuming a competitive labour market, increasing average wages would reflect increasing quality of the work force in an establishment. As the quality of human capital increases, efficiency is also expected to improve.

The $Trade_{it}$ variables used as determinants of TE in this study include export intensity (X/Q_{it}), a dummy variable for two-way traders (*2wayTRDdum*) and vertical trade intensity (*VTQ*). Previous studies like Yasar and Paul (2007) and Seker (2012) do not take into account the intensity of two-way trading or trade verticality of the establishments on productivity. The intensity of two-way or vertical trade relative to production at the establishment level is measured using the *VTQ* measure of Khalifah and Azhar (2013). The *VTQ* measure can be utilized to delineate establishments as vertical traders or not, by selecting suitable threshold values to split the sample into two sub-samples. The binary variable, *VTdummy* take on the value 1 for vertical traders and 0 otherwise. It is intuitive that as the threshold *VTQ* measure increases, the pool of firms that are considered as vertical traders decreases and the pool considered as non-vertical or ordinary traders increases.

Traditionally, *VA/Q* was used to measure the degree of vertical integration (*VI*) in production with higher values indicating production in-house rather than buying the inputs or outsourcing (subcontracting) to others -- the “make” or “buy” decision. If the production cost or transaction cost of producing in-house is high relative to outsourcing, firms may choose the “buy” option (Holmes, 1986; Grossman and Helpman, 2002; Antràs, 2003). Taymaz and Yilmaz (2005) and Paul and Yassar (2009) study the subcontracting relationship in Turkish textile and engineering industries and distinguished between subcontract offering (subcontracting input) and subcontract receiving (or subcontracting output) models.

In developing countries like Malaysia, international fragmentation manifests itself as firms providing outsourcing/offshoring services in terms of relatively unskilled-labour intensive stages of the production process to developed countries with the developed countries being the outsourcers who sub-contract for assembling of inputs or offer subcontracts in this multi-stage production process. From the perspective of the outsourcing provider (developing countries), the larger the value-added per unit of output (or vertical integration), the higher the volume of production provided to the outsourcer. In contrast, from the developed country perspective, the higher the *VA/Q* or vertical integration, the lower the outsourced fragment. Thus, the perspective of the outsourcer (receiving offshoring services) and outsourcee (outsourcing provider) needs to be distinguished when using the *VA/Q* variable[5]. Sethupathy (2013) also alluded to this phenomenon in the context of "productive" parents transferring production to their foreign subsidiaries leading to vertical disintegration of parent's production and increasing vertical integration of subsidiary production. In the ambience of vertical and processing trade, higher *VI* possibly suggest higher sub-contracting "received" from other establishments (provided to others) whether "parents" or otherwise; whether local or foreign establishments and thus not differentiating between arms-length or within firm transactions.

4. Results

Performance Premia for Vertical Traders

The estimates of the coefficients of equation (9) are presented in Table 1 and include as explanatory variables of technical efficiency, the scale of production of the establishments, the foreign equity ownership share, the *HHI* index, average wages paid by the establishment as a proxy for labour quality and the different trade variables. The γ values are significant in all models estimated in Table 1 showing that the stochastic frontier analysis is appropriate compared to the mean response function. In other words, technical inefficiency effects are present. The *SCALE* variable is significant and negatively associated with technical inefficiency in all of the models estimated. Higher market power or less market competition as measured by *HHI* is positively and significantly associated with technical inefficiency. The degree of foreign ownership of establishments is not a significant determinant of technical efficiency of establishments.

The variable *VI* is an interesting determinant of technical efficiency of establishments in Malaysia's E&E industries. In models 1.1 and 1.2, the variable *VI* is not included as an explanatory variable and both the export intensity variable and *VTQ* variable are not significant determinants of technical efficiency. Upon inclusion of the *VI* variable in models 1.3 to 1.6, higher *VI* is positively associated with technical efficiency of the establishments in the E&E industries. This shows that establishments that can produce higher value added relative to output or establishments that receive higher outsourcing contracts are technically efficient. Moreover, in model 1.3, higher export intensity is positively related to technical efficiency and similarly in model 1.4, higher vertical trade intensity is positively associated with TE upon inclusion of the *VI* variable. Higher average wages paid by establishments which proxy for higher labour quality is also positively related to technical efficiency of establishments.

In order to test for the relative effects of two-way trade (*2wayTRDdum*) and export-intensity (*X/Q*), both the two-way trade dummy variable (as used in Seker, 2012) and the export intensity variable are included as determinants of technical efficiency of establishments in model 1.5. The results show that both the *2wayTRDdum* and *X/Q* variables are insignificant determinants of technical efficiency. Substituting the *2wayTRDdum* variable with the vertical trade intensity (*VTQ*) variable; the results in model 1.6 show that vertical trade intensity is positively and significantly associated with technical efficiency of establishments but not export intensity (*X/Q*) *per se*.

Vertical trade intensity premia versus export intensity premia

As a robustness check, we compare the relative performance of the vertical trade intensity variable and the export intensity variable as determinants of TE. Different threshold values of the *VTQ* measure are selected to delineate the group of vertical and ordinary trading establishments with the *VTdummy* taking on a value of 1 for the former and 0 for the latter depending on the selected threshold values. It is intuitive that as the threshold *VTQ* measure increases, the pool of firms that are considered as vertical traders decreases and the pool considered as ordinary or non-vertical traders increases.

The models in Table 2, show the regression results for the different threshold values used to classify establishments as vertical traders or not. For example, in model 2.1, establishments with a *VTQ* measure greater than or equal to 0.2 are classified as vertical traders and those establishments with a *VTQ* measure less than 0.2 are ordinary traders. In model 2.2, the threshold *VTQ* measure is 0.3; in model 2.3, the threshold is 0.6 and so on as shown in the second row of Table 2. The results of the stochastic frontier analysis for the different threshold values are generally similar to that of Table 1 except for the trade variables. When low threshold values of the *VTQ* measure are used to denote an establishment as a vertical trader or not (models 2.1 and 2.2), both the export intensity and *VTdummy* variable are not significant determinants of TE. When the threshold *VTQ* measure is 0.4 and 0.5, the maximum likelihood iterations did not converge. When the *VTQ* measure is in the intermediate range of 0.6 to 1.0, the *VTdummy* is a significant determinant of TE whereas the *X/Q* variable is not significant showing that it is the verticality of trade that is associated with TE and not export intensity *per se*.

When the *VTQ* measure takes on values 1.1 and 1.2 as thresholds; both *VTdummy* and *X/Q* are significant determinants of TE. We suspect that at higher thresholds, more of the establishments will fall into the category of ordinary traders and less will fall into the category of vertical traders and thus the *X/Q* variable is significant since ordinary traders will also encompass establishments with high trade verticality. At the other extreme, with low threshold values of the *VTQ* measure (models 2.1 and 2.2); a relatively large number of establishments will fall within the category of vertical traders whose trade verticality is not important and the remaining ordinary traders have small export intensities; hence resulting in insignificant effects on TE for the trade variables.

Export Premia only for ordinary traders

Vertical trading establishments can be distinguished from ordinary trading establishments based on different threshold values of the *VTQ* measure. We choose a threshold *VTQ* measure of 0.9 to categorize establishments as ordinary trading (*VTQ* < or = 0.9) establishments versus vertical trading (*VTQ* > 0.9) establishments.[6] The results for the sub-samples of vertical trading and ordinary trading establishments are shown in Table 3. The sub-sample of vertical trading establishments consists of 306 observations with the regression estimates shown in model 3.1 whereas the sub-sample of ordinary trading establishments consist of 1242 observations and regression results shown in model 3.2 of Table 3. Our findings in model 3.1 show that export intensity is not a significant determinant of TE for ultra-vertical or processing trade establishments. In model 3.2 for the sub-sample of ordinary trading establishments, *X/Q* is a significant determinant of TE. These results lend support to the “traditional” view that exporting is positively related to technical efficiency and productivity of “ordinary” or “traditional” establishments with almost complete value added chains produced in the exporting country. In the current globalized scenario with establishments sometimes wholly owned by foreigners producing incomplete value added chains as vertical traders; exporting is not necessarily associated with technical efficiency of establishments. In view of the results from our study, it is possible to interpret the results of Görg and Hanley (2005) whereby high export intensity establishments are probably vertical traders with outsourcing already incorporated in vertical trading and thus outsourcing is not related to productivity.

Ordinary trading establishments probably are involved in segments of the E&E industries where market power is not a significant determinant of technical efficiency. Higher market power is associated with higher inefficiency in the sub-sample of vertical trading establishments. Labour quality as proxied by average wages is not a significant determinant of TE for both sub-samples of ordinary and vertical trading establishments. A possible interpretation of these results is that vertical traders are paying efficiency wages above the competitive level and that average wages does not necessarily reflect labor quality. A larger scale of production and higher vertical integration are associated with TE of both vertical and ordinary trading establishments. The coefficient of capital for the ordinary trading establishments (model 3.2) is higher than that of the vertical trading establishments (model 3.1) and vice-versa for the coefficient of labour, showing higher capital intensity in production for ordinary traders compared to vertical traders. When looking at the sum of the coefficients of capital and labour, vertical traders experience decreasing returns to scale with a scale factor of 0.8733 (= 0.1256 + 0.7477) and this is lower than that of ordinary traders of 0.9484 (= 0.2094 + 0.7390) showing that replacement capacity is not as forthcoming for the vertical traders compared to ordinary traders. Technical progress as depicted by the coefficient of *t* is not significant in both sub-samples of ordinary and vertical trading establishments suggesting insignificant technology progress in the E&E industries of Malaysia over the study period.

5. Conclusion

In theory, international trade in goods is expected to benefit trading nations but the pervasiveness of vertical-based trade in intermediate goods due to fragmented production processes by MNEs may cloud economic relationships and produce contrary results. While MNEs became a major source of not only employment but also technology and access to the world markets for Malaysia's manufacturing sector, the rapid increase of export processing trade and vertical production networks as a result of assembly-type activities of these MNEs may have diminished the causal link between exporting and technical efficiency at the establishment level. This study shows that vertical trade is associated with technical efficiency of establishments and not export intensity *per se* for the overall sample of establishments. Only in the sub-sample of ordinary trading establishments is export intensity associated with technical efficiency. Higher export intensity does not necessarily mean higher efficiency of establishments and thus an unqualified policy of export expansion within the context of vertical trade and global value chains in production should be conducted with caution.

Higher degree of vertical integration is positively associated with technical efficiency of establishments in Malaysia's E&E industries pointing to the importance of net production relative to gross production. Higher foreign equity ownership of establishments is not related to technical efficiency of establishments. Labour quality as measured by average wages is generally associated with efficiency of establishments in the overall sample. Higher market power is associated with technical inefficiency of establishments in all of the models estimated except for the sub-sample of ordinary traders where it is insignificant. Whether market power breeds complacency resulting in inefficiency or that market power leads to the payment of efficiency wages is still open to interpretation. A larger scale of operation is associated with technical efficiency suggesting that the development of small and medium enterprises may be burdened by technical inefficiency. The coefficient of capital in the production function is higher for the sub-sample of ordinary traders compared to vertical traders showing higher capital intensity for the ordinary trading establishments. Returns to scale on average is 0.8733 for vertical trading establishments showing production at more than the optimal scale with entry of establishments not as forthcoming compared to 0.9484 for ordinary trading establishments. Technical progress as depicted by the coefficient of time is not significant in all of the models estimated in Malaysia's E&E industries.

Global value chains and fragmentation of production in the global arena dictate the harsh reality of global competition in containing costs and promoting technical efficiency of establishments in Malaysia's E&E industries without export intensity being a significant determinant of technical efficiency in the presence of vertical trade. The insignificant technical change in Malaysia's E&E industries and the low estimates of the coefficient of capital in net production function show that low labour cost is the driver of technical efficiency with no evidence of innovation. In the current scenario of China being a base for vertical trade and other countries like Vietnam also wooing foreign direct investment with relatively cheaper labour than Malaysia; it is imperative that Malaysia genuinely develop her physical and human capital as well as innovativeness in order to generate technical efficiency and technical progress and move up the quality ladder to survive international competition.

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Table 1. Performance Premia for Vertical Traders

	Model 1.1		Model 1.2		Model 1.3	
Variable	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Constant	1.3470***	18.92	1.3515***	19.06	1.2174***	15.35
K	0.2046***	8.86	0.2058***	8.90	0.2022***	9.00
L	0.7391***	21.05	0.7371***	20.96	0.7572***	22.56
t	0.0041	0.27	0.0037	0.24	0.0058	0.39
*K*K/2*	0.0350***	4.66	0.0354***	4.73	0.0361***	4.85
*K*L*	-0.0384***	-3.00	-0.0383***	-3.01	-0.0491***	-3.81
*K*t*	-0.0211***	-2.65	-0.0215***	-2.71	-0.0175**	-2.27
*L*L/2*	0.0272	1.14	0.0260	1.09	0.0489**	2.08
*L*t*	0.0219**	2.05	0.0224**	2.11	0.0182*	1.78
*t*t/2*	0.0151	1.33	0.0142	1.24	0.0180	1.64
Intercept	1.3619***	16.64	1.3620***	15.86	1.5948***	19.38
SCALE	-0.2886***	-27.16	-0.2926***	-33.51	-0.2653***	-25.39
FORsh	-0.0005	-1.21	-0.0005	-1.24	-0.0003	-0.79
HHI	0.0001***	4.06	0.0001***	3.80	0.0001***	2.64
Avgwage	-0.0037*	-1.80	-0.0034	-1.44	-0.0039**	-2.04
VI					-0.9828***	-9.48
X/Q	-0.0442	-1.15			-0.1179***	-3.00
2wayTRDdum						
VTQ			-0.0488	-1.34		
σ^2	0.3005***	21.91	0.3041***	23.62	0.2824***	23.70
γ	0.5665***	16.93	0.5761***	20.72	0.5415***	16.48
Log-likelihood	-1189.430		-1189.361		-1128.754	
LR test one-sided error	324.030		324.167		445.381	
Observations	1548		1548		1548	

Table 1. (Continue) Performance Premia for Vertical Traders

	Model 1.4		Model 1.5		Model 1.6	
Variable	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Constant	1.2220***	16.05	1.2243***	16.52	1.2286***	15.61
K	0.2037***	9.08	0.2024***	9.08	0.2037***	9.16
L	0.7518***	22.09	0.7547***	22.32	0.7522***	22.25
t	0.0077	0.51	0.0072	0.47	0.0078	0.52
*K*K/2*	0.0365***	4.95	0.0361***	4.90	0.0366***	4.98
*K*L*	-0.0502***	-3.88	-0.0497***	-3.86	-0.0500***	-3.88
*K*t*	-0.0170**	-2.17	-0.0169**	-2.14	-0.0170**	-2.17
*L*L/2*	0.0512**	2.14	0.0509**	2.14	0.0503**	2.13
*L*t*	0.0181*	1.74	0.0172	1.63	0.0181*	1.74
*t*t/2*	0.0160	1.45	0.0173	1.57	0.0156	1.44
Intercept	1.6167***	20.49	1.5941***	19.35	1.6193***	19.74
SCALE	-0.2660***	-24.30	-0.2662***	-25.30	-0.2675***	-23.97
FORsh	-0.0003	-0.87	-0.0003	-0.86	-0.0003	-0.87
HHI	0.0001***	3.08	0.0001***	2.89	0.0001***	3.02
Avgwage	-0.0040**	-2.57	-0.0034*	-1.87	-0.0037*	-1.74
VI	-1.0496***	-9.69	-0.9796***	-9.52	-1.0436***	-10.11
X/Q			-0.1008	-1.58	-0.1614	0.04
2wayTRDdum			-0.0148	-0.25		
VTQ	-0.1589***	-4.62			0.0021***	-3.20
σ^2	0.2798***	22.25	0.2830***	22.98	0.2787***	24.05
γ	0.5392***	19.19	0.5435***	17.73	0.5382***	15.43
Log-likelihood	-1123.128		-1128.706		-1123.186	
LR test one-sided error	456.633		445.478		456.517	
Observations	1548		1548		1548	

Notes:***, ** and * denote significance at 1%, 5% and 10% at levels, respectively.

Source: Own estimation based on the panel data used for the study.

Table 2. Vertical Trade Premia vs Export Premia at Different Threshold Values of Vertical Trade

	Model 2.1 Threshold VT (0.2)		Model 2.2 Threshold VT (0.3)		Model 2.3 Threshold VT (0.6)		Model 2.4 Threshold VT (0.75)	
Variable	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Constant	1.2241***	16.21	1.2240***	15.19	1.2321***	15.39	1.2261***	16.77
K	0.2017***	9.12	0.2021***	9.13	0.2044***	9.25	0.2040***	9.04
L	0.7551***	22.33	0.7548***	22.13	0.7541***	22.10	0.7535***	21.93
t	0.0072	0.47	0.0070	0.46	0.0071	0.47	0.0070	0.49
*K*K/2*	0.0361***	4.93	0.0360***	4.91	0.0369***	5.12	0.0366***	4.95
*K*L*	-0.0494***	-3.81	-0.0496	-3.84	-0.0501***	-3.88	-0.0500***	-3.92
*K*t*	-0.0169**	-2.16	-0.0167**	-2.16	-0.0171**	-2.18	-0.0171**	-2.28
*L*L/2*	0.0498**	2.05	0.0504**	2.12	0.0496**	2.05	0.0502**	2.10
*L*t*	0.0175*	1.67	0.0172*	1.66	0.0182*	1.74	0.0182*	1.85
*t*t/2*	0.0167	1.55	0.0165	1.53	0.0166	1.49	0.0167	1.47
Intercept	1.5916***	18.30	1.6039***	18.23	1.6184***	19.12	1.6092***	20.03
SCALE	-0.2659***	-26.65	-0.2666***	-23.23	-0.2636***	-20.77	-0.2647***	-23.58
FORsh	-0.0003	-0.88	-0.0004	-0.93	-0.0003	-0.82	-0.0003	-0.84
HHI	0.0001***	2.97	0.0001***	2.85	0.0001***	2.92	0.0001***	3.05
Avgwage	-0.0036**	-2.30	-0.0037*	-1.85	-0.0038*	-1.77	-0.0039**	-2.01
VI	-0.9725***	-9.19	-0.9875***	-9.20	-1.0233***	-9.57	-1.0209***	-9.99
X/Q	-0.0640	-1.07	-0.0865	-1.62	-0.0329	-0.68	-0.0499	-1.13
VTdummy	-0.0601	-1.13	-0.0400	-0.80	-0.1386***	-2.97	-0.1221***	-2.67
σ^2	0.2808***	21.98	0.2803***	21.96	0.2795***	23.02	0.2793***	21.89
γ	0.5471***	17.01	0.5419***	15.59	0.5370	0.03	0.5395***	17.44
Log-likelihood	-1128.144		-1128.355		-1124.149		-1125.148	
LR test one-sided error	446.601		446.178		454.591		452.593	
Observations	1548		1548		1548		1548	

Table 2. (Continue) Vertical Trade Premia vs Export Premia at Different Threshold Values of Vertical Trade

	Model 2.5 Threshold VT (0.9)		Model 2.6 Threshold VT (1.0)		Model 2.7 Threshold VT (1.1)		Model 2.8 Threshold VT (1.2)	
Variable	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Constant	1.2147***	17.30	1.2245***	15.63	1.2184***	15.23	1.2190***	16.36
K	0.2044***	9.09	0.2049***	9.13	0.2040***	9.10	0.2042***	9.14
L	0.7530***	21.89	0.7527***	21.84	0.7541***	21.75	0.7537***	21.73
t	0.0079	0.52	0.0070	0.46	0.0061	0.41	0.0067	0.45
*K*K/2*	0.0366***	4.99	0.0366***	5.00	0.0366***	4.96	0.0365***	4.96
*K*L*	-0.0500***	-3.87	-0.0501***	-3.88	-0.0501***	-3.88	-0.0501***	-3.89
*K*t*	-0.0170**	-2.17	-0.0173**	-2.20	-0.0173**	-2.21	-0.0169**	-2.19
*L*L/2*	0.0500**	2.06	0.0499**	2.09	0.0497**	2.07	0.0505**	2.09
*L*t*	0.0183*	1.75	0.0184*	1.75	0.0184*	1.77	0.0178*	1.74
*t*t/2*	0.0169	1.54	0.0153	1.35	0.0169	1.56	0.0163	1.51
Intercept	1.6040***	19.24	1.6099***	18.77	1.6081***	19.04	1.6090***	20.25
SCALE	-0.2669***	-23.55	-0.2669***	-24.69	-0.2659***	-22.88	-0.2664***	-26.38
FORsh	-0.0003	-0.80	-0.0004	-0.97	-0.0004	-0.96	-0.0003	-0.91
HHI	0.0001***	2.74	0.0001***	3.15	0.0001***	2.96	0.0001***	2.88
Avgwage	-0.0041**	-2.49	-0.0039**	-2.07	-0.0041**	-2.44	-0.0037**	-2.35
VI	-1.0285***	-9.26	-1.0400***	-10.66	-1.0330***	-9.34	-1.0313***	-11.15
X/Q	-0.0505	-1.22	-0.0633	-1.48	-0.0733*	-1.90	-0.0958**	-2.44
VTdummy	-0.1687***	-3.38	-0.1470***	-2.96	-0.1512***	-2.97	-0.1479**	-2.59
σ^2	0.2799***	22.87	0.2811***	23.95	0.2791***	24.31	0.2788***	24.08
γ	0.5378***	16.17	0.5394***	16.96	0.5365***	12.46	0.5419***	16.58
Log-likelihood	-1121.957		-1123.881		-1124.588		-1124.838	
LR test one-sided error	458.975		455.127		453.714		453.213	
Observations	1548		1548		1548		1548	

Notes: ***, ** and * denote significance at 1%, 5% and 10% at levels, respectively.
Source: Own estimation based on the panel data used for the study.

Table 3: Export Premia Only for Ordinary Traders

	Model 3.1 (Vertical Traders)		Model 3.2 (Ordinary Traders)	
Variable	Coefficient	t-ratio	Coefficient	t-ratio
Constant	1.2942***	11.09	1.2504***	14.54
K	0.1256**	2.45	0.2094***	9.15
L	0.7477***	11.61	0.7390***	22.07
t	-0.0087	-0.46	0.0145	0.92
*K*K/2*	0.1022**	2.15	0.0359***	4.72
*K*L*	-0.1463**	-2.35	-0.0472***	-3.46
*K*t*	-0.0069	-0.32	-0.0175**	-2.05
*L*L/2*	0.1530	1.49	0.0429	1.63
*L*t*	0.0527*	1.83	0.0148	1.28
*t*t/2*	-0.0050	-0.22	0.0214*	1.83
Intercept	1.4908***	8.19	1.5790***	17.53
SCALE	-0.2474***	-8.52	-0.3052***	-19.12
FORsh	-0.0005	-0.72	-0.0004	-0.90
HHI	0.0002***	4.92	0.0000	0.89
Avgwage	-0.0039	-0.95	-0.0001	-0.04
VI	-0.7665**	-2.19	-1.1230***	-10.07
X/Q	0.0155	0.18	-0.1073**	-2.53
σ^2	0.2212***	10.43	0.2824***	21.10
γ	0.5234***	3.30	0.5534***	11.58
Log-likelihood	-191.349		-894.570	
LR test one-sided error	106.096		387.327	
Observations	306		1242	

Notes: ***, ** and * denote significance at 1%, 5% and 10% at levels, respectively.
Vertical (ordinary) traders refer to cross-sections with a majority of *VTQ* measure greater than or equal to 0.9 (< 0.9).
Source: Own estimation based on the panel data used in the study.

NOTES

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[1] Athukorala (2003) acknowledged that this phenomenon has also been labelled in the literature as “vertical specialization” (Hummels et al., 1998 and 2001), “slicing up the value chain”, “outsourcing” (Grossman and Helpman, 2005), etc.

[2] Veradi and Wagner (2010) discuss the effects of outliers on estimations using the linear fixed effects panel data models.

[3] There were 260 establishments in the initial panel but 2 establishments had changing 5-digit MSIC classification over the study period and thus deleted from the study.

[4] In the Yasar and Paul (2007) study, importing refer to the import of machine and equipment whereas in Seker (2009) and the current study, importing refer to the import of intermediate inputs.

[5] In Paul and Yasar (2009), firms in the Turkish textile and apparel plants can “offer” subcontracts for the production of inputs and at the same time “receive” subcontracts for the manufacture of output. Görg and Hanley (2005) contend that outsourcing of unskilled (skilled) labor fragments of production raises (reduces) productivity of the plant.

[6] Over the 6 year (2000-2005) study period, we compare the *VTQ* measure for each individual year. Establishments with $VTQ > 0.9$ a majority of times will be considered as vertical traders. In cases of a tie, the *VTQ* measure closer to 2005 will be used to classify establishments.