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Export Expansion and Production Sharing in Malaysian Manufacturing

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ABSTRACT

The rapid expansion of Malaysia's non-resource-based manufactured exports is closely related to its participation in international production networks that are largely mediated by multinational enterprises. This study examines the extent of the Malaysian manufacturing industry participating in international production sharing and the role of intermediate imports in production sharing exports. Intermediate imports are embedded in a standard gravity equation model of bilateral exports as essential complementary inputs for international production sharing. The data is based on OECD STAN database and models estimated using dynamic panel system generalized method of moment technique to account for the dynamic process of bilateral exports and endogeneity issues. The findings show evidence of non-resource-based industry's participation in international production sharing as supported by the positive and significant impact of intermediate imports. Malaysia's resource-based industry involves bilateral exports based on the Heckscher-Ohlin model as evidenced by the positive and significant impact of differences in relative per capita income between countries..

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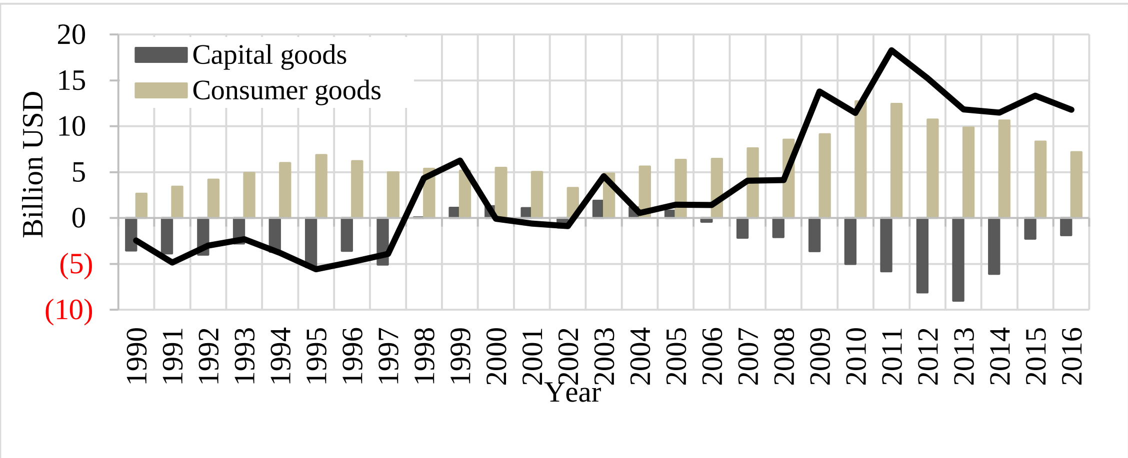
INTRODUCTION

International production sharing accelerates bilateral trade flows between countries as parts and components are being transported for modular production process in different countries; this is known as vertical specialization (Hummels et al., 2001). As a result, export values of manufactured goods are at least being double counted due to the embodiment of foreign inputs in exports, failing to imply export competitiveness of a country (Johnson, 2014; Koopman et al., 2014). The evolution of information and communication technology as well as the declining trade and transport costs diminished cross-border costs and magnified global production networks (Yi, 2003).

The rapid expansion of East Asian vertical specialization trade, intra-ASEAN trade and North-South intra-industry trade were accompanied by the East Asian developing countries' unilateral tariffs reduction and favorable investment policies, riding on foreign direct investment (FDI)-led international production sharing linked industrialization[1] (Baldwin and Lopez-Gonzalez, 2015). Baldwin and Okubo (2014) characterized the complexity of FDI motive based on sales and input sourcing as opposed to Carr et al. (2001). Moreover, a lower trade cost makes FDI more footloose as it encourages the relocation of production facilities from a small economy to a large economy, resulting in home market magnification effect (Baldwin, 2006).

In 2014, Malaysia's manufactured exports expanded at least nine times higher from a low US 21 billion dollars in 1990 and moved in tandem with its total imports over the period of 1990 to 2016, drawing on the calculations based on OECD STAN database (OECD, 2017). Moreover, about two-third of manufactured products was traded in intermediate inputs. Figure 1 shows the trend of Malaysian manufactured net exports by end-use category over the period of 1990 to 2016. Net exports in intermediate goods expanded steadily since 2004, becoming the largest contributor to the Malaysian manufactured exports over the period of 2009 to 2016. In addition, Malaysia recorded net manufactured exports in consumer goods over the years, while net imports in capital goods occurred most of the years. This has seemingly implied the important role of intermediate trade in the Malaysian manufacturing industry.



Source: Authors' calculation based on OECD STAN database.

Figure 1 Net Manufactured Exports in Malaysia by End-use Category

This study aims to examine the extent of Malaysian manufacturing industry participating in international production sharing and specifically, the role of intermediate imports in production sharing exports based on the gravity equation model in Bergstrand and Egger (2007). To allow for comparisons, Malaysia's manufactured exports are classified based on the type of inputs used for similar industries, namely resource-based and non-resource-based industries. As conventional exports data are measured in gross output value, using exporting country's gross domestic product (GDP) as a proxy of production capacity in a gravity

[1] Industrialized countries locate their labor-intensive production facilities in low-wage developing countries and resulting in low-wage developing countries becoming the exporters of high-technology manufactured products via high reliance on imported firm specific assets from industrialized countries, which form a North-South production network (Baldwin and Lopez-Gonzalez, 2015).

model can be mis-specified when dealing with international production sharing[2] (Baldwin and Taglioni, 2013). Moreover, trade in intermediate goods reflects firms' outsourcing activities and multinational enterprises' intra-firm trade between countries (Bergstrand and Egger, 2010). In view of the scarcity of data on intermediate trade at firm level, OECD STAN database is applied in this study which emphasizes international flows of intermediate inputs by country-pair and industry level[3]**.** Dynamic panel system generalized method of moment (SYS-GMM) technique is applied in this study to account for the dynamic process of bilateral exports as well as issues of autocorrelation, heteroskedasticity and endogeneity which appeared in static panel estimation.

This paper is organized as follows: A literature review on production sharing and trade-based gravity equation model is presented in the following section, followed by a section on the specification of gravity equation model of bilateral exports associated with production sharing, data and methodology applied in this study. In the subsequent section, regression results obtained from SYS-GMM estimation are reported and discussed. Key inferences of the findings are summarized in the final section.

Production Sharing and The Gravity Model

The term 'production sharing' (or 'vertical specialization') refers to the disintegration of production processes across different borders where at least one country must use imported inputs to perform sequential stages of a production process for exports (Hummels et al., 2001). The key difference between vertical specialization trade and trade in intermediate goods is the import content of exports (Hummels et al., 2001). Baldwin and Lopez-Gonzalez (2015) indicated the embodiment of firm-specific assets in imported inputs as essential, but that developing countries will not benefit from 'knowledge transfer' when participating in the labor-intensive stage of a production network. Moreover, the high reliance on imported inputs weakens the effect of real exchange rates on exports (Jongwanich, 2010; Nordås, 2008) as exporter's currency depreciation increases the price of imported inputs but decreases the price of exports, making exports being less responsive to exchange rate changes. A marginal reduction in service-link costs will lower production costs and magnify vertical specialization trade as goods-in-process crosses multiple borders multiple times over an entire production process (Yi, 2003). The effect will be intensified by technological breakthrough into different modular production processes across different borders (Hummels et al., 2001; Jones and Kierzkowski, 2005).

The gravity equation model has been widely used in empirical research on the bilateral trade flows of commodities between trading countries. Tinbergen (1962) was the first to apply the model to international trade flows based on the idea of Newton's Law of Gravitation. The standard gravity model is positively related to the national income of each trading country, and negatively related to bilateral trade barriers between countries relative to multilateral trade resistance[4] (Anderson and van Wincoop, 2003; Bergstrand and Egger, 2013). As the effect of multilateral trade resistance between small countries is less than that between large countries, a bilateral tariffs reduction will enhance bilateral trade flow between small countries more than that between large countries (Anderson and van Wincoop, 2003). To avoid omitted variable bias (endogeneity issue), country-pair and time-specific fixed effect were used to capture unobserved multilateral trade resistance using static panel fixed effect estimator (Bergstrand and Egger, 2013; Head and Mayer, 2014). However, the panel fixed effect technique raises the issues of autocorrelation and heteroscedasticity, which can be solved using micro panel SYS-GMM technique (Roodman, 2009a). Hanson and Xiang (2004) showed that large countries can be a net exporter of goods traded riding on high transport costs and strong scale economies. With moderate high transport costs, the relocation of industry from a small country is weaker when located nearby large neighboring countries. However, a lower trade cost will intensify vertical specialization, making the relocation of industry more footloose due to home market effect (Baldwin, 2006).

Various studies on the determinants of vertical specialization trade were carried out in the late-2000s and which emphasized the role of imported inputs in production sharing exports between countries at the industry level. For example, Nordås (2008) used vertical specialization share of exports[5] and export share of

[2] As trade is measured in gross sales value and GDP is measured in value added, the bilateral exports between trading countries depend on the gross output values i.e. sum of value added (GDP) plus costs of inputs (including imported inputs) of exporting country (Baldwin and Taglioni, 2013) where imported inputs are important components for vertical specialization trade.
[3] Service-link costs include communication, co-ordination and transportation costs (Jones and Kierzkowski, 2005).
[4] Multilateral trade resistance refers to each trading country's average trade resistance with other trading countries.
[5] Vertical specialization index in Nordås (2008) is calculated based on the formula developed by Hummels *et al.* (2001).

output to examine the essence of infrastructure and governance in international production networks, while Jongwanich (2010) applied the "general to specific" modelling procedure[6] to emphasize the increasingly important role of parts-and-components exports. Markusen and Venables (2007) showed that declining trade and transport costs facilitate countries with moderate factor endowments to fragment their production activities across different countries and accelerate trade in parts and components. Egger and Egger (2005) showed market size as a less important factor for processing trade among developed EU-12 economies, but Awokuse et al. (2012) revealed its importance for the exports of United States' affiliates. Baldwin and Okubo (2014) characterized the behavior of FDI as networked FDI, where foreign affiliates sourced substantial imported inputs to produce exported output either from the parent country or the rest of the world, and extended home-host country's linkage to a third country in a complex production sharing network.

MODEL SPECIFICATION, DATA AND ESTIMATION METHOD

This study aims to emphasize the important role of intermediate imports in production sharing exports by which imported intermediate goods are essential complementary inputs for modular production process, where the resulting output – as intermediate inputs or final goods – is exported back to the partner country. The current study classified the Malaysian manufacturing industry into resource-based and non-resource-based industries for comparison purpose[7]. Bergstrand and Egger (2007) formulated a standard frictionless gravity equation of bilateral exports from country i to country j at year t (X_{ijt}) as follows:

$$X_{ijt} = Y_{it}Y_{jt}/Y_t^W \tag{1}$$

where $Y_i(Y_j)$ is GDP of country $i(j)$ and Y^W is world GDP. Alternatively, Bergstrand and Egger (2007) modified a standard gravity equation algebraically to aggregate economic sizes ($Y_i + Y_j$) and their similarities ($s_i s_j$) as follows:

$$X_{ijt} = (Y_{it} + Y_{jt})^2(s_{it}s_{jt})/Y_t^W \tag{2}$$

where $s_i = Y_i/(Y_i + Y_j)$ and similarly for country j. When countries i and j are similar in size ($s_i = s_j = 0.5$), $s_i s_j$ is at a maximum.

Equation (1) captures the impact of relative economic sizes of trading countries on bilateral exports, which is similar to the relation of bilateral exports to the aggregate and similar endowments of both trading countries in Equation (2). When dealing with vertical specialization, the production of exported goods not only rely on exporting country's GDP, but also intermediate imports contributed by value added (GDP) of importing country and third countries in the earlier modular production processes. As such, exporting country's GDP may not be a good proxy of production capacity of exported goods; hence, this study is based on gravity model in Equation (2).

Bergstrand and Egger (2007) included third country ($RowY_{ij}$) in the trade-based gravity equation model to 'complement' bilateral exports with respect to aggregate and similarity of trading countries' GDP. In the presence of a third country, the larger and more similar economic sizes of trading countries allow the coexistence of national firms and multinational enterprises, and increase bilateral exports of countries i and j[8].

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[6] The "general to specific" modelling procedure refers to the use of different exports categories, which are total merchandise exports, manufacturing exports, and exports of machinery and transport equipment (SITC 7), to examine the determinants of exports (Jongwanich, 2010).

[7] Resource-based industries are mostly owned by public institutions and local producers who employ simple production technology and domestic resources for their production activities, while non-resource-based industries are largely owned by multinational enterprises which usually access their parts and components as well as sophisticated production technology from their home countries for sequential production process (Alavi, 1999).

[8] In a two-country model, when GDP of country *j* is larger than GDP of country *i*, country *j*'s national firms will be replaced by country *i*'s multinational enterprises due to profit motives of multinational enterprises. This process will proceed until national firms are completely being replaced by multinational enterprises in country *j* when countries *i* and *j* reach similar sizes and decrease the bilateral exports; this contradicts the standard gravity model. In the presence of third country, country *i*'s multinational enterprises can invest in country *j* and/or third country; this allows national firms and multinational enterprises to coexist in country *j* when similarity of economic

As such, the bilateral exports of countries i and j are positively related to aggregate and similarity of economic sizes.

Imported intermediate goods applied in production implies intermediate outsourcing activities of unaffiliated firms and/or multinational enterprises' intra-firm trade whereby imported inputs are transported from country j to country i to perform sequential stages of a production network. To explain different trade theories, Bergstrand (1989) incorporated factor endowment (per capita income) variable to the gravity equation model. Drawing on Equation (2), the specification of production sharing-based gravity equation model of the bilateral exports is expressed in log-linear form in Equation (3) as follows:

$$X_{ijt}^{k} = \beta_0^k + \beta_1^k Inter.\, IM_{ijt}^{k} + \beta_2^k Diff\text{-}in\text{-}pCapY_{ijt} + \beta_3^k AggY_{ijt} + \beta_4^k SimY_{ijt} + \beta_5^k RowY_{ijt} + \beta_6^k Rel.\, REER_{ijt} + \beta_7^k Dist_{ij} + \beta_8^k B_{ij} + \beta_9^k Lang_{ij} + \epsilon_{ijt}^{k} \quad (3)$$

where X_{ij} denotes the bilateral exports from country i to country j; $Inter.\, IM_{ij}$ is the bilateral intermediate imports from country j to country i; $AggY_{ij}$ is the sum of trading countries' GDP; $SimY_{ij}$ is the similarity of GDP between countries i and j; $RowY_{ij}$ is the third country's GDP rather than aggregate GDP of countries i and j; $Diff\text{-}in\text{-}pCapY_{ij}$ is the difference in relative per capita income between countries; $Rel.\, REER_{ij}$ is the relative real effective exchange rate between Malaysia and country j; $Dist_{ij}$ is the bilateral distance between countries i and j; B_{ij} is a dummy variable of common border; and $Lang_{ij}$ is a dummy variable of common language. In addition, the subscript *ij* indicates country-pair between Malaysia and partner country j (ij = 1,…,92), subscript t indicates annual time period by three-year average (t = 1990,…,2016), and superscript k denotes resource-based (*RbI*) or non-resource-based (*non-RbI*) industry. The variables' construction and data description are summarized in Table 1.

Table 1 Variable and Data Source

Variables	Variable definition and construction	Data source
k	k denotes as type of manufactured products, which is resource-based (*RbI*) or non-resource-based (*non-RbI*) product.	
$\boldsymbol{X^k_{ij}}$	The volume of bilateral exports of k from Malaysia i to its partner country j, deflated by Malaysia's Producer Price Index (PPI) at 2010 price measured in thousand US dollar.	OECD STAN Database
$\boldsymbol{Inter.\, IM^k_{ij}}$	The volume of bilateral imports of k in the form of intermediate goods from Malaysia i to country j deflated by Malaysia's PPI at 2010 price measured in thousand US dollar.	OECD STAN Database
$\boldsymbol{Y_{i(j)}}$	Malaysia's (partner country j's) GDP at 2010 price measured in US dollar.	WDI
$\boldsymbol{RowY_{ij}}$	Third country's GDP rather than aggregate GDP of Malaysia and country j at 2010 price measured in US dollar, where $\boldsymbol{RowY_{ij}}=\mathbf{Y^w}-(\boldsymbol{Y_i}+\boldsymbol{Y_j})$ and $\mathbf{Y^w}$ is world GDP.	
$\boldsymbol{AggY_{ij}}$	The sum of exporter's and importer's GDP at 2010 price measured in US dollar, where $\boldsymbol{AggY_{ij}}=\boldsymbol{Y_i}+\boldsymbol{Y_j}$.	
$\boldsymbol{SimY_{ij}}$	Similarity in economic sizes of two trading countries, where $\boldsymbol{SimY_{ij}} = 1-[(\boldsymbol{Y_i}^2+\boldsymbol{Y_j}^2)/(\boldsymbol{Y_i}+\boldsymbol{Y_j})^2]$.	
$\boldsymbol{pCapY_{i(j)}}$	Exporter's (or Importer's) per capita GDP at 2010 price, where the country's GDP is divided by its population.	WDI
cont.		
$\boldsymbol{Diff\text{-}in\text{-}pCapY_{ij}}$	Differences in *pCapY* between countries is used as a proxy of differences in relative factors, where $\boldsymbol{Diff\text{-}in\text{-}pCapY_{ij}} = 1 + (\boldsymbol{pCapY_i}-\boldsymbol{pCapY_j})/(\boldsymbol{pCapY_i}+\boldsymbol{pCapY_j})$.	
$\boldsymbol{Rel.\, REER_{ij}}$	Relative real effective exchange rate index of Malaysia i to that of country j where *REER* refers to country $i(j)$'s currency against a weighted average of foreign currencies deflated by consumer price index at 2010=100.	WDI
$\boldsymbol{Dist_{ij}}$	Bilateral great-circle distance between major cities of Malaysia and its partner country j, taken as a proxy for cross-border costs.	CEPII
$\boldsymbol{B_{ij}}$	A binary dummy variable which takes the value 1 for the two countries that share a common land border and 0 otherwise.	CEPII
$\boldsymbol{Lang_{ij}}$	A binary dummy variable which takes the value 1 for the two countries that share a common language and 0 otherwise.	CEPII

Note: All variables are taken in logarithmic forms except for dummy variables. WDI denote World Development Indicators (World Bank, 2017).

sizes increases. Hence, the larger and more similar economic sizes of trading countries, the larger bilateral exports between countries (Bergstrand and Egger, 2007).

The bilateral production sharing exports is expected to have a positive function of intermediate imports when imported inputs are essential for modular production process, but a negative function when imported inputs are competing inputs to domestic resources for production process. To be consistent with the gravity equation model, coefficient estimates of aggregate and similar trading countries' GDP β_3 and β_4, are expected to have positive signs. The bilateral exports are expected to have a negative relationship with a third country's GDP, suggesting the larger economic sizes of the third country relative to the aggregate economic sizes of trading countries decrease the country-pair's bilateral exports. Difference in relative per capita GDP between countries i and j ($\textit{Diff-in-pCapY}_{ij}$) is applied as a proxy for the difference in relative factor endowment. To be consistent with the Heckscher-Ohlin model of trade theory, the coefficient estimate of β_2 is expected to be positive as the larger difference in relative per capita GDP increases bilateral exports between countries. Based on Carr *et al*. (2001), the larger difference in relative factors motivates resource-seeking multinational enterprises and increases bilateral exports between countries, while the more similar relative factors between countries encourages market-seeking multinational enterprises and decreases the bilateral exports. The difference in relative per capita income is formulated as follows:

$$\textit{Diff-in-pCapY}_{ij} = 1 + \frac{(pCapY_i - pCapY_j)}{(pCapY_i + pCapY_j)} \quad (4)$$

where $pCapY_i(pCapY_j)$ refers to Malaysia's (country j's) GDP per capita. The log of $\textit{Diff-in-pCapY}_{ij}$ is positive (negative) when Malaysia's per capita GDP is larger (smaller) than country j's, and equal to zero when per capita GDP between countries are identical. This equation is formulated based on the product quality differences index of Azhar and Elliott (2006), which distinguishes differences in relative per capita GDP of both countries by indicating the extent of relative per capita GDP of both trading countries. In this form, $\textit{Diff-in-pCapY}_{ij}$ maintains symmetry and proportionality in scaling and importantly, it is able to compare the variation in Malaysia's per capita GDP relative to its trading country's GDP across different countries and over a number of years[9]. Meanwhile Bergstrand and Egger (2007) applied the absolute value of the difference in log of the GDP per capita for Malaysia and its trading partner as a measure of trading countries' relative per capita GDP.

Real effective exchange rate of Malaysia relative to country j's real effective exchange rate ($\textit{Rel. REER}_{ij}$) measures Malaysia's international competitiveness against a partner country and the coefficient estimate of β_6 is expected to be negative. However, the role of $\textit{Rel. REER}_{ij}$ as a measure of export competitiveness diminishes when dealing with international production sharing and the coefficient estimate is expected to be insignificant. Geographical distance between Malaysia and country j measures transportation costs between countries and the relationship is expected to be negative. Common border and common language are expected to enhance bilateral exports between countries due to lower transaction costs; hence, the coefficient estimates of β_8 and β_9 are expected to be positive.

Dynamic Panel GMM Estimation

Dynamic panel data estimator is applied in this study to account for three common endogenous problems: unobserved time invariant country-pair specific behavior; presence of lagged-dependent variable; and possible occurrence of weakly exogenous variable (Bond, 2002). First-differenced generalized method of moment (Diff-GMM) developed by Arellano and Bond (1991), and system GMM (SYS-GMM) extended by Blundell and Bond (1998), work well with small time series data (T<10) and large cross-section data as increasing time series data will proliferate the number of instruments and weaken Hansen test of instrument validity (Roodman, 2009b). Moreover, GMM estimators are able to control time-invariant country-pair specific effects in the dynamic structure of the regression equation. A general specification of dynamic panel regression model is expressed as:

$$y_{ij,t} = \alpha y_{ij,t-1} + \beta x_{ij,t} + \mu_{ij} + \varepsilon_{ij,t} \quad (5)$$

[9] For details on the construction of differences in size index of the trading countries, see Azhar and Elliott (2006).

where $y_{ij,t}$ is the logarithm of the dependent variable; $x_{ij,t}$ is the set of explanatory variables (other than lagged-dependent variable) for which cross-sectional and time series data are collected; μ_{ij} is an unobserved country-pair specific effect; $\varepsilon_{ij,t}$ denotes random error term; and the subscripts ij and t represent country-pair and time period, respectively. A lagged dependent variable is included to allow for partial adjustment of bilateral exports towards its long run mean value. To remove country-pair specific effects, Arellano and Bond (1991) took the first difference of Equation (5) and expressed it in the form as:

$$\Delta y_{ij,t} = \alpha \Delta y_{ij,t-1} + \beta \Delta x_{ijt} + \Delta \varepsilon_{ij,t} \quad (6)$$

Potential endogenous problem as well as the correlation between lagged-dependent variable and error term can be eliminated using lagged-level of variables as instruments under the following moment condition:

$$E\left[y_{ij,t-s} \Delta \varepsilon_{ij,t}\right] = 0 \text{ for } s \geq 2; \; t = 3, \ldots, T \quad (7)$$

In the estimation process, lagged-dependent variable is assumed to be endogenous variable using moment condition in Equation (7) as instrument, while other explanatory variables are assumed to be strictly exogenous variables which are instrumented by their own. Diff-GMM estimator works well in a balanced panel because omitted data in an unbalanced panel will magnify the gap of first-differenced lagged-dependent variable (Roodman, 2009a). SYS-GMM estimator is preferred over Diff-GMM estimator as the lagged-dependent variable at level is often a weak instrument when it is highly persistent and closest to random walk, resulting in a finite sample bias (Arellano and Bond, 1991). In addition, first differencing will drop time-invariant explanatory variables such as geographical distance between countries, common border and common language from the model (Roodman, 2009a). SYS-GMM estimator combines the differenced regression in Equation (6) with the level regression in Equation (5) to generate a more consistent and efficient coefficient estimation as it uses a larger set of different instruments (Bond, 2002). The additional set of moment conditions for the second part of the system (regression in levels) is

$$E\left[\Delta y_{ij,t-s}(\mu_{ij} + \varepsilon_{ij,t})\right] = 0 \text{ for } s = 1 \quad (8)$$

Equation (8) indicates no correlation between lagged-differenced of dependent variable ($\Delta y_{ij,t-s}$) and country-pair specific fixed effect (μ_{ij}). The interaction between fixed effects and autoregressive process is governed by the coefficient estimate of lagged dependent variable (α); this will converge dependent variable toward long run mean value only if α is less than unity in absolute value (Roodman, 2009a; 2009b). Therefore, the possibility of violation in Equation (8) is trivial.

The consistency of GMM estimator depends on two specification tests: tests of first-order and second-order serial correlation in disturbances of differenced equation; and Hansen test of over-identification restrictions (Baltagi, 2013). To imply no second-order serial correlation in disturbances, the current study expects to reject the null hypothesis of first-order serial correlation (AR1) but not the second-order serial correlation (AR2). This study expects not to reject Hansen test of over-identification restriction to infer the validity of instruments used in estimation. Time dummies are included in the model to remove cross-sectional correlation among unobserved country-pair effects due to time-related shocks (Roodman, 2009a). Two-step estimator depends on estimates of differenced residuals to compute weight matrix which results in standard errors to be severely downward-biased (Bond, 2002). However, this issue was corrected by Windmeijer (2005) in a two-step estimation and reported by STATA program using *xtabond2* command (Roodman, 2009a), making two-step SYS-GMM estimator more efficient and robust than one-step estimator. The following dynamic panel gravity equation is performed in the empirical analysis. Equation (9) is an extension of Equation (3) which includes lagged dependent variable and time dummies in the model.

$$X_{ijt}^{k} = \beta_0^k + \phi^k X_{ij,t-1}^{k} + \beta_1^k \mathit{Inter.\,IM}_{ijt}^{k} + \beta_2^k \mathit{Diff\text{-}in\text{-}pCapY}_{ijt} + \beta_3^k \mathit{AggY}_{ijt} + \beta_4^k \mathit{SimY}_{ijt} + \beta_5^k \mathit{RowY}_{ijt} + \beta_6^k \mathit{Rel.\,REER}_{ijt} + \beta_7^k \mathit{Dist}_{ij} + \beta_8^k B_{ij} + \beta_9^k \mathit{Lang}_{ij} + \sum_{t=1}^{9} \tau_t T_t + \epsilon_{ijt}^{k} \quad (9)$$

Data Measurement and Sources

The overall sample has 148 partner countries (see Appendix Table A1) over a nine-time period coverage from 1990 to 2016[10]. However, data on real effective exchange rate only has 92 partner countries. For specifications which do not include real effective exchange rate variable, we use the full sample, but for specifications including real effective exchange rates variable, we use the smaller sample. The classification of country income group for the two samples is presented in Appendix Table A2. The results are not much influenced by the change in the sample size. OECD STAN database provides data on bilateral trade flows between Malaysia and country *j* by country and industry level, and by end-use categories. Resource-based and non-resource-based industries are classified based on Ministry of International Trade and Industry (2006) as shown in Table 2. The statistical summary in Table 3 shows an unbalanced panel data where the variation between country-pairs of each variable is more than 90% relative to its overall variation except for variables of a third country's GDP (17%) and relative real effective exchange rate between country-pairs (58%).

Table 2 Grouping of Resource-based and Non-resource-based Industry

Code	Description
Resource-based Manufacturing Industries	
D10T12	Food products, beverages and tobacco
D16	Wood and products of wood and cork, except furniture
D17T18	Paper and printing
D19T22	Chemicals, rubber, plastics and fuel products
D23	Other non-metallic mineral products
D31T32	Furniture, other manufacturing
Non-Resource-based Manufacturing Industries	
D13T15	Textiles, wearing apparel, leather and related products
D24T25	Basic metals and fabricated metal products, except machinery and equipment
D26T28	Machinery and equipment
D29T30	Transport equipment

Source: Authors' compilation based on MITI (2006) and OECD STAN database.

Table 3 Statistical Summary

Variable		Mean	Std. Dev.	Min	Max	Observations
$lnX^{Non\text{-}Rb}_{ijt}$	overall	9.452	3.184	-2.330	17.140	N = 1302
	between		3.009	3.295	16.669	n = 148
	within		1.108	1.118	14.044	T-bar = 8.797
lnX^{R}_{ijt}	overall	9.583	2.980	-2.030	16.300	N = 1302
	between		2.763	3.531	15.603	n = 148
	within		1.177	1.797	13.046	T-bar = 8.797
$lnInter.\ IM^{Non\text{-}Rb}_{ijt}$	overall	7.793	3.989	-5.340	16.550	N = 1221
	between		3.828	0.527	16.198	n = 148
	within		1.306	0.873	11.870	T-bar = 8.25
$lnInter.\ IM^{R}_{ijt}$	overall	7.841	3.566	-3.210	15.260	N = 1154
	between		3.435	-0.344	14.696	n = 148
	within		1.332	0.113	13.148	T-bar = 7.797
$lnDiff\text{-}in\text{-}pCapY_{ijt}$	overall	-0.043	0.675	-2.030	0.670	N = 1296
	between		0.672	-1.890	0.660	n = 147
	within		0.081	-0.628	0.482	T-bar = 8.816
$lnAggY_{ijt}$	overall	26.483	0.859	25.220	30.460	N = 1296
	between		0.775	25.930	30.203	n = 147
	within		0.360	25.325	27.545	T-bar = 8.816
$lnSimY_{ijt}$	overall	-2.592	1.165	-7.230	-1.390	N = 1296
	between		1.186	-7.202	-1.391	n = 147
	within		0.143	-3.337	-1.707	T-bar = 8.816
$lnRowY_{ijt}$	overall	31.612	0.224	31.000	31.950	N = 1296
	between					
Cont.			0.037	31.341	31.790	n = 147

[10] This panel data is a micro panel data with 148 cross-sectional data (N) and 27 annual time series data (T). To avoid proliferating with large number of moment conditions using dynamic SYS-GMM technique, the 27 annual time period is averaged by three-year to obtain a 9-time period (Roodman, 2009b). Alternatively, the number of instruments can be reduced by using only certain lags instead of all available lags for instruments (Roodman, 2009b).

Table 3 Cont.

Variable		Mean	Std. Dev.	Min	Max	Observations
	within		0.221	31.245	31.975	T-bar = 8.816
*ln**Rel. REER**$_{ijt}$*	overall	0.056	0.232	-1.000	1.160	N = 808
	between		0.135	-0.329	0.470	n = 92
	within		0.189	-0.734	0.805	T-bar = 8.783
*ln**Dist**$_{ij}$*	overall	9.022	0.661	5.750	9.890	N = 1332
	between		0.663	5.750	9.890	n = 148
	within		0.000	9.022	9.022	T = 9
***B**$_{ij}$*	overall	0.027	0.162	0.000	1.000	N = 1332
	between		0.163	0.000	1.000	n = 148
	within		0.000	0.027	0.027	T = 9
***Lang**$_{ij}$*	overall	0.047	0.212	0.000	1.000	N = 1332
	between		0.213	0.000	1.000	n = 148
	within		0.000	0.047	0.047	T = 9

EMPIRICAL RESULTS

Table 4 presents the regression results of bilateral exports of Malaysia's resource-based and non-resource-based industries in a two-country model using two-step dynamic panel SYS-GMM estimator and similar is for Table 5 in a three-country model. To compare the results of a two-country model in Table 4, the presence of a third country variable ($RowY_{ij}$) generally increases the impacts of all explanatory variables except the impact of lagged-exports variable. Regression results of models 1 and 3 in Tables 4 and 5 are based on bilateral exports of 92 partner countries while models 2 and 4 are based on 148 partner countries. The results in Tables 4 and 5 are consistent and conform the expected sign.

The estimated coefficient of lagged-exports is positive and significant at the 1% level for all manufactured exports with coefficient estimates of less than unity, indicating the dynamic process of bilateral manufactured exports towards the long run equilibrium value; this confirms the appropriate use of dynamic panel SYS-GMM estimator. Diagnostic tests reported in Table 5 suggest the appropriateness of GMM estimation. The Hansen tests do not reject the validity of over-identifying restrictions, concluding that the instruments are valid. The serial correlation tests do not reject the null hypothesis of no second order serial correlation, indicating no second-order correlation between lagged-dependent variable and cross-sectional county-pair fixed effects.

Table 4 Empirical Results of Malaysian Manufactured Exports in a Two-country Model

	Non-Resource-based Industry		***Resource-based Industry***	
Model	(1)	(2)	(3)	(4)
*ln**X**$^{k}_{ij\,t-1}$*	0.542***	0.459***	0.805***	0.791***
	(0.158)	(0.080)	(0.071)	(0.082)
*ln**Inter. IM**$^{k}_{ijt}$*	0.110**	0.087***	0.024	0.016
	(0.043)	(0.019)	(0.019)	(0.020)
*ln**Diff-in-pCapY**$_{ijt}$*	-0.016	-0.216	0.130***	0.128**
	(0.129)	(0.112)	(0.039)	(0.055)
*ln**AggY**$_{ijt}$*	0.678***	0.840***	0.261**	0.311**
	(0.233)	(0.154)	(0.113)	(0.142)
*ln**SimY**$_{ijt}$*	0.308***	0.432***	0.105**	0.124**
	(0.108)	(0.088)	(0.052)	(0.062)
*ln**Rel. REER**$_{ijt}$*	-0.257		-0.078	
	(0.179)		(0.116)	
*ln**Dist**$_{ij}$*	-0.400**	-0.582***	-0.332**	-0.302**
	(0.178)	(0.123)	(0.128)	(0.139)
***B**$_{ij}$*	-0.127	-0.196	-0.294**	-0.004
	(0.449)	(0.368)	(0.131)	(0.182)
***Lang**$_{ij}$*	0.330	0.409	-0.052	-0.095
	(0.313)	(0.325)	(0.045)	(0.125)
Hansen test	0.111	0.402	0.169	0.411
Diff-in-Hansen test	0.527	0.264	0.150	0.356
AR(2)	0.671	0.537	0.992	0.789
No. of obs.	636	1008	625	975
No. of country-pair	90	145	89	143
No. of instruments	41	48	49	48

Notes: (1) All models are estimated using two-step dynamic panel SYS-GMM estimation (Stata *xtabond2* command). (2) The definition of each variable is reported in Table 1. (3) The estimation is based on year 1990–2016 with three-year average. (4) Significant time dummies are included in the estimation, but are not reported here. (5) Outliers found in the sample data are excluded. (6) Figures in the parentheses are standard errors. (7) Figures for Hansen, Diff-in-Hansen and AR are ρ-values. (8) *** and ** indicate significance at the 1% and 5% levels, respectively.

Table 5 Empirical Results of Malaysian Manufactured Exports in a Three-country Model

	Non-Resource-based Industry		*Resource-based Industry*	
Model	(1)	(2)	(3)	(4)
$lnX^{k}_{ij\,t-1}$	0.213**	0.317***	0.754***	0.717***
	(0.099)	(0.078)	(0.076)	(0.113)
$ln\boldsymbol{Inter.\ IM}^{k}_{ijt}$	0.181***	0.108***	0.035	0.034
	(0.032)	(0.025)	(0.023)	(0.017)
$ln\boldsymbol{Diff\text{-}in\text{-}pCapY}_{ijt}$	-0.142	-0.257	0.157***	0.143**
	(0.154)	(0.133)	(0.045)	(0.058)
$ln\boldsymbol{AggY}_{ijt}$	1.167***	1.032***	0.307**	0.408**
	(0.181)	(0.142)	(0.128)	(0.203)
$ln\boldsymbol{SimY}_{ijt}$	0.544***	0.523***	0.165**	0.176**
	(0.106)	(0.073)	(0.064)	(0.082)
$ln\boldsymbol{RowY}_{ijt}$	-1.085***	-2.104***	-1.603***	-0.307**
	(0.224)	(0.300)	(0.219)	(0.126)
$ln\boldsymbol{Rel.\ REER}_{ijt}$	-0.440		-0.175	
	(0.230)		(0.151)	
$ln\boldsymbol{Dist}_{ij}$	-0.756***	-0.719***	-0.428***	-0.395**
	(0.187)	(0.142)	(0.145)	(0.198)
$\boldsymbol{B}_{ij}$	-0.160	0.014	-0.397**	-0.094
	(0.613)	(0.468)	(0.168)	(0.150)
$\boldsymbol{Lang}_{ij}$	0.525	0.326	-0.086	-0.047
	(0.375)	(0.470)	(0.059)	(0.122)
Hansen test	0.386	0.447	0.221	0.421
Diff-in-Hansen test	0.231	0.534	0.599	0.055
AR(2)	0.628	0.510	0.897	0.813
No. of obs.	638	1024	623	960
No. of country-pair	90	145	89	142
No. of instruments	38	48	42	47

Notes: (1) All models are estimated using two-step dynamic panel SYS-GMM estimation (Stata *xtabond2* command). (2) The definition of each variable is reported in Table 1. (3) The estimation is based on year 1990–2016 with three-year average. (4) Significant time dummies are included in the estimation, but are not reported here. (5) Outliers found in the sample data are excluded. (6) Figures in the parentheses are standard errors. (7) Figures for Hansen, Diff-in-Hansen and AR are ρ-values. (8) *** and ** indicate significance at the 1% and 5% levels, respectively.

The results in Tables 4 and 5 show that difference in relative per capita income is insignificant for non-resource-based bilateral exports, but positive and significant for resource-based exports at the 5% level. The impact of intermediate imports on non-resource-based exports is positive and significant at the 5% level, but insignificant for resource-based exports. These results suggest that Malaysia's bilateral resource-based exports follow the Heckscher-Ohlin model of trade theory, whereby there is no much reliance on intermediate imports and the larger difference in relative per capita income increases bilateral exports due to the availability of natural resources. On the other hand, intermediate imports are essential complementary inputs for the bilateral exports of Malaysian non-resource-based industry, implying its participation in international production sharing. The insignificant coefficient estimate of difference in relative factor suggests the complexity of multinational enterprises' behavior as described in Baldwin and Okubo (2014).

The results in Tables 4 and 5 show the positive and significant impact of aggregate and similar trading countries' economic sizes on the bilateral exports of non-resource-based industry at the 1% level, while their impacts on the bilateral exports of resource-based industry are significant at the 5% level. The coefficient estimate of aggregate economic sizes is about twice larger than the estimate of similar economic sizes, in line with gravity model in Equation (2). In addition, the coefficient estimates of aggregate and similar economic sizes for non-resource-based exports are about three times higher than the estimates of resource-based exports, implying the importance of aggregate and similar economic sizes for production sharing exports. The results in Table 5 show the negative and significant impact of a third country's GDP on the bilateral manufactured exports at the 1% level of significance with the coefficient estimates of more than unity, implying the intense competition faced by the Malaysian manufacturing industry in the global market.

The geographical distance between countries has negative and significant impact on the bilateral exports of both resource-based and non-resource-based industries, implying the significance of transportation costs on the bilateral exports. Based on the regression results in Table 5, non-resource-based exports are more responsive to the bilateral distance between countries than the responsiveness of resource-based exports, implying the importance of transportation costs for production sharing exports. Relative real effective exchange rate between countries, bilateral common border and common language are insignificant for the bilateral exports for all Malaysian manufacturing industries except for the impact of common border on the

Malaysian resource-based exports being negative and significant at the 5% level using the 92 trading country data. The negative impact of common border on the Malaysian resource-based exports implies resource-based products as being homogenous to its neighbouring countries and decrease bilateral exports.

CONCLUSION

This study examines the extent of Malaysian manufacturing industries participation in international production sharing and the role of intermediate imports in the production sharing exports using panel data of 92 and 148 partner countries over the period of 1990 to 2016. The results provide evidence of Malaysian non-resource-based industry's participation in international production sharing-based bilateral exports as supported by the positive and significant coefficient of intermediate imports. This implies that outsourcing and processing trade activities and multinational enterprises' intra-firm trade motivate bilateral production sharing exports. On a different note, the bilateral exports of resource-based industry follow the Heckscher-Ohlin model of trade theory as supported by the positive and significant impact of difference in relative factors and insignificant impact of intermediate imports, suggesting Malaysia's competitiveness in resource-based exports due to the availability of natural resources. Moreover, the negative and significant impact of common border suggests resource-based products as being homogeneous to and enhances competition among its neighboring countries. The conclusion is valid using two-step dynamic panel SYS-GMM estimator as it accounts for the dynamic process of bilateral exports and manages to control time-invariant country-pair specific effects. This study performs a robustness check with different coverage of trading country-pairs and a comparison between two-country and three-country models.

Based on production sharing gravity equation model of bilateral manufactured exports, the results show the distinguished features of resource-based and non-resource-based manufacturing industries in Malaysia. Resource-based industry uses domestic resources instead of foreign inputs for producing exported goods, while non-resource-based industry employs foreign inputs or goods-in-process to perform modular production process largely facilitated by multinational enterprises. As such, the embodiment of foreign inputs in non-resource-based exports accelerates the bilateral export values due to multiple border-crossings, which fail to reflect the industry's export competitiveness in the global market. However, international production network allows a developing country to participate in modular production process of non-resource-based manufacturing activities. The Malaysian government should encourage the development of non-resource-based industry dealing with higher value added modular production processes and continue to advance the export competitiveness of the resource-based industry.

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