PATTERNS AND DETERMINANTS OF INTRA-INDUSTRY TRADE IN SOUTHEAST ASIA: EVIDENCE FROM THE AUTOMOTIVE AND ELECTRICAL APPLIENCES SECTORS

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Using finely disaggregated data at six-digit harmonized code classification level, this paper examines the patterns and determinants of horizontal and vertical intra-industry trade in the automobile and electrical appliances sectors during the past few decades among the six major Southeast Asian countries. It is found from the analysis of the data that intra-industry trade is much higher than the inter-industry trade in each of these two sectors. Further, the determinants of these two types of trade are found to differ somewhat in terms of sign and magnitude across the sectors, implying the importance of sector-specific factors as influences on the pattern of trade.

Key Words: Intra-industry trade, Gravity model, Southeast Asia

JEL Classifications: F12, F14, O53

1. Introduction:

A notable development observed during the past few decades, especially starting from the 1980s, is that the conventional one-way trade in final goods has to a large extent

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been replaced. Instead, there is parts and components trade (also known as vertical intra-industry trade or product fragmentation or outsourcing), where instead of the whole commodity a portion of it is imported or exported on cost consideration. Also, there is trade in differentiated products (also known as horizontal intra-industry trade), where different varieties of the product within the same industry are exported or imported. This new pattern of trade is happening throughout the world, and Southeast Asia is far ahead in this development (Authukorala and Yamashita, 2006).

The rapid export growth in the Southeast Asia region is particularly attributed to the rise of intra-industry trade in the automotive and electrical appliances sectors (Lall et al. 2004). The automobile and electrical appliances sectors are important parts of the manufacturing sector, which have attracted a large amount of foreign direct investment. European and American automobile producers are, for example, shifting their production bases toward the emerging market economies of East Asian countries among others (Turkcan, 2011) to take locational advantages and to ensure timely delivery of parts and components. Both the automobile and electrical appliance sectors have been subjected to substantial amounts of intra-industry trade during the past few decades (Athukorala 2006), and hence deserve special attention for analysis.

To facilitate intra-regional trade, member states of the Association of the Southeast Asian Nations (ASEAN) agreed in 2008 to make the regional forum a legal entity and convert it into a European Community (EC) style ASEAN economic community (AEC) by December 2015. Primarily 9 sectors, including the automobile and the electrical sectors, were identified for special attention. Once the program is fully implemented, intra-industry trade within the region will gain momentum through free cross-border movement of resources and increased amounts of foreign direct investment.

From a policy perspective, globalization through intra-industry trade is more convenient than through the traditional inter-industry trade. Economic liberalization through inter-industry trade means expansion of some industries at the expense of others. Hence, the associated adjustment cost is substantial and political opposition to the reform program is often strong. Liberalization of intra-industry trade, on the contrary, yields benefits by flourishing the same industry in both countries. Firms in this case can shift resources internally with minimal retraining costs and without losing substantial amounts of firm-specific skills of the displaced workers.

Intra-industry trade is a common form of trade among the industrialized and the newly industrialized economies. Of late, globalization has enabled many other developing countries to participate in the intra-industry trade. Menon (1996) shows that intra-industry trade is rising faster among the ASEAN countries compared to the intra-industry trade between the ASEAN countries and the rest of the world. Convergence of income among the members, increasing importance of manufacturing items in total trade, and the regionalization of production structure are important factors behind the increasing trade among the ASEAN members.

This changing pattern of intra-industry trade is more pronounced in the electrical machinery sector. Only 5 per cent of total trade in this sector was intra-regional in 1991 which has gradually increased to 31 per cent in 2012. ASEAN countries have thus reduced dependence on the rest of the world in the electrical machinery sector. For the automotive sector, however, total trade within the region remains steady and below 30 per cent during the past two decades. The trend of the percentage share of total trade in the electrical and automotive sectors of the ASEAN countries within the region and with the rest of the world (ROW) are shown in Figure A3 in the appendix.

Automobile and electrical appliances are two core manufacturing sectors in the Southeast Asia region and in some segments of these two broadly defined sectors this region is a global leader. For example, more than 80 per cent of the world's hard drives are made from this region. [2] From the country perspective, Thailand has developed strong production base in the air-conditioning and refrigerator segment of the market, while the Philippines has attracted many top class international investors, including Texas Investments and Philips, in the hard drive and semi-conductor industries.

There is dynamism of production re-structuring within the region. Malaysia is moving up the value chain by incurring research and development expenditure and outsourcing activities. This type of production adjustment has shifted the labor-intensive part of the production to other less developed member countries like Vietnam and Indonesia. Structural change within the value chain and regional cooperation imply the rising importance of intra-industry trade in electronics and electrical appliances sectors in Southeast Asia, and make it an interesting case for study.

The rest of the paper is organized as follows. Section 2 discusses some selected literature relevant to this paper. Section 3 describes the data, data sources, and the conceptual framework for classifying trade into various categories. Section 4 presents the relative importance of various types of trade in the automobile and electrical appliances sectors in Southeast Asia during the past two decades. Section 5 explains the determinants of various types of trade in each of these sectors with a standard gravity model and, finally, Section 6 concludes.

[2] http://investasean.asean.org/index.php/page/view/electronics (accessed on March 23, 2015)

2. Review of Related Literature

Intra-industry trade is attributed to several factors. From a theoretical perspective, Balassa and Bauwens (1988) emphasize the role of scale economies as a source of intra-industry trade. They argue that in the absence of scale economy all countries could potentially produce all varieties of goods. Helpman and Krugman (1985) utilize an imperfect market structure to explain the existence of intra-industry trade, while Davis (1995) combines the Heckscher-Ohlin model with the Ricardo model to explain intra-industry trade within the perfectly competitive market and constant returns to scale framework. In particular, Davis (1995) shows that when countries differ in terms of technology, a significant amount of intra-industry trade can take place, even though these countries have similar factor endowments.

A part of the intra-industry trade literature is concerned with the international division of the supply chain in commodity production. Instead of producing the whole commodity in a single country, the relevant production line is segmented into several parts depending on skill, technology and factor requirements, and then countries engage in back and forth trade in intermediate inputs until the final product is assembled.

Zeddies (2011) examines the evidence of parts and components trade in a major portion of the manufacturing sector (SITC groups 7 and 8 that cover 70 per cent of manufacturing trade) among 15 European countries using a fixed-effect method on a panel dataset comprising four distinct years, 1999, 2002, 2005 and 2008. Both country-specific and industry-specific explanatory variables are employed and it is found that parts and components trade between the European countries increases with the average size of industrial output of the trading partners. Differences in labour productivity between the trading partners do not have any significant effect on the

parts and components trade, implying the irrelevance of the Ricardian approach in explaining intra-industry trade. Though distance is an important factor for parts and component trade, especially for heavy items like automobile parts, it is left out of the analysis because of the fixed-effect estimation strategy.

Authokorala and Yamashita (2006) examine fragmentation trade in various regions of the world and find that this type of trade is rising faster than the trade in final goods and services. Southeast Asia region is far ahead of the other regions in the fragmentation trade. Low adjustment costs, regional preferences, and availability of required skills with competitive wage have fostered a vibrant intra-regional trade in parts and components in the Southeast Asia region. This intra-regional trade expansion has been accompanied by extra-regional trade creation in final goods and services. This finding points toward a symbiotic relationship between regional and global trade liberalization. Increased trade in parts and components through regional trade liberalization requires market access opportunity in other regions in final goods through global trade liberalization.

The case of relative importance of fragmentation trade in East Asia and Europe is analysed in Kimura et al. (2007). In this study 60 traded items within the SITC commodity code 7, 82, 87, 88, and 89 are identified as parts and components trade for the machinery and transport sectors. The rest of the commodities within these classes are considered as traditional inter-industry trade in final goods. During the period 1987 to 2003 parts and components trade grew faster in the East Asia region (334%) compared to the EU region (194%). The rising amount of intra-industry trade is attributed to location advantage (e.g. agglomeration effects) and reduced costs of the services link between production blocs across neighbouring countries.

Cortinhas (2007) examines the relationship between the intensity of intra-industry trade and synchronization of business cycles in the ASEAN region. Using all reported four-digit SITC trade data during the period 1962-1996, this study finds a positive correlation between intra-industry trade and business cycle synchronization. Similar findings are found in Song and Sohn (2012), but in a broader country coverage including ASEAN and six other East Asian countries. In case of inter-industry trade, trading partners specialize along different lines of production. Recession or boom that arise from demand shock in selected sectors affect inter-industry trade differently in different countries depending on their specialization pattern, and policy responses of the trading partners are also different. Specialization in various components within the same sector, a feature of intra-industry trade, makes business cycle synchronous. They are pulled together by external shocks. Thus expansion of the intra-industry trade means trading partners are likely to expand and contract together making harmonious policy response or closer economic cooperation (such as currency union) more desirable.

Sawer et al. (2010) examine the determinants of intra-industry trade in ten SITC sectors among 22 countries from Central, East, Southeast, and South Asia for the year 2003. Intra-industry trades for these ten sectors are measured by a variant of the Grubel-Lloyed index. The study finds that the level of intra-industry trade is higher for countries that have higher incomes, larger share of manufacturing sectors, and more open economies. However, geographic distance and differences in economic sizes of the trading partners have negative effects on the level of intra-industry trade.

Examination of the current literature shows that the determinants of intra-industry trade analysed in the context of the ASEAN countries do not differentiate

between the horizontal and vertical components of the intra-industry trade. Depending on the trade types, the importance of the determinants of trade might differ. Jones et al. (2005), for example, argue that the gravity model related variables like GDP and distance have much stronger impact on the parts and components trade than on final goods trade. The contribution of the current paper is to identify the extent of intra-industry trade and inter-industry trade in the automobile and electrical appliances sectors among the six major Southeast Asian countries and examine the trends and determinants of various types of trade flows within these sectors over the past two decades. Further, intra-industry trade is decomposed into vertical intra-industry trade (parts and components) and horizontal intra-industry trade (differentiated products) to see whether there are differences across these types of trade in trends and determinants.

3. Data and Conceptual Framework

Choosing a low level of aggregation is crucial in identifying intra-industry trade. At the coarse level (e.g. Harmonized System (HS) two-digit level), all sectors might artificially look like they engage in intra-industry trade. Thus, highly disaggregated export and import values of commodities at six-digit HS level for the automotive and electrical machinery sectors (under HS85 and HS87 class, respectively) are used in this study. The data are obtained from the United Nations COMTRADE database. Unit values of these commodities are calculated by dividing the total values by their respective quantities.[3] Export values are expressed on free on board (f.o.b.) basis and import values are on cost, insurance, and freight (c.i.f.) basis, so the former are multiplied by 1.05 (as assumed in Ando, 2006) to generate equivalent values.

[3] Some items that do not have quantity information in the data are excluded from the analysis.

The sample period is from 1991 to 2012 and the values are for total bilateral trade flows (i.e., export plus import) among the six major ASEAN members: Indonesia, Malaysia, Singapore, Philippines, Thailand and Vietnam. These six countries accounted for around 96 per cent of the total ASEAN GDP in 2012. A list of all 10 ASEAN members, their date of joining, and GDP information is provided in Table A1 in the Appendix.

Trade flows of a country are initially classified into inter-industry trade (INTER) and intra-industry trade. The latter is then further divided into horizontal intra-industry trade (HIIT) and vertical intra-industry trade (VIIT) depending on the unit value difference between exports and imports in the same product category. Commodities that fall under the HIIT intrinsically serve the same purpose, but with different attributes (e.g., automobiles of different makes). VIIT commodities are differentiated by their qualities and technology content of the product as reflected in their per unit value (intermediate products have lower value per unit).

Following Ando (2006), we consider trade in commodity k between country i and j is the inter-industry type if condition (1) is satisfied,

$$\frac{Min(X_{ijk}, M_{ijk})}{Max(X_{ijk}, M_{ijk})} \leq 0.01 \tag{1}$$

where X_{ijk} is the export of commodity k from country i to country j, and M_{ijk} is the import of commodity k into country i from country j. Commodities that do not fulfill the above criterion fall into one of the two intra-industry trade categories. Trades are considered HIIT if unit value of exports and imports fall within the range given by equation (2),

$$\frac{1}{(1+\alpha)} \leq \frac{P_{ijk}^{X}}{P_{ijk}^{M}} \leq (1+\alpha) \tag{2}$$

where P_{ijk}^{X} and P_{ijk}^{M} are unit values of commodity k charged on exports from country i to country j, and imports into the country i from partner j, respectively. Here α is assumed at 0.25. Trade in commodities that fall outside the range indicated in both equation (1) and equation (2) is classified in the VIIT category.

4. Intra-industry Trade in Automobile and Electric Machinery Sectors in Southeast Asia

Automobile or electrical machinery plants require markets for their products as well as a low-cost resource base to operate competitively. Southeast Asia is in an advantageous position from this perspective. The economies of this region are growing at fast rates and have a combined market of 600 million people. Low cost of operation and ready availability of skilled labor at competitive wages attract international investors in this region. Also, the current outward foreign direct investment policies of China, thanks to the huge trade surplus that is putting upward pressure on her currency, are encouraging many Chinese firms to invest in the Southeast Asia region. Between 2011 and 2013, investment in Southeast Asia from China has increased from $0.12 billion to $5.9 billion (Hong, 2013).

In a broader context, Asian countries are gradually shifting their export oriented economic activities from the primary to the manufacturing sector. In 2006-7 manufacturing exports accounted for 92 per cent of all exports in Asia, primarily driven by a surge in the export of the information and communication technology (ICT) and electrical products (Athukorala, 2011). This particular production pattern results in part from the involvement of Japan and China in the production fragmentation and network trade.

Japan is using the Southeast Asia region as a low-cost production base to supply to that region as well as the outside world. In case of China, final assemblies of

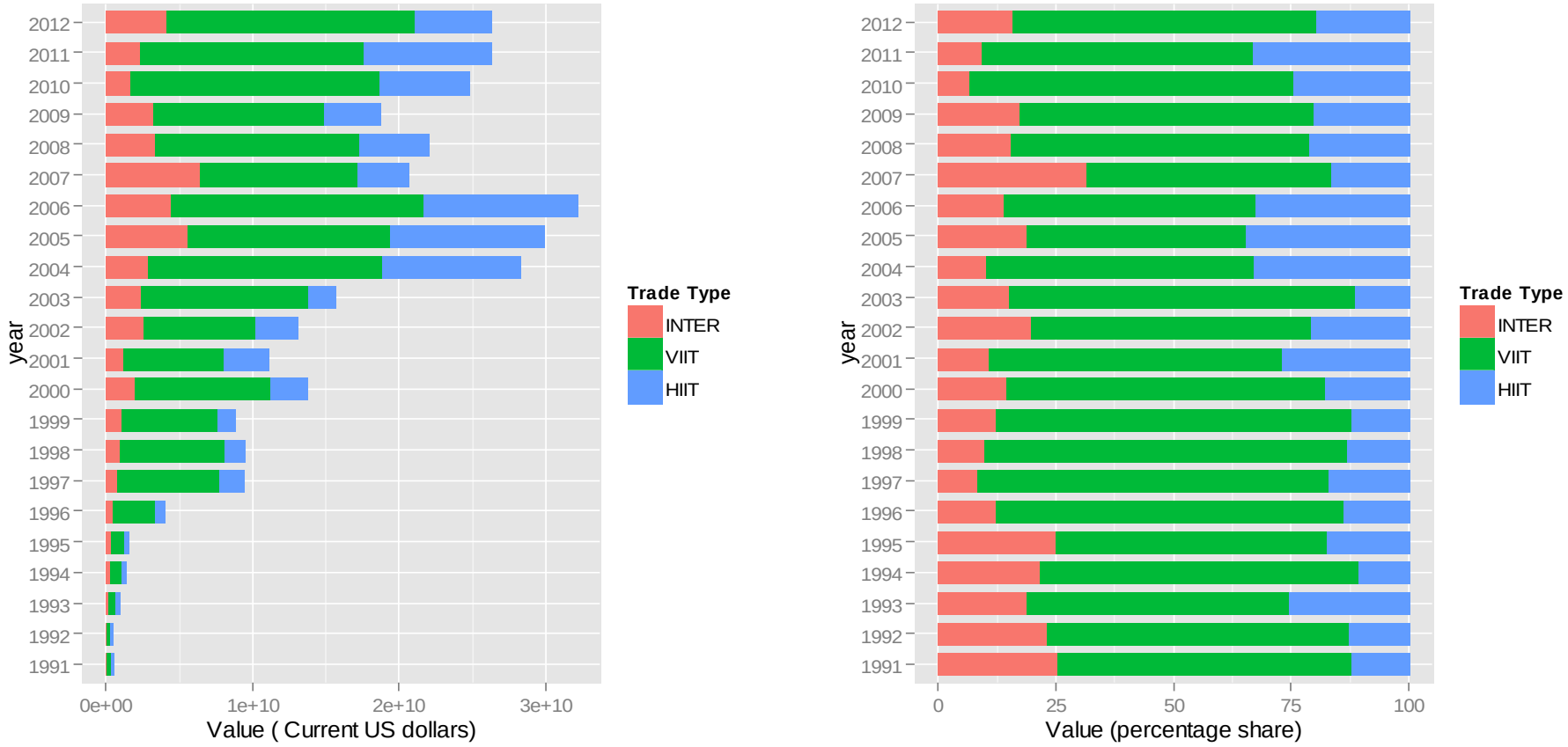
various high-tech electronic products and automobiles have been accelerated, especially from the early nineties. Parts and components required for these assembly lines are often sourced from the Southeast Asia region. A symbiotic relationship between regionalism and globalization has emerged from this phenomenon. Asian economies are regionally integrated through their parts and component business, which in turn thrives on the demand for their final products from the outside region, especially in the developed countries.

The pattern of specialization around the world is, however, in a state of flux. Over the past two decades the nature of trade in automobile and electrical machinery sectors in the ASEAN region at the six-digit level has gone through substantial structural changes. The relative importance of inter-industry trade in these two sectors is less important than the horizontal and vertical intra-industry trade. The changing patterns of trade over the past two decades in these two sectors are shown separately in Figure 1.

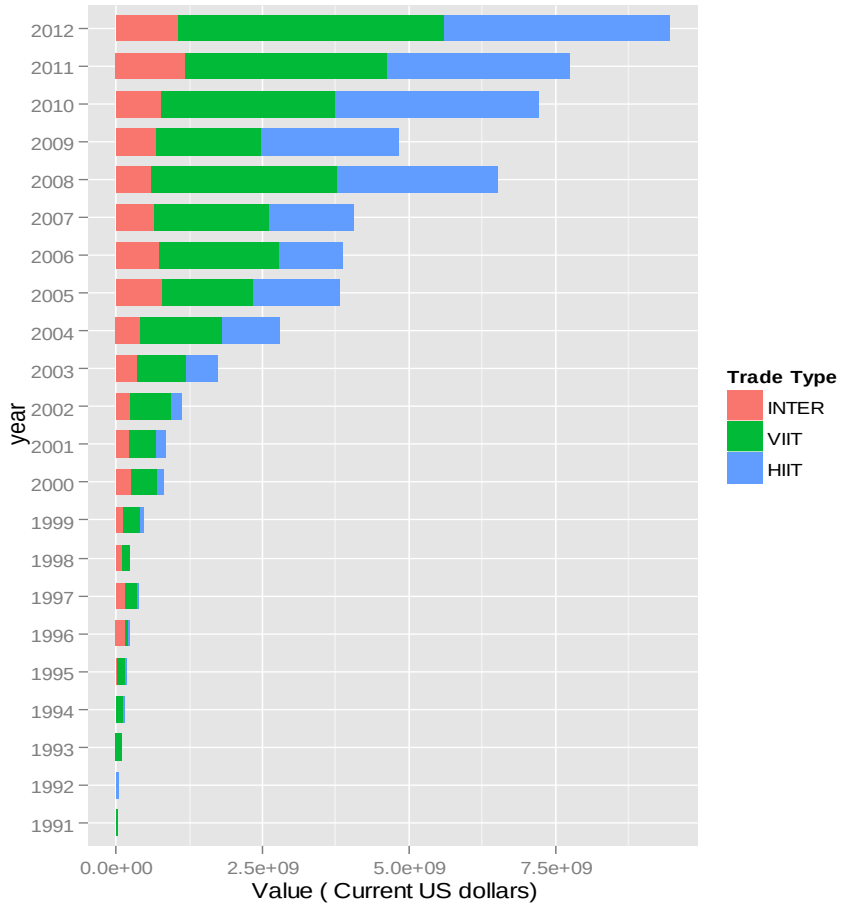
As can be seen from Figure 1, the amount of trade in each of these sectors within Southeast Asia has evolved differently and the responses to the global economic crisis for trade flow in these two sectors are also different. At the beginning the nineties, trade flow in these two sectors within Southeast Asia was only few million US dollars. In the mid-nineties trade in the automobile sector grew rapidly and surpassed the billion-dollar mark. Trade in the electrical machinery sector gained momentum near the end of last century. In 2008 the total amount of trade in the electrical machinery sector reached 6 billion dollars. After a dip in in 2009, trade flow in the electrical machinery sector continued to grow and reached near 8 billion dollars in 2012.

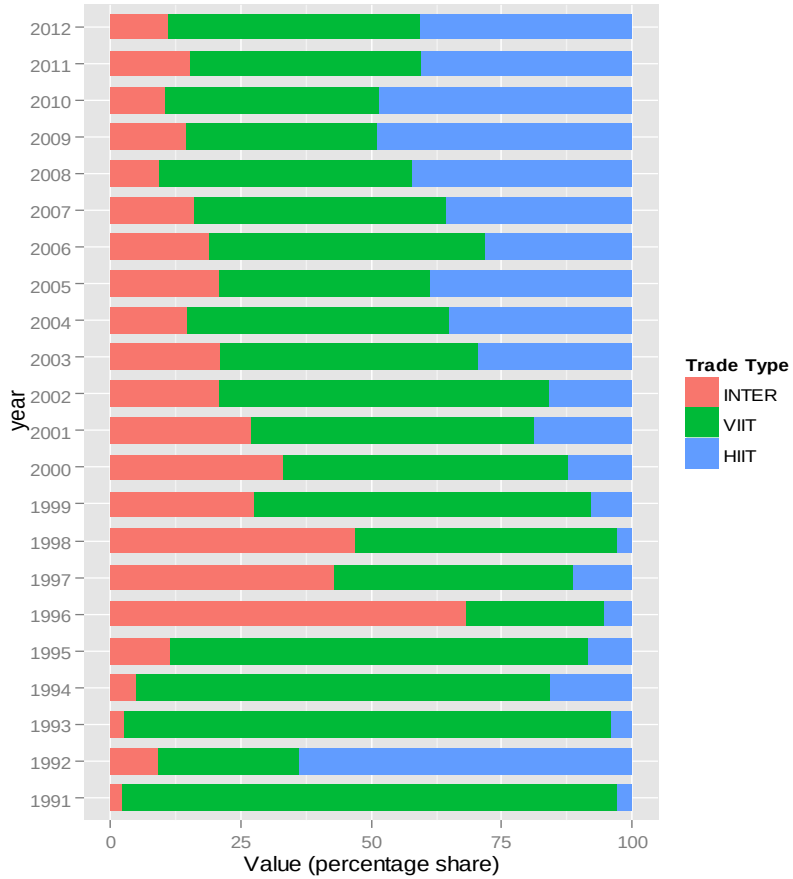
In terms of the compositional change (right-hand part of Figure 2a and 2b) trade in the electrical machinery sector is more erratic. Vertical intra-industry trade, for example, is the dominant form of trade in1991, and between 1993 and 1995, but in 1992 and in 1996 the dominant form of trade consists respectively of the horizontal intra-industry and the inter-industry type. For the automobile sector, vertical intra-industry trade is more or less dominant throughout the sample period.

Figure 1: Relative Importance of Inter-industry, Horizontal and Vertical Intra-industry Trade in the Automobile and Electric Machinery Sectors in Southeast Asia (1991-2012)



(a) Automobile Sector





(b) Electrical Machinery Sector

5. Explaining Various Types of Trade Flows with the Gravity Model

The gravity model is the most widely used approach in analysing empirical bilateral trade-flow data. In its simplest form, the model states that the amount of trade between two countries depends directly on their economic sizes and inversely on the geographical distance between them. Usually the model is extended to include other variables that act as barriers to trade or promote trade (see for detail Islam, et al. 2014). The version of the model employed in this study includes GDP of the exporters and importers, per capita GDP differences of the trading partners, distance, and a measure of income similarity between the trading partners as well as dummy variables for the Asian financial crisis and the global financial crisis. More specifically, the proposed model is:

$$\log(X_{ijt}) = \beta_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{jt}) + \beta_3 \Delta \mid PGDP_{ijt} \mid + \beta_4 \log(D_{ij}) + \beta_5 \log(S_{ijt}) + \beta_6 AFC_t + \beta_7 GFC_t + \varepsilon_{ijt} \quad (3)$$

where X_{ijt} is the amount of total trade between the reporter (indexed by i) and the partner (indexed by j) countries in time period t. The distance between the trading partners and their income similarity are indicated by D_{ij} and S_{ijt}, respectively. The distance measure is in kilometre between the capital cities of the trading partners and obtained from the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) website, www.cepii.fr/../distance.htm. The GDP values, measured in current US dollars, are from the World Development Indicators.

The income similarity index is calculated as the product of relative income shares of the two trading partners, i.e., S_{ijt} = (GDP_{it} / (GDP_{it} + GDP_{jt}) * (GDP_{jt} / (GDP_{it} + GDP_{jt}). This type of index for comparing GDP similarity between two

countries is suggested in Feenstra (2004).[4] The index varies from 0 for perfect dissimilarity to 0.25 for perfect similarity. $\Delta|PGDP_{ijt}|$ is the absolute difference in per capita GDPs of the trading partners, introduced to capture the effect on trade flows of different factor endowment status of the trading partners. Two dummies, AFC_t and GFC_t, control for the effect of the Asian financial crisis (year 1998) and the global financial crisis (year 2009) on bilateral trade among the ASEAN members. The observation specific idiosyncratic error term, ε_{ijt}, is provisionally assumed to follow the standard independently and identically distributed normal distribution, but the validity of this assumption is tested and appropriate methods to deal with rejection of the test are adopted.

Covariates in equation (3) are expected to affect various types of trade flows in different ways. Higher GDPs, for example, affect inter-industry and overall trade through market size. Changes in GDP, however, closely follow changes in per capita GDP and the latter affects intra-industry trade by changing the demand for variety. Similar movements in per capita and total GDP series can be conjectured by noting that total GDP is a composite of per capita GDP and population. For most of the countries, population grows at steady rates while the per capita GDP series fluctuates depending on economic conditions. This causes GDP and per capita GDP to follow similar patterns. Yet, differences in per capita GDP are considered a proxy for different factor endowments (Kimura et al. 2007, and Turkcan, 2011) and, hence, provide a greater opportunity for vertical intra-industry trade.

In estimating equation (3), initially two additional gravity model related variables, common border and common language, are included. These two variables

[4] An alternative suggested by Baltagi et al. (2003), Sij = [1 – (Yi/(Yi+Yj))^2 –(Yj/(Yi+Yj))^2], which varies between 0 and 0.5, is also applied. The results, which are very close, are available from the authors.

appear to create multi-collinearity problems with other variables of the model. Examination of the variance inflation factor (VIF) reported in Table 1, indeed, reveals these two as the offending variables. Relatively high values of VIFs for the three variables in the initial model, namely the common border, common language and distance, suggest that the multi-colinearity problem arises from linear combinations among these variables.

Table 1: Variance Inflation Factors (VIF) of the Model Variables

	$\log(GDP_i * GDP_j)$	$\log(D_{ij})$	$\log(S_{ij})$	$\Delta PGDP_{ijt}$	AFC	GFC	CB	CL
Initial Model	1.65	4.86	1.76	2.81	1.08	1.06	3.57	3.50
Final Model	1.39	1.30	1.25	1.50	1.08	1.05	--	--

Note: Excluding common border and common language improves the VIF of other variables in the model (notably for the log of distance variable).

Support for incorporating trade-flow specific fixed effects in the model is found from an F-test on two competing models. Comparison of the models, with and without trade-flow specific fixed effects (alternative and null model, respectively), yields a p-value of less than 0.001, which means that we have strong statistical support for retaining fixed effects in the model. Thus, the results reported below include 15 trade-flow specific dummies, one for each pair of trading partners.

Two additional concerns with our estimated models are the possibilities of group wise heteroskedasticity in the fixed-effect model and panel serial correlation. A model with group specific effect has error components that are serially correlated by definition. The presence of time invariant error component creates serial correlation that does not die out over time. Thus, standard tests of serial correlation applied to pooled data tend to reject the null hypothesis of spherical errors (Wooldridge, 2002).

The standard Breusch-Pagan-Godfrey and Wooldridge test for serial correlation yields a p-value of less than 0.05 in our models implying the presence of serial correlation. Similarly, the Breusch-Pagan heteroskedasticity test applied in the context of the fixed-effect models produce p-values of less than 0.05, confirming the presence of heteroskedasticity in these models. Because of violation of these two assumptions, heteroskedasticity and autocorrelation corrected robust standard errors were examined, but the conclusion about the parameter significance remained the same. This is probably because we have used bootstrapped confidence interval that takes into account the distributional shapes.

In each year, there are many commodity-specific trade flows at the six-digit level classification for both the automobile and the electrical machinery sectors. These individual trade flows are aggregated into horizontal intra-industry, vertical intra-industry, and inter-industry trade in accordance with the rules described in Section 3. Thus, we have a total of three trade-flow equations for each of the two sectors, for which results are reported in Table 2. The table also includes an additional regression equation for total trade in each sector, which is used to evaluate the acceptability of imposing the restriction of uniform coefficients across the trade types.

Normality of the model residuals is an important element in drawing valid conclusion about the estimated parameters. The bottom part of Table 2 reports quartile values of residuals for all the models. In case of normally distributed errors, the median of the distribution should be close to zero and the second and the third quartiles will be roughly placed equidistance from the median. Examination of these residual quartile values and the probability density plots reported in Figure A2 in the Appendix suggest that in most of the cases these residuals are not normally distributed. We therefore rely on bootstrap confidence intervals (based on 2000

replications) for evaluating the statistical validity of the estimated parameters. The 95 per cent confidence intervals for each of the estimated parameters are reported below the respective estimated values in Table 2. Estimates that are significantly different from zero based on these confidence intervals are marked by a double asterisks sign.

The results in Table 2 indicate that the basic gravity model related variables are of expected sign and statistically significant. The combined economic size of the trading partners has positive impact on bilateral trade flows and the effect is stronger in case of either horizontal and vertical intra-industry trade than in the case of either overall trade or inter-industry trade. In the automotive sector, the GDP elasticity of trade flow is about 1.3 for intra-industry (both vertical and horizontal) trade and 0.98 for inter-industry trade. For overall trade, the average GDP elasticity of trade for automotive products is 1.17, a value in between the inter-industry and intra-industry trade elasticities.

Table 2: Determinants of Trade Flows in the Automobile and Electrical Machinery Sector in Southeast Asia

Explanatory Variables	Automotive Sector (Model / Response Variable)				Electrical Machinery Sector (Model / Response Variable)			
	Model (1a) HIIT	Model (1b) VIIT	Model (1c) INTER	Model (1d) ALL	Model (2a) HIIT	Model (2b) VIIT	Model (2c) INTER	Model (2d) ALL
Constant	20.020	15.411	39.788**	20.891	-130.564**	35.016	57.304	-7.322
	[-14.95; 58.30]	[-15.78; 47.28]	[-15.04; 55.57]	[-14.47; 56.41]	[-208.51; -62.12]	[-10.53; 69.16]	[20.94; 98.88]	[-52.44; 30.41]
$\log(GDP_i \times GDP_j)$	1.386**	1.315**	0.989**	1.177**	1.732**	1.672**	1.212**	1.402**
	[1.11; 1.68]	[1.11; 1.50]	[1.10; 1.66]	[1.11; 1.68]	[1.17; 2.13]	[1.44; 1.93]	[0.85; 1.40]	[1.17; 1.61]
$\log(D_{ij})$	-9.432**	-8.458**	-9.841**	-8.379**	6.892	-13.135**	-14.381**	-6.920**
	[-15.09; -4.78]	[-13.24; -4.35]	[-14.63; -4.71]	[-14.74; -4.57]	[-3.14; 17.69]	[-17.82; -7.48]	[-19.65; -9.13]	[-12.34; -0.47]
$\log(S_{ij})$	4.826**	3.232**	2.409**	2.952**	-5.184**	7.112**	-1.500	-0.133
	[1.67; 7.84]	[1.51; 5.17]	[1.36; 7.57]	[1.32; 7.69]	[-8.26; -0.11]	[4.60; 10.25]	[-5.24; 1.35]	[-2.21; 2.47]
$\Delta \mid PGDP \mid$	-0.054	-0.067**	-0.060	-0.062	-0.057	-0.104**	-0.070**	-0.070**
	[-0.11; 0.004]	[-0.09; -0.03]	[-0.113; 0.001]	[-0.114; 0.002]	[-0.112; 0.018]	[-0.14; -0.05]	[-0.129; -0008]	[-0.107;-0.034]
AFC_t	0.229	0.481	0.587	0.438	-1.008	0.097	0.315	0.059
	[-0.97; 1.16]	[-0.28; 1.60]	[-1.02; 1.17]	[-0.95; 1.24]	[-2.62; 1.06]	[-0.46; 0.74]	[-1.74; 2.58]	[-0.95; 0.86]
GFC_t	-0.262	-0.258	0.075	-0.142	0.493	-0.183	0.068	0.165
	[-0.97; 0.48]	[-0.74; 0.24]	[-0.98; 0.51]	[-0.93; 0.50]	[-0.17; 1.25]	[-0.60; 0.39]	[-1.02; 0.68]	[-0.33; 0.57]
Residual quartiles								
Q1	-0.748	-0.561	-0.767	-0.923	-0.904	-0.604	-0.970	-1.094
Q2	0.198	-0.012	0.058	0.120	0.265	0.096	0.169	0.445
Q3	0.901	0.709	0.779	1.067	1.266	0.858	0.964	1.385
Multiple R^2	0.65	0.80	0.53	0.49	0.58	0.67	0.46	0.39
Observations	264	287	255	808	200	247	216	665

*Notes: ** indicates that estimates are within 95 percent confidence interval that excludes zero. Values inside brackets under the coefficient estimates are lower and upper limit of this interval. HIIT, VIIT, INTER, ALL indicate horizontal intra- industry trade, vertical intra-industry trade, inter-industry trade, and overall trade in the automobile and electrical machinery sectors, respectively. Trade flow specific dummies are not reported to conserve space.*

The pattern of coefficients for combined GDP is similar for the electrical machinery sector, though with somewhat higher values. Rising GDP allows firms to produce at a lower per unit cost by exploiting scale economy, which increases trade flows in general. Higher income also raises the demand for variety, which creates additional horizontal intra-industry trade flows.

The distance coefficients are negative and are of almost equal magnitude for all trade types in the automotive sector. In case of the electrical machinery sector, distance does not play a role for horizontal intra-industry trade among the Southeast Asian countries. However, for vertical intra-industry trade, distance appears as an important factor for determining trade flows, with a coefficient of -13.14 that is statistically significant. Distance is also a negative and statistically significant deterrent to inter-industry trade, so when overall trade is considered, we get a significant negative role of distance for electrical machinery.

The importance of distance in vertical intra-industry trade in the automotive and electrical machinery sectors means that geographically proximate countries stand to gain more, compared to the geographically distant countries, by placing themselves in the international supply chain. This result may also indicate that the cost of establishing services links, an essential element of vertical intra-industry trade, is lower in the automotive and electrical machinery sectors for closer countries. In a vertically integrated production structure, commodities have to cross international borders several times and, thus, benefit from lower transportation costs is associated with nearby location. A similar argument holds for inter-industry trade, which is generally in the form of trade of raw materials for intermediate or finished consumer goods from a different industry sector. Notably, the coefficients for distance in the inter-industry trade regressions for both the automotive and electrical machinery

sectors are of similar magnitude and statistical significance to that of the corresponding vertical intra-industry trade regression.

The estimated coefficients of the income similarity index are positive for all trade types in the automobile sector, suggesting that countries of similar size trade more with each other in the automobile related items. The response rate of trade flows in the horizontal and vertical intra-industry trade regressions for the automobile sector is around 4.8 and 3.2, respectively. The coefficient is slightly lower at 2.4 for inter-industry trade in this sector. Similarity of incomes raises trade among countries in general. However, as similar income countries are considered to possess similar factor endowment, they especially engage in horizontal intra-industry trade and to a lesser extent in vertical intra-industry and inter-industry trade.

In the electrical machinery sector the pattern of coefficients for the similarity index is more complex than in the automotive sector. The overall trade response to the similarity index is insignificant, but this hides two opposing significant effects of similarity on vertical and horizontal intra-industry trade.[5] This pattern suggests that when countries are more similar their intra-industry trade is more heavily of the vertical, rather than horizontal, variety. Substantial economies of scale might encourage the specialization of production at a particular location at each stage of the production process, even though there is substantial participation of both trading partners in the production chain when the countries have similar GDP. Likewise, substantial economies of scale might result in concentration of final assembly of products in a single country inside or outside of ASEAN.

[5] An important point to note about all these similarity coefficients is that they are greater than the GDP coefficients. This implies that similar countries not only trade more (or less in case of negative response) with each other, but also that their trade share as a portion of GDP is higher (lower for negative response) than less similar income countries.

The negative coefficients of the $\Delta|PGD|$ variable lend support to the hypothesis that intra-industry trade among countries with similar level of development is relatively higher. However, the effect is statistically significant only for vertical intra-industry trade, suggesting that similar development (and hence similar skill bases in the labour force) impacts more strongly on the vertical integration of production processes across countries than it impacts on trade in finished goods. Interestingly, there is also a significant negative coefficient for inter-industry trade in the electrical machinery sector, which might reflect the particular pattern of natural resource endowments in ASEAN countries. The per capita GDP difference is measured here in hundreds of dollars, and so the estimated (negative) coefficient of this variable indicates that for each hundred dollar less difference in per capita GDP among the trading partners, bilateral trade rises by about 5 per cent to 10 per cent depending on trade type. None of the estimates of the coefficients of the trade crises dummies are statistically significant, suggesting weak impacts of the crises on the trade flows between ASEAN countries.

To further check whether these results are influenced by the choice of sample period, all the models are run again with the sample period restricted to the period from 2005 to 2012.[6] This experiment produced significant negative signs for the GFC coefficients in all the models in Table 2. Thus, it seems that the global financial crisis has a clear negative effect on trade flows compared to the contiguous years, but not compared to the periods in the early nineties.

[6] Intra-regional trade flows in these two sectors are shown in Figure 1 to have been substantially lower in the 1990s compared to the recent years, which may be the reason for the GFC coefficients appearing with insignificant and mixed signs.

6. Conclusion

Intra-industry trade is spreading in many parts of the world and Southeast Asia is ahead of other regions in this process. Technological innovations, the emergence of modular production processes and reductions in services link costs have created a particularly favourable environment for intra-industry trade in Southeast Asia. Our analysis shows that inter-industry trade is relatively a small portion of total trade in the automobile and electrical appliances sectors among the Southeast Asian countries and most of the trade flows are of the intra-industry type, either vertical or horizontal.

The importance of various factors in determining these three types of trade flow is investigated using a standard gravity model. The results show that the economic size of the trading partners affects all types of trade flow positively, while distance affects all types negatively. However, the intensity of the effects differs depending on the trade type. The effect of combined GDP is somewhat stronger for both types of intra-industry trade than for inter-industry trade in each sector. The deterrent effect of distance is much stronger for vertical intra-industry trade and inter-industry trade than for horizontal intra-industry trade in the electrical machinery sector, but roughly equal across trade types in the automotive sector.

GDP similarity of the partners positively affects trade flows across all types in the automotive industry, but is significantly positive only for the vertical intra-industry trade type in electrical machinery. For GDP per capita differences, the dominant finding is that vertical intra-industry trade declines when there is a difference in the level of development as reflected in GDP per capita. Finally, only weak adverse effects of financial crises are identified, except when the sample is restricted to only a few years around the Global Financial Crisis.

Overall, the results suggest that intra-industry trade is promoted among ASEAN members by the size of their GDPs, their geographic closeness, the similarity in their aggregate GDP and a similar level of their GDP per capita. These findings suggest that economic integration among the ASEAN countries combined with geographic proximity and similar economic size and level of development has brought strong intra-industry trade across differentiated product varieties and along the supply chain within the manufacturing sectors studied.

There is also some indirect evidence of the importance of economies of scale. This finding is consistent with the large-scale production structure of heavy manufacturing industries where fixed-cost accounts for a significant amount of total cost. Existence of scale economy suggests that economic policies of the Southeast Asian countries should favour the expansion of the existing plants in the automobile and the electrical appliances sectors instead of allowing establishing new firms. The choice of variety for the consumers can be met from imports. Finally, the automobile and the electrical machineries considered in this study are only two key elements of the overall manufacturing sectors. No doubt, further research is required to examine if the results obtained in this study equally apply to other economic sectors or geographic regions.

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APPENDIX

Table A1: List of ASEAN Members

Country	Country Code	Year of Membership	GDP in 2012 (billion US dollars)	GDP per capita in 2012 (billion US dollars)
Malaysia	MYS	1967	305.03	10432
Philippines	PHL	1967	250.18	2587
Singapore	SGP	1967	274.70	51709
Thailand	THA	1967	365.97	5480
Brunei	BRN	1984	16.95	41127
Laos	LAO	1997	9.42	1417
Myanmar[1]	MMR	1997	59.43	915
Vietnam	VNM	1995	155.82	1755
Cambodia	KHM	1999	14.04	944
Indonesia	IDN	1967	878.04	3557

[1] Figures are for the year 2013

Figure A1: GDP Trends of the Six Major ASEAN Economies (1991-2012)

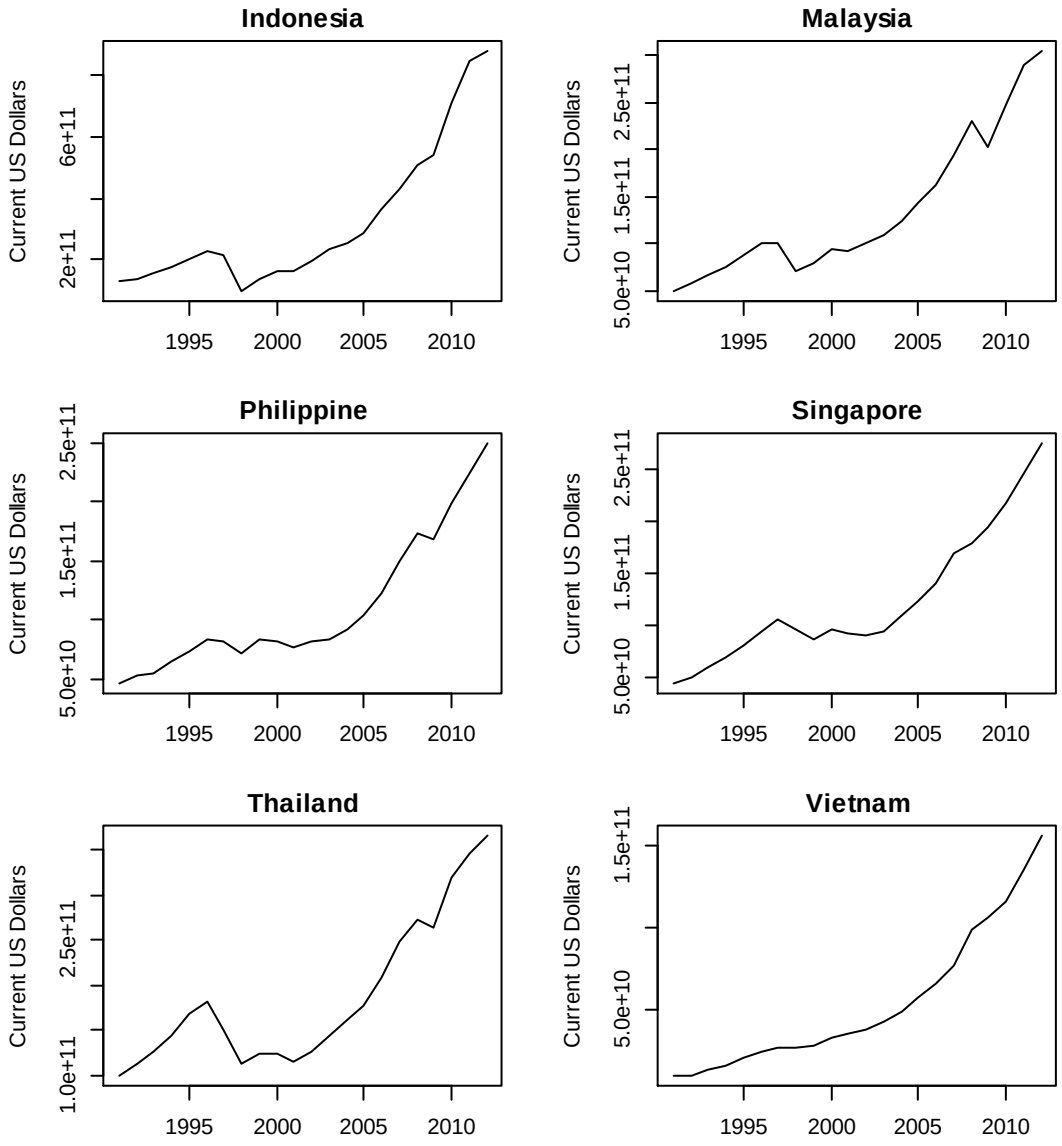

Figure A2: Residual Plots of the Models

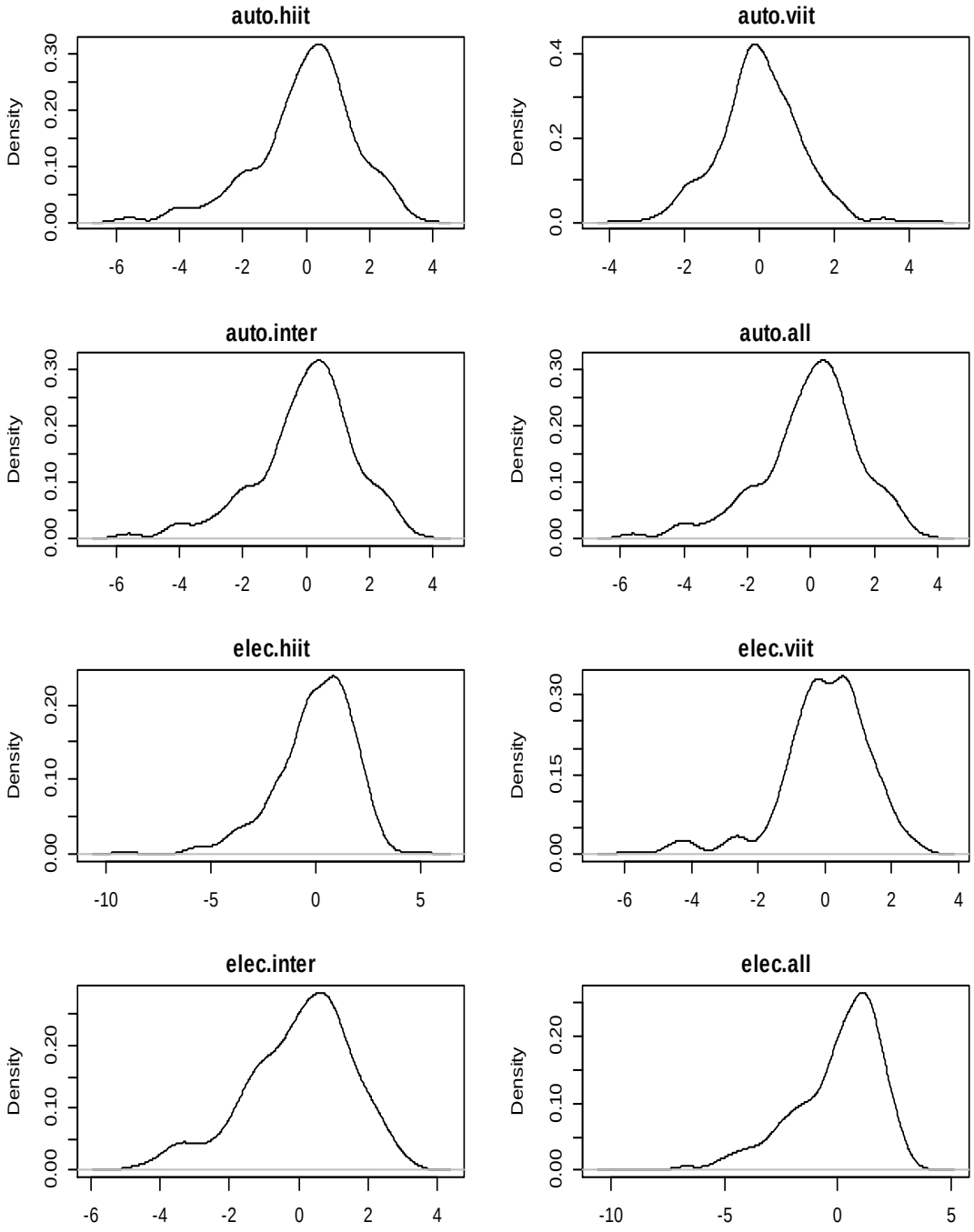

Figure A3: Percentage share of trade within ASEAN and with the ROW in the electrical machinery sector (top) and the automotive sector (bottom)