Global Production Sharing in Machinery and Transport Equipment Industry in the ASEAN4

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1 March 2015

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Abstract

The production network of machinery and transport equipment in the ASEAN4 countries is dominated by the automobile industry, and the way it connects to East Asia is particularly well documented. This paper aims to offer a divergent analysis on the posture of the industry, the trade pattern of time period region-based parts and components, and the model of determinants of this trade flow. The Trade Balance Index (TBI) is applied to reveal the pattern of this trade. A Panel Ordinary Least Square estimate is used as the gravity equation to deal with this trade flow in machinery and transport equipment (SITC 7) Rev. 3 which is decomposed into a 5-digit parts and components level. For the purpose of the analysis, only the ASEAN4 and East Asian countries, comprising of Thailand, Indonesia, Malaysia, the Philippines, Japan, South Korea, and China, are studied using data on parts and components for machinery and transport equipment from 1992 to 2012. This paper's conclusions show that the posture of the ASEAN4 machinery and transport equipment industry is supported by the vital participation of MNCs, especially of East Asian origin. In this trade pattern, the competitiveness of parts and components made in the ASEAN4 induces specialized dynamics as time goes by, notably from 1992 to 2012. It is also found that the determinants of the trade flow, such as the trade volume, real gross domestic products, logistics performance index, distance, and real effective exchange rate, remains varied among the ASEAN4 because of their different policies and orientations for trade.

Keywords: global production sharing, machinery and transport equipment, parts and components
JEL: F14,F15.

I. INTRODUCTION

Global production sharing sounds like a plausible idea, because it features opportunities for firms to relocate stages of the production process, notably for parts and components, to different countries depending on their relative cost advantages and other economic fundamentals. In the case of standard consumer goods such as clothing and footwear, global production sharing normally takes place through arm's length relationships, with international buyers playing a key role in linking producers and sellers in developed countries (Helleiner, 1973; Gereffi et al., 2005). In this case, the goods displayed in the shop window are the product of a long story of global production through multiple factories located in various countries. Indeed, due to its significance, it needs to be analyzed in detail.

International trade literature over the last few decades has offered an array of terminologies for this subject. Hummels, Rapoport and Yi (2001) and Irwin (2002) place this under the name of 'vertical specialization'. 'Slicing the value chain' comes from Krugman (1995). Several others seem to have similar concepts such as 'international production sharing' (Ng and Yeats 2001; Yeats 2001), 'product fragmentation' (Venables 1999; Jones, 2000; Baldwin 2001), and 'outsourcing' (Rangan and Lawrence 1999; Hanson, Raymond and Slaughter 2002). Following Drucker (1977), Athukorala and Menon (2010), Athukorala (2011), and others this paper will stick to the term of 'global production sharing'.

It shapes the behavior of multinational corporations (MNCs)[1] that apply this dispersion of component production/assembly within vertically integrated production processes. Helleiner (1973) reveals that during the early period, the processes normally involved a MNC building a subsidiary abroad to perform some of the functions that it once did at home. Over the years, MNCs' subsidiaries have begun to subcontract some of their activities to local (host-country) firms, for which they provide detailed specifications and even limited quantities of their own technology. Moreover, many MNCs have begun to rely increasingly on independent contract manufacturers for the operation of their global-scale production networks. This process has been facilitated by the standardization of some components and by advances in modular technology (Sturgeon 2003; Brown and Linden 2005). At the same time, many firms which are not part of the MNCs' networks have begun to procure components globally. Furthermore, it results in a steady growth of the trade in 'goods in process'[2] at a rate exceeding that of the trade in final goods, because parts cross the borders several times on average before the process is completed.

The practice of global production sharing made its initial start in the electronics and clothing industries in the late 1960s. It has spread to gradually include sports' footwear, televisions and radio receivers, sewing machines, office equipment, electrical machinery, power and machine tools, cameras and watches, printing and publishing and automobiles. The last mentioned has the highest production complexity within the machinery and transport equipment industry. It necessitates some of the most integrated manufacturing processes in the world, so it is worthy of further study. Moreover, the automobile industry is among the biggest in the world and employs more than 8 million people making the vehicles directly, and more than 40 million people indirectly, through its related manufacturing and services sectors (OICA, 2007). In principle, the automobile industry is an assembly industry, where more than a 1,000 parts and components are produced by independent industries.

Production networks for machinery and transport equipment in the ASEAN4 countries are dominated by the automobile industry. A car assembler usually deals with a large number of components, and a lot of them are subcontracted to component suppliers. Japanese car producers, for example, export engine parts to their affiliates in Thailand where they are assembled into engines using some other components procured from other countries in the region, such as Indonesia and Malaysia, and then exported back to Japan and other third-country markets.

(Table 1 is about here)

Table 1 shows the dynamics of car production and its world share. During the 1980s Japan showed a dramatic development in its automotive production with an almost 55 folds increase in production, and experienced 15% annual growth, which increased its share of global production. In the late 1990s, China started to enter into global automotive production with a relatively high level of production of more than 2 million units. Automotive production reached its highest annual growth during the period 1989-2000, with almost 5% growth per annum. However, in 2000, South Korea and Malaysia experienced higher growth compared to other countries.

(Table 2 is about here)

Table 2 shows the trade value of automobile parts and components. The world's auto parts trade increased significantly from US$170 billion in 1990 to almost US$700 billion in 2007, with an annual growth of 8.7% which reflected the higher intensity of global production networks in the automotive industry. The share in the world auto parts trade is around 21-23% for the period 1990-2007. Among East Asian countries, Japan, China and South Korea are the major players in the auto parts trade. Japan's role is declining over time with an export share of 18% in 1990-1994 dropping to 11% in 2000-2007, although it is still the largest exporter of auto parts in Asia. Meanwhile China's export share increased from a low of 1.2% in 2000 to more than 4% in 2007. Other countries in Asia which experienced an increase in export share are South Korea, Thailand and Indonesia. South Korea's share increased from 1.5% in 1990-1994 to more than 2.3% in 2007, while the increase in Thailand's and Indonesia's export shares were relatively modest.

On the import side, the East Asian countries' contribution of around 11% seems much lower than on the export side. Most of the ASEAN countries experienced a decline in import values in 2000 due to the depreciation of their currencies caused by the Asian financial crisis in 1997-1998, as this resulted in more expensive imported goods. In 2007, some ASEAN countries such as Thailand and Indonesia recovered from the Asian financial crisis and their imports of auto parts rose to be even higher than the 1995 level. Although in 2007 the import value increased to more than double the 1995 level, East Asian countries' import share was relatively constant at 11% of the world's auto parts imports.

An important feature of auto parts is that there are few fully generic parts and components which can be used in a wide variety of final products without extensive customization unlike in the electronics industry. This characteristic limits auto parts firms in reaching economies of scale in production and economies of scope in design. The relationship between auto parts suppliers and car assemblers is typically captive and relational. Many components are relatively heavy compared to those in the electronics industry therefore when parts/components require relocation to the next factory and production stage, it is preferable for that factory to be in close proximity than at a more distant location. This condition leads to agglomeration in the automotive industry.

Sturgeon, et al., (2008) argued that the dispersion of the automotive industry has a nested geographical and organizational structure. Global integration occurred through buyer-supplier relationships, especially between car makers and their largest suppliers. Production tends to be organized regionally or nationally, where suppliers of parts and components which are bulky and heavy tend to be located in close proximity to the assembler to ensure on-time delivery and to save transportation costs. Meanwhile smaller, lighter and standardized parts and components can be located at a distance to take advantage of lower labor cost and economies of scale. Vehicle development is concentrated in a few design centers. As a result, local, national and regional production networks in the automotive industry are nested within the global organizations and structures of the largest car maker firms. Mapping of the interaction between both parties involved in automobile part and component production sharing, East Asia as shown originally by Japan, then succeeded by South Korea and China, and their arms-length production bases in the ASEAN4 countries namely Thailand, Indonesia, Malaysia, and the Philippines should be interesting and is required to fill the gaps left by prior studies. They merely focused on either examining the causes and modalities of global production sharing and its implications for trade flow analysis and trade policy (Baldwin 2001; Cantwell 1994; Deardorff 2001; Jones 2000; Venables 1999) or on case studies of how multinational enterprises conformed to international production and trade patterns (Borrus 1997 and 1999; Crosby and Nakamori 1991; Dobson and Chia 1997; Naughton 1999; McKendrick, Doner and Haggards 2000).

Compared to these papers, the present chapter aims to offer a divergent analysis on both the trade pattern of time period region-based parts and components case and the model of determinants of trade flow. The approach employed here is essentially empirical by design, but the empirical analysis in carried out in the context of the existing body of theoretical literature, where the discussion on this new form of international specialization known as global production sharing is explored.

This paper changes from a general to a specific approach by setting the case of machinery and transport equipment first, before projecting embedded automobile parts and the component industry into the following discussion. Such an approach is taken as the automobile industry embraces the most integrated parts and components from the machinery and transport equipment industries in the region. To highlight a comprehensive way of delivering the idea, the rest of this paper is organized as follows. Part II shows the methodology. Part III presents the results and analysis. Part IV draws on the conclusions of the research and policy implication.

II. METHODOLOGY

A. Data

Estimates use the gravity equation to deal with the trade flow in machinery and transport equipment (SITC 7) Rev. 3[3] which is decomposed into a 5-digit parts and components level. The main data source is the UNCOMTRADE[4] database which is supported by WDI, CEPII, and BIS. For the purpose of the analysis, only the ASEAN4 and East Asian countries comprising of Thailand, Indonesia, Malaysia, the Philippines, Japan, South Korea, and China supplied the data of their parts and components in machinery and transport equipment from 1992 and 2012.

B. Model

In estimating a gravity equation using cross-country panel data, it is necessary to augment the original formulation by incorporating variables to capture inter-country heterogeneity as suggested by Athukorala and Nasir (2010). Thus, 4 control variables are added, guided by the standard practice in the recent literature on estimating cross-country trade equations.[5] These are the income of countries engaging in bilateral trade relations (GDP), an index of the quality of trade-related logistics (LPI), trade-weighted distance to major markets (DST), and the real effective exchange rate (REER).

After augmenting the basic model by adding a number of explanatory variables which were proposed by Atukorala (2010) to improve the explanatory power, the estimation equation is formed thus:

$$nT_{ijt} = \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnLPI_{it} + \beta_1 lnDST_{ijt} + \beta_5 lnREER_{ijt} + \varepsilon$$

where T symbolizes bilateral trade between country i referring to the reporting (exporting country) and country j denoting the partner (importing country) while t is the signing time specific. This model is in natural logarithms form. The explanatory variables are defined below, with the expected sign of the regression coefficient in brackets.

GDP : Real Gross Domestic Product, a measure of economic size (+)
LPI : Logistics Performance Index, an index of logistic performance (trade-related institutional setting and infrastructure) (+)
DST : The distance between the economic centers of i and j (–)
REER : Real Effective Exchange Rate (+)
ε : A stochastic error term, representing the omitted other influences on bilateral trade

C. Pooled Ordinary Least Square

The model is implicitly assuming that the coefficients (including the intercepts) are the same for all the individuals. In order for the Pooled Ordinary Least Square (POLS) estimates to be unbiased and consistent, the regressor should satisfy exogeneity assumptions.The presence of inefficiency in the OLS makes testing for heteroscedasticity and autocorrelation desirable. This White test[6] and Breusch-Godfrey test[7] are applied to deal with such condition.

D. Global Production Sharing

The significant transformation of world trade has been underpinned by 3 mutually reinforcing developments. First, rapid advancements in production technology have enabled industries to slice the value chain into finer, portable components. Second, technological innovations in communication and transportation have shrunk the distance that once separated the world‘s nations, and improved the speed, efficiency, and economy of coordinating geographically dispersed production processes. This has facilitated the establishment of services links that combine various fragments of the production process in a timely and cost-effective manner. Third, liberalization policy reforms in both the home and host countries have removed a considerable amount of barriers to trade and investment (Jones, 2000; Jones and Kierzkowski, 2001).

(Figure 1 is about here)

Figure 1 shows the development process of a production network within a global production sharing system. In the initial formulation (stage A), all production by the manufacturer was conducted in 1 place as a single integrated product development. Innovations in telecommunications and transportation led to the development of a fragmented production process which consists of more than 1 product as shown in stage B. These production blocks are not independent, but are connected through service links such as transportation, design and others services. Several patterns of interdependence between production blocks and service links can be envisaged. Stage C shows that the output of 1 production block can become an input for another production block, while in stage D, a more complex relationship among production blocks exists where there is a simultaneous operation of production blocks and the output of each of these is assembled in the last production block. The degree of fragment is determined by the number of stages or production blocks. As the degree of fragmentation increases, so does the importance of service links.

The recent developments set the stage for the rapid increase in fragmentation-based trade as a share of world trade. First, some fragments of the production process in certain industries have become standard fragments, which can be used effectively in a number of products. For instance, long-lasting cellular batteries, which were originally developed by computer manufacturers, are now widely used in mobile phones and electronic organizers; transmitters, which were originally designed for radios, are now used in personal computers and missiles as well; and the use of electronic chips has spread well beyond computers to consumer electronics and motor vehicles, (Jones 2000; Jones and Kierzkowski 2001; Brown et al., 2004). Second, as the international supply networks of components have become firmly established, producers in advanced countries have begun to move final assembly of an increasing range of consumer durables (such as computers, cameras, televisions, and automobiles) to overseas locations to be physically closer to final users and/or to take advantage of inexpensive labor.

E. Trade Balance Index

The Trade Balance Index (TBI) is employed to analyze whether a country has a specialization in exports representing its status as a net-exporter, or imports establishing its position as a net-importer for a specific group of products (Lafay, 1992). The TBI is simply formulated as follows:

$$TBI_{ij} = \frac{(x_{ij} - m_{ij})}{(x_{ij} + m_{ij})}$$

Where TBI_{ij} denotes the trade balance index of country i for group of products (SITC) j, x_{ij} and m_{ij} represent the export and import of the group of products j by country i. Values of the index range from -1 to +1. Any value within -1 and +1 implies that the country exports and imports a commodity simultaneously. A country is referred to as a net-importer of a specific group of products where the value of its TBI is negative and as a net-exporter of a specific group of products where its TBI value is positive.

III. RESULTS AND ANALYSIS

A. Trade Posture

Regional Snapshot

In the 1970s Japan started to penetrate the world's markets with their new lean production systems. These new systems enabled Japan to produce automobiles more efficiently compared to the US and Europe, with far fewer employees and a "just-in-time" parts delivery system compared to the "just-in-case" system operating in the US. During the 1970s and 1980s Japan showed dramatic developments in automobile production with an almost 55 fold increase in production and experienced 15% annual growth which increased its share of global production from only 1.3% in 1960 to 28% in 1989. In the late 1990s, China started to enter the global automotive production market with relatively high levels of production, at more than 2 million units.

Since 2000 China has become one of the major car producers in the world and since 2008 it has overtaken Japan to be the second largest car producer. After China's entrance into the WTO the automotive industry began to grow faster than ever. Overall production increased by 38.8% and 36.7% in 2002 and 2003. After China's entrance into the WTO the automotive industry began to grow faster than ever. Overall production increased by 38.8% and 36.7% in 2002 and 2003, respectively, making China the fourth largest auto producer and third largest auto market in the world. Yin (2010) estimates that as before 2015, China will reach more than 22 million on total unit of auto production, reshaping the structure of automotive production network in East Asia, including ASEAN.

South Korea also has shown significant growth in its car production and its share of global car production. As of 2012, Korea's automotive industry ranked 5th globally, occupying a 5.3% share of global production, while its domestic market ranked 10th globally, at 1.41 million units, and its export sales ranked 4th globally, at 3.15 million units (Invest Korea, 2015). The existence of two giant South Korean car makers, Hyundai and Kia, creates the momentum for developing the higher concentration of parts and components industry in ASEAN4 and followed by higher trade intensity between South Korea and ASEAN4 as well.

In the ASEAN4 it is mostly Japanese firms that top the production and unit sales rankings. Among the primary reasons for this are strong economic links through bilateral trade relations between Japan and individual ASEAN states, which have facilitated the Japanese firms' entry into the respective markets. The share of Japanese automakers in both local auto production and also in unit sales of new vehicles in Indonesia and Thailand is over 80%.

(Table 3 is about here)

Table 3 above reveals that Thailand has the largest domestic market for automobiles in the region. For the past 2 decades, annual vehicle sales in Thailand has ranged from about

300,000 units to 500,000 units, accounting for over 40% of the total sales in the ASEAN4 countries, followed by Indonesia (27%), Malaysia (22%) and the Philippines (10%).

(Table 4 is about here)

Table 4 shows the volume of trade in machinery and transport equipment between the ASEAN4 and their East Asian partners. In 1992, trade in the region was dominated by Japan with its main partner, Thailand, recording trade valued at US$ 8619 between them. This still holds true for the 2012 figure in which Japan and Thailand bilateral trade amounts to US$ 37127. China successfully surpassed South Korea to secure the position of its second largest partner in 2012, moving up from last in 1992. Malaysia, during this period strengthen its trade links with the both of them, while Indonesia and the Philippines try to keep up.

In 1995 the ASEAN Brand-to-Brand Complementation (BBC) program was initiated. This program aimed to promote the trade in parts and components among auto companies operating in ASEAN member countries. It provided for a 50% reduction in prevailing import duties on parts and components traded among the member countries, while treating these imports as part of the local content in estimating the minimum local content of the final products applicable to duty concessions under the ASEAN Free Trade Agreement (AFTA).

In 1998, this program was generalized to cover the entire trade in auto parts under the new title of the ASEAN Industrial Cooperation Scheme (AICO). This program has also had a major impact on automotive trade within the region. Under the AICO program, approved companies are eligible to benefit immediately from the AFTA 0-5% preferential tariff rate, for trade in approved items. In the automotive sector this applies to completed vehicles, parts, half finished goods and materials. In order to qualify, products must have a minimum of 40% ASEAN content and demonstrate resource sharing between participating companies. In addition, ASEAN members are required to abolish the localization arrangements in each country as well as the import tariff exemptions and local capital requirements.

Country Case

1. Indonesia

Indonesia's automotive sector started to expand as early as the 1960s when the Government of Indonesia established the sector as one of its strategic/priority sectors for the development of import-substitution industries. This was justified for to several reasons. Firstly, the automotive sector was the main supplier of transportation needs. Secondly, the sector contributes significantly to domestic economic growth, employment and has a high technology exposure.

In 1978, commercial vehicle manufacturers were required to use glass parts. In the following year, they had to use locally-supplied chassis and in 1984, they had to use domestically-produced engine blocks. The manufacturers who could not fulfill these requirements would be sanctioned; their import tariff was raised to 100%. In the end, these local content requirements were considered unsuccessful and only a small proportions of automotive components have been locally manufactured, most of them being characterized by low technology requirements such as car lamps and tires.

The Government implemented an incentive program for automotive manufacturers who used locally-produced components. The incentive scheme was arranged so that the automotive manufacturer who had a higher proportion of local components in their products would receive lower import tariffs. In this program, tariff structure was related to the use of local components rather than to the type of vehicle under manufacture.

The government's Automobile Policy of 1999, which substantially reduced import duties on vehicles and vehicle parts (though they are still high by international standards), has had a positive effect on the industry. In particular, the reduction of duties on motor vehicle components has lowered the cost base of the motor vehicle assembly industry, leading to increased production.

A deregulation package was introduced in 1995 in which the Government offered a 0% tariff on imported components for commercial vehicles, as long as such vehicles have a minimum of 40% local content, and 60% for passenger vehicles. The package also allowed for new foreign investment, which was part of Indonesia's commitment to AFTA and APEC. However, in 1996, the Government launched the controversial national car program which was severely criticized by heavyweight WTO members such as Japan, the US and the European Union.

The automobile industry is one of Indonesia's key industrial sectors with Rp 13.9 trillion of investment in 2006 and providing employment to about 185,000 people. Indonesia is currently the third-largest car market in Southeast Asia, after Thailand and Malaysia. With foreign principals generally controlling the ownership of automotive companies in Indonesia, international production networks have become very important. Indonesia has become the production center for the Suzuki APV and Toyota Kijang Innova. These 2 cars are exported to other ASEAN countries.

2. Malaysia

The history of the Malaysian automobile industry dates back to the early 1960s, when the Malaysian government developed a policy to promote an integrated automobile industry to strengthen its industrial base and reduce its dependency on the agricultural sector. In the 1960s and 1970s, the industry was fragmented and consisted of inefficient assembly plants. The industrial progress to a well-developed manufacturing sector with regards to motor vehicles as well as components can be traced back to numerous government incentives that were initiated in the mid-1980s and remain in-place until today. As a result of this policy 2 National car projects, Proton which commenced operations in 1985 and Perodua, which was founded in 1994, dominate the automobile industry, commanding 26% and 30 % respectively of the local market. In the non-National car segment, Nissan held a 6.5% share of the market, while Toyota held 18% and Honda 6%.

The entry of Proton into the local automobile market resulted in massive structural changes in the industry. The industry shifted from assembly activities to the manufacture of vehicles and automobile parts. The sales and market share of Japanese cars, which had dominated the market prior to the launch of Proton, were reduced as Malaysians flocked to buy their National car. The success stories of Proton and Perodua were positively influenced by high tariffs imposed by the government. Many analysts viewed the protectionist policies implemented by the Malaysian government as the most intervening among the ASEAN countries. As a consequence, the National cars' market share amounted to more than 59% of the total sales in 2009 and the market share of the 2 big Malaysian car manufacturers Proton and Perodua still accounted for 59% in February 2011.

In 2006 the government introduced the National Automotive Policy (NAP) that envisioned the progressive liberalization of the car market through strategic tie-ups and alliances in order to eliminate competition. Today, with the opening-up of the market due to the ASEAN Free Trade Agreement (AFTA) the National cars domestic market share has dropped to less than 60%.

In ASEAN, Malaysia is the third biggest car market with 3 car manufacturers, 8 car assemblers, 9 motor assemblers and more than 800 component manufacturers and employs more than 300,000 people. The National car's dominance is expected to decline further with more liberalization in the near future. In the Government Budget 2012, several incentives for further development of the domestic automobile industry were announced. Following the global trend for environmentally friendly vehicles and fuel efficiency, a 100% exemption in import and excise duties was proclaimed to be in continuance until the 31st of December 2013.

The launching of Proton in the early 1980s catalyzed the development of the ancillary and supporting industries by creating opportunities for growth in the manufacturing of component parts and accessories. Currently, there are more than 704 automotive component and parts manufacturers and 110 producing motorcycle components and parts.

Today there are about 45 vendors in the automotive components industry who have achieved the capabilities and competency to design and develop, source components and parts and manufacture the whole module/component both for the original equipment and replacement markets. Malaysia continues to be one of the main producers and exporters of vehicle parts, components and accessories in the region. These products have been accepted in Japan, Germany and the UK due to their quality, compliance with international standards and competitive prices.

Due to the dynamic development of the sector, the sales volume of components and parts has registered a steady growth during the last decades. In 2010, sales reached RM6.13 billion (RM 5.77 billion in 2009). Along with this, the local content of the National cars of all ranges averages between 50-90 % (Proton) and 35-

80 % respectively (Perodua) while the percentage of local content in domestically assembled foreign cars of all ranges averages between 35-65%. Local component manufacturers, besides having the capability to export, have also undertaken cross border investment into neighboring ASEAN countries, especially Thailand.

3. The Philippines

The main investors and assemblers in the Philippines market have long been Honda, Toyota, Nissan and PAMCO (which assembles Mitsubishi vehicles) which account for 75% of the domestic market for passenger vehicles and over 50% of the market for commercial vehicles (Abrenica, 2000).

The Philippines automotive industry is small and fragmented, being based on assembly operations. It consists of 14 major assemblers who are supplied by around 200 parts manufacturers, as well as imports, predominantly from Japan. The total market fell to less than 100,000 vehicles annually after the Asian economic crisis (after a peak of 162,000 in 1996), so that no one producer can possibly attain sufficient economies of scale or international cost competitiveness based only on the domestic market. Capacity utilization is also relatively low (Abrenica, 2000).

4. Thailand

Following the imposition of import tariffs in the early 1960s, multi-national car makers, who had until then served the Thai market through exports from their home bases, set up assembly plants in Thailand. By the late 1960s all Japanese car makers (Toyota, Honda, Nissan, Mitsubishi, Daihatsu, and Isuzu) were present in Thailand. Until 1975, local car assembly was predominantly from imported parts and components. At the time, there were about 20 parts and component manufacturers.

The number of parts manufacturers had increased to around 180 enterprises by 1980. The range of locally manufactured auto parts had also widened and included rubber parts, suspension systems, radiators, inner panel pressed parts, brake drums, gaskets, pistons, safety glass, electrical equipment and wiring harnesses. Production capacity in the car assembly industry began to increase rapidly from the second half of the 1990s. Total production capacity recorded a 10-fold increase (from 160,000 to 1.6 million) between 1989 and 2006, with Japanese car makers accounting for over 90% (and Toyota alone accounting for a third) of the total installed capacity

During the period from 1960 until the late 1990s, the rate of growth of the automobile industry in Thailand was compatible with the overall growth of the manufacturing sector; the share in manufacturing output (i.e. value added) remained at around 8% (about 2% of GDP). The ensuing years have seen much faster growth lifting its share in GDP to about 8% by 2008.

Employment in the automotive industry too has grown over time, but at a much slower rate, from about 3.3% of total employment in the 1990s to 4.5% (around 350,000 workers) in 2008. The gap between the output and employment share reflects the relatively high capital intensity of the automobile industry compared to the average level for total manufacturing. The value added per worker (a rough indicator of the capital intensity of production) in transport equipment manufacture is about 3 times of that for total manufacturing (Kohpaiboon, 2006).

A major concern in the debate on national gains from the expansion of the auto industry in Thailand relates to the extent of its value addition to the national economy. A number of studies conducted in the early 1990s have come up with estimates which suggest a very low value added, less than 20% (Kohpaiboon, 2006).

However, the evidence from firm level surveys suggests that value added would have increased significantly during the ensuing years as the local production of parts and components have rapidly increased in line with the rapid expansion in output. The bulk of the parts and components embodied in locally assembled cars (over 90%) are now sourced locally, although the import content of some automotive components is admittedly still high.

B. Trade Pattern

(Figure 2 is about here)

(Table 5 is about here)

Figure 2 presents the Indonesian TBI in machinery and transport equipment. It shows that the crowd shifts from below the line to above it implying more parts and components gaining a positive TBI. Almost half of the items identified within a 2-digit SITC 7 Rev.3, 72 (machinery specialized for particular industries), 73 (metalworking machinery), 74 (general industrial machinery and equipment), 76 (telecommunications and sound-recording and reproducing apparatus and equipment), and 78 (road vehicles), reveal a higher TBI in 2012. To observe more specifically the dynamics of Indonesian machinery and transport equipment production, the TBI of the top 10 parts and components is noted in Table 5.

(Figure 3 is about here)

(Table 6 is about here)

Figure 3 presents the Malaysian TBI for machinery and transport equipment. It shows that the main pattern of the crowd does not change significantly even though more parts and components gain a positive TBI. A higher TBI in 2012 is revealed especially for items identified within the 2-digit SITC 7 Rev.3, 73 (metalworking machinery), 75 (office machines and automatic data-processing machines), 77 (electrical machinery, apparatus and appliances), and 78 (road vehicles). To observe more specifically the dynamics of Malaysia's machinery and transport equipment production, the TBI of its top 10 parts and components is noted in Table 6.

(Figure 4 is about here)

(Table 7 is about here)

Figure 4 presents the Philippines' TBI in machinery and transport equipment. It shows that several divisions containing parts and components are gaining a positive TBI. A higher TBI in 2012 is revealed especially for items identified within the 2-digit SITC 7 Rev.3, 73 (metalworking machinery), 74 (general industrial machinery and equipment), 77 (electrical machinery, apparatus and appliances), and 78 (road vehicles). To observe more specifically the dynamics of the Philippines' machinery and transport equipment production, the TBI of the top 10 parts and components is noted in Table 7.

(Figure 5 is about here)

(Table 8 is about here)

Figure 5 presents Thailand's TBI in machinery and transport equipment. It shows that several divisions containing parts and components gain a positive TBI. A higher TBI in 2012 is revealed especially for items identified within the 2-digit SITC 7 Rev.3, 73 (metalworking machinery), 75 (office machines and automatic data-processing machines), 77 (electrical machinery, apparatus and appliances), and 79 (other transport equipment). To observe more specifically the dynamics of Thailand's machinery and transport equipment production, the TBI of the top 10 parts and components is noted in Table 8.

(Table 9 is about here)

Table 9 puts the average number of the 5-digit SITC 7 Rev. 3 on view for each group from the years 1992 and 2012 for each ASEAN4 country. The leading country in Group A in 2012 was Indonesia, with on average 215 from 564 items (38.12%) overtaking Thailand which previously (1992) had on average 134 out of 322 items (41.64%). In a less specialized basket, Indonesia does show higher attainment as the number of parts and components in this category degrades from 555 of 1857 items (29.89%) to 235 of 1591 items (15.90%). However, the total number of Indonesian parts and components decreases from 593 out of 2179 (27.21%) in 1992 to 468 of 2155 (21.72%) in 2012.

C. Trade Flow

The theoretical foundation for doing regression on the gravity model was explained in Chapter II. Here is the process, as taken from the following results and findings related to the discussion on trade flow. 3 model are tested, 1 for each peer observation set, namely ASEAN4 trade with Japan, ASEAN4 trade with China, and ASEAN4 trade with South Korea.

Before carrying out the panel data estimations, it is necessary to choose the appropriate estimation techniques for the model and test for the characteristics of specification. Tests for heteroscedasticity, autocorrelation and multicollinearity assist in this specification and estimation. In the 3 models, pooled cross section and time series is preferable due to a near singular matrix[8] appearance of the fixed effects and an insufficient number of cross sections over number of coefficients in the random effects. This phenomenon is commonly found when running a gravity model.

Model 1 represents the ASEAN4 parts and components trade with Japan in machinery and transport equipment. The only inconformity is on GDP Japan which indicates 2 conditions. Firstly, the parts and components trade flow in machinery and transport equipment between the ASEAN4 and Japan does not dominantly move from Japan to the

ASEAN4, but actually in the opposite direction, even though the role of MNCs seems still to be quite pivotal. This is because parts and component production in regional intra-industry trade has involved more players, especially the domestic business entities, as global production sharing opens new doors for them. Secondly, Japan's "first comer" in the parts and components trade with the ASEAN4 is now threatened by some competitors from the region (namely China and South Korea) extending their vast networks.

(Table 10 is about here)

Table 10 (column 2) states the estimation result of the final model obtained from pooled cross-section and time-series data using POLS estimates. The result suggests that POLS is the appropriate panel data estimator for this research. The efficiency gain in this model is substantial. Standard errors for the POLS approach are substantially small. The sign of coefficients are as were expected except for GDP Japan. Recall that in the log linear model of the coefficients is the interpretation of elasticity. The GDP of the ASEAN4's elasticity of trade is estimated to be 1.14. It implies that a 1% increase in GDP for the ASEAN-4, ceteris paribus, results in a 1.14 increase in trade. The GDP of Japan's elasticity of trade is estimated to be -0.41. It implies that a 1% decrease in Japan's GDP, ceteris paribus, results in a 0.41 increase in trade. The logistics index of the elasticity of trade is estimated to be 6.11. It implies that a 1% increase in the logistics index, ceteris paribus, results in a 6.11 increase in trade. The distance of the elasticity of trade is estimated to be -0.48. It implies that a 1% decrease in distance, ceteris paribus, results in a 0.48 increase in trade. Having a R^2 of 0.747 means approximately 74.7% of the variation in trade between the ASEAN4 and Japan can be attributed to the GDP of the ASEAN-4, the GDP of Japan, the logistics index, and distance. Meanwhile, other observable and unobservable factors affecting the trade volume beside those mentioned previously account for around 25.3% of the variation.

Model 2 represents the ASEAN4 parts and components trade with China in machinery and transport equipment. Findings on variables of the GDP of the ASEAN-4, the distance, and effective exchange rate detect different signs when the common gravity model is applied. The facts can be affected by the abundant items exported by China, more than its imports, so it corrects the balance of trade orientation in the ASEAN4 countries. Those imports are used in machinery and transport equipment industry plants located in the area.

Table 10 (column 3) states estimation results for the final model obtained from pooled cross-section and time-series data using POLS estimates. The result suggests that POLS is the appropriate panel data estimator for this research. The efficiency gain in this model is substantial. Standard errors for the POLS approach are substantially small. The signs of the coefficients were as expected except for the GDP of the ASEAN-4, the distance and real effective exchange rate. Recall again that in the log linear model of the coefficients is the interpretation of elasticity. The GDP of the ASEAN4's elasticity of trade is estimated to be -7.67. It implies that a 1% decrease in the ASEAN4's GDP, ceteris paribus, results in a 7.67 increase in trade. The GDP of China's elasticity of trade is estimated to be 5.81. It implies that a 1% increase in China's GDP, ceteris paribus, results in a 5.81 increase in trade. The logistics index of the elasticity of trade is estimated to be 17.76. It implies that a 1% increase in the logistics index, ceteris paribus, results in a 17.76 increase in trade. The distance of the elasticity of trade is estimated to be 8.33. It implies that a 1% increase in the distance, ceteris paribus, results in a 8.33 increase in trade. The real effective exchange rate elasticity of trade is estimated to be -2.85. It implies that a 1% decrease in this real effective exchange rate, ceteris paribus, results in a 8.33 increase in trade. Having a R^2 of 0.726887 means approximately 72.7% of the variation in trade between the ASEAN4 and China can be attributed to the GDP of the ASEAN-4, the GDP of China, the logistics index, distance, and real effective exchange rate. Meanwhile, other observable and unobservable factors affecting the trade volume beside those mentioned previously are around 27.3% of the variation.

Model 3 represents the ASEAN4 parts and components trade with South Korea in machinery and transport equipment. The pattern of inconformity looks like the one for the trade between the ASEAN4 and Japan. The ASEAN4 countries play the role of the supplier of parts and components for South Korea's machinery and transport equipment production. Thus, the direction of flow for the trade in parts and components is significantly from the ASEAN4.

Table 10 (column 4) states the estimation result of the final model obtained from pooled cross-section and time-series data using POLS estimates. The result suggests that POLS is the appropriate panel data estimator for this research. The efficiency gain in this model is substantial. Standard errors for the POLS approach are substantially small. The sign of coefficients were as expected except for the GDP of South Korea. Again, recall that in the log linear model of the coefficients is the interpretation of elasticity. The GDP of the ASEAN4 elasticity of trade is estimated to be 4.08. It implies that a 1% increase in the GDP of the ASEAN4, ceteris paribus, results in a 4.08 increase in trade. The GDP of South Korea's elasticity of trade is estimated to be -2.82. It implies that a 1% decrease in South Korea's GDP, ceteris paribus, results in a 2.82 increase in trade. The distance of the elasticity of trade is estimated to be -4.32. It implies that a 1% decrease in this distance, ceteris paribus, results in a 4.32 increase in trade. The real effective exchange rate elasticity of trade is estimated to be 3.71. It implies that a 1% increase in the real effective exchange rate, ceteris paribus, results in a 3.71 increase in trade. Having a R^2 of 0.804663 means that approximately 80.5% of the variation in trade between the ASEAN4 and South Korea can be attributed to the GDP of the ASEAN4, the GDP of South Korea, the distance, and the real effective exchange rate. Meanwhile, other observable and unobservable factors affecting the trade volume beside that mentioned previously are around 19.5% of the variations.

IV. CONCLUSIONS AND POLICY IMPLICATIONS

Conclusions

This paper examines 3 issues related to the existence of the ASEAN-4, namely Indonesia, Malaysia, the Philippines, and Singapore, their parts and components production sharing in machinery and transport equipment industry, comprising their posture, trade pattern and trade flow. Using the theory of new trade, the concept of global production sharing, and the model of gravity, this approach stresses the importance of integrated instruments to endorse developing countries involvement in global production sharing.

The evidence coming from this paper shows that the posture of the ASEAN4 machinery and transport equipment industry is supported by the vital participation of MNCs, especially those originating in the East Asian countries of Japan, China, and South Korea. In their trade patterns, the competitiveness in the development of parts and components made by the ASEAN4 induced specialized dynamics as time passed, notably from 1992 to 2012. It is found that the determinants of trade flow, such as trade volume, real gross domestic products, the logistics performance index, distance, and real effective exchange rate, remain variable among the ASEAN4 because of their different policies and orientation towards trade.

There is an exciting and rich agenda for continued research into the global production sharing and an urgent need to incorporate detailed policy analysis into the models and data analysis. Future theoretical research should focus on building trade flow models to respond to the dynamics of the gravity model which still remains one of the best available non-technical expositions.[9] In the mean-time, empirical research should consider the broader factors affecting bilateral trade, such as the recently initiated new trade theory.

Policy Implications

Global production sharing opens up new opportunities for countries to participate in a finer international division of labor and to specialize in different stages of the production process. As far as global production sharing is concerned, the intra-industry trade of machinery and transport equipment within the East Asian MNCs in which Japan is the pioneer transmits a comparative advantage to the ASEAN4 countries in the form of parts and components production. Moreover, there are still a number of parts and components which could be extended by industry in the future to this region such as from the electric equipment industry (e.g.: semiconductor and telecommunication tools) and certain manufacturing products (e.g.: metalworking, aircraft and household appliances).

To respond to such an upcoming trend, the ASEAN4 countries must be well prepared for the rise of industries focusing on parts and components production. The key in winning the attention of these new industries and keeping existing industries operating is to create more comparative advantage and trade balances. Discussing this matter in the policy arena, it seems that governments need to improve their domestic infrastructure, to initiate industrial clusters, and to promote competitive factor prices.

The first knits with logistical performance in which the ease of access remains important. To gain more insight into the global production sharing phenomenon in which production can be fragmented into production blocks dispersed in different countries, service links such as transportation and communications infrastructure must be competitive and effective in advance. Information gathering and the costs of coordinating production blocks that form part of a related production process which is spread over many regions or countries are also important, as noted by Jones and Kierzkowski (1990).

The second deals with the uncontrollable physical distance between production locations in the production chain for parts and components. Industrial clusters can play an essential role, particularly in keeping efficient procurement channels for customized blocks with strict delivery times. It suits the production networks in East Asia and their connection to the parts and components producers in the ASEAN4 in machinery and transport equipment. Moreover, a sophisticated combination of intra-firm and arm's-length transactions along with flexible de-internalization decisions to outsource some fragmented production processes signify this suggestion as discussed by Golub, Jones, and Kierzkowski (2007).

The third faces the requirement of tighten up labor productivity along the international production chain. Factors of production tend to be available at different prices in different areas and also to differ in their productivities, including wages. In this case, wage variables should not be solely perceived as the nominal earnings of labor, but should focus on the productivity of labor. A country's success in joining global production sharing and industrial enhancement does not depend on the availability of labor at relatively low wages alone. Other factors, such as the quality of human resources, for example their education levels and management capabilities, is considered necessary to permit technology upgrades and to move up the value chain as argued by Athukorala (2011b).

References

Athukorala, P., 2011a, 'Production Networkd and Trade Patterns in East Asia: Regionalization or Globalization?', *Asian Economic Papers*, Vol. 10, No.1, pp. 65-95.

Athukorala, P., 2011b, 'Growing with Global Production Sharing: The Tale of Penang Export Hub', *ANU Working Paper No. 2011/13*, Canberra: Australian National University.

Athukorala, P., and Kohpaiboon, A., 2010, *Thailand in Global Automobile Networks*, Geneva: *World* Trade Organization/International Trade Center.

Athukorala, P., and Menon, J., 2010, ‘Global Production Sharing, Trade Patterns, and Determinants of Trade Flows in East Asia’, *ADB Economic Working Paper No. 41*, Manila: Asian Development Bank.

Athukorala, P., and Nasir, S., 2012, ‘Global Production Sharing and South-South Trade’, *ANU Working Paper No. 2012/012*, Canberra: Australian National University.

Balassa, B., 1966, ‘Tariff Reductions and Trade In Manufactures Among Industrial Countries’, *American Economic Review*, Vol. 56, pp. 466-473.

Baldwin, R.E., 2001, ‘Core-Periphery Model With Forward-Looking Expectations’, *Regional Science and Urban Economics*, Vol. 31, No. 1, pp. 21-49.

Blomstrom, M., and Goldberg, L.S., 2001, *Topics in Empirical International Economics: A Festschrift in Honor of Robert E. Lipsey*, Chicago: The University of Chicago Press.

Bowen, H.P., Hollander, A., and Viaene, J.M., 1998, *Applied International Trade Analysis*, Ann Arbor: The University of Michigan Press.

Brown, C., and Linden, G., 2005, ‘Offshoring in the Semiconductor Industry: A Historical Perspective’, in Brainard, L., and Collins, S.M., eds., *The Brookings Trade Forum 2005: Offshoring White-Collar Work: The Issues and Implications*, Washington DC: Brookings Institution Press, pp. 270-333.

Brown, D.K., Deardoff, A.V., and Stern, R.M., 2004, ‘The Effect of Multinational Production on Wages and Working Conditions in Developing Countries’, in Baldwin, R.E., and Winters, L.A., eds., *Challenges of Globalization: Analyzing the Economics*, Chicago: University of Chicago Press, pp. 279-332.

Breusch, T.S., 1978, ‘Testing for Autocorrelation in Dynamic Linear Models’, *Australian Economic Papers*, Vol.17, pp. 334-355.

Deardorff, A.V., 2001, ‘International Provision Of Trade Services, Trade, and Fragmentation’, *Policy Research Working Paper Series No. 2548*, The World Bank.

Dixit, A.K. and Stiglitz, J., 1977, ‘Monopolistic Competition And Optimum Product Diversity’, *American Economic Review*, Vol. 67, pp. 297–308.

Dobson, W., and Chia, S.Y., 1997, *Multinationals and East Asian Integration*, Singapore: Institute of Southeast Asian Studies.

Drucker, P.F., 1977, *An Introductory View of Management*, New York: HarperCollins College.

Eaton, J., and Grossman, G.M., 1986, ‘Optimal Trade and Industrial Policy under Oligopoly’, *The Quarterly Journal of Economics*, Vol. 101, No. 2, pp. 383-406.

Gareffi, G., Humphrey, J., and Sturgeon, T., 2005, ‘The Governance of Global Value Chains’, *Review of International Political Economy*, Vol. 12, No. 1, pp. 78-104.

Godfrey, L.G., 1978, ‘Testing against General Autoregressive and Moving Average Error Models When the Regressors Incude Lagged Dependent Variables’, *Econometrica*, Vol. 46, pp.129-1302.

Golub, S.S., Jones, R.W., Kierzkowski, H., 2007, ‘Globalization and Country-Specific Service Links’, *Journal of Economic Policy Reforms*, Vol. 10, No. 2, pp. 78-104.

Grossman, G.M., and Horn, H., 1988, ‘Infant-Industry Protection Reconsidered: The Case of Informational Barriers to Entry’, *The Quarterly Journal of Economics*, Vol. 103, No. 4, pp. 767-787.

Grossman, G.M., and Helpman, E., 1991, ‘Trade, Knowledge Spillovers, and Growth’, *European Economic Review*, Vol. 35, No. 2, pp. 517-526.

Grossman, G.M., and Rossi-Hansberg, E., 2006, ‘Trading Tasks: A Simple Theory of Offshoring’, *NBER Working Papers No. 12721*, Cambridge: National Bureau of Economic Research, Inc.

Grubel, H.G., and Lloyd, P.J., 1975, *Intra-Industry Trade: Theory and Measurement of International Trade in Differentiated Products*, London: The Macmillan Press, Ltd.

Gujarati, D.N., 2003, *Basic Econometrics*, New York: McGraw Hill.
Hanson, G.H., Mataloni, R.J, and Slaughter, M.J., 2001, 'Expansion Strategies of U.S. Multinational Firms', *NBER Working Papers No. 8433*, Cambridge: National Bureau of Economic Research, Inc.
Helleiner, G.K., 1973, 'Manufactured Exports from Less-Developed Countries and Multinational Firms', *Economic Journal*, Vol. 83, No. 329, pp. 21-47.
Hummels, D., Isii, J., and Yi, K-M., 2001, 'The Nature and Growth of Vertical Specialization in World Trade', *Journal of International Economics*, Vol. 54, No. 1, pp. 75-96.
Irwin, D.A., 2002, 'Long-Run Trends In World Trade and Income', *World Trade Review*, Vol. 1, No. 1, pp. 89-100.
Jones, R.W., 2000, *Globalization anad the Theory of Input Trade*, Cambridge: Massachusett Institute of Technology Press.
Jones, R.W., and Kierzkowski, H., 1990, 'The Role of Services in Production and International Trade: A Theoretical Framework', in Jones, R.W., and Krueger, A.O., eds., *The Political Economy of International Trade: Essays in Honor of Robert Baldwin*, Oxford: Basil Blackwell, pp. 31-48.
Jones, R.W., and Kierzkowski, H., 2001, 'Globalization and the Consequences of International Fragmentation', in Dornbusch, R., Calvo, G., and Obstfeld, M., eds., *Money, Factor Mobility, and Trade: The Festchrift in Honor of Robert Mundell*, Cambridge: Massachusett Institute of Technology Press.
Kennedy, P., 2003, *A Guide To Econometrics*, Malden: Blackwell Publishing.
Kmenta, J., 1986, *Elements of Econometrics*, New York: MacMillan.
Krugman, P.R, 1979. 'Increasing Returns, Monopolistic Competition, and International Trade', *Journal of International Economics*, Vol. 9, No. 4, pp. 469-479.
Krugman, P.R, 1980, 'Scale Economies, Product Differentiation, and the Pattern of Trade', *American Economic Review*, Vol. 70, No. 5, pp. 950-959.
Krugman, P.R, 1984, 'The U.S. Response to Foreign Industrial Targeting', *Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution*, Vol. 15, No. 1, pp. 77-132.
Krugman, P.R, 1986, 'Industrial Organization and International Trade', *NBER Working Papers No. 1957*, Cambridge: National Bureau of Economic Research, Inc.
Krugman, P.R, 1991, 'Increasing Returns and Economic Geography', *Journal of Political Economy*, Vol. 99, No. 3, pp. 483-499.
Krugman, P.R., 1995, 'Technology, Trade, and Factor Prices', *NBER Working Papers No. 5355,* Cambridge: National Bureau of Economic Research, Inc.
Krugman, P.R., Obestfeld, M., and Melitz, M., 2012, *International Economics: Theory and Policy*, Boston: Pearson.
Lafay, G., 1992, 'The Measurement of Revealed Comparative Advantages', in Dagenais, M.G., and Muet, P.A., eds, *International Trade Modeling*, London: Chapman&Hill.
Limao, N. And A.J. Venables, 2001, 'Infrastructure, Geographic Disadvantage, Transport Costs, and Trade', *World Bank Economic Review*, Vol. 15, No. 3, pp. 451-479
Markusen, J.R., 1984, 'Multinationals, Multi-Plant Economies, and The Gains From Trade', *Journal of International Economics*, Vol. 16, No. 3, pp. 205-226.
Markusen, J.R., 1997, 'Trade versus Investment Liberalization', *NBER Working Papers No. 6231*, Cambridge: National Bureau of Economic Research, Inc.
Markusen, J.R., Melvin, J.R., Kaempfer, W.H., and Makus, K.E., 1995, *International Trade: Theory and Evidence*, Singapore: McGraw-Hill, Inc.
McKendrick, D.G., Doner, R.F., and Haggard, 2000, *From Silicon Valley to Singapore: Location and Competitive Advantage in the Hard Disk Drive Industry*, Stanford: Stanford University Press.

Ng, F., and Yeats, A., 2001, 'Production Sharing in East Asia: Who Does What for Whom, and Why?', in Cheng, L.K., and Kierzkowski, H., eds., *Global Production and Trade in East Asia*, Boston: Kluwer Academic Publishers, pp. 63-109.

Rangan, S., and Lawrence, 1999, *A Prism on Globalization*, Washington DC: Brookings Institution Press.

Sanyal, K.K., and Jones, R.W., 1982, 'The Theory of Trade in Middle Products'. *The American Economic Review*, Vol. 72, No. 1, pp. 16-32.

Seddighi, H.R., Lawler, K.A., and Katos, A.V., 2000, *Econometrics: A Practical Approach*, London: Routledge.

Sturgeon, T.J., 2003, 'What Really Goes on Silicon Valley? Spatial Clustering and Dispersal in Modular Production Networks', *Journal of Economic Geography*, Vol. 3, No.2, pp. 199-255.

Tinbergen, J., 1962, *Shaping the World Economy: Suggestions for and International Economic Policy*, New York: the Twentieth Century Fund.

Van Bergeijk, P.A.G., and Brakman, S., eds., 2010, *The Gravity Model in International Trade*, Cambridge: Cambridge University Press.

Venables, A.J., 1999, 'Fragmentation and Multinational Production', *European Economic Review*, Vol.43, No. 3, pp. 935-945.

Verbeek, M., 2005, *A Guide to Modern Econometrics*, Chichester: John Wiley&Sons, Ltd.

Verdoorn, P.J., 1960, 'The Intra-Block Trade of Benelux, in Robinson, E.A.G., eds., *Economic Consequences of the Size of Nations*, London: Macmillan.

Widodo, T., 2010, *International Trade, Regionalism, and Dynamic Market*, Yogyakarta: BPFE.

Yeats, A., 2001, 'Just How Big is Global Production Sharing?', in Arndt, S. And Kierzkowski, H. (eds.), *Fragmentation: New Production Patterns in the World Economy*, New York: Oxford University Press, pp. 108-143.

Yin, X., 2010, 'The future of China's Automobile Industry', *Fudan Journal of Humanities and Social Science*, Vol. 3, No. 3, pp. 39-69.

Table 1.
Car Production and World Share, 1989-2010

Country	1989		2000		2005		2010	
	Production (thousands unit)	World Share (%)	Production (thousands unit)	World Share (%)	Production (thousands unit)	World Share (%)	Production (thousands unit)	World Share (%)
East Asia	9,924	28	15,325	26	19,215	30	32,163	41
Japan	9,052	25.53	10,141	17.37	10,512	16.30	9,626	12.40
South Korea	872	2.46	3,115	5.34	3,469	5.38	4,272	5.50
China	NA	NA	2,069	3.54	5,234	8.12	18,265	23.53
ASEAN-3	94	0.27	988	1.69	1808	2.8	2918	3.76
Thailand	NA	NA	412	0.71	928	1.44	1,645	2.12
Indonesia	NA	NA	293	0.50	408	0.63	705	0.91
Malaysia	94	0.27	283	0.48	472	0.73	568	0.73
World	35,455	100.00	58,374	100	64,496	100	77,610	100

Source: International Organization of Motor Vehicle Manufacturers (2011)

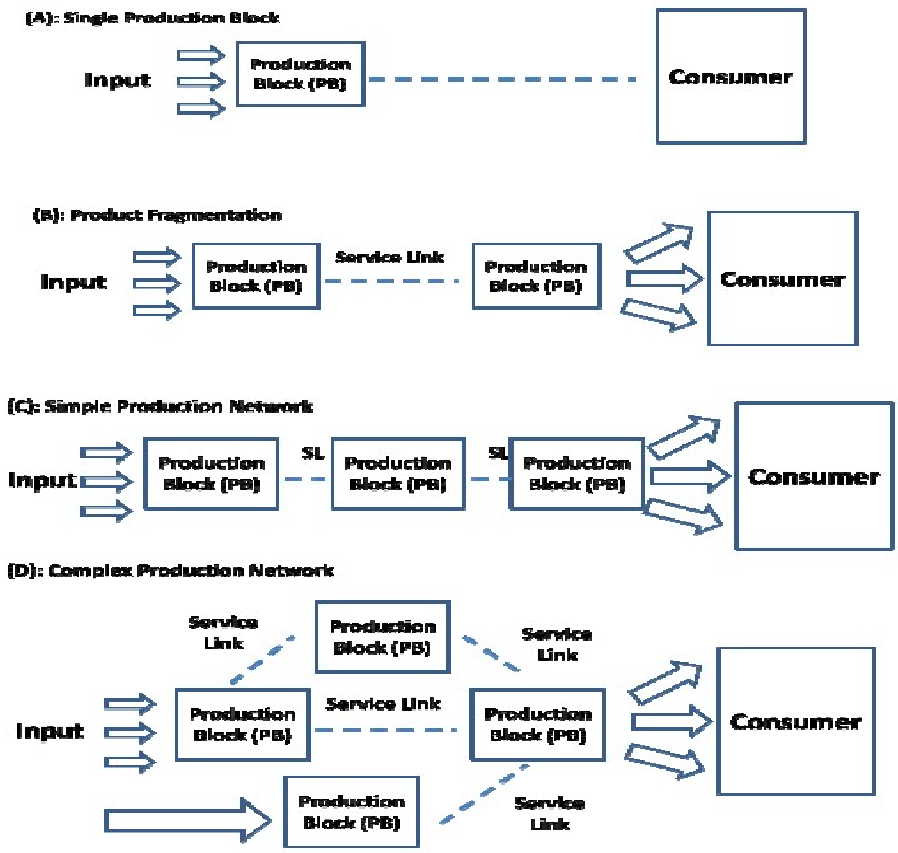
Table 2.
Trade Value of Automobile Parts and Component, 1990 – 2007 (US$ million)

Country	Export				Import				Trade (Export+Import)			
	1990	1995	2000	2007	1990	1995	2000	2007	1990	1995	2000	2007
East Asia	33,036	67,428	70,711	166,265	11,991	33,454	32,928	86,887	45,027	100,882	103,639	253,152
Japan	28,361	49,842	45,403	64,973	2,751	5,081	7,370	18,427	31,112	54,923	52,773	83,400
South Korea	2,522	3,862	5,558	20,761	1,679	3,940	4,017	10,381	4,201	7,802	9,575	31,142
China	NA	2,715	6,806	47,792	NA	3,467	6,291	29,331	NA	6,182	13,097	77,123
ASEAN-4	750	3902	6847	19601	5602	12044	7904	15289	6,352	15,946	14,751	34,890
Thailand	314	1,309	2,375	10,109	3,351	5,519	3,022	7,285	3,665	6,828	5,397	17,394
Indonesia	113	595	1,397	3,589	1,543	3,878	2,517	3,363	1,656	4,473	3,914	6,952
Malaysia	323	1,197	1,634	2,874	708	1,686	1,560	3,674	1,031	2,883	3,194	6,548
Philippines	NA	801	1,441	3,029	NA	961	805	967	NA	1,762	2,246	3,996
World	169,519	265,749	333,865	699,960	154,746	258,327	338,598	699,157	324,265	524,076	672,463	1,399,117

Source: UNCOMTRADE, author's calculation

Figure 1.

Production Network



Source: Jones and Kierzkowski (1990)

Table 3.

Domestic Automobile Sales in the ASEAN4, 1980-2005 (thousand units)

Year	Indonesia	Malaysia	Thailand	Philippines	Total
1992	170	145	61	363	738
1993	211	155	84	456	905
1994	321	200	103	486	1111
1995	379	285	128	572	1364
1996	332	365	162	589	1448
1997	387	405	144	364	1299
1998	58	164	80	144	446
1999	94	288	74	218	674
2000	105	687	262	120	200

Source: Guilheux and Lecler (2000)

Table 4.

ASEAN4 Trade* in Machinery and Transport Equipment, 1992 and 2012 (US$ million)

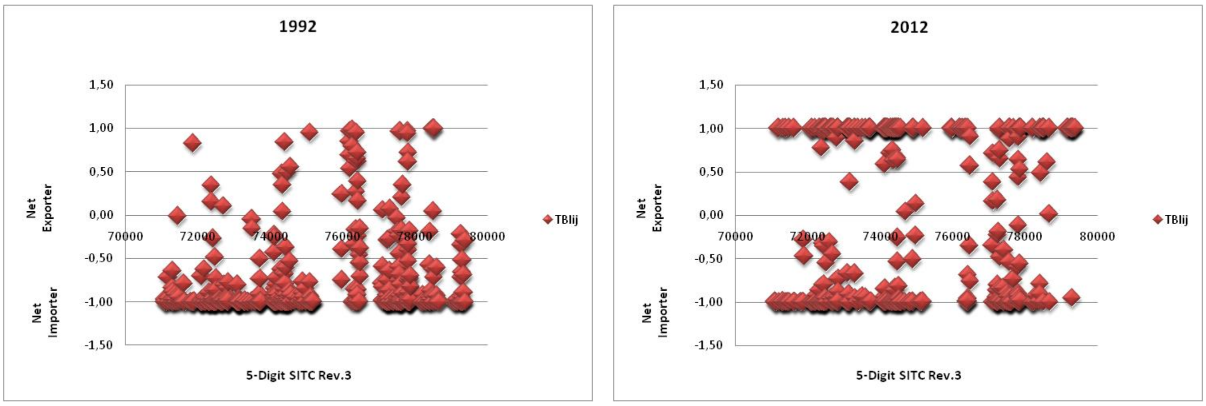
Country	Trade With					
	Japan		China		South Korea	
	1992	2012	1992	2012	1992	2012
Indonesia	3852	13527	183	14381	403	2902
Malaysia	8252	17221	194	32140	899	5830
Philippines	2155	9159	20	7262	140	2676
Thailand	8619	37127	189	2830	526	4611

Note:
*Trade is summation of export and import.
Source: UNCOMTRADE, author's calculation

Figure 2.

TBI Mapping of Parts and Components:

Indonesian Machinery and Transport Equipment, 1992 and 2012



Source: UNCOMTRADE, author's calculation

Table 5.

TBI of Top 10 Parts and Components:

Indonesian Machinery and Transport Equipment, 1992 and 2012

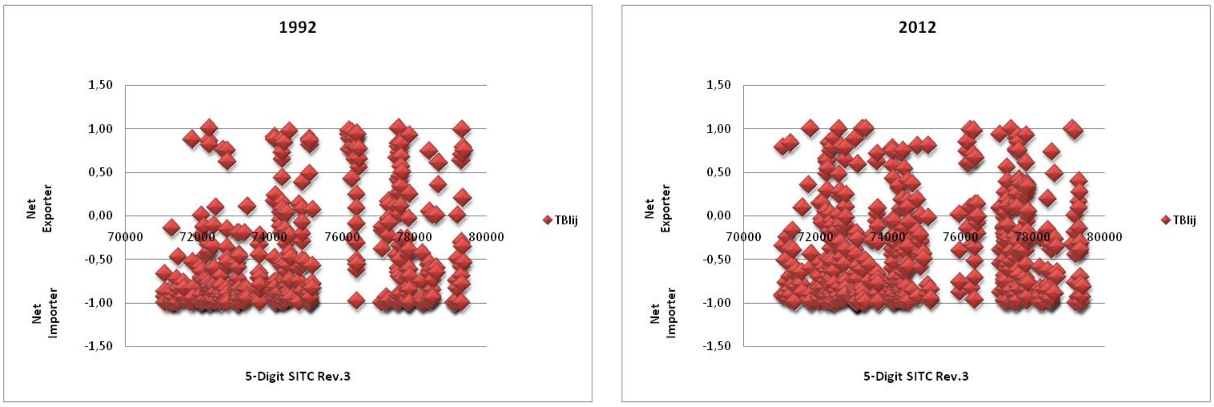
1992		2012	
SITC	TBIij	SITC	TBIij
78511	1.00	71191	1.00
78513	1.00	71192	1.00
78536	1.00	71333	1.00
76281	0.98	71391	1.00
77811	0.97	71392	1.00
76222	0.97	71499	1.00
77585	0.96	71632	1.00
75115	0.95	72112	1.00
76381	0.95	72127	1.00
77812	0.94	72129	1.00

Source: UNCOMTRADE, author's calculation

Figure 3.

TBI Mapping of Parts and Components:

Malaysian Machinery and Transport Equipment, 1992 and 2012



Source: UNCOMTRADE, author's calculation

Table 6.

TBI of Top 10 Parts and Components:

Malaysian Machinery and Transport Equipment, 1992 and 2012

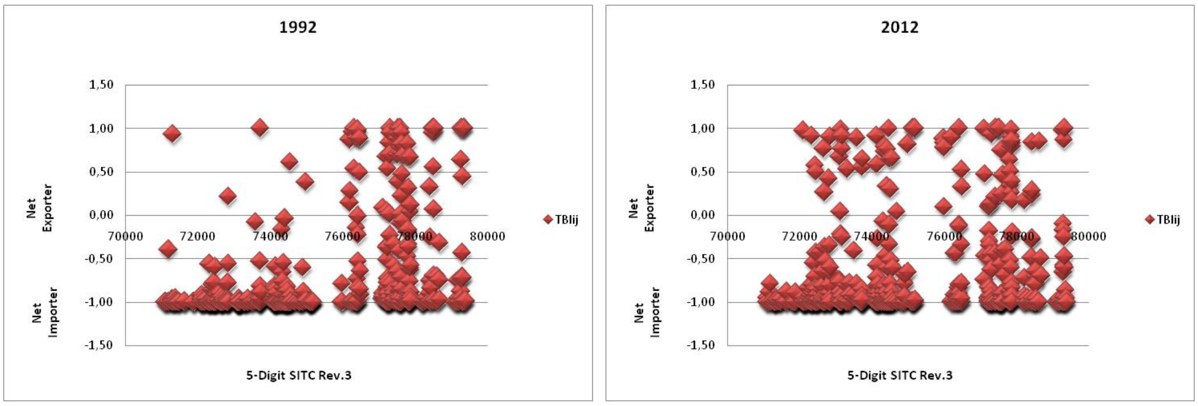
1992		2012	
SITC	TBIij	SITC	TBIij
72346	1.00	77411	1.00
77585	1.00	71871	1.00
79328	0.99	73399	1.00
76212	0.98	73314	1.00
74561	0.97	79111	0.99
76282	0.96	72661	0.99
76419	0.94	76289	0.99
76432	0.94	76384	0.97
76211	0.94	79182	0.97
76411	0.93	77111	0.93

Source: UNCOMTRADE, author's calculation

Figure 4.

TBI Mapping of Parts and Components:

The Philippines' Machinery and Transport Equipment, 1992 and 2012



Source: UNCOMTRADE, author's calculation

Table 7.

TBI of Top 10 Parts and Components:

The Philippines' Machinery and Transport Equipment, 1992 and 2012

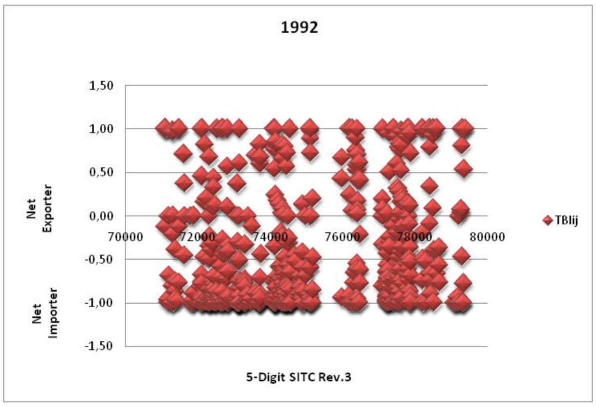
1992		2012	
SITC	TBIij	SITC	TBIij
73741	1.00	75134	1.00
76331	1.00	75192	1.00
77322	1.00	76413	1.00
77542	1.00	77429	1.00
77585	1.00	77511	1.00
78511	1.00	77521	1.00
78516	1.00	79326	1.00
78517	1.00	75133	1.00
78536	1.00	74479	1.00
79291	1.00	77111	1.00

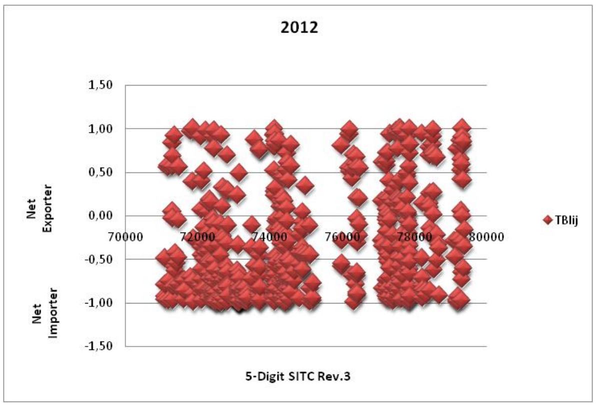
Source: UNCOMTRADE, author's calculation

Figure 5.

TBI Mapping of Parts and Components:

Thailand's Machinery and Transport Equipment, 1992 and 2012





Source: UNCOMTRADE, author's calculation

Table 8.

TBI of Top 10 Parts and Components:

Thailand's Machinery and Transport Equipment, 1992 and 2012

1992		2012	
SITC	TBIij	SITC	TBIij
71112	1.00	71877	1.00
71121	1.00	71878	1.00
71122	1.00	77586	1.00
71481	1.00	77611	1.00
71489	1.00	79326	1.00
72112	1.00	74134	1.00
72138	1.00	77871	0.99
72529	1.00	76222	0.99
72665	1.00	78516	0.98
72711	1.00	72241	0.98

Source: UNCOMTRADE, author's calculation

Table 9.

Average Number of Parts and Components:

ASEAN4's Machinery and Transport Equipment, 1992 and 2012

1992					
Group A			Group B		
Country	Number of Parts and Components	Percentage	Country	Number of Parts and Components	Percentage
Indonesia	38	11.80%	Indonesia	555	29.89%
Malaysia	90	27.95%	Malaysia	358	19.28%
Philippines	60	18.63%	Philippines	514	27.68%
Thailand	134	41.61%	Thailand	430	23.16%
Total	322	100.00%	Total	1857	100.00%
Average	81	25.00%	Average	464.25	25.00%
2012					
Group A			Group B		
Country	Number of Parts and Components	Percentage	Country	Number of Parts and Components	Percentage
Indonesia	215	38.12%	Indonesia	253	15.90%
Malaysia	121	21.45%	Malaysia	439	27.59%
Philippines	73	12.94%	Philippines	495	31.11%
Thailand	155	27.48%	Thailand	404	25.39%
Total	564	100.00%	Total	1591	100.00%
Average	141	25.00%	Average	398	25.00%

Table 10.
Determinants of Trade Flows
in Machinery and Transport Equipment Industry (1992-2012)

	Model 1: Log ASEAN4 Trade with Japan	Model 2: Log ASEAN4 Trade with China	Model 3: Log ASEAN4 Trade with South Korea
Log GDP ASEAN4	1.14 (7.64)***	-7.67 (-7.87)***	4.08 (7.78)***
Log GDP Trading Partner Countries	-0.41 (-3.56)***	5.82 (9.95)***	-2.82 (-6.44)***
Log Logistics Index	6.11 (7.73)***	17.77 (5.40)***	0.84 (0.84)***
Log Distance to Trading Partner Countries	-0.48 (-2.18)**	8.33 (6.05)***	-4.32 (-8.68)*
Log Real Effective Exchange rate	0.35 (1.29)*	-2.86 (-3.11)***	3.72 (8.13)***
R-squared	0.75	0.73	0.80
Sum squared resid	7.74	69.96	13.72
Number of observation	84	84	84

Note: 1) Level of statistical significance is denoted as: *** 1%, ** 5%, and *10%.
2) t-statistic of regression coefficients are given in brackets.

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[1] To substitute the term, there are several others such as multinational enterprises (MNEs), multinational firms (MNFs), and transnational corporations (TNCs).

[2] Defined here as 'middle products' or 'fragments of final goods'.

[3] Standard International Trade Classification (SITC) is one of international standards of classification used in analyzing internationally trade products. The development of SITC can be traced from its original form appearing in 1961 (SITC Rev.1). This UN data reporting system did not provide for the separation of fragmented-based trade (in components) from final manufactured goods. SITC Rev. 2 came up in 1975 with more detailed commodity classification that allowed for the separation of components for machinery and transport but with a considerable overlap (Ng and Yeats, 2001). To fill the gap, SITC Rev.3 has been available since 1986 introducing significant improvements especially on the coverage of SITC 7 component. Thus, the last is considered to be most favorable because it meets the scope of this research.

[4] The UNCOMTRADE provides detailed data on trade (export, import, re-export, and re-import) by countries of reporter, by countries of partner, by years, and by commodity classification system (Widodo, 2010).

[5] Limao and Venables (2001) uses GDP, LPI, DST, and LNDL as followed by Athukorala and Nasir (2012). Meanwhile, this research adopts a slightly different methodology where LNDL is replaced by REER due to geographical location of countries observed (all are homogenously non land-locked, no need to distighuishes this characteristics).

[6] Detailed explanation can be retrieved from White (1980) where

$$X'\sigma^2\Omega X \quad \begin{bmatrix} x_1 & x_2 & x_n \end{bmatrix} \begin{vmatrix} \sigma_1^2 & 0 & 0 \\ 0 & \sigma_2^2 & 0 \\ 0 & 0 & \sigma_n^2 \end{vmatrix} \begin{vmatrix} x'_1 \\ x'_2 \\ x'_3 \end{vmatrix} \quad \sum_{t=1}^{n} \sigma_t^2 x_t x'_t$$

[7] Breusch (1978) and Godfrey (1978) develop this identification method by stating that $w_t \quad \begin{bmatrix} 1 \\ x_t \\ \varepsilon_{t-1} \end{bmatrix}$

[8] The determinant of regressor matrix, X'X, is approximately zero. A near singular matrix indicates perfect collinearity.

[9] Bergeijk and Brakman (2010) provide recent methodological and theoretical advances in its application to trade flow modeling.